test

1993

Test & Measurement Catalog

HEWLETT PACKARD

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Test & Measurement Catalog

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Table of contents The table of contents lists product groups and shows the thumb tabs assigned to each group.

Indexes Alphabetical index by function or by product description. See page 35. Model number index. See page 61.

Selection guides Selection guides in many product sections help you locate specific products.

New product information For highlights, see pages 4 through 32.

New products are identified by the NEW symbol.

Specifications Specifications describe product performance. Parameters described as *typical, nominal,* or *approximately* are supplemental characteristics.

This symbol identifies products that have HP-IB (IEEE-488) capability. See page 97.

This symbol identifies products that support HP Instrument Drivers for easy generation of test code. See page 111.

Prices & Terms For current prices or a formal quote, contact your nearest HP office. See page 665.

Shipping Shipments can be made by either surface or air, as requested.

Support & Warranty For operating environments, support life, and warranty terms, see page 664. For support options, see pages 635 to 662.

Assistance For assistance in selecting or configuring products, contact your nearest HP sales office. See page 665.

Orders Place orders with your local HP sales office or distributorship. See page 665.

Contents

HEWLETT-PACKARD: AN OVERVIEW

Since Hewlett-Packard Company (HP) was founded in 1939, the company has designed, manufactured, marketed, and serviced more than 12,000 electronic products and systems used for measurement and computation. Applications for HP products range from science to industry, and from education to engineering.

Headquartered in Palo Alto, California, HP employs more than 90,000 people worldwide, maintains a sales force of 140 offices in the U.S., and has more than 300 sales and support sites and distributors in 100 countries (including Japan, Canada, the Far East, and Latin America).

Part of HP's philanthropy includes contributing both funds and equipment to technical programs at universities. In addition, HP has created a formal policy regarding environmental protection, setting the aggressive goal of eliminating all chlorofluorocarbons (CFCs) from manufacturing by 1994. Evidence of HP's commitment to improving the environment can also be found in this book, which is printed on recycled paper.

Research and Development

HP is firmly committed to technical innovation, and views research and development as a crucial function. Each year, HP invests approximately 10 percent of its net revenue into this area. The company distributes about 85 percent of its annual research and development budget among 58 divisions for product development. The remaining 15 percent of the budget is allocated to high-risk, long-term research by HP Laboratories, one of the world's leading scientific and technical research centers.

When designing a new product, engineers at HP tap into networks that allow them to communicate with key people working on the same project. In addition, these engineers solicit early input from manufacturing experts to create products that have few parts, are relatively easy to manufacture, and can be made with existing equipment and processes. The end results are high-quality, reliable products that are quickly brought to market.

Shown seated are Dave Packard (left) and Bill Hewlett (right), founders of Hewlett-Packard.

Range of Products

Computers, computer systems, networks, electronic instruments, peripheral devices, medical and analytical instruments, and calculators constitute a major portion of HP products.

HP products support the electronics, telecommunications, aerospace, aircraft, and automotive industries, as well as scientific research programs. The company also manufactures products related to electronics technology, including solid-state components (primarily microwave, semiconductor, and optoelectronic devices).

Through computer technology, most HP instruments incorporate automation and precision unavailable in competing products.

Open Industry Standards

Computer and instrument consumers want open systems in which different manufacturers' products can work in unison. HP has taken a leadership role in developing industry standards that define interfaces between hardware and software elements—crucial for creating open systems.

By making available the necessary elements for building test system components on open industry standards, HP helps customers reduce test cost, time, and risk.

In this catalog, HP's commitment to open systems can be seen in the wide range of VXI, Modular Measurement Systems (MMS), and HP-IB products offered.

In addition, by providing a single set of commands for all types of instruments, SCPI simplifies and encourages software development and increases the compatibility of software as hardware is upgraded. HP intends to implement SCPI in all the company's new systems instruments.

Test and Measurement Systems

HP's Test and Measurement Organization combines the activities of the Electronic Instruments and Microwave and Communication groups, Communications Test Business Unit, and Automatic Test Equipment Business Unit. In addition, there is a sales force dedicated solely to the organization.

Customers use HP's instruments in evaluating the performance of their own equipment, in creating new products, in quality control and manufacturing processes, and in field service applications. Precision electronic equipment is built into interactive systems, providing complete solutions to information needs.

These test and measurement products have solid value to customers. HP's integrated-circuit test system, with its innovative ability to drive devices to their performance limits, enables engineers to detect failures earlier than before.

The company's IC evaluation system helps customers shorten time to market and reduce test costs.

In addition, HP's board-test systems help customers hasten product development by reducing testing time. These systems test both complex digital and analog printed-circuit boards, and provide the first total test solution for surface-mount manufacturing of these boards.

Sales and Service

Good customer relationships are a cornerstone of HP's success. In 1990, the company implemented a new selling process that analyzes the structure that underlies a customer's crucial success factors, then uses that knowledge to build information-flow and solution sets that solve particular business problems. This process is backed by industry-specific expertise and by 4,500 third-party solution providers.

HP takes steps from the beginning of a product's history to ensure that high standards are built into that product. Quality parts are chosen after establishing close working relationships with suppliers.

Consolidation centers have been created by HP to help provide simultaneous and on-time delivery of all the products a customer orders, regardless of how far throughout the world these products must travel to reach that customer.

Through marketing, customer feedback helps to improve products. HP regularly conducts international consumer surveys to understand how to best serve its customers.

HP's Customer Support Services

Comprehensive support is available from HP in three basic areas: planning/design, implementation, and operation. To further strengthen these services, the customer may also take advantage of HP's software, hardware, consulting, and educational support.

Planning and design are essential to any operation's success, from a single instrument system to a large factory. HP can help you build the best setup for your needs by providing technical assistance that can include designing a system for you.

To take full advantage of HP's equipment, the customer must understand the best ways to apply it in a particular operating environment. Through HP's installation services, or by using the company's education courses and materials, you can ensure that your equipment is installed quickly and properly.

It is important to keep your equipment in peak condition through maintenance operation—a process that can minimize downtime. To help you in this area, HP has a trained, international staff, supported by a large inventory of replacement parts. In addition, HP provides software updates that may affect your operation.

Hardware is supported through several channels, including onsite and customer-return services. Because HP's Customer Service Centers are highly automated, calibrating and diagnosing problems is an efficient process.

A variety of customer services are available free of charge, including concise hardware and software manuals and other publications. By perusing these manuals, the customer can choose products best suited to particular needs, can benefit from the know-how of engineers and other experts, and can learn how to maintain products. For information about these publications, see page 644 of this catalog.

To further educate its customers in the use of its equipment, HP offers educational courses in operation, application, and software and hardware maintenance for HP products. Classes are taught by highly trained instructors, and are limited to between six and 10 students. For more infomation, refer to page 641 of this catalog.

The Structure of This Book

The purpose of this catalog is to give you useful information about HP products in an easy-to-use format. You will find general reference information for HP test and measurement products in the first four pages of the book. Inside the front cover is the Product Category Index. Following the title page is the Description of Terms and, on the facing page, the Table of Contents. The Table of Contents defines the beginnings of major sections and chapters, which are keyed to blue tabs on the outside edges of the pages.

Beginning on page 4, you will see this year's New Products for 1993. This is the place to discover exciting new products that HP isoffering for the first time. Immediately following the New Products section are alphabetical and model-number indexes of the products featured in this catalog. Note that a listing printed in boldface in the model number index indicates a new product.

After the product descriptions and information that constitute the bulk of this book, you'll find nearly 50 pages of useful and detailed information regarding customer support, instrument financing, operating environments, warranties, and ordering products. In addition, a comprehensive listing of HP test & measurement sales offices is provided, arranged alphabetically by country. Application and product notes that provide free aids to solving your test and measurement problems are also listed in these 50 pages. More free publications about selecting, using, and maintaining HP test and measurement products are also enumerated in this section. Finally, reader service and subscription cards for test and measurement product and application literature have been bound into the back of the book.

Contacting Hewlett-Packard

For the locations of HP sales and service offices, see page 665. Calls to your local HP office are routed to the person best qualified to help you.

You can also contact the Hewlett-Packard Direct Marketing Organization (DMO) to refer you to the appropriate sales or support organization. In many countries you can call DMO toll free.

Ordering Products Quickly by Phone

The telephone icon next to the price in the catalog means that the product is available for off-the-shelf shipment through HP DIRECT. The HP DIRECT phone number can be found inside the front cover of this catalog.

Suggestions Welcome

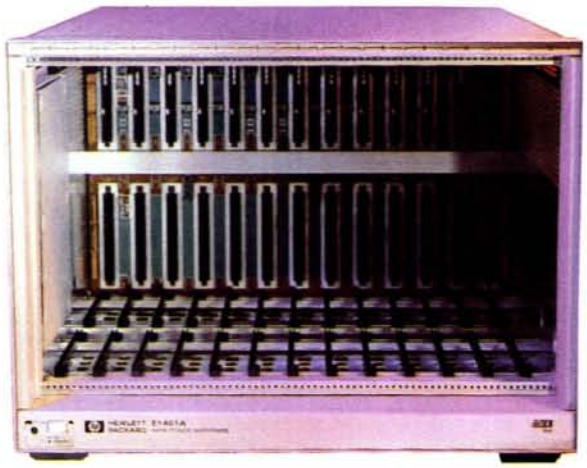
HP is always interested in hearing comments or suggestions about this catalog. These should be sent to the following address:

Hewlett-Packard Company
Stu Center, T&M Catalog Manager
5301 Stevens Creek Boulevard
MS: 54L AF
P.O. Box 58059
Santa Clara, CA 95052-8059
U.S.A.

New Products for 1993
VXIbus

HP E1401A High-Power Mainframe

The new HP E1401A high-power mainframe provides all the power and cooling you need for your application. Any combination of HP's VXI plug-in modules—and most other manufacturers' modules—can be plugged into the mainframe without worrying about power limitations. With HP's pressurized air channel cooling system, you can be sure your modules are receiving clean, even airflow directly at the VXI module, regardless of your configuration. The HP E1401A will supply enough power and cooling for all your present and future needs.



Specifications—see page 78
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41650

HP E1430A 10 MS/s A/D Module

The HP E1430A is more than just a digitizer, it is a complete A/D module. Complementing its exceptionally low-distortion, low-noise 23-bit A/D are flexible signal conditioning, tunable digital filtering, and deep FIFO memory.

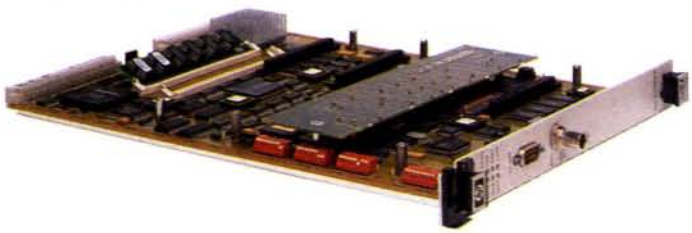
HP E1485A/B Digital Signal Processing Module

The HP E1485A/B is a high-performance measurement controller as well as a digital signal processor. Configure DSP performance to meet your application needs. Select the 32-bit Motorola 96002 floating-point DSP IC, capable of 49.5 MFLOPs peak, or the 24-bit Motorola 56001 fixed-point DSP. Up to 4 DSP ICs and 12 MB of RAM can be added to these modules.

Software for the HP E1485 is developed on a host workstation using the Programmers Toolkit (HP 35635T).

Specifications—see page 87
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #s 41663 (HP 1430A); 41651 (HP E1485A)

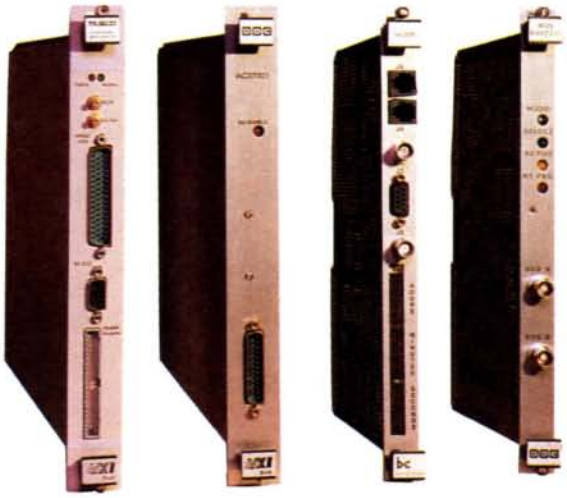


*For faxed details on these new products, contact HP FIRST.
Within the U.S. and Canada call 1-800-333-1917; outside the U.S. and Canada call 208-344-4809.
For detailed instructions on using HP FIRST, see page 33.

Avionics and Special-Purpose Products

Hewlett-Packard offers additional VXI products manufactured by third-party VXI vendors. These products are sold and supported by the HP sales organization, and include: ARINC-429 and Mil-Std 1553 interface cards for avionics applications; a synchro/resolver simulator card for applications requiring synchro-to-digital or digital-to-synchro conversions; and an IRIG B time code processor card for high-accuracy system pacing.

Included with each of these products are SCPI and Compiled SCPI software drivers.



Specifications—see page 80
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41655

HP 75000 Model HD2000 Data Acquisition System

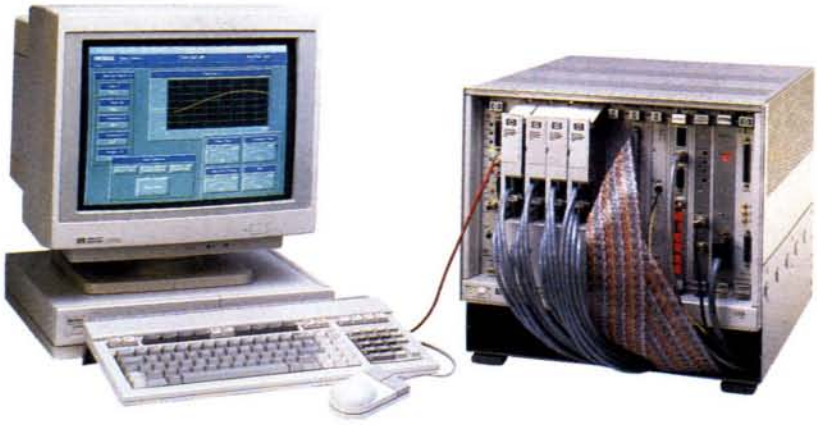
The new HP 75000 Model HD2000 is a high-performance VXI-based data acquisition system for high-speed mixed measurements. With an embedded VXI controller such as the HP V/382, the continuous data throughput to disk is greater than 200,000 readings/s.

More complete measurements can be integrated into a single backplane datapath than ever before.

Available measurements and controls include: Temperature, pressure, strain, voltage, resistance, frequency, digital I/O, IRIG B, synchro/resolver, ARINC-429, and Mil-Std 1553B.

This system is fast and is easy to program because it uses the new Compiled SCPI software development tool execution.

For more turnkey solutions, HP offers a choice of several third-party system integrators that are part of the HP Value-Added Business Partner program.



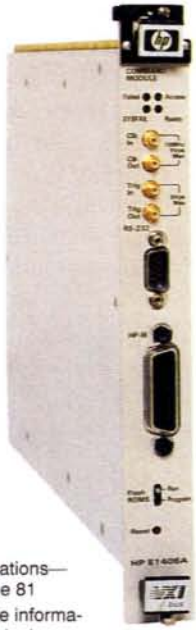
Specifications—see page 86
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41656

HP E1406A Command Module

The HP E1406A command module yields new performance capabilities that make it a superset of most Slot 0 modules on the market today. In addition to providing VXIbus Slot 0 and resource manager functions, the HP E1406A provides much more, including: Message-based (SCPI) personalities for HP and other vendors' register-based devices; powerful resource manager functions that allow commands for accessing any manufacturer's register-based devices and shared memory; and memory for downloading SCPI drivers for future registered-based modules including other manufacturers' products listed in the VXIbus section of this catalog.

Hewlett-Packard has ensured that the HP E1406A is fully open to support any vendor's message or register-based products.



Specifications—see page 81

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41652

HP E1499A V/382 Controller

The new HP E1499A V/382 controller offers workstation performance in a two-slot, C-size package.

This exceptional, high-performance controller supports HP-UX (HP's enhanced version of UNIX®) and HP BASIC workstation operating systems. Both are identical to external HP Series 300 controllers to ensure application portability.

A wealth of standard interfaces is provided, including: HP-IB, LAN, RS-232, SCSI, and HP Parallel, which includes direct VXI backplane support for high-throughput applications.

HP ITG, HP VEE Test, and Compiled SCPI are supported by the HP 1449A V/382.

Specifications—see page 81

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41653

HP RADI-EPC7 VXIbus Embedded PC Controller

The HP RADI-EPC7 or Radisys EPC-7 combines the high-I/O performance of direct VXI backplane support and the space-saving size of an embedded VXI controller with the high power and speed of an Intel i486 processor-based PC. This two-slot, C-size controller is a fully functional PC supporting MS-DOS, Standard Instrument Control Library on MS-DOS, and Compiled SCPI.

Standard and optional interfaces include HP-IB (IEEE-488), serial, parallel, SCSI, super VGA, keyboard, and LAN. In addition, an embedded hard drive and 3½-inch floppy disk are included. Now you can select a PC-compatible controller with the ruggedness, flexibility, and performance required of complex test systems.

Specifications—see page 82

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41658

*For faxed details on these new products, contact HP FIRST.

Within the U.S. and Canada call 1-800-333-1917; outside the U.S. and Canada call 208-344-4809.

For detailed instructions on using HP FIRST, see page 33.

HP E1413A, E1427A, E1429A, and E1430A VXI Digitizers

The industry-standard VXI architecture provides an excellent platform for capturing analog waveforms. Because of VXI's modularity, you can easily configure a measurement system that meets the needs of your application. To give you a choice, HP offers a broad range of sample rates and resolutions with our new family of VXI digitizers.

For scanning applications, the HP E1413A offers 64 analog input channels that are multiplexed to a 100-kSa/s, 16-bit A/D. Electrical quantities, such as voltage and resistance, as well as physical quantities, such as temperature and strain, can be read by the HP E1413A. A variety of plug-in, signal-conditioning modules are available to match measured signals.

For high-speed transient capture, select the HP E1427A. Its 2-GSa/s, 7-bit A/D can capture very fast signals, such as edges and pulses. The internal 48-kSa memory is battery-backed to preserve data even when the VXI mainframe loses power.

For general-purpose waveform capture and recording, the HP E1429A can be programmed to sample from 0.05 Sa/s to 20 MSa/s. Two channels are provided, each with 12-bit A/D and 512-kSa nonvolatile memory. In addition, the HP E1429A supports data transfers at full speed over the VXI local bus to other VXI cards, such as the HP E1485A digital signal processor and the HP E1488A instrument memory.

For high-resolution frequency and time-domain measurements, the HP E1430A offers a state-of-the-art speed/resolution tradeoff. Its maximum sample rate is 10 MSa/s. Using the on-board digital filtering, it can achieve 18-bit linearity and 23-bit resolution. Included with the HP E1430A are analog and digital filters to protect against aliasing effects. Used with the HP E1485A digital signal processor, instruments such as the HP 3587S VXI spectrum analyzer can be fully realized.

Specifications—see page 79

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #s 41664 (HP E1413A); 41657 (HP E1427A/1429A); 41663 (HP E1430A)

Compiled SCPI

Compiled SCPI is an easy way for C programmers to take advantage of the high throughput of HP register-based VXI test instrumentation without the time and cost of writing drivers.

Register-based instruments provide the highest throughput because you can communicate directly with their registers. However, creating your own direct register communications requires more programming effort than is needed when using high-level ASCII commands, such as SCPI.

Compiled SCPI gives you both the throughput advantage of register-based instruments and the easy programming of SCPI commands.

Specifications—see page 78
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41654

Controllers/Software

HP Instrument Tools for Windows

HP instrument tools for Windows consists of three new products that bring the benefits of the Microsoft Windows operating environment to scientists and engineers who use personal computers as test-system controllers. The three products are: HP Instrument BASIC for Windows (HP E2200A), HP Interactive Test Generator II (HP E2020B), and HP-IB for Windows and DOS (HP 82335B).

HP Instrument BASIC for Windows is a BASIC language designed to help engineers and scientists get to measurement results quickly.

HP Interactive Test Generator II (HP ITG II) is a programming tool that assists in developing test applications in a variety of traditional programming languages.

HP-IB for Windows and DOS contains software utilities and interface hardware that allow HP-IB devices to be controlled from Windows languages, applications, and development environments.

All three products support Window's Dynamic Data Exchange (DDE), allowing you to share data and graphics freely with other Windows applications and languages.

Specifications—see page 112
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41745

*For faxed details on these new products, contact HP FIRST.

Within the U.S. and Canada call 1-800-333-1917; outside the U.S. and Canada call 208-344-4809.
For detailed instructions on using HP FIRST, see page 33.

HP 89410A, 89440A Vector Signal Analyzers

Hewlett-Packard's new line of vector signal analyzers integrate frequency-domain and time-domain analysis to provide the most advanced measurements of complex and time-varying signals. These analyzers perform complex signal analysis, including: digital modulation analysis; AM, FM, PM demodulation; vector spectrum analysis; and time-gated spectrum analysis.

Deep time-capture RAM of up to 1 MB is available with flexible postprocessing in time and frequency domains. Display types include waterfall, spectrogram, log frequency, polar, eye, and constellation diagrams, along with simultaneous time and frequency.

The HP 89410A covers baseband frequencies from dc to 10 MHz. The HP 89440A covers baseband through RF frequencies of dc to 1.8 GHz.

Specifications—see page 229

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41729

HP 64700 Series Emulators/Analyzers

New emulators and software expand the HP 64700 Series of development tools. The emulators offer real-time, transparent emulation of AMD AM29050, Intel 80186/C186/188 EA/EB/EC/XL, 80960SA/SB, and Motorola 68EC000, 68HC000, 68HC001, 68030, and 68340 processors. These emulator cards are installed in a cardcage based on modular architecture that allows reconfiguration at minimum cost. For workstation-based embedded system development, new software provides integrated, motif-based, graphical interfaces with multiple measurement windows to speed the debugging of target systems through the emulation system. A real-time operating measurement tool makes it easy to debug real-time operations at the task level.

Specifications —see page 336

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41732

*For faxed details on these new products, contact HP FIRST.

Within the U.S. and Canada call 1-800-333-1917; outside the U.S. and Canada call 208-344-4809.

For detailed instructions on using HP FIRST, see page 33.

HP 54512B 1-GSa/s, 4-Channel Oscilloscope

The HP 54512B oscilloscope continues HP's performance leadership by being the first portable oscilloscope to offer four channels of simultaneous 1 GSa/s sampling. Each channel features its own 1-GSa/s custom analog-to-digital converter, and—unlike other scopes—neither speed nor digitizing integrity are compromised at any time. Typical applications include design and characterization of TTL, high-speed CMOS and ECL logic families, as well as applied energy research and automated tests.

The HP 54512B is the flagship of a family of four new oscilloscopes that enhance and expand the power of the HP 54500 Series scopes. These new scopes—including the HP 54505B, HP 54506B and the HP 54510B—enjoy all the traditional features of the HP 54500 Series scopes while adding many important user features such as FFTs, enhanced sequential single-shot, logic triggering with a 5-ns glitch trigger, mask testing, and more.

Specifications—see page 138
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41727

HP 54505B 2-Channel and HP 54506B 4-Channel, 500-MSa/s Oscilloscopes

These two new oscilloscopes feature simultaneous 500-MSa/s sampling on all channels at very affordable prices. As members of the enhanced family of HP 54500 Series scopes, these scopes offer all the expanded user features of the HP 54512B at a reduced price. Typical applications are TTL design and characterization and automated tests where throughput rates, pass/fail testing, accuracy, and repeatability are critical.

Specifications—see page 138
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41728

HP 53131A and HP 53132A Universal Counters

The HP 53131A and HP 53132A are Hewlett-Packard's newest, best-performance, best-value universal counters. Between them, these new counters offer a range of price and performance, suiting them to needs that range from field service to high-speed automatic testing. Both provide wide frequency coverage, 10 to 12 bits of frequency resolution/s, and single-shot time-interval measurements of 125 ps to 500 ps.

Consider the HP 53131A for bench applications in manufacturing, in service, or in the lab. The HP 53132A is optimized for high-speed ATE applications.

Specifications—see page 178
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41738

*For faxed details on these new products, contact HP FIRST at 1-800-333-1917.
Within the U.S. and Canada call 1-800-333-1917; outside the U.S. and Canada call 208-344-4809.

For detailed instructions on using HP FIRST, see page 33.

HP 54602A 150-MHz Oscilloscope

The HP 54602A 150-MHz oscilloscope continues the tradition of the HP 54600 family, bringing you the comfortable feel of analog and the measurement power of digital architecture. The instrument has a familiar, analog-like front panel layout with plenty of knobs and a real-time display. Waveform storage, automatic measurements, and remote programming are some of the scope's digital power features. Best of all, you can get these capabilities at a price that fits your budget.

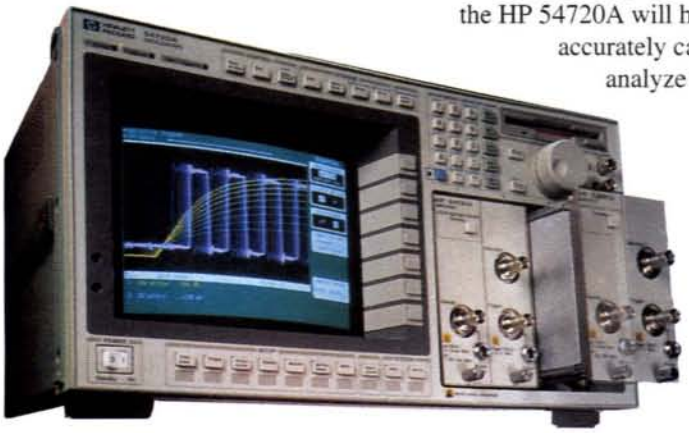
Specifications—see page 142

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41725

HP 54700 Series 4-GSa/s Modular, Real-Time Oscilloscope

The HP 54720A and the HP 54710A are the first two products in a new family of high-performance modular oscilloscopes aimed at solving the most difficult high-speed time-domain problems. The HP 54720A's 4-GSa/s sample rate and 32-K memory depth on two channels provides the best information for making critical decisions about high-speed, single-shot events that occur in your system. With up to 1.5-GHz bandwidth, 30-ps time interval measurement accuracy, 6-ps RMS jitter, 300-µV RMS noise, and 500-ps glitch trigger, the HP 54720A will help you accurately capture and analyze transient phenomena-like glitches, metastable states, EMI pulses, ESD pulses, laser signals, and disk drive pulses. With front-end signal conditioning, a flash ROM firmware system, and a 3½-inch disk drive, the hardware and the firmware can be easily upgraded in this highly versatile laboratory scope mainframe. This allows you to configure and upgrade the scope performance and feature set to suit your needs both today and tomorrow. The HP 54710A is a 4-GSa/s, one-channel version of the HP 54720A offered at a lower price.



Specifications—see page 130

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41726

*For faxed details on these new products, contact HP FIRST.

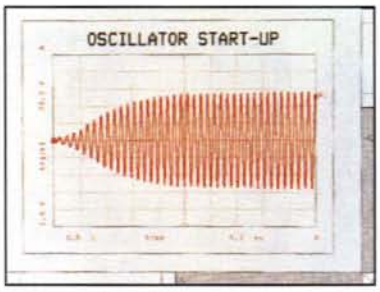
Within the U.S. and Canada call 1-800-333-1917; outside the U.S. and Canada call 208-344-4809.

For detailed instructions on using HP FIRST, see page 33.

HP Impulse High-Frequency Time Domain Simulator

Introducing HP Impulse, the first integrated CAE tool to bring SPICE-like time-domain simulation to the high-frequency designer. Now high-frequency analog circuits and high-speed digital packages and interconnects can be simulated in the time domain with all the dispersion effects included.

Before HP Impulse, the simulation world was separated into frequency- and time-domain solutions. Now designers can take advantage of accurate physical models and frequency-domain



data, such as S-parameters, directly in the time domain without converting these models into equivalent RLGC networks. A SPICE netlist translator is also available to bring existing circuits into HP MDS for time-domain simulation.

HP Impulse is tightly integrated into HP MDS. Along with frequency-domain simulators, it shares complete compatibility with schematic entry, artwork, data storage, postprocessing, and documentation facilities within the HP MDS system.

Specifications—see page 307
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41746

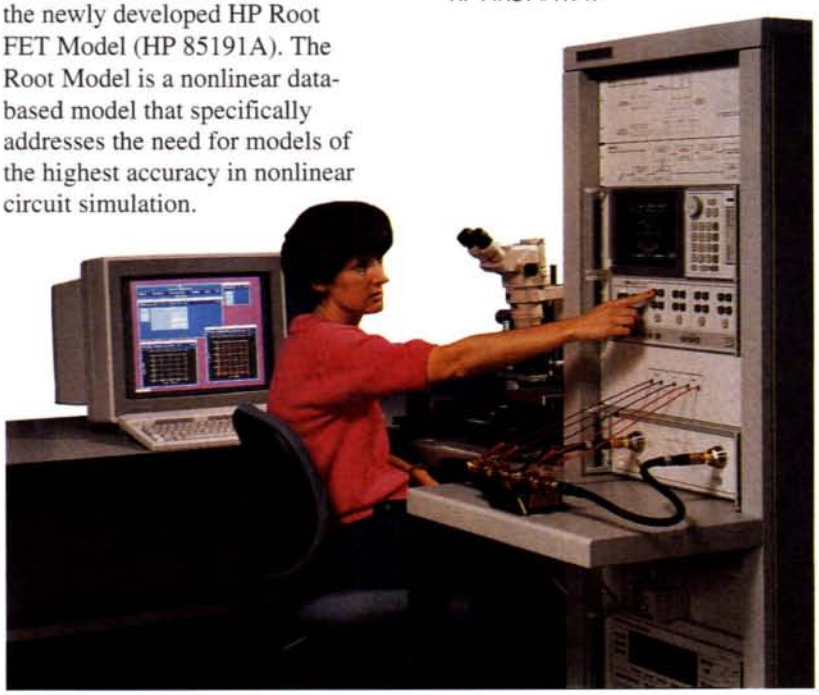
HP High-Frequency Modeling System

The HP High-Frequency Modeling System (HFMS) is a complete system dedicated to extracting or generating active device models for circuit simulation. It combines the HP 85122A parameter extraction test system with the HP 85190 Series of HF ICCAP test and modeling software for a total modeling solution. The HP 85122A combines either the HP 8510C or HP 8753C network analyzer with the HP 4142B dc source/monitor to ensure the highest accuracy in S-parameter and dc parametric testing. The HP 85190A software completely controls all required tests and then performs model extraction or generation. It can then transfer model data to a high-frequency circuit simulator, such as HP's Microwave Design System.

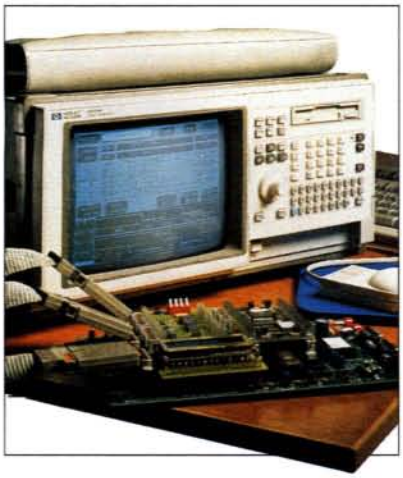
The software also includes a series of industry standard FET (HP 85192A) and BJT (HP 85193A) models as well as the newly developed HP Root FET Model (HP 85191A). The Root Model is a nonlinear data-based model that specifically addresses the need for models of the highest accuracy in nonlinear circuit simulation.

Specifications—see page 313
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41747



HP 1660 Series Logic Analyzers



The new HP 1660 Series logic analyzers provide the right balance of performance, flexibility, and ease of use. With 100-MHz state and 500-MHz timing, these portable logic analyzers have enough speed to handle your high-performance applications. Choose from four models to get the right channel count (34, 68, 102, or 136) for your measurements. The carefully designed and tested human interface makes your HP 1660 Series logic analyzer easy to use. You can operate the logic analyzer from the keypad or optional keyboard, mouse, or trackball.

Specifications—see page 326
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41730

HP 3587S High-Speed Baseband Spectrum Analyzer

The HP 3587S is a 1-MHz, real-time bandwidth baseband signal analyzer with the measurement power and flexibility to characterize the most advanced electronic systems.

An HP proprietary 23-bit, 10 MS/s A/D gives the HP 3587S 110 dB FS dynamic range. Complementing this is an input sensitivity of 2.4 nV/$\sqrt{\text{Hz}}$.

The display is extremely flexible. Choose between frequency, time, or amplitude domain displays. Spectrogram and waterfall displays are also standard. Adjust the apparent angle of the spectrogram and waterfall displays to aid evaluation of signal characteristics. Marker functions are also provided.

Specifications—see page 228
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41733

*For faxed details on these new products, contact HP FIRST.
Within the U.S. and Canada call 1-800-333-1917; outside the U.S. and Canada call 208-344-4809.
For detailed instructions on using HP FIRST, see page 33.

HP 16550A 100-MHz State, 500-MHz Timing Logic Analysis Card

The HP 16550A card for the HP 16500A logic analysis system offers an affordable solution for digital design and test applications that range from general purpose debugging to high-performance computer system development. Each card provides 102 channels with 4-K memory depth. Two HP 16550A cards can be connected together to operate as a wide, 204-channel logic analyzer. The HP 16550A features 100-MHz state, 500-MHz timing, and powerful triggering for today's fastest designs.

The HP 16550A is compatible with previous HP logic analyzers. HP logic analyzer users do not have to spend time refixturing, reprobing, or relearning the new HP 16550A. With over 150 preprocessor solutions, the HP 16550A supports most processors and buses available today.

Specifications—see pages 320
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41600

HP 16542A 2-MB Deep Memory Logic Analysis Card

The HP 16542A card for the HP 16500A logic analysis system offers affordable, high-speed deep memory logic analysis. The HP 16542A speeds up analyzing digital-data streams and debugging high-performance computer systems. Each card provides 16 channels with 1-Mb trace depth. Multiple HP 16542A cardscan be combined to capture and analyze up to 1 Mb of data on 80 channels, or up to 10 Mb of data on 8 channels using the HP E2430A memory expansion interface.

Specifications—see page 322
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41735

HP 53310A Modulation Domain Analyzer Option 031

The HP 53310A's new Option 031 digital RF communications analysis/high-resolution 2.5-GHz input is developed especially for mobile communications measurement needs. Option 031 helps you make measurements such as settling time, center frequency, peak deviation, RF eye diagram, and frame jitter on DECT, CT2, CT3, and other digital communications systems.

Improved frequency resolution for RF signals means you won't waste time with complicated external downconversion to meet your resolution requirements. Other features offered with Option 031 include time-referenced triggering, increased modulation bandwidth, and an external local oscillator input.

Specifications—see page 183
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41690

HP 87510A Gain-Phase Analyzer

The HP 87510A gain-phase analyzer makes accurate amplitude, phase, and group-delay transmission-only measurements over a 100-kHz to 300-MHz range, with 0.25 ms/point speed at 8-kHz bandwidth. Automatic filter and resonator parameter extraction commands minimize the Go/No-Go decision time. A built-in power splitter and synthesized source simplify device connection An advanced list sweep provides dynamic ranges up to 130 dB. Incorporating the user interface of the HP 8751A vector network analyzer, the HP 87510A reduces filter-tune–test and resonator characterization time. It includes a 3½-inch disk drive, HP-IB and parallel I/O ports, and HP Instrument BASIC.

Specifications—see page 289
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41734

HP 6680A Series 5-KW System Power Supplies

The HP 6680 Series power supplies offer the efficiency and compact size of switching power supplies combined with performance close to that of linear power supplies. At 5000 W and current ratings up to 875 A, these are HP's highest power HP-IB programmable power supplies. The HP 6680A's peak-to-peak noise is less than 10 mV. For use in ATE systems, the HP 6680 Series power supplies feature SCPI programming and a serial-link interface that allows up to 16 power supplies to be connected to a single HP-IB address.

Specifications—see page 474
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41739

HP 5071A Primary Frequency Standard

The HP 5071A primary frequency standard is the world's most precise commercially available timekeeping device—keeping time to one second in 1.6-million years. The new HP 5071A is twice as accurate as the previous record holder, the HP 5061B, and reaches new levels of stability and reliability.

Hewlett-Packard's new Cesium II technology allows the HP 5071A to achieve these higher levels of performance by reducing the standard's susceptibility to frequency pulling and a host of environmental effects. Cesium II technology—comprising an improved cesium-beam tube design and microprocessor-controlled digital electronics—allows the HP 5071A to achieve near-laboratory specifications under full environmental conditions, virtually ignoring changes in temperature, humidity, and magnetic fields.

Specifications—see page 497

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41737

HP 54701A 2.5-GHz, 0.6-pF Active Probe

The HP 54701A active probe provides superior nonintrusive probing of devices under test because of its low, 0.6-pF input capacitance and its high 100-kΩ input resistance. Its industry-leading 2.5-GHz bandwidth provides the most faithful reproduction of signals under test. Unlike many other active probes, this probe is reliable. Its 200-Vac maximum input voltage rating, 12-kV ESD protection, and replaceable probe tips significantly reduce the three largest sources of reliability problems in active probes. When used with the HP 1143A probe offset and power module, the probe provides reliable, high-bandwidth probing for your HP 54120 Series scope, network analyzer, or spectrum analyzer.

Specifications—see page 151

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41736

*For faxed details on these new products, contact HP FIRST.

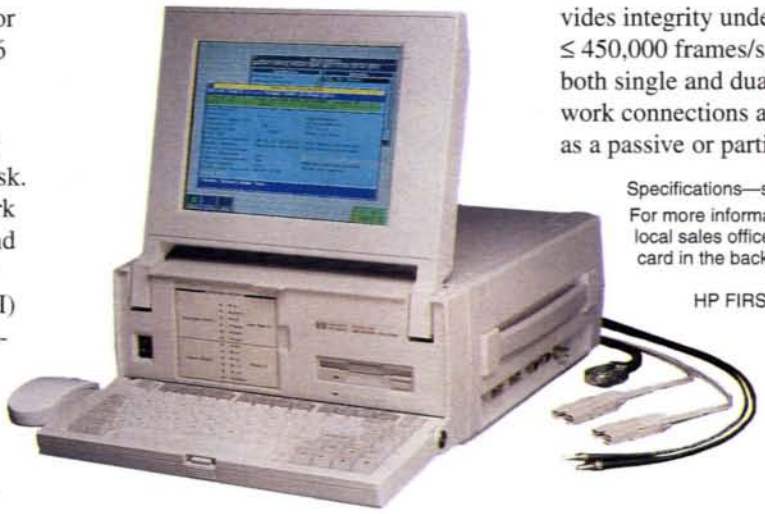
Within the U.S. and Canada call 1-800-333-1917; outside the U.S. and Canada call 208-344-4809.

For detailed instructions on using HP FIRST, see page 33.

HP J2219A Network Advisor Series 486
HP 4983A FDDI Network Advisor

The HP J2219A network advisor is now available on a Series 486 platform for enhanced performance. It includes a 33-MHz 486DX mainframe with 16 MB of RAM and a 172-MB hard disk.

The HP 4983A FDDI network advisor eases the installation and maintenance of 100 Mb/s fiber distributed data interface (FDDI) networks. It supports a windowing interface, statistical measurements, runtime and postprocessing decodes, and a powerful traffic generation capability. The HP 4983A provides integrity under any load ≤ 450,000 frames/s. It contains both single and dual attached network connections and can operate as a passive or participating node.



Specifications—see page 544
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41705

HP 4959A WAN Protocol Analyzer

The HP 4959A WAN protocol analyzer is a rugged, standalone analyzer based on MS-DOS. The HP 4959A offers the flexibility needed by network service organizations to quickly solve problems in X.25, frame relay, ISDN, and SNA environments. A spare PC-AT card slot offers expandability to test at 2.048 Mb/s for high-speed frame relay, SMDS (switched multimegabit digital service), and X.25 protocols.

HP Toolkit, a program manager, allows you to run any HP 4959A menu or load any application with the press of a single softkey. In addition, DOS programs can be executed from HP Toolkit, providing the user with a central point for running applications.

Specifications—see page 535
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41706

HP PT502 Dual-Port T1 Frame Relay and SMDS Testing

With its dual-port T1 options, the HP PT502 facilitates troubleshooting by displaying network traffic from different protocols at the same time. Its versatile dual-port architecture with synchronized multiple processors allows you to test frame relay and SMDS or X.25 traffic simultaneously. Use the T1 and the European E1 option for testing your gateways or switches that carry both T1 and E1 framing formats. The choice of interface connectors for each port includes: T1 (RJ-48 and Bantam), E1 (DB-9), and WAN (V.35/V.11, RS-449/V.11).

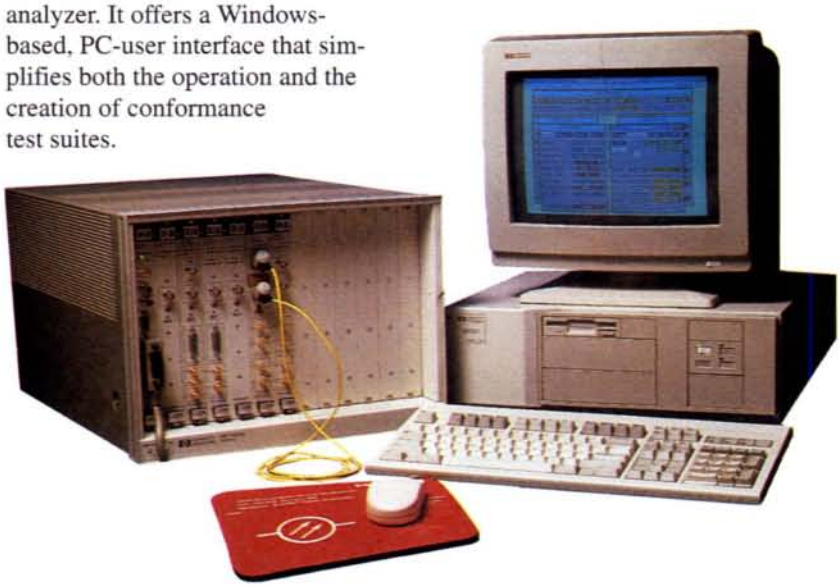
Specifications—see page 537
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41717

HP 75000 Series 90 155-Mb/s ATM Analyzer

The HP 75000 Series 90 155-Mb/s ATM analyzer provides ATM and SONET/SDH measurement capability for testing B-ISDN networks. It meets telecom manufacturers' needs for research and development, conformance, and production. It also meets telecom service providers' needs during field trials and installation of B-ISDN equipment. The analyzer provides comprehensive ATM cell generation and analysis within a SONET/SDH frame structure. Multiple ATM-virtual channels can be generated in a variety of different cell distributions to simulate a B-ISDN network.

The ATM analyzer complies with the latest CCITT recommendations, and can be updated easily through software and hardware ATM upgrades. The analyzer employs industry-standard VXI platform and modules, and is compatible with HP's existing range of modules for the HP 75000 Series 90 SONET/SDH analyzer. It offers a Windows-based, PC-user interface that simplifies both the operation and the creation of conformance test suites.



Specifications—see page 554
For more information, contact your local sales office or use the reply card in the back of this catalog.

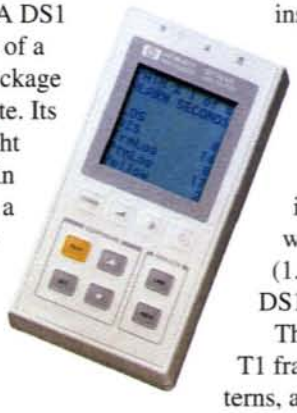
HP FIRST #41708

*For faxed details on these new products, contact HP FIRST.

Within the U.S. and Canada call 1-800-333-1917; outside the U.S. and Canada call 208-344-4809.
For detailed instructions on using HP FIRST, see page 33.

HP 37741A DS1 Tester

The handheld HP 37741A DS1 tester has all the features of a full-size T1 tester in a package the size of a video cassette. Its small size and light weight make it ideal for testing in awkward places, such as a telephone pole or a manhole. Its ease of use makes testing simple, saving time and money for those involved in the installation and maintenance of DS1 circuits and services.



The HP 37741A is intended for telephone companies and interexchange carriers who operate at DS1 (1.544 Mb/s) rates and DS1 equipment end users. The tester generates all T1 frame formats, test patterns, and loop codes, and can insert a tone in any DS0 channel. For in-service testing, it provides alarm, frame, code, CRC-6, and signaling-bit monitoring. For out-of-service testing, it can perform bit-error and G.821 measurements. To help identify timing problems, the HP 37741A can perform slip detection and clock-frequency measurement.

Specifications—see page 553
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41709

HP 37742A 2M Test Set

The handheld HP 37742A 2M test set is a small, rugged, lightweight tester for complete in-service and out-of-service BER testing of 2-Mb/s circuits and services. It is designed for installation, fault-finding, and maintenance of 2-Mb/s equipment and services, and is aimed at PTTs and service providers who operate primary circuits and services to end users.

The HP 37742A is also targeted for military and private network operators, such as utilities and TV companies. The HP 37742A is easy to use with full 2 Mb/s transmit and receive capability, compatibility with CRC-4 formats, and voice-frequency access. Key features of the test set include: framed pattern generation; regenerator substitution; $n \times 64$ kb/s testing; and RS-232 port for print results or remote control.

Specifications—see page 551
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41710

HP 37743A DS3 Test Set

The portable HP 37743A DS3 test set lightens the load that telephone technicians typically carry to install and maintain DS3 circuits and services. Weighing just 4 kg (9 lb), the lunchbox-sized test set replaces multiple test units and provides complete DS3 and in-service DS2- and DS1-test capability. The HP 37743A generates all DS3 frame formats, test patterns, and alarms. For in-service testing at DS3 rates, the test set can perform alarm, code, parity, and frame-error measurements. For out-of-service testing at DS3, it can perform error insertion (singly or at controlled rates) and bit-error measurements.

The HP 37743A also provides in-service testing at DS2 and DS1 rates with frame and CRC error measurements. It comes with a DS3/DS1 drop and insert feature for testing cross-connect switches.

Specifications—see page 553
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41711

*For faxed details on these new products, contact HP FIRST at 1-800-333-1917.
Within the U.S. and Canada call 1-800-333-1917; outside the U.S. and Canada call 208-344-4809.

For detailed instructions on using HP FIRST, see page 33.

HP 37724A SDH/PDH Test Set

The HP 37724A SDH/PDH test set is a field-portable tester for comprehensive functional testing of SDH/PDH telecommunications equipment. The HP 37724A provides a single-unit solution for the installation, commission, and maintenance of SDH equipment operating at 155 Mb/s (STM-1) and 622 Mb/s (STM-4).

A range of plug-in modules provides optical SDH interfaces at STM-1 or STM-4. The test set generates and analyzes mapped 140-Mb/s signals within SDH, as well as all modes for 2-Mb/s signals (TU12). Separate 2-Mb/s and 140-Mb/s transmit/receive interfaces allow PDH/SDH cross-multiplexer testing.

The HP 37724A verifies the operation of SDH network alarms, error monitors, automatic protection switches, pointer processors, and desynchronizer circuits. Results are presented clearly on a large screen in text or graphic form. A trouble scan function highlights errors and alarms in extra-large text as they occur. Graphic results can be stored internally for later analysis or printing.

Specifications—see page 555

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41712

HP 37730A Frame Analyzer

The HP 37730A frame analyzer is a single, portable, complete in-service test set unit for testing network equipment at 140, 34, 8 and 2 Mb/s. The analyzer is intended for telephone company technicians and network operators who install, maintain, or repair 140-Mb/s systems. It also has applications in production and quality assurance tests in network equipment manufacturing.

The frame analyzer demultiplexes and checks all the tributaries below the input rate. A fast-scan feature allows immediate identification of network problems by checking all 85 frames on a 140-Mb/s system in less than 2 seconds. For harder-to-find faults, a trace feature allows long-term monitoring over a selected path with internal, time-stamped result storage for all alarm occurrences. Error-performance analysis is provided on FAS errors at all hierarchies according to G.821 Annex D or true G.821 on a PRBS at 64 kb/s.

Specifications—see page 551

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41713

*For faxed details on these new products, contact HP FIRST.

Within the U.S. and Canada call 1-800-333-1917; outside the U.S. and Canada call 208-344-4809.

For detailed instructions on using HP FIRST, see page 33.

HP 37729A Frame Generator

The HP 37729A frame generator provides a complete solution for framed-signal generation in a single, portable box with a flexible multiplexing structure from 64 kb/s to 140 Mb/s. The HP 37729A complements the HP 37730A, a frame analyzer that operates from 2 Mb/s to 140 Mb/s. The generator is intended for network equipment manufacturers who design, manufacture, and install higher-order digital systems. It also has applications in automated production testing, quality-assurance checking, and system commissioning.

The HP 37729A constructs framed signals from 2 Mb/s to 140 Mb/s and provides full control over the framing structure and tributary contents. A variety of signals can be generated into a 64-kb/s channel. These signals include tones, PRBS, and word patterns that can be multiplexed up to any of the higher rates. Control of the frame-alignment signal at each rate allows full simulation of frame-alignment loss and recovery conditions.

Specifications—see page 551

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41714

HP 37702A Digital Data Tester

The HP 37702A digital data tester is a complete measurement solution for the maintenance and installation of T1, FT1, DDS, and datacom circuits and services in a single, portable box.

Because all network interfaces are built into the tester, users don't need plug-in cards. A large-screen display simplifies operation; measurement results can be presented graphically or in tabular form. All error types, including CRC errors, can be measured simultaneously for in-service and out-of-service tests.

Comprehensive FT1 tests (n × 56 kb/s and 64 kb/s) include timeslot mapping and delay measurements. DDS tests, including loopbacks and MJU functions, can be performed within a selected T1 timeslot (DS0A) or via a DS0 64-kb/s interface.

An optional datacom module includes interfaces for RS-232, RS-449, and V.35 for rates from 50 bits/s to 1.544 Mb/s using a built-in synthesizer.

Specifications—see page 552

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41715

HP 11759C RF Channel Simulator
HP 11759D Dynamic Ghost Simulator

Models HP 11759C and HP 11759D simulators bring powerful signal simulation to engineering and testing of rapidly growing worldwide cellular, video, and personal communications systems. The HP 11759C RF channel simulator now covers 40 to 2500 MHz with an expanded Doppler to 340 Hz, a wider bandwidth of 6 MHz, and a 12-path configuration capability for GSM and DCS 1800 measurements. The HP 11759D Dynamic Ghost simulator provides precision signal impairments of ghosting and airplane flutter for simulating tower sway, multiple paths, people movement, and other tests required for modern video equipment designs.

Specifications—see page 587

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41665

HP 8167A, HP 8168A Tunable Laser Sources

Hewlett-Packard's tunable laser sources, the HP 8167A and HP 8168A, are excellent tools for research and design engineers who work on optical amplifiers and related components. The HP 8167A and HP 8168A provide fast and reliable characterization over a wide tuning range—approximately 1300 nm and 1550 nm, respectively. The wavelength can be selected or swept in fine steps of 0.001 nm with a typical repeatability of better than 20 pm and a tuning speed of less than 150 ms per 1-nm step. True single-mode operation is guaranteed for each wavelength setting with a side-mode-supression ratio of better than 40 dB without manual fine adjustments.

Specifications—see page 563

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41697

HP 83441/2 Family of Lightwave Reference Receivers

The HP 83441/2 amplified, dc-coupled lightwave reference receivers simplify SDH/SONET optical-pulse and eye-diagram measurements at frequencies up to 1 GHz. The HP 83441A and HP 83441B are reference receivers for

production and R&D parametric testing at 155 Mb/s (STM-1/OC-3) and 622 Mb/s (STM-4/OC-12), respectively. Each includes a built-in filter that conforms to CCITT G.957 specifications. The HP 83442A, which has no filter, offers a 1-GHz optical bandwidth and is ideal for pulse measurements and non-SDH/SONET eye-diagram measurements.

The HP 83441/2 family features 500-V/W minimum conversion gain, a 1200- to 1580-nm range, 30-dB input optical return loss, and multiple connector options.

Specifications—see page 575

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41696

*For faxed details on these new products, contact HP FIRST.

Within the U.S. and Canada call 1-800-333-1917; outside the U.S. and Canada call 208-344-4809.

For detailed instructions on using HP FIRST, see page 33.

HP 71450A and HP 71451A Optical Spectrum Analyzers

The HP 71450A and HP 71451A optical spectrum analyzers display the amplitude of light versus wavelength over the 600- to 1700-nm wavelength range. They make fast spectral measurements of LEDs, Fabry-Perot lasers, DFB lasers, and erbium-doped fiber amplifiers. A unique double-pass monochromator provides them with the high dynamic range of double-monochromator instruments and the sensitivity of single-monochromator instruments. The analyzers offer high amplitude and wavelength accuracy and polarization insensitivity.

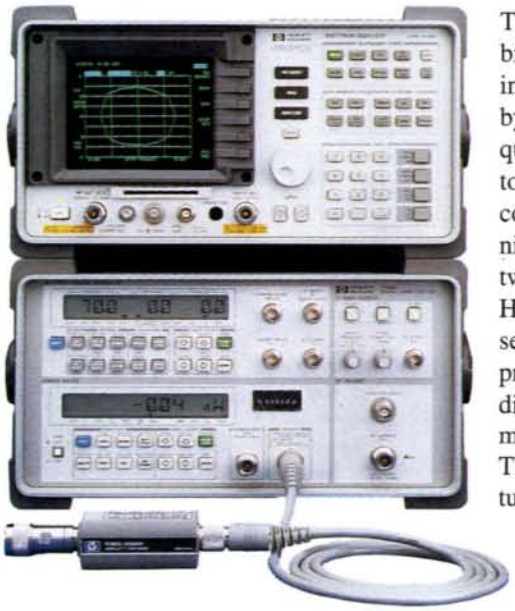
In addition, the HP 71451A extends standard optical spectrum analysis capability with four added measurement ports.

Specifications—see page 570

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41695

HP 11758V Digital Radio Test System



The HP 11758V brings portability to microwave radio installation and maintenance by combining the most frequently used measurement tools (power meter, frequency counter, spectrum analyzer—nine in all) in a convenient, two-box solution. The HP 11758V also incorporates several enhancements to its predecessor, the HP 11758U digital radio test system. The most notable is group delay. The group delay and amplitude flatness option allows the test system to perform several important microwave link analysis functions including end-to-end link analysis, diversity antenna delay equalization (DADE), and IF return loss. The HP 11758V now uses the HP 8593E spectrum analyzer and has an improved user interface, which allows easier control of such features as the signature display DLP and the group delay option. The RF source has been extended to cover new, higher-frequency radios.

Specifications—see page 558

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41716

HP 8560 E Series Spectrum Analyzers

The HP 8560 E Series spectrum analyzers combine exceptional measurement capabilities and speed, powerful new features, and affordable prices in a rugged, portable package. Three models cover frequency ranges from 30 Hz to 2.9, 6.5, or 26.5 GHz with continuous, full-band sweeps.

Key specifications include: –13 dBc/Hz phase noise at 10 kHz offset, displayed average noise level of –145 dBm from 2.9 to 6.5 GHz, and frequency accuracy of ±135 Hz. Narrow digital resolution bandwidths to 1 Hz, time-gated spectrum analysis, a memory card reader, and many one-button measurements are standard.

Specifications—see page 241

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41676

HP 8590 E Series Spectrum Analyzers

Portable HP 8590 E Series spectrum analyzers offer versatility and performance at economical prices. Measurement personalities on ROM cards customize these analyzers for CATV, EMC, GSM, CT2-CAI, JDC, noise figure, and scalar network analysis applications.

Five models cover frequencies from 9 kHz to 22 GHz. Specifications include 30-Hz bandwidths, –105 dBc/Hz phase noise at 30-kHz offset from the carrier, and an amplitude range of +30 to –130 dBm.

Standard features include zoom window capability, a marker table, and many one-button measurements, including adjacent channel power, "n" dB points, third-order intercept, and a fast Fourier transform measurement utility. Circuit-card options further enhance the HP 8590 E Series with built-in tracking generators, an analog-like digital display, time gating, TV-trigger circuitry, AM/FM demodulation, and quasi-peak detection. Narrow resolution bandwidths of 30, 100, 200 (EMI), and 300 Hz can be added to these spectrum analyzers at any time.

Specifications—see page 235

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41677

*For faxed details on these new products, contact HP FIRST.

Within the U.S. and Canada call 1-800-333-1917; outside the U.S. and Canada call 208-344-4809.

For detailed instructions on using HP FIRST, see page 33.

HP 71707A Microwave Downconverter System

The HP 71707A microwave downconverter translates microwave signals to RF frequencies with minimal phase and AM noise contribution. The HP 71707A's internal local oscillator has exceptionally low phase noise for a commercially available microwave synthesizer. Specified phase noise is −113 dBc/Hz and −125 dBc/Hz at 1-kHz and 10-kHz offsets at a 10-GHz carrier frequency.

When used with the HP 3048A phase noise measurement system, the HP 71707A provides the user with the lowest measurement noise floor available. For automatic testing, the HP 3048A with Option 301 software can be used to control the HP 71707A. With the HP 71707A, you can be confident that you have the best measurement capability commercially available. The HP 71707A downconverts frequencies from 1.5 to 26.5 GHz (to 110 GHz with additional harmonic mixers) to an RF frequency in the range of 5 to 1200 MHz.

The HP 71707A consists of the HP 70427A microwave downconverter module and the HP 70004 MMS color display/mainframe.

Specifications—see page 260
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41678

HP 8370 Series Synthesized CW Generators

The HP 83711A and HP 83712A CW generators are high-performance, economical solutions for local oscillator/exciter applications through 20 GHz. With extremely low broadband noise, phase noise, and spurious content, they reduce the effects of LO leakage and maximize measurement sensitivity and accuracy in receiver-test and noise-figure measurement applications. The HP 83712A further reduces noise and spurious signals below 2 GHz, making it an excellent choice as a LO in the HF to UHF range, as well as at microwave. High output power eliminates the need for external power amplifiers that can contribute significant amounts of broadband noise and degrade measurement accuracy. These generators are the recommended signal sources for use with the HP 8970 noise figure meter.

Specifications—see page 412
For more information, contact your local sales office or use the reply card in the back of this catalog.

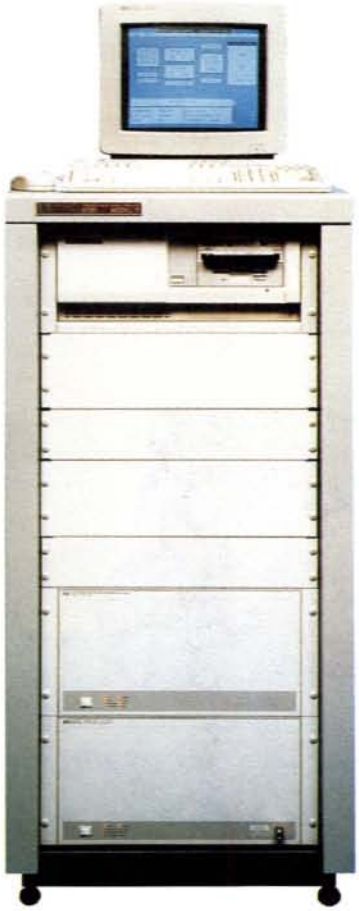
HP FIRST #41679

HP 84815A Peak Power Sensor

Now you can extend the peak power measurements of the HP 8990A peak power analyzer down to 50 MHz (usable to 20 MHz) with the new HP 84815A sensor. This allows design and test engineers to measure from 18-GHz microwave frequency through radio frequencies down to intermediate frequencies forradar/EW, communications, and navigation system work. The HP 8990A characterizes 13 pulse parameters (eight time and five amplitude) and features low measuring uncertainty with low-SWR sensors. In addition, corrections are made for temperature, power level, and frequency.

Specifications—see page 11.1
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41680



HP 8791 Model 7 Frequency-Agile Signal Simulator (Baseband)

Sometimes only complex baseband signals are needed from dc to 50 MHz for baseband testing applications in radar-target simulators, radar exciters, ECM/ECCM studies, military communications, and automatic test equipment. HP 8791 Model 7 features advanced direct-digital synthesis and 50-MHz instantaneous bandwidth for completely arbitrary AM, FM, and phase modulation with an 8-ns agility. It has expanded memory, phase-coherent frequency switching, and dynamic sequencing of multiple-emitter scenarios.

Specifications—see page 422
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41682

HP 8370 Series Synthesized Signal Generators

The HP 83731A and HP 83732A signal generators feature high output power, synthesized frequency accuracy, excellent spectral purity, and extensive modulation capabilities. They are ideal signal sources for radar, EW, and communication receiver testing from .01 to 20 GHz.

Satellite receiver testing can benefit from wideband FM to create telemetry signals without unlocking the synthesizer. EW receiver test applications can take advantage of the standard built-in multimode pulse source that simplifies the generation of burst and doublet pulses. The HP 83732A's spectral purity improves below 2 GHz without any degradation in modulation performance. This makes it the perfect choice when receivers need to be tested at IF as well as at microwave frequencies.

Specifications—see page 414
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41681

*For faxed details on these new products, contact HP FIRST.

Within the U.S. and Canada call 1-800-333-1917; outside the U.S. and Canada call 208-344-4809.
For detailed instructions on using HP FIRST, see page 33.

HP 71708A Microwave Source System

The HP 71708A microwave source provides signals with exceptionally low phase and AM noise performance from 2.4 to 26.4 GHz. The HP 71708A is an ideal source for testing microwave receivers, verifying noise floors of phase noise measurement systems, or substituting for the local oscillator in radar systems. Phase noise specifications are – 113 dBc/Hz and – 125 dBc/Hz at 1-kHz and 10-kHz offsets from a 10.2-GHz carrier. Up to +16 dBm of output power is available for your testing needs. The standard HP 71708A offers 600-MHz frequency resolution with an option available that offers 0.1-Hz frequency resolution.

The HP 71708A consists of the HP 70428A microwave source module and the HP 70004A MMS display/mainframe.

Specifications—see page 96
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41683

HP 83020A 1-Watt Microwave System Power Amplifier

The HP 83020A microwave system amplifier offers 1 watt of ultra-broadband power where you need it. Its ultra-broad bandwidth from 2 to 26.5 GHz allows system designers to replace several narrow bandwidth amplifiers with a single unit.

The HP 83020A comes fully integrated with a heat sink and bias circuitry to save valuable design time and for easy incorporation into a system rack. It also includes an internal directional detector for external leveling applications.

GaAs MMIC technology has been utilized, resulting in very low part count for improved reliability. With excellent noise figure relative to its ultra-broad bandwidth and high gain, the HP 83020A can make a significant improvement to system noise figure.

Specifications—see page 396
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41684

HP 8133A 3-GHz Pulse Generator

The HP 8133A 3-GHz pulse generator provides precise pulse performance for designers and manufacturers of digital components with clock rates from 33 MHz to 3 GHz. It features transition times of less than 100 ps and overall timing jitter of less than 5 ps. Delay and width parameters have 1-ps resolution. An optional second pulse channel or an optional second pulse data channel—which features 32-bit data as well as a PRBS sequence 2^{23}–1 can test the highest performance designs.

Specifications—see page 451

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41765

HP 80000 Data Generator System

The HP 80000 data generator system is a modular platform designed to offer top performance and versatility. It enables accurate testing of advanced digital devices at clock rates from 10 MHz to 1 GHz. The system consists of a mainframe, a clock/strobe module, and a 4-channel data module. 16 Kb of data, NRZ and RZ (50 percent duty cycle) formats, as well as PRBS data capabilities and ±2-ns delay with 2-ps resolution on all channels, provide the functionality and timing accuracy to stimulate and characterize digital components.

Specifications—see page 452

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41766

HP 8110A 150-MHz Pulse Generator

The HP 8110A generates all pulses, digital patterns, and multilevel waveforms necessary to test digital designs, particularly CMOS, with confidence. The pulse generator offers 150-MHz timing, 10 V p-p amplitude, and 2-ns variable transitions. Real pulses can be generated using the 4-kb pattern and can channel additional capabilities of the HP 8110A.

Enhancements are possible with a second output channel and the external locking (PLL) feature. The graphic display makes it easy to use on a bench top.

The HP 8110A allows trouble-free integration into automated test systems because of its small rack size and SCPI standard programming commands for HP-IB control.

Specifications—see page 454

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41767

*For faxed details on these new products, contact HP FIRST.

Within the U.S. and Canada call 1-800-333-1917; outside the U.S. and Canada call 208-344-4809.

For detailed instructions on using HP FIRST, see page 33.

HP E3650B Power-Supply Test System

The HP E3650B provides custom-tailored solutions for power supply testing. Each system includes measurement instruments, a Vectra PC, power supply test application software, site verification, delivery, installation, on-site training, a one-year on-site warranty, and support from HP.

The HP E3650B is based on proven quality hardware and software for accurate and repeatable measurements.

The modular hardware and software architecture of the HP E3650B gives each system the flexibility to test many kinds of dc power supplies, dc-to-dc converters, and batteries.

No programming is required, and an operator can simply use the mouse and pull-down menus to select and run tests.

Specifications—see page 504
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41755

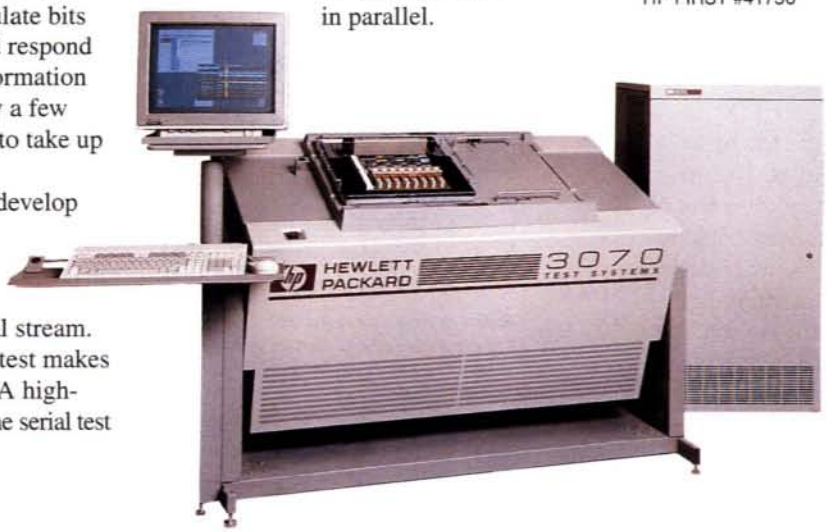
HP 3079CT Board Test System

The HP 3079CT board test system allows you to emulate serial backplanes without complex fixture electronics. The system can also manipulate bits in any serial stream and respond to nondeterministic information in real time. Spend only a few days on a job that used to take up to six months.

In addition, you can develop functional serial tests quickly because you can assign multiple processors to each serial stream. A built-in bit error rate test makes testing quick and easy. A high-level language controls the serial test resources and simplifies control of multiple processors. Get the highest throughput by testing multiple channels in parallel.

Specifications—see page 503
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41756

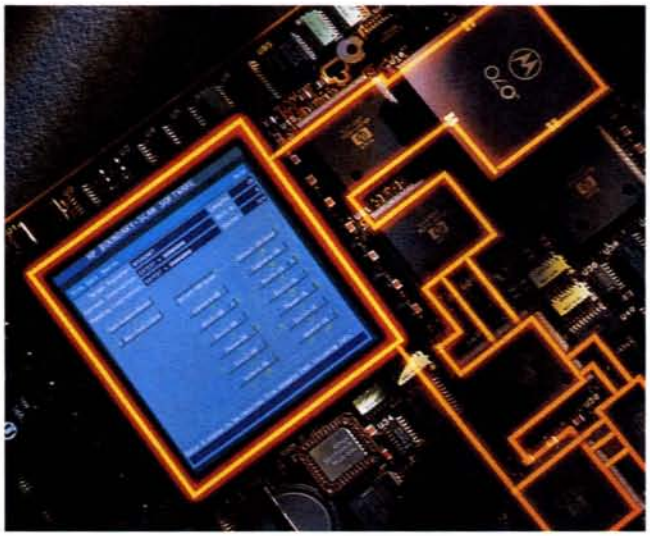


*For faxed details on these new products, contact HP FIRST at 1-800-333-1917.
Within the U.S. and Canada call 1-800-333-1917; outside the U.S. and Canada call 208-344-4809.

For detailed instructions on using HP FIRST, see page 33.

HP InterconnectPlus Software

HP InterconnectPlus boundary-scan software offers fast test generation, fast execution of comprehensive tests, and accurate diagnostics on existing HP 3070 board test hardware. Test generation time is quick because the software is tightly integrated with the existing HP 3070 board test software. Testability analysis can provide insight on where node access can be removed. Tests for single boundary-scan devices and chains of devices are automatically generated. The software will also test nonboundary-scan digital components through the boundary scan chain, a technique HP calls Silicon-Nails. All of this capability is available on any member of the HP 3070 family.



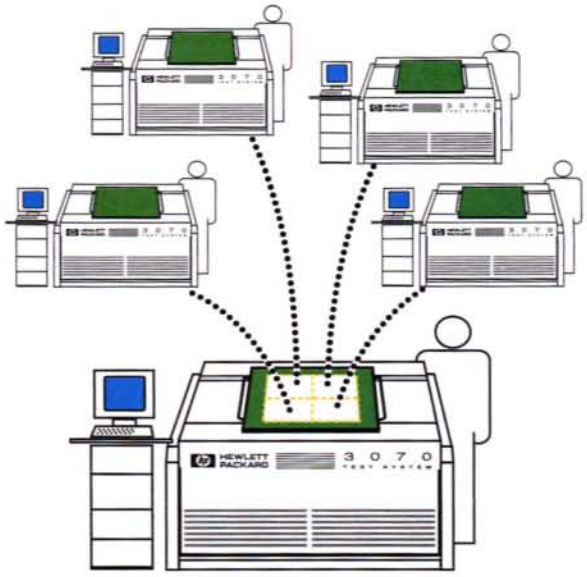
Specifications—see page 502

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41757

HP Throughput Multiplier

The HP 3070 board test family's innovative architecture supports up to four test modules within a single test system. Each of these self-contained modules provides complete analog and digital in-circuit measurements. As a result, each module can test boards independently of the others. HP Throughput Multiplier manages these test modules simultaneously, allowing an HP 3070 family test system to test up to four boards in parallel. The dramatic throughput improvement of parallel testing, made possible by the system's modular architecture and HP Throughput Multiplier, provides a cost-effective solution for manufacturers who would otherwise have to buy many board test systems.



Specifications—see page 502

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41758

*For faxed details on these new products, contact HP FIRST.

 Within the U.S. and Canada call 1-800-333-1917; outside the U.S. and Canada call 208-344-4809.

For detailed instructions on using HP FIRST, see page 33.

HP 83000 Model F660 Digital Test System

The HP 83000 Model F660 is the fastest and the most precise digital test system that Hewlett-Packard offers in the market.

The test system offers true tester-per-pin architecture up to 512 pins, straightforward capability to test up to 660 MHz on all channels without multiplexing, and accuracy of ±50 ps.

The HP 83000 digital test system is targeted at prototype verification, characterization, failure analysis, and production testing of digital ICs, such as ASICs, gate arrays, PLDs, standards ICs, and multichip modules.

Specifications—see page 508
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41731

Physical & Mechanical Design & Test

HP 35670A 4-Channel Dynamic Signal Analyzer

The HP 35670A is a 2- or 4-channel FFT-based spectrum/network analyzer in a small, portable package that can be easily taken into the field. A broad range of measurement options allow the instrument to be configured according to user needs. These options include real-time octave, computerized order tracking, swept-sine measurements, curve fit/synthesis, arbitrary source, and HP Instrument BASIC. A 90-dB (typical) dynamic range and a 25.6-kHz real-time rate with 800 lines of resolution provide the performance needed for demanding measurements. The HP 35670A can be used for electronic spectrum/network analysis, machinery vibration analysis, acoustics analysis, general mechanical noise and vibration troubleshooting, and analysis of control systems.

Specifications—see page 217
For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41665

HP 3569A Real-Time Frequency Analyzer

The HP 3569A is a real-time frequency analyzer designed for on-site product-noise-characterization measurements, including sound-intensity analysis. This two-channel analyzer provides laboratory-quality acoustic measurements in a rugged, portable package that weighs less than 3.2 kg (7 lb). State-of-the-art digital signal processing make these measurements more affordable than ever before.

The standard HP 3569A includes real-time octave and one-third octave measurements, sound level statistics, and real-time acoustic intensity measurements in octave and one-third octave bands. There are also three measurement options: narrowband FFT, reverberation time, and data transfer utilities for the HP 95LX Palmtop PC.

HP also offers a variety of microphones, probes, cables, and other acoustic measurement accessories for use with the HP 3569A.

Specifications—see page 213

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41666

HP 5529A Dynamic Calibrator

The HP 5529A dynamic calibrator improves machine-tool accuracy and productivity by finding and compensating for machine-tool positioning errors. The new calibrator makes standard machine-tool measurements and diagonal measurements to the new ANSI B5.54 standard, a quick means of checking machine-tool accuracy.
The HP 5529A also makes dynamic measurements which allow characterization of a machine's dynamic performance and can speed calibration.

The HP 5529A features a graphical user interface for ease of use. Context-sensitive help screens and on-line documentation help operators quickly learn the system. The HP 5529A comes with a three-year warranty.

Specifications—see page 390

For more information, contact your local sales office or use the reply card in the back of this catalog.

HP FIRST #41667

HP FIRST

HP FIRST delivers information about many of Hewlett-Packard's most popular products by fax to your office. Now you can call HP FIRST from your touch-tone phone toll free in the United States and Canada. For product or service information not available through HP FIRST, contact your local HP sales office.

Products listed in HP FIRST

- Test and measurement equipment and systems
- PCs, workstations, and computer systems
- Networking products
- Peripherals and office products

Information available through HP FIRST

- Product data sheets
- Software/hardware compatibility
- Value-added business partners
- Driver update information
- Upgrade information
- Service parts lists
- Application notes

How to use HP FIRST within the United States and Canada

1. Call 1 (800) 333-1917 for HP's Automated Support Access Program featuring HP FIRST.
2. Select "1" for HP FIRST.
3. Follow the voice prompts that will guide you to either an index or directly to the product information you need.
4. After selecting the information you need, you will be prompted to enter the phone number of your nearest fax machine.
5. After the system acknowledges your document requests, you will then be prompted to hang up.
6. In a few minutes, you will receive the information you requested from your fax machine. The time required to receive your information will vary depending on the length or complexity of the documents sent.

How to use HP FIRST outside the United States and Canada

Note: Your fax machine must have a keypad and a hand set to work with this system.

1. Pick up the handset of your fax machine and dial (208) 344-4809 from your fax keypad.
2. Next, follow the voice prompts in English that will guide you to either an index or directly to the product information you need.
3. After selecting the information you need, you will be prompted to press the (START/COPY) or (RECEIVE) button on your fax machine.
4. Hang up after hearing the tone.
5. In a few minutes, you will receive the information you requested from your fax machine. The time required to receive your information will vary depending on the length or complexity of the documents sent.

How to receive information on Value-Added Businesses using HP FIRST.

For information on application-specific products that will help provide a complete measurement system solutions when joined with the Hewlett-Packard Test & Measurement Products, call HP FIRST. When prompted, enter the(five-digit) document ID number that corresponds with your area of interest.

41010 Communications/Networks
41020 Component Test
41030 Data Aquisition
41040 Electronic Test
41050 Logic Analysis

Mechanical Test
41061 Acoustics
41062 Modal Analysis
41063 Rotating Machine

PC Board Test
41071 Fixturing
41072 Program Development
41073 Software Supplies
41074 General

RF & MW
41081 Antenna Test
41082 EMC/EW/Rader Simulation
41084 Materials Measurement
41085 Microwave Semiconductor Test
41086 Network Analysis
41087 Radar Cross Section
41088 General Test

41090 Semiconductor Test
41090 Software Test

PRINTERS, SCANNERS, & FAX MACHINES

Below is a listing of information available for popular HP peripherals and PCs through HP FIRST.

Peripherals—General Information

ID No.	Document Name	Document Description
	General Peripheral Information	
1308	HP Peripheral Products Data Sheet	Comparisons of HP peripherals in the DOS Environment
8304	HP Peripherals used on Apple Macintosh computers	Comparisons of HP peripherals in the DOS Environment
	Printers and Plotters — DOS Environment	
1301	HP Laser Jet III Data Sheet	HP LaserJet III printer
1302	HP Laser Jet IIID Data Sheet	HP LaserJet IIID printer
1303	HP Laser Jet IIP Data Sheet	HP LaserJet IIP printer
1310	HP Laser Jet IIIP Data Sheet	HP LaserJet IIIP printer
1313	HP Laser Jet IIISi Data Sheet	HP LaserJet IISi printer
2301	HP Desk Jet 500 Data Sheet	HP Desk Jet 500 printer
2304	HP Desk Jet 500C Data Sheet	HP Desk Jet 500C printer
	Scanners — DOS Environment	
3100	HP Scan Jet IIc Product Brief	Hp ScanJet IIc features and system requirements
3304	HP Scan Jet IIp Product Brief	Hp ScanJet IIp features and system requirements
	Plain Paper Fax — DOS Environment	
2802	HP FAX—310 Product Brief	Features for the HP FAX-300
3900	HP LaserJet FAX Product Brief	HPLaserJet FAX features and system requirements
	Palmtop PC Products	
8800	HP 95LX Palmtop PC with Lotus 1-2-3	Features for the HP 95LX Palmtop
	Printers and Plotters — Apple Macintosh Environment	
1304	HP LaserJet Apple Talk Data Sheet	HP LaserJet family connected to Apple Macintosh comput
1305	HPLaser Jet IIP Postscript Printer with Apple Talk Data Sheet	HP LaserJet family connected to AppleTalk
1317	HP LaserJet IIISi for the Macintosh	HP LaserJet IIISi for the Apple Macintosh
1319	HP LaserJet Postscript Printers Data Sheet	HP Postscript Printers including the HP 95LX Palmtop
2302	HP DeskWriter with Apple Talk Data Sheet	HP DeskWriter family
2303	DeskWriter C Data Sheet	DeskWriter connected to Apple Macintosh computers

A

ALPHABETICAL INDEX

B

C

D

E

F

G

H

M

N

O

P

ALPHABETICAL INDEX

Q

R

ALPHABETICAL INDEX

T

U

V

W

X

Z

MODEL NUMBER INDEX

New product listings are printed in boldface type

MODEL NUMBER INDEX

New product listings are printed in boldface type

3000

4000

5000

6000

7000

8000

MODEL NUMBER INDEX

New product listings are printed in boldface type

9000

10000

MODEL NUMBER INDEX

New product listings are printed in boldface type

20000

30000

MODEL NUMBER INDEX

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40000

50000

60000

70000

80000

MODEL NUMBER INDEX

New product listings are printed in boldface type

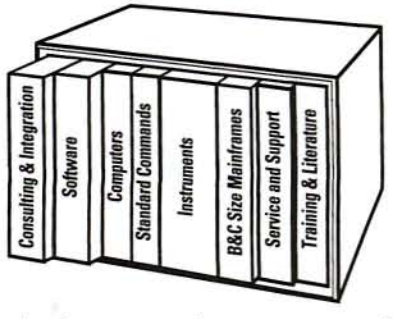
- World-class products
- VXI systems architecture
- VXI consulting and support services

VXI-Based Test Systems

Implementing a new, VXI-based test system is a major decision. Hewlett-Packard offers you a broad line of products and services that turn this major decision into a safe solution. With HP products, you can be confident that your test systems will provide good on-time performance, at a reasonable cost, with the performance level you need.

Choosing VXI gives you an open, industry-standard architecture supported by more than 250 companies. With VXI, you get a wide selection of products, a scalable modular architecture, and a small physical size.

What sets VXI suppliers apart is their full utilization of the VXI architecture, their test expertise, and their commitment to the test and measurement industry. When you choose HP and VXI, you get the right combination of world-class products, VXI systems architecture, and VXI consulting and support services needed to reduce the risk of implementing a new test strategy.



All from the test and measurement company you can trust.

A commitment to VXI means a commitment to more than hardware. Software often becomes the most critical factor in the test system development cycle. Operating systems, programming languages, and application software for VXI are all available from HP.

A commitment to VXI also means a commitment to consulting and support services. HP has a group of specialists to help you make informed decisions, find answers quickly, and develop the best strategy for your needs. Your local HP field engineer coordinates a team of professionals to help you through the phases of the test system development cycle. Call on HP to augment your test system development team.

For a free 225-page catalog, ask for HP p/n 5091-5269EUS (U.S.); 5091-5269EN (Other Countries)

HP 75000 VXIbus Hardware

Multimeters	Digitizers & Oscilloscopes	Counters	Sources	Digital	Switches	Telecom	Mainframes	Computers & Commanders	Specialty	Mass Interconnect	
HP E1326B		HP E1322A HP E1333A	HP E1328A HP E1340A	HP E1330B	Relay Mux FET Mux RF Mux Matrix Form C		HP E1300A HP E1301A	Built-in Commander	IRIG B MIL 1553B		B-Size
HP E1410A HP E1411B	HP E1413A HP E1426A HP E1427A HP E1428A HP E1429A HP E1430A	HP E1420B	HP E1440A HP E1445A HP E1446A	Model D20 HP E1450A HP E1451A HP E1452A	Relay Mux FET Mux RF Mux Matrix Form C	Series 90 TOH RX TOH Gen Interface Payload Timing	HP E1400B HP E1401A HP E1400T	HP E1405B HP E1406A HP E1499A	Synchro/ Resolver ARINC-429	HP E3720A HP E3722A HP 9420A	C-Size

HP 75000 VXI Hardware

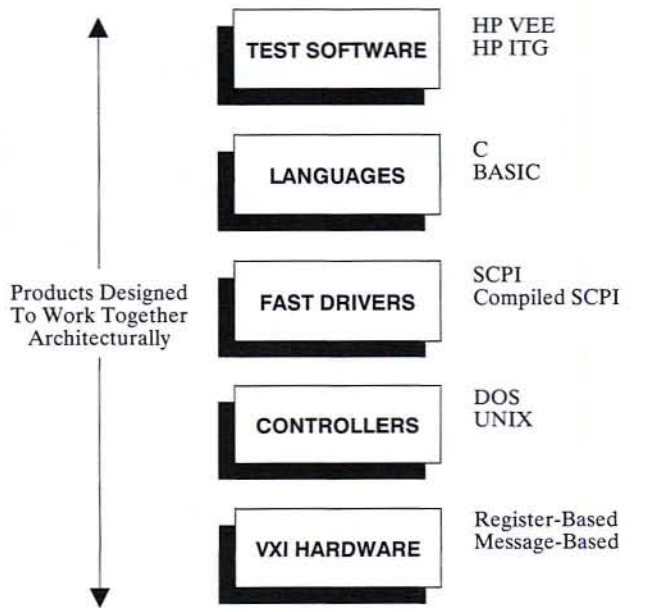
Hewlett-Packard gives you a choice of many VXI modules for your application. Three digital multimeters are offered, ranging from 4½-digit to 6½-digit resolution. Two oscilloscopes and three digitizers are available for capturing analog waveforms. The three counters range from simple multichannel counters to a full-featured universal counter. Arbitrary function generators, synthesized function generators, and digital-to-analog converters provide low-frequency analog signals. For mixed-signal testing, the Model D20 combines high-performance digital stimulus and response while maintaining low cost. Matrices, multiplexers, and Form-C switches are available in both B- and C-size formats. Telecom test for SONET/SDH is performed with the Series 90 system. Mainframes are available in B- and C-size formats. High-performance HP-UX and BASIC workstations round out the HP 75000 family of VXI hardware products. Finally, mass interconnect fixtures are offered for fast wiring changes between the instruments and the device under test (DUT).

HP VXI Systems Architecture

Often, ease-of-integration and test throughput are key issues. That's why, at HP, we use a systems approach in our design of VXI hardware and software.

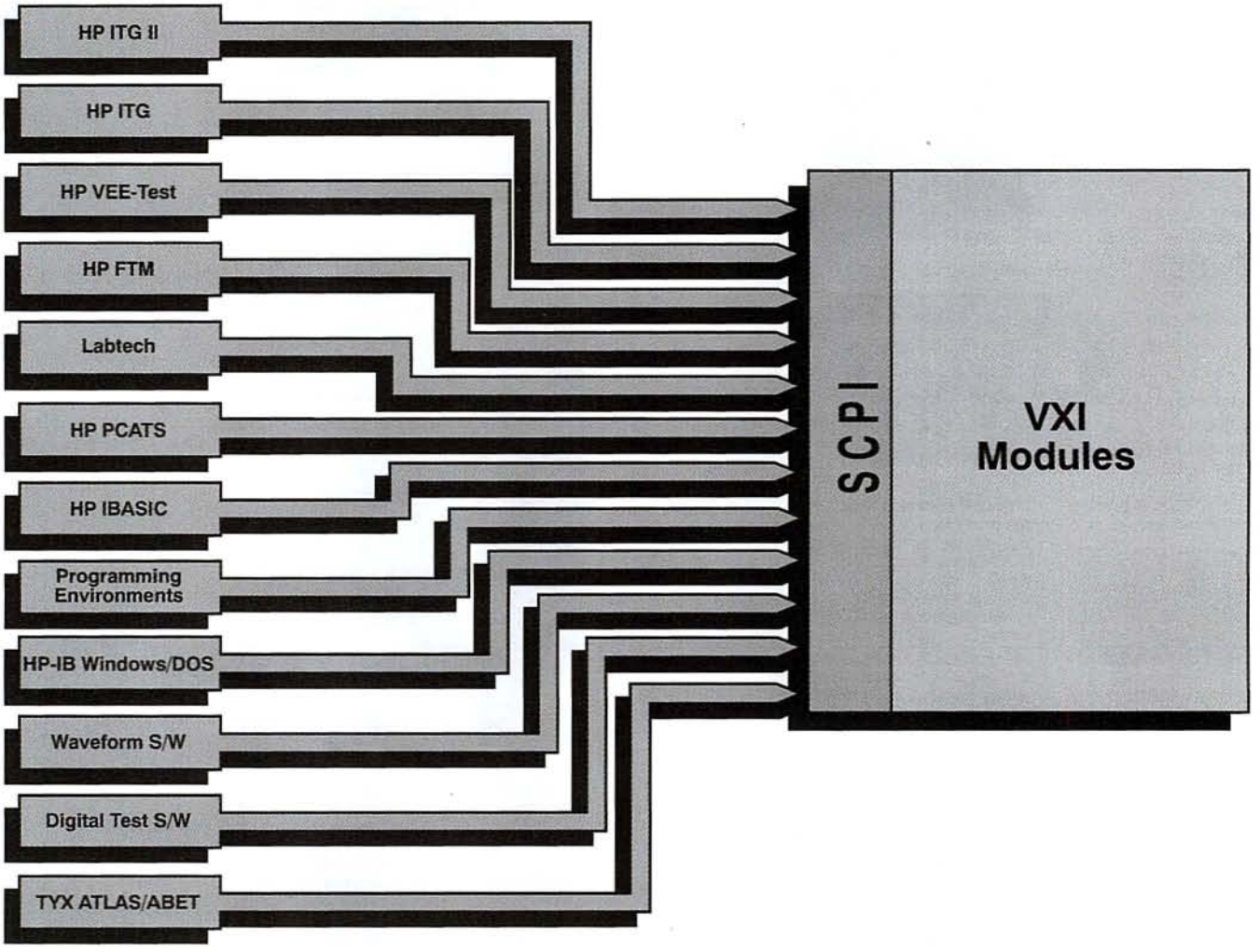
HP's message-based modules maximize ease of programming and interoperability, and HP's register-based modules minimize cost and maximize throughput. In addition, both B- and C-size VXI products are featured to give you a scalable architecture and a choice of price and performance.

SCPI mnemonics are available for all standard HP 75000 products. By using SCPI, you reduce the time needed to learn a new instrument because a particular function always uses the same command, regardless of the instrument type. HP's message-based modules interpret SCPI commands directly, and HP's register-based modules use the C-size command module or the B-size mainframe to perform SCPI interpretation. If you need both high throughput and ease of programming, HP offers Compiled SCPI, which provides register-based speed with SCPI programming ease.



HP VXI Systems Architecture

HP 75000 VXI Software



Software is a major part of any test system. Often, it is the component that determines the test system's ease of use and throughput. Whether you need programming languages, instrument drivers, or application software, Hewlett-Packard has a variety of software products designed to work with VXI hardware.

HP's high-performance VXI computers have two primary operating systems for VXI. The first is HP-UX, an industry-standard UNIX implementation. With HP-UX, a variety of languages, networking, and program development products are available. The second is the HP BASIC operating system/language. HP BASIC has been optimized for instrument I/O and excels in its power and simplicity. A subset of HP BASIC, known as IBASIC, is an option for the VXI command modules.

HP ITG for MS-Windows and HP BASIC help create test software quickly and easily by using virtual front panels for the VXI instruments. Their mouse-driven environments facilitate instrument setup and control.

Software for specific VXI modules is available to help develop test code. For example, the Model D20 digital tester is supported by a development environment designed to build timing and data files. Graphical editing of analog waveforms is also possible using the arbitrary waveform generation software.

HP VEE-Test is a graphical-icon–based environment for developing programs without using a conventional, text-based language. By linking icons together with a mouse, you create executable block diagrams and, at the same time, dramatically reduce program development time.

Application software packages, such as HP FTM and Labtech for HP System 10, provide a higher level of functionality. HP FTM is optimized for manufacturing tests, and Labtech works well in data acquisition applications.

Software is a major component of HP's VXI systems approach to design. The computer operating systems, languages, and application packages all must be compatible for the individual pieces to act together in a VXI system. That's why HP offers more than individual components. HP offers test systems that include instruments, computers, and software—all from the test and measurement company you can trust: HP.

VXIbus PRODUCTS
HP 75000 VXI Products

HP 75000 VXI Product Information

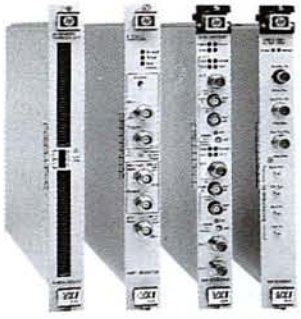
Product	Description	Price
Mainframes		
 HP E1401A C-Size high-power mainframe		
 HP E1301A B-Size VXI mainframe with front panel		
HP E1300A B-Size VXI Mainframe	· Low-cost switching and measurement · Built-in command module with SCPI (slot 0 not required) · Seven B-size and three A-size slots · Optional hard disk, floppy disk, dc power operation, and RS-232 ports	$2,320
HP E1301A B-Size VXI Mainframe with Front Panel (HP ITG)	· Identical to the HP E1300A except that the HP E1301A also includes a front-panel keyboard/display	$2,900
HP E1401A C-Size High-Power Mainframe	· Thirteen C-size slots; P1 and P2 connectors · Easy to service while mounted in a test rack (MTTR <5 min for power supply or fans) · High-power (650 W at 55° C) · Clean, filtered, uniform airflow from a pressurized air channel	$6,350
Software		
HP 34806G HP Functional Test Manager	· Focused on functional testing of subassemblies and assemblies · See HP FTM Functional Test Manager in this catalog.	$3,450
HP 82335B HP-IB for Windows and DOS	· HP-IB interface product for PCs · Includes an HP-IB interface card and software that allow you inexpensively to add instrument control capability to your Vectra Series PC or IBM PC/XT/AT compatible · See HP-IB for Windows and DOS in this catalog.	$525
HP E1445A Opt 005 and HP E1340A Opt 005 Arbitrary Waveform Generation Software	· Menu-driven software · Data input with mouse, graphics tablet, and digitizer · Built-in waveforms · Runs on HP Series 300 computers using HP BASIC	$700
HP E1395C System 10+ Data-Acquisition Software	· No programming required: PC-based iconic software · Labtech Notebook software for experiments and tests · Labtech Control software for process automation · See System 10+ Data-Acquisition Software in this catalog.	$1,100
HP E1496A Digital Test Development Software	· See Model D20 Digital Functional Test System at the end of this section.	$3,500
HP E1570A Compiled SCPI	· Software for high-throughput testing · Easy way to program HP register-based instruments · For the C programmer (with ANSI C-compatible compiler) · Unified programming environment	$4,000

Product	Description	Price
Software (continued)		
HP E2000A Interactive Test Generator (HP ITG)	· Accelerates test program development · Mouse-driven interface to HP-IB instruments · Generates code automatically · See HP Interactive Test Generator (HP ITG) in this catalog.	$995
HP E2200A Instrument BASIC for Windows	· Allows downloading of programs to instruments with the IBASIC option · Develop IBASIC programs on your PC in Windows · See HP IBASIC for Windows in this catalog.	$395
HP E2110A HP VEE-Test	· HP's visual engineering environment for test applications · See HP VEE-Test in this catalog.	$4,900
Multimeters		
 HP E1410A, HP E1411B, and HP E1326B		
HP E1326B 5½-Digit Multimeter	· Two slots, B size · Functions: DCV, ACV, 2- and 4-wire Ω, offset-compensated Ω, thermocouples, thermistors, RTDs · Dual A/D: 5½-digit low-noise, integrating A/D and a high-speed (14 kHz) sampling A/D	$1,300
HP E1411B 5½-Digit Multimeter	· One slot, C size · Functions: DCV, ACV, 2- and 4-wire Ω, offset-compensated Ω, thermocouples, thermistors, RTDs · Dual A/Ds: 5½-digit low-noise, integrating A/D and a high-speed (14 kHz) sampling A/D	$1,600
HP E1410A 6½-Digit Multimeter	· One slot, C size · Functions: DCV, ACV (ac and dc coupled), 2- and 4-wire Ω, offset-compensated Ω, frequency, period, thermistor, RTDs · 1450 readings/second at 3½ digits, or normal mode rejection of up to 90 dB in the 6½-digit mode	$3,540
Counters		
 HP E1420B		
 HP E1333A and HP E1332A		

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 75000 VXI Product Information

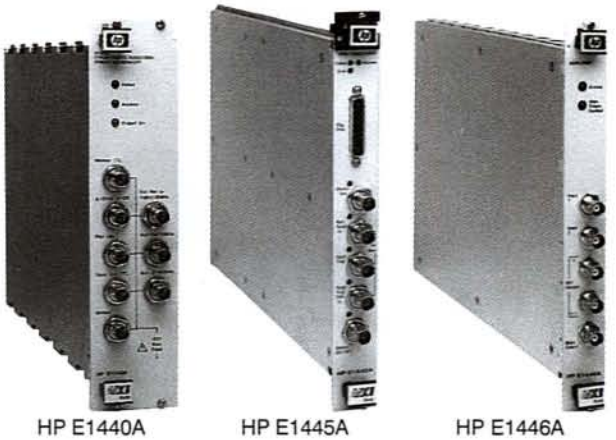
Product	Description	Price
Counters (continued)		
HP E1333A Three-Channel Universal Counter	· One slot, B size · Frequency, period average, ratio, pulse width, time interval, and totalize to 100 MHz · 1-GHz frequency measurement available on channel 3 · 1-ns time interval and pulse width resolution (average mode)	$910
HP E1332A Four-Channel Counter/Totalizer	· One slot, B size · Totalize, up/down count, gated totalize, pulse width, time interval, period average, and frequency measurement up to 4 MHz · Programmable direct or isolated inputs · Programmable digital input filter and trigger levels	$910
HP E1420B High-Performance Universal Counter	· One slot, C size · 200-MHz frequency range with 9-1/2 digits/sec resolution and optional high-frequency channel · 2-ns time-interval resolution (200 psec with averaging) · x10 attenuator	$3,450
Oscilloscopes/Digitizers		



HP E1413A, HP E1427A, HP E1429A, and HP E1430A

HP E1426A 500-MHz Digitizing Oscilloscope	· Two slots, C size · 500-MHz bandwidth, four input channels, 8-bit vertical resolution · 20 Msample/s digitizing rate · Two command sets: HP 54503A and SCPI	$7,950
HP E1428A 1-GSa/s Digitizing Oscilloscope	· One slot, C size · Two channels, 1 GSa/s maximum sample rate (simultaneous on both channels) · 250-MHz bandwidth · Two command sets: HP 54510A and SCPI	$12,950
HP E1429A Digitizer	· One slot, C size · 12-bit resolution, 20 MSa/s maximum sample rate · 1-MB reading memory · Two channels · 50 amd 75 Ω single-ended input	N/A
HP E1430A Digitizer	· One slot, C size · 18-bit linear, 23-bit resolution, 10 MSa/s maximum sample rate · 4-MB reading memory · One channel · 50 Ω input impedance	$12,000
HP E1427A Digitizer	· One slot, C size · 7- to 9-bit resolution, 2GSa/s maximum sample rate · 16-KB sample memory · One channel	$11,800
HP E1413A Scanning A/D	· One slot, C size · 16-bit resolution, 100 KSa/s maximum sample rate · 64-KB sample memory · 64 channels multiplied into a single A/D · Signal conditioning options for temperature, strain, and pressure	$7,500 to $9,000

Product	Description	Price
Sources		



HP E1440A HP E1445A HP E1446A

HP E1340A

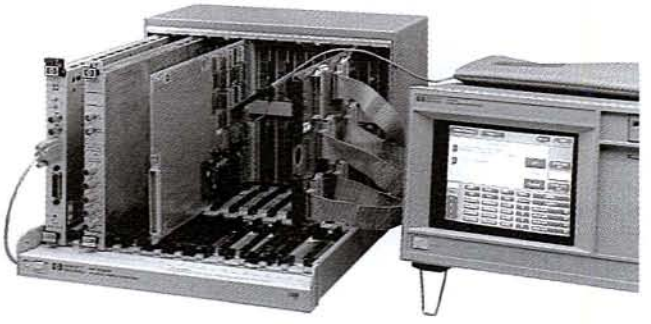
HP E1328A

HP E1340A Arbitrary Function Generator	· One slot, B size · 12 bits, 42 MSa/s · 16-K sample RAM · Sine, square, ramp, triangle, sin(x)/x, noise, haversine, and arbitrary waveforms	$2,500
HP E1328A Four-Channel D/A Converter	· One slot, B size · Four isolated voltage or current DACs · ±10.92-V or ±21.8-mA output · Software calibration	$1,110
HP E1440A 21-MHz Synthesized Function/ Sweep Generator	· Two slots, C size · Sine, square, triangle, negative and positive ramps, dc, and TTL clock waveforms · Amplitude and phase modulation · Multiinterval sweep and multimarker mode	$5,750
HP E1445A Arbitrary Function Generator	· One slot, C size · 13-bit resolution, 40 MSa/s · 256 K sample memory with sequencer · Waveform and frequency hopping with sweep function	$7,000
HP E1446A Summing Amplifier/DAC	· One slot, C size · Drive 50 Ω loads with 20 V p-p or 40 V p-p into high Z with 16-bit resolution · Sum two input signals · Add dc offset with internal DAC	$2,750

VXIbus PRODUCTS
HP 75000 VXI Products (cont'd)

HP 75000 VXI Product Information

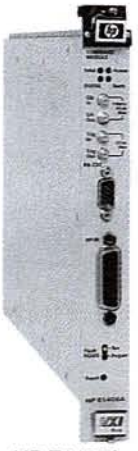
Product	Description	Price
Power Meter		
 HP E1416A		
HP E1416A Power Meter	· One slot, C size · ±0.02-dB or ±0.5% accuracy · 100 kHz to 110 GHz · −70 to +44 dBm	$2,625
Digital		
HP E1330B Quad 8-Bit Digital Input/Output	· One slot, B size · Quad 8-bit bidirectional data ports · Three separate handshake lines for each port · Interface to industry standard opto-isolator racks for isolation	$625
HP E1450A 160-MHz Timing Module; HP E1451A 20-MHz Pattern I/O Module; HP E1452A 20-MHz Pattern I/O Module; HP E1496A Digital Test Development Software	· For more information on these products, see Model D20 Digital Functional Test System at the end of this section.	
Special Purpose		
HP DDCC-37001 Synchro/Resolver Simulator and Indicator	· One slot, C size · Independent D/S and S/D functions · Programmable: Wraparound self-test, Synchro/resolver modes, resolution, dynamic rate and direction	$8,033
HP BANC-350 IRIG B Time Code Processor	· One slot, B size · IRIG B time-code input and output · Real-time clock with 0.5-μs precision using IRIG B · 10-MHz disciplined oscillator, current-time display	$2,700
Interfaces and Communications		
HP E1324A RS-232C/422	· One slot, A size · Single serial channel · Separate ports for RS-232C and isolated RS-422 · 8 KB input and output buffers	$650
HP E1482A VXIbus Extender	· One slot, C size · Connects the VXIbus to the high-speed MXIbus cable link for connection to another VXIbus mainframe or external MXIbus controller · Multiple VXIbus mainframes appear as a single VXIbus system and can be controlled by a single HP E1406A or E1499A.	$2,754

Product	Description	Price
Interfaces and Communications (Continued)		
HP DDCC-1553 MIL-STD-1553B Interface	· One slot, B size · VXIbus interface with intelligent 1553 BC/RT/MT · Supports all 1553B dual redundant message formats and mode codes · 8 K × 16 on-board dual-access RAM and on-board time-tag counter	$6,745
HP TASC-429 Tester/ Simulator Interface	· One slot, C size · Four receive and four transmit ARINC-429 independently programmable channels · Full ARINC-429 electrical and protocol compatibility · Error detection/injection and time stamp	$9,720
Telecom Test		
HP E1650A Modular SONET/SDH Analyzer (52/155/622 Mb/s) HP E1652A Modular SONET/SDH Analyzer (52/155 Mb/s)	· For more information on these products, see HP 75000 Series 90 Modular SONET/SDH Analyzer in the Telecom Test section of this catalog.	
Development Tools		
		
HP E1400T VXI Development Mainframe	· Thirteen slots, C size · Has no top, allowing easy access to modules that are being developed or repaired · Meets all specifications of the HP E1400B VXI mainframe, including power and cooling · Can be used as a VXI development or repair station	$6,350
HP E1323A VXI Preprocessor for HP Logic Analyzers	· Provides a complete mechanical and electrical connection between a VXI mainframe and an HP 16500 or 1650 Series logic analyzer · Fits in B-, C-, or D-size VXI mainframes	$1,200
HP E1399A Register-Based Breadboard	· One slot, B size · Provides a 16-bit interface through the P1 connector · Contains PC board, connectors, front panel, custom PAL IC, and other ICs (assembled) · Terminal module for easy connections	$400
HP E1490B Register-Based Breadboard	· One slot, C size · Provides a 16-bit interface through the P1 and P2 connectors · Contains PC board, connectors, front panel, custom PAL IC, and other ICs (assembled) · Terminal module for easy connections	$900

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 75000 VXI Product Information

Product	Description	Price
Development Tools (continued)		
HP E1403A Active Module Carrier	· One slot, C size · For mounting B-size VXI modules (no P2 connector) in any C-size mainframe · Provides direct access to front panel I/O connections	$298
Controllers and Slot O Controllers		

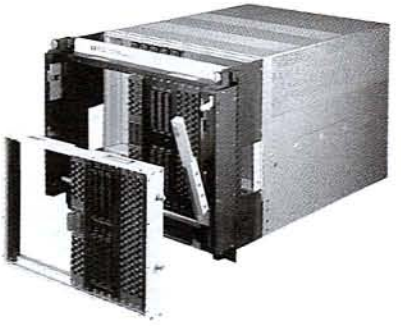


HP E1406A

HP E1499A

HP E1499A V/382 Controller	· Two slots, C size · Highest performance VXI controller for fast test program development · Large selection of RAM options and color graphics display systems · Wide selection of operating systems and application tools	$13,300
HP E1406A Command Module	· One slot, C size · HP-IB, RS-232, slot 0, and resource manager capabilities · Message-based (SCPI) personalities for register-based devices · GP-IB command for any vendor's message-based instruments and access to any vendor's register-based devices · HP IBASIC option to add standalone program control	$2,830
HP E1485A Digital Signal Processing Module	· One slot, C size · Uses either 56001 integer or 96000 floating-point DSP chips · Up to five DSP chips per module · High-speed data transfer over VXI local bus (also on HP E1429A, E1430A, E1445A, and E1488A) · Optional interface to HP 3565A DSA products	$8,000
HP RAD-EPC7 VXIbus Embedded PC Controller	· Two slots, C size · PC-compatible, high-performance VXI controller · Large selection of RAM, hard drive, and I/O options · Supports MS-DOS, SICL on DOS, and Compiled SCPI	N/A
Memory		
HP E1488A Instrument Memory	· One slot, C size · 32- to 54-MB modular memory in 8-MB blocks · Static RAM with battery-backup option · Optimized for use with HP E1429A, E1430A, E1445A, and E1485A with high-speed data transfers over the VXI local bus	N/A

Product	Description	Price
Mass Interconnect		



HP E3722A

HP 34592A Quick Interconnect System	· Easy way to interface VXI and rack-and-stack instruments to a device under test (DUT) · Ten connector slots for up to 960 general-purpose pins · Power connections to 250 VAC, 3 A per pin	$1,360
HP 9420A Rack Mount Interface Connector Assembly (ICA)	· Highest density (up to 4,032 general-purpose pins) · Power connections up to 250 VAC, 30 A per pin · Mounts directly to a rack cabinet · Interface test adapters (ITAs), connector blocks, contacts, and cables available as separate products	$3,425
HP E3720A VXI Interface Connector Assembly (V/ICA)	· Mounts directly onto the HP 75000 Series C mainframe · Shortest wire lengths between VXI plug-in modules and the unit under test (UUT) · Up to 2,496 general-purpose pins · ITAs, connector blocks, contacts, and cables available as separate products	$4,500
HP E3722A Hinged Interface Connector Assembly (H/ICA)	· Mounts directly onto the HP 75000 Series C mainframe · H/ICA hinges to allow easy access to VXI plug-in modules · Up to 4,032 general-purpose pins · ITAs, connector blocks, contacts, and cables available as separate products	$4,900
Switches		

HP E1351A, HP E1352A

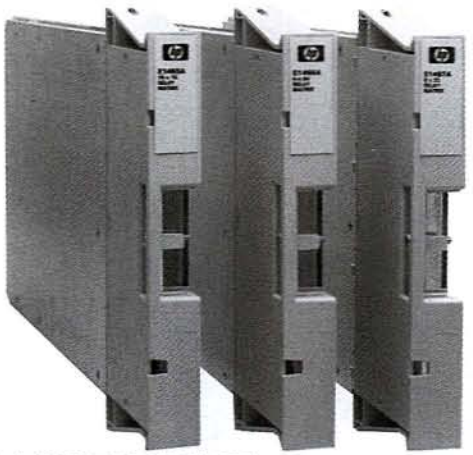
HP E1345A, HP E1346A

VXIbus PRODUCTS
HP 75000 VXI Products (cont'd)

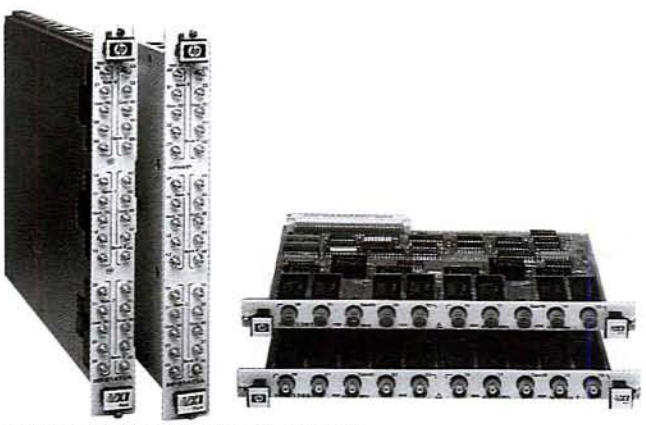
HP 75000 VXI Product Information

Product	Description	Price
Switches (continued)		
HP E1343A 16-Channel High-Voltage Relay Multiplexer	· One slot, B size · Sixteen 3-wire or eight 4-wire channels · High-voltage measurements up to 250-V dc or ac (rms) · Space available for series and shunt signal conditioning	$1,025
HP E1344A 16-Channel General-Purpose and T/C High-Voltage Relay Multiplexer	· One slot, B size · Use with the HP E1326A/B or E1411A/B multimeter to measure thermocouple, voltage, current, and Ω (has a built-in thermistor reference junction). · High-voltage measurements up to 250-V dc or ac (rms)	$1,125
HP E1345A 16-Channel Relay Multiplexer	· One slot, B size · Sixteen 3-wire or eight 4-wire channels · Low thermal offset reed relays (< 4 μV, differential H-L) · Use with the 5½-digit digital multimeter (HP E1326A/B or E1411A/B) as a virtual scanning voltmeter.	$660
HP E1346A 48-Channel Single-Ended Relay Multiplexer	· One slot, B size · Common low and guard terminals · Use with the 5½-digit digital multimeter (HP E1326A/B or E1411A/B) as a virtual scanning voltmeter. · Break-before-make channel scanning	$810
HP E1347A 16-Channel General-Purpose and T/C Relay Multiplexer	· One slot, B size · Use with the HP E1326A/B or E1411A/B multimeter to measure thermocouple, voltage, current, and 2-wire Ω (has a built-in thermistor reference junction). · Space available for series and shunt signal conditioning · Break-before-make channel scanning	$760
HP E1351A 16-Channel FET Multiplexer	· One slot, B size · Use with the HP E1326A/B or E1411A/B multimeter to measure voltage, current, and Ω. · Scan up to 13,000 channels/second with the HP E1326B or E1411B 5½-digit multimeter. · Increased system reliability; no mechanical wearout	$875
HP E1352A 32-Channel Single-Ended FET Multiplexer	· One slot, B size · Common low terminals · Use with the HP E1326A/B or E1411A/B multimeter to measure voltage, current, and Ω. · Scan up to 13,000 channels/s with the HP E1326B or E1411B 5½-digit multimeter. · Increased system reliability; no mechanical wearout	$1,000
HP E1353A 16-Channel General-Purpose and T/C FET Multiplexer	· One slot, B size · Use with the HP E1326A/B or E1411A/B multimeter to measure voltage, current, Ω, and temperature. · Fast (up to 13,000 channels/s) thermocouple measurements with built-in thermistor reference junction (HP E1353A with HP E1326B or E1411B) · Increased system reliability; no mechanical wearout	$975

Product	Description	Price
Switches (continued)		



HP E1465A, HP E1466A, HP E1467A



HP E1472A, E1473A, E1366A, E1367A

HP E1355A Eight-Channel 120-Ω Strain Gage Relay Multiplexer	· One slot, B size · Use with the HP E1326A/B or HP E1411A/B multimeter to measure eight-channel strain (with ¼, ½, and full bridge configurations), voltage, current, and 2-wire Ω. · Built-in +5 Vdc excitation · Built-in bridge-completion resistors	$925
HP E1356A Eight-Channel 350-Ω Strain Gage Relay Multiplexer	· One slot, B size · Use with the HP E1326A/B or HP E1411A/B multimeter to measure eight-channel strain (with ¼, ½, and full bridge configurations), voltage, current, and 2-wire Ω. · Built-in +5 Vdc excitation · Built-in bridge-completion resistors	$925
HP E1357A Eight-Channel 120-Ω Strain Gage FET Multiplexer	· One slot, B size · Use with the HP E1326A/B or HP E1411A/B multimeter to measure voltage, current, Ω, and strain. · Dynamic strain measurements (up to 13,000 readings/second) with ¼, ½, and full bridge configurations and built-in 4.6-V excitation power supply (HP E1357A with HP E1326B or E1411B) · Built-in +5-Vdc excitation · Built-in bridge-completion resistors	$1,125

HP 75000 VXI Product Information

Product	Description	Price
Switches (continued)		
HP E1358A Eight-Channel 350-Ω Strain Gage FET Multiplexer	· One slot, B size · Use with the HP E1326A/B or HP E1411A/B multimeter to measure voltage, current, Ω, and strain. · Dynamic strain measurements (up to 13,000 readings/second) with 1/4, 1/2, and full bridge configurations and built-in 4.6-V excitation power supply (HP E1358A with HP 1326B or E1411B) · Built-in +5-Vdc excitation · Built-in bridge-completion resistors	$1,125
HP E1460A 64-Channel Relay Multiplexer	· One slot, C size · Sixty-four 2-wire, thirty-two 3-wire, thirty-two 4-wire, or 128 single-ended latching relay channels · Reconfigurable, for example: eight 1 × 8 multiplexers, four 1 × 8 and two 1 × 16 multiplexers, two 1 × 32 multiplexers, one 1 × 64 multiplexer, or 128 single-ended channels · Maximum voltage: 220 Vdc, 250 Vac rms; maximum current: 1-A dc or ac rms	$2,420
HP E1366A 50-Ω RF Multiplexer	· One slot, B size · Two 1 × 4 multiplexers · Switch signals up to 1.3 GHz · BNC connectors · Off-channels are terminated.	$860
HP E1472A 50-Ω RF Multiplexer	· One slot, C size · Six 1 × 4 multiplexers · Switch signals up to 3 GHz · SMB male connectors for high performance	$2,530
HP E1473A 50-Ω RF Multiplexer Expander	· One slot, C size · Six 1 × 4 multiplexers · Each E1472A can support up to two E1473A units. · Mount next to E1472A or next to the DUT.	$1,520
HP E1367A 75-Ω RF Multiplexer	· One slot, B size · Two 1 × 4 multiplexers · Switch signals up to 1.3 GHz · BNC connectors · Off-channels are terminated.	$860
HP E1474A 75-Ω RF Multiplexer	· One slot, C size · Six 1 × 4 multiplexers · 75-Ω input impedance and new 75-Ω SMB male connectors for high performance · Switch signals up to 1.3 GHz	$2,830
HP E1475A 75-Ω RF Multiplexer Expander	· One slot, C size · Six 1 × 4 multiplexers · Each E1474A can support up to two E1475A units. · Mount next to E1474A or next to the DUT.	$1,820
HP E1368A 18-GHz Microwave Switch	· One slot, B size · dc to 18 GHz · Three SPDT 50-Ω terminated switches · 3-mm SMA connectors	$2,120
HP E1369A Microwave Switch Driver	· One slot, B size · Drive any three HP 8762/3/4/5X microwave switches in 50 Ω or 75 Ω. · Select internal energizing voltages or supply your own energizing power.	$510

Product	Description	Price
Switches (continued)		
HP E1370A Microwave Switch/Attenuator Driver	· Two slots, B size · Drive any HP 8766/7/8/9K microwave switch or any HP 849XX step attenuator · Select internal energizing voltages or supply your own energizing power.	$500
HP E1361A 4 × 4 Relay Matrix	· One slot, B size · Connect multiple inputs to multiple outputs · Flexible dual 2 × 4 or single 4 × 4 two-wire matrix · 250 V, 1-A dc or ac signal switching, latching relays	$660
HP E1465A 16 × 16 Relay Matrix	· One slot, C size · 16 × 16 two-wire switching · 256 crosspoint matrix for connecting multiple inputs to multiple outputs · 200 Vdc, 170 Vac rms, 1-A dc or ac peak signal switching	$4,950
HP E1466A 4 × 64 Relay Matrix	· One slot, C size · 4 × 64 two-wire switching · 256 crosspoint matrix for connecting multiple inputs to multiple outputs · 200 Vdc, 170 Vac rms, 1-A dc or ac peak signal switching	$4,950
HP E1467A 8 × 32 Relay Matrix	· One slot, C size · 8 × 32 two-wire switching · 256 crosspoint matrix for connecting multiple inputs to multiple outputs · 200 Vdc, 170 Vac rms, 1-A dc or ac peak signal switching	$4,950
HP E1468A 8 × 8 Relay Matrix	· One slot, C size · 8 × 8 two-wire switching with a guard or shield available for each row and column · 220 Vdc, 250 Vac rms, 1-A dc or ac rms (Vmax < 30 V or 250 Vac rms), or 0.3A dc or ac rms (Vmax < 220 Vdc or 250 Vac rms) · Connect multiple inputs to multiple outputs (full crosspoint)	$2,400
HP E1469A 4 × 16 Relay Matrix	· One slot, C size · 4 × 16 two-wire switching with a guard or shield available for each row and column · 220 Vdc, 250 Vac rms, 1-A dc or ac rms (Vmax < 30 Vdc or 250 Vac rms), or 0.3-A dc or ac rms (Vmax < 220 Vdc or 250 Vac rms) · Connect multiple inputs to multiple outputs (full crosspoint)	$2,400
HP E1364A 16-Channel Form-C Switch	· One slot, B size · Normally closed, normally open, and common terminals · 250 V, 1-A dc or ac signal latching relays · 5-V and 12-V power for digital output	$660
HP E1463A 32-Channel 5-Amp Form-C Switch	· One slot, C size · Normally closed, normally open, and common terminals · 125 Vdc, 250 Vac rms, 5-A dc or ac rms nonlatching relays · <7 μV (< 3 μV typical) thermal offset per channel	$1,600

VXIbus PRODUCTS

HP 75000 VXIbus Family

HP 75000 Model D20

- Scalable architecture for the price and performance you need
- Comprehensive triggering for mixed-signal capability
- On-the-fly timing changes and multiple timing/control signals to improve your testing capability
- Bus handshaking and wait-state capability
- Automatic pin-to-pin deskew and compensation for pod cable delays (including delay compensation for custom field wiring)
- Optional development software with menu-driven graphic interface

HP 75000 Model D20 Digital Functional Test System

The HP 75000 Model D20 digital functional test system can be used to test the functions of digital and mixed-signal devices-under-test (DUTs). It is easy to program since it works the way your DUT works. High-speed control signals are separated from the data with different memories for each. Tester cycles, like your DUT's bus cycles, can have on-the-fly duration changes and edge placement. This architecture maximizes the pattern memory's effectiveness and gives the system a versatile interface capable of emulating most standard and proprietary buses or card edge interfaces.

Deep memory behind each pin means longer, uninterrupted test sequences, and minimizes time-consuming data loads. Segmentation allows multiple tests to be loaded at the same time.

A 20-MHz maximum data rate with 40 MHz clocks, strobes, and other control signals means many DUTs can be tested at speed. Real-time compare with masking and minimum data reloads provide high test throughput.

Interfacing to your DUT or analog instrument is easy. Qualifier inputs, control outputs, and a ready input allow the system to handle bus handshaking and wait states. Mixed-signal testing is made possible by comprehensive trigger input and output capability.

The Model D20 has four major components: HP E1450A 160-MHz timing module, E1451A/E1452A 20-MHz pattern I/O modules, E1453A/E1454A/E1455A/E1456A pods, and E1496A development software.

160-MHz Timing Module (HP E1450A)

The HP E1450A timing module is used with the HP E1451A and HP E1452A pattern modules, and controls the test. Each timing module can control up to 10 pattern modules (a full VXI mainframe). Up to three timing modules can be connected together using the master/slave function, allowing a system to contain up to 960 pattern I/O channels. Skew between any two pins (control signals and I/O channels) is less than ±3 ns, even in systems containing three VXI mainframes.

The HP E1450A has three independent timing generators for controlling the pattern modules and creating bus control signals, data strobes, and clocks. Up to 256 different timing cycles can be created, and these timing cycles can be changed on-the-fly. This on-the-fly timing ability allows timing parameters such as cycle length and edge placement to change on a vector-by-vector basis. All timing signals can be placed with 6.25-ns resolution and 6-ns accuracy.

The timing module also has complete test synchronization abilities. Condition inputs and control outputs provide bus handshaking, and a READY input allows for bus wait states. Comprehensive input and output triggering capability means that the Model D20 can be fully synchronized with analog instrumentation for mixed-signal testing. All of these features allow the Model D20, the DUT, or external instrumentation to pace the test.

20 MHz Pattern I/O Modules (HP E1451A, E1452A)

The HP E1451A and E1452A pattern I/O modules are used to send data to and receive data from the DUT at up to a 20-MHz pattern rate. Each module contains 32 I/O channels arranged in four ports of 8 bits. Each port can be programmed statically to output, record, or perform a real-time compare. On-the-fly tri-stating (on a port basis) allows two ports to be paralleled to form bidirectional channels. These pattern modules contain 64 K of memory behind each I/O channel. Multiple tests can be downloaded into this memory.

When the pattern modules are combined with the E1450A timing module, a pin-to-pin deskew operation automatically takes place at power-up. In addition, a command is provided to allow compensation for field wiring and fixturing delays.

Timing and Pattern Pods (HP E1453A, E1454A, E1455A, E1456A)

The HP E1453A and E1455A timing pods and HP E1454A and E1456A pattern pods are optional active pods with 2-m cables. One timing pod is used per timing module; two pattern pods are required for each pattern module. These pods buffer the timing and pattern channels to ensure maximum signal fidelity and bring system accuracy to the DUT. The pod cable delay is compensated for automatically.

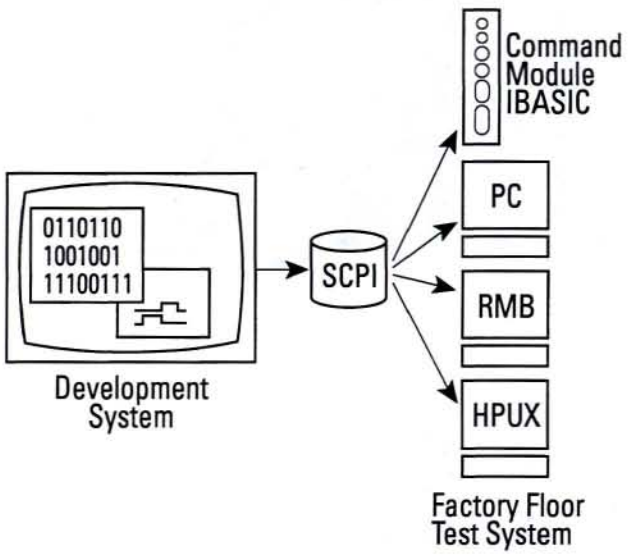
The HP E1455A and E1456A ICA pods can be used in the HP 75000 mass interconnect. Up to two pods can be mounted into each ICA slot by using HP 91474A Model D20 connector blocks. Use the general-purpose connector blocks, HP 91451A, to connect to the pods.

Digital Test Development Software (HP E1496A)

The HP E1496A development software helps you quickly and easily develop tests for the Model D20. This software runs on HP-UX workstations and is based on X Windows, Version 11, and OSF Motif. It uses pop-up windows and pull-down menus in a mouse-driven environment.

The software can be used standalone to develop tests, or the Model D20 hardware can be added to provide online debugging of tests. A window is included for developing timing cycles. The timing of various control signals and pattern clocks is graphically entered into this timing window. The timing of mixed-signal triggers also is entered into the timing window. Another window is used to enter and edit data patterns. Other screens are used for hardware configuration, signal naming, debugging, and so on.

Once a test is completed, it is converted into SCPI commands and stored as an ASCII or binary file. This file is platform-independent and can be used on different computers (such as an HP Vectra PC or HP BASIC Workstation) at run time. This file can also be used with Compiled SCPI.



Large vector files can be imported into the development software from other sources, such as logic simulators. A LASAR Version 6 translator for the Model D20 is currently available from Lewis Systems, Inc. (1915 Peters Road, Suite 113, Irving, Texas 75061, tel. 214-438-2177).

Model D20 Specifications

Timing

Skew (between any two pins): ±3 ns
Maximum number of timing cycles: 256
Subcycle resolution: 6.25 ns
Pattern clock delay resolution: One subcycle
Control output delay resolution: One subcycle

Pattern I/O

Maximum pattern rate: 20 MHz
Maximum pattern depth: 65536 (64 K) vectors
Skew between I/O pins (same port): 3 ns typical
Output levels
High, open-circuit: 4.4 V min
Low, open-circuit: 0.1 V max
High, sourcing 24 mA: 3.7 V min
Low, sinking 24 mA: 0.44 V max
Input levels
High: > 2.0 V
Low: < 0.8 V

Development Workstation Configuration (for HP E1496A)

Requires an HP 9000 Series 300 or 400 HP-UX workstation with:
- HP-UX 7.0 or greater, X/11, and OSF/Motif
- 8 MB RAM minimum; 16 MB recommended
- HP-IB (IEEE-488) interface, mouse
- Midrange graphics (1024 × 768) or better; color recommended
- Recommended models: HP 382, V/382, 380C+, 425s

Model D20 Ordering Information

The Model D20 requires an HP E1406A command module (or Compiled SCPI on an HP V/382) and a SCPI driver for SCPI compatibility. A command module is also required if the development software (HP E1496A) is used with the Model D20 hardware for online debugging. In general, each Model D20 system should contain an HP E1450A timing module and an HP E1452A terminating pattern I/O module. Additional I/O channels are obtained by adding additional HP E1451A pattern I/O modules. The SCPI drivers are provided in the basic configurations listed here (HP E1493A and E1494A).

To expand a Model D20 system beyond one mainframe (up to two additional mainframes), two choices for frame-to-frame communications are available. The system can be extended using HP-IB or MXIbus (HP E1482A). An HP E1406A command module is required in all VXI mainframes for HP-IB expanded systems. If MXIbus is used for expansion, a command module is not needed in the second and third mainframes. In all cases, one HP E1450-61603 master/slave expansion cable is required for each timing module.

Ordering Information	Price
HP E1493A, HP 75000 Model D20	$11,455
Includes HP E1450A timing module, HP E1453A timing pod, HP E1452A terminating pattern I/O module, two HP E1454A pattern I/O pods, downloadable SCPI drivers in LIF and DOS formats (two 3.5-in floppy disks), and documentation	
Opt 010 Add an HP E1451A Pattern I/O and HP E1454A Pod	$4,680
HP E1494A, HP 75000 Model D20 Development System	$14,455
Includes the same items as the HP E1493A plus HP E1496A development software	
Opt 010 Add an HP E1451A Pattern I/O and HP E1454A Pod	$4,680
Opt AA0 ¼-in Tape Cartridge	N/C
Opt AAH DDS Tape Cartridge	N/C
Other Components	
HP E1450A 160 MHz Timing Module	$6,600
HP E1451A 20 MHz Pattern I/O	$3,500
HP E1452A Terminating 20-MHz Pattern I/O	$3,500
HP E1453A Timing Pod	$675
HP E1454A Pattern I/O Pod	$590
HP E1455A ICA Timing Pod	$825
HP E1456A ICA Pattern I/O Pod	$740
HP E1496A Model D20 Development Software	$3,500
Opt AA0 ¼-in Tape Cartridge	N/C
Opt AAH DDS Tape Cartridge	N/C
HP E1450-80001 Model D20 SCPI Driver	$175
HP E1450-61603 Master/Slave Expansion Cable	$0
HP 91474A Model D20 ICA Connector Block	$191

For More Information

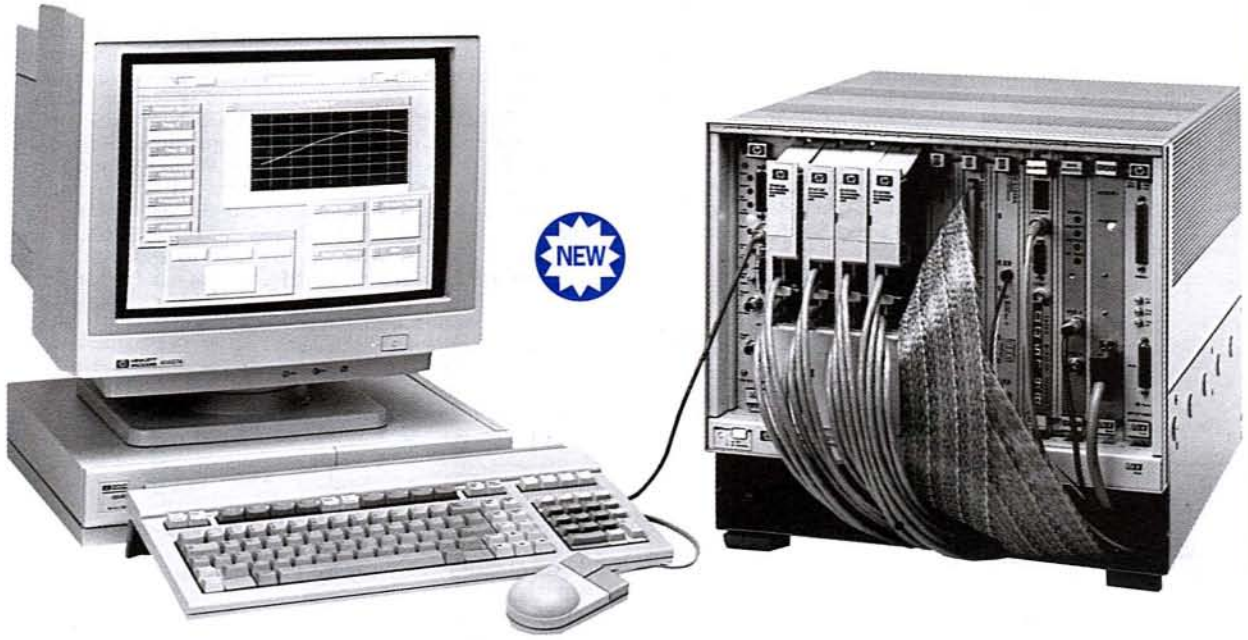
Consult the *HP 75000 Family of VXI Products* catalog or the HP 75000 Model D20 Product Note (HP 5091-2105E).

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

VXIbus PRODUCTS

High-Speed Data Acquisition System

HP 75000 Model HD2000



HP 75000 Model HD2000 High-Speed Data Acquisition System

The HP 75000 Model HD2000 Data Acquisition System provides a standards-based, integrated data acquisition and computer system optimized for high-speed data acquisition applications. These applications include engine test, wind tunnel test, structural analysis, vehicle test, thermal mapping, and rocket test, among others.

Industry-Standard VXIbus Architecture

The performance advantages of the VXIbus standard offer a perfect architecture for the new HP 75000 Model HD2000 high-speed data acquisition system. The industry-wide, open VXIbus architecture provides guaranteed system compatibility and reduced risk of integration problems.

Flexible, Modular, Scaleable

Using the VXIbus architecture, a system of any size can be configured to meet your unique application needs. Extender card cages are available to provide a future growth path as your applications expand. Various card types, sizes, and capabilities provide system flexibility and allow easy reconfiguration of systems at any time.

High Continuous Data Throughput

By utilizing the full capability of the VXIbus backplane, the Model HD2000 can achieve high continuous data throughput from measurement cards to computer, disk, and/or display. This together with the power of an embedded controller, FIFO buffering, and on-board engineering unit conversions, makes the Model HD2000 a truly high-performance data acquisition system.

Complete Static and Transient Measurement and Control

The Model HD2000 provides a complete set of measurement, control, and interfacing capabilities. Measurement capabilities include both static and transient temperatures (thermocouples, RTDs, and thermistors), strain, pressure, analog voltage and resistance, frequency, RPM, period, digital input, and angular rotation. Digital and analog outputs, RS-232, LAN, IEEE-488, ARINC-429, MIL-STD-1553, and IRIG B time codes encompass the output control and interfacing features of the Model HD2000. The system offers a complete solution to all of your data acquisition application needs.

Consistent, Efficient Software Environment

The Model HD2000 software development environment includes the new Compiled SCPI software. Compiled SCPI is based on the standard commands for programmable instruments (SCPI) programming language, the industry standard. Compiled SCPI, which can be compiled along with standard C programming code, provides high-speed data acquisition without the tedious process of programming at the register level. This feature means less programming time, less documentation, and fast throughput for your high-speed data acquisition application.

Integrated Data Acquisition and Computer System

The Model HD2000 system offers all of the tools necessary to address your measurement needs. These include precision measurement hardware tuned for high-speed data acquisition, powerful embedded controllers, and efficient software development tools. Thus, with the Model HD2000, integration tasks such as configuring, programming, and installing your VXI data acquisition solution are made easier.

The HP 75000 Model HD2000 provides a complete standards-based, high-performance solution to your high-speed data acquisition application needs.

For complete details, please see the HP 75000 Model HD2000 Technical Data Sheet (HP p/n 5091-4830E).

- 10 MSamples/second ADC
- 23-bit resolution
- 18-bit (110 dBFS) linear operating range
- −135 dBFS/Hz Noise Floor
- Filtering
- Memory

NEW

HP E1430A Digitizer

The HP E1430A is more than just a digitizer, it is a complete A/D module. Included with its low distortion and low-noise analog-to-digital converter are flexible input signal conditioning, tunable digital filtering, and deep FIFO memory.

The HP E1430A A/D is a two-pass, 10 MSample/s A/D with 23-bit resolution. It combines dithering with an HP-proprietary on-the-fly distortion-correction technique to produce up to 18 bits (110 dBFS) of distortion-free, spur-free operating range.

The HP E1430A is quiet. Its noise floor is −135 dBFS/Hz, state of the art for digitizers.

Advanced filtering is standard in the module. The anti-alias filter is a 4-MHz analog filter that can be bypassed when aliasing is not a concern and when signals above 4 MHz need to be digitized. Multi-stage digital filtering follows the digitizer and provides 25 frequency spans, starting at 4 MHz and going down to 0.24 Hz in octave steps. All spans center frequencies are tunable in 10 μHz steps by a digital LO.

Input signal conditioning includes ac/dc coupling and 11 attenuation/gain ranges.

A high-speed 4 MSample memory captures transients or acts as a FIFO for continuous samples.

Transfer data off board over the standard VXI back plane P1 connector or use the high-speed local bus. The local bus uses pins on the P2 connector and a gate array developed by Hewlett-Packard to make card-to-card data transfers at rates as high as 25 MB/s.

Register-based programming provides high-speed control of the HP E1430A. C language library and coding examples illustrate how to control each register and are provided in the manual. Instrument drivers for higher-level programming control from HP VEE and ITG are also provided.

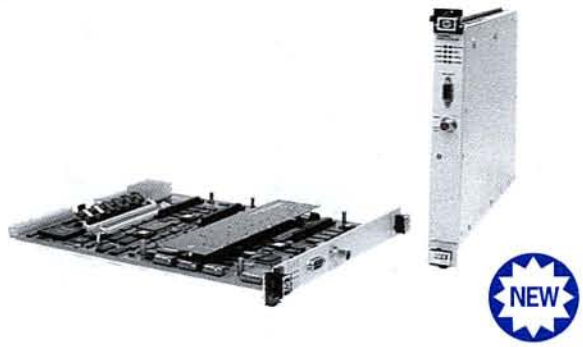
Specifications

Amplitude Ranges: +26 dBm to −34 dBm, in 6 dB steps
Frequency Ranges: 4 MHz to 0.24 Hz, in octave steps, alias protected
Distortion: < −110 dBFS or −80 dBc, whichever is greater
Spurious/Alias: < −110 dBFS
Noise Floor: < −135 dBFS/Hz, 1KHz < Fo < 4 MHz and top 8 ranges
Filtering: 4 MHz anti-alias filter (switchable), 25 digital decimation and filter spans, digital LO for tuning the spans

Ordering Information

	Price
HP E1430A 10 MSa/s ADC with Filter/Memory	$12,000

- Digital signal processor
- Choice of DSPs
- 4 MB RAM standard, upgradable to 16 MB
- Programming toolkit for application development
- Flash ROMs for operating system and applications software



NEW

HP E1485A/B Digital Signal Processor Module

The HP E1485A/B Digital Signal Processor Module is a high-performance measurement controller and digital signal processor. It combines a 32-bit microprocessor with a choice of state-of-the-art DSP ICs to achieve measurement processing performance previously seen only in top line workstations.

DSPs

For FFT speed select the HP E1485A. Its 32-bit Motorola 96002 floating-point DSP IC does 1K complex FFTs in under 2 ms. Up to four DSPs can be added to the HP E1485A. For economy, select the HP E1485B. Its 24-bit Motorola 56001 fixed-point DSP IC does 1K complex FFTs in under 4 ms. Up to 3 DSPs can be added to the HP E1485B.

High-Speed Data Transfer

Transfer data on or off board over the standard VXI P1 connector or use the high-speed local bus. The local bus uses pins on the P2 connector and a gate array developed by HP to make data transfers at up to 20 MB/s.

This bus is HP's implementation of a VXI protocol. Only VXI cards that use this protocol can send data over the local bus to the HP E1485A/B.

Software

Software for the HP E1485A/B is developed on a host workstation using the HP 35635T Programmers Tool Kit. This C-language-based development environment provides the tools to develop downloadables to control the HP E1485A/B. These tools include VXI I/O, host communication, DSP control, optimized data transfers, timer operations, software signaling, math functions, and debugging. DSP libraries for the 56001 and 96002 include FFT (forward and inverse), block math (+, −, *, constant, scale, offset) and digital filtering functions.

DSP Co-Processor Driver (Option AS2)

To get the user up and running quickly, the HP E1485A/B has a DSP co-processor driver. This driver is for use with HP VEE or ITG. It provides single DSP FFT with variable block sizes.

HP 3565S I/0 (Option 1FN)

The HP E1485A/B has an optional I/O port to the HP 3565S. This interface gives the HP E1485A/B all the system control capabilities of a native HP 3565S Signal Processor.

Ordering Information

	Price
HP E1485A Signal Processor (96002)	$10,500
HP E1485B Signal Processor (56001)	$8,000
Opt AN2 Add 4 MB RAM	$1,500
Opt UFC Add 8 MB RAM	$3,000
Opt UF5 Add 12 MB RAM	$4,500
Opt 1FL Add One 96002 DSP	$3,000
Opt 1FM Add One 56001 DSP	$1,500
Opt 1FN Add 3565 I/O	$1,500
Opt AS2 Co-Processor Driver	$50
HP 35635T Programmers Tool Kit	$4,000

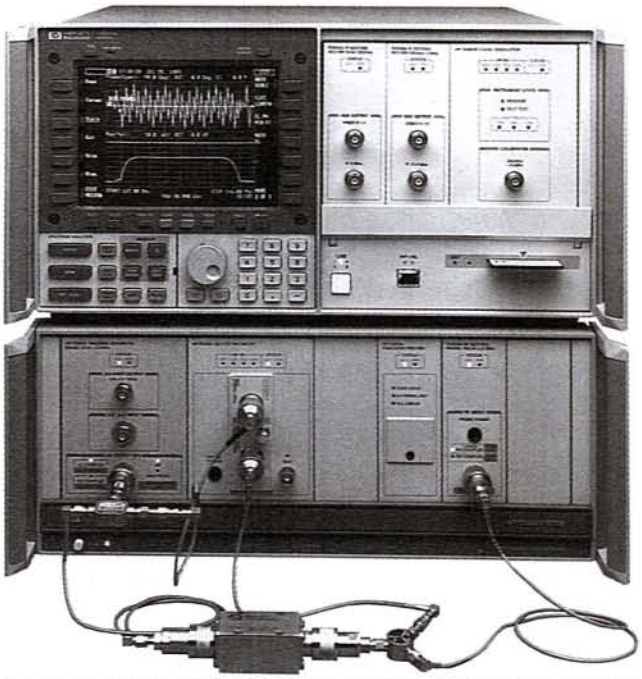
For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

MMS PRODUCTS

HP 70000 Modular Measurement System

General Information

- Optimized for RF and microwave automatic test systems
- Modular for easier system integration
- Wide variety of products and configurations available



Spectrum analyzer integrated with tracking generator and vector voltmeter

DESIGNED FOR HP-IB SYSTEMS

HP 70000 Modular Measurement System

The HP 70000 modular measurement system (MMS) is a high-performance modular platform featuring:

- A wide variety of over 40 modules that offer low-frequency, RF, microwave, and even lightwave measurement capability
- Easy system integration aided by standard and custom switching modules, plus an open architecture with design tools that allow you to design and build your own specialized modules
- Multiple displays that allow operation from local or remote locations, and mainframes and displays that can be separated by up to 1.2 km
- Electromagnetic compatibility (EMC) design for microwave environments
- Compatibility with other open standards (for example, HP-IB) to allow you to use new and existing hardware, software, and engineering expertise

Maximize Your Investment

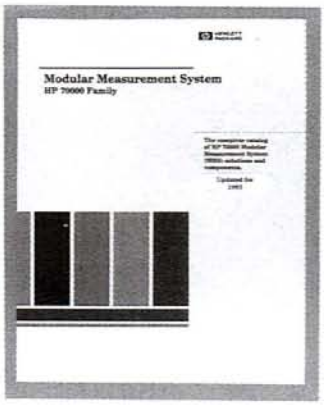
Several factors reduce MMS life-cycle costs:

- MMS integrates quickly using off-the-shelf mainframes, components, and software packages.
- MMS allows system configuration to provide just the right amount of measurement capability.
- Downsizing enhances ATE systems by reducing rack space.
- A central, shared display allows operator focus and monitors up to four instruments at once in real time, further reducing rack space. The system even works without a display, saving more space and reducing cost.
- Built-in diagnostics and modularity team up to maximize system uptime, allowing you to make the best use of your investment.

A variety of products and services are available to help you customize your entire system or design and build a single custom module. Multiple support alternatives allow you to customize the logistics of each system to fit installation needs. With MMS, you are assured of the highest performance and best customer support—today and in the years to come.

Free MMS Catalog

The following pages highlight selected components and systems in the HP 70000 family. A complete list of all MMS products with full descriptions, specifications, and services is also available. For a free copy of the new *HP 70000 Modular Measurement System* catalog, contact your local Hewlett-Packard sales and support office listed on page 676. Ask for part number 5091-4897E.



- Broadband frequency coverage: 10 MHz to 20 GHz
- Outstanding output level accuracy and flatness
  ±1 dB accuracy
  ±0.5 dB flatness
- Versatile programming: SCPI and CIIL
- Superior EMI performance
- High-performance modulation: AM, FM, and pulse
- Excellent spectral purity: −55 dBc harmonics
  −60 dBc spurious

HP 70340A

DESIGNED FOR HP-IB SYSTEMS

HP 70341A

NEW

HP 70340A Modular Synthesized Signal Generator
HP 70341A Frequency Extension Module

A New Standard of Performance and Value

The HP 70340A modular signal generator and new HP 70341A frequency extension module satisfy the demands of modern ATE for smaller high-performance signal sources. Their small size, light weight, excellent reliability, and high performance make them the signal sources of choice for downsized and portable ATE. Their high MTBF (> 20,000 hours), extended calibration cycle (two years) and low calibration time (< six hours for full cal) reduce system downtime in high throughput commercial ATE. A wide selection of options adds extra capability where you need it and saves money in less stringent systems. SCPI programming assures that system software designed around the HP 70340A/41A will remain compatible and upgradable for years to come.

All the Performance of Traditional Rack-n-Stack Sources in Half the Rack Space

Test receivers and subsystems from 10 MHz through 20 GHz with confidence knowing that even at full power (typically > +14 dBm) the HP 70340/41A provide superior harmonic (−55 dBc) and spurious (−60 dBc) performance. Excellent output power accuracy (±2 dB) and flatness (±0.5 dB) are maintained across the full HP 70340/41A > 100 dB dynamic range.

The HP 70340/41A combine superior internal level accuracy and flatness with the flexibility of User Level Correction. This feature allows users to calibrate and program the signal generator output for automatic leveled power at distant test ports. Level correction tables can be stored in memory for quick access as the system is reconfigured for different DUTs or test scenarios. Internal level accuracy is maintained at all output levels by means of pre-programmed correction data.

Generate real world signals using the FM, pulse, and logarithmic AM modulations. The logarithmic AM can be combined with the fast pulse modulation to simulate antenna scanning patterns of pulsed EW emitters. Log AM also can be used to sweep output power with excellent linearity for use in component testing. The high index FM provides extra capability for testing telemetry and other wide deviation systems.

Extend Your Capabilities with High-Performance RF Testing

The new HP 70341A frequency extension module brings microwave performance to RF and IF testing. The HP 70340A's powerful modulation, low harmonics (−55 dBc) and zero subharmonics are available from 10 MHz to 1 GHz with higher output power (> +13 dBm) and lower phase noise. Phase noise decreases 6 dB per octave as the output frequency is reduced making the HP 70340A/41A combination an ideal in-channel receiver test stimulus as well as a powerful microwave signal source. Elimination of downconversion mixers reduces broadband noise, and switched low pass filters generate fast, high-fidelity pulse modulation. Logarithmic AM adds capability not found in conventional RF signal sources. Full 10 MHz to 20 GHz coverage is yours from a single RF output connector without sacrifice in level accuracy (±2 dB) or flatness (±0.5 dB). The HP 70341A is slaved to the HP 70340A so all your system software runs on the combination without change!

Performance, Value, and Flexibility to Satisfy Any Application

Combine the HP 70340/41A with other HP modular instruments to provide high-performance test stations.

For example the HP 70340/41A are natural companion signal sources for the HP 71500A Microwave Transition Analyzer. Together, these modular instruments offer powerful pulsed component test capability. Option 1E8 provides the 1 Hz frequency resolution needed for full system capability.

Abbreviated Specifications

For complete specifications, refer to the HP 70340/41A technical data sheet lit. no. 5091-4649E.

Frequency Range: 1 to 20 GHz; 10 MHz to 20 GHz with HP 70341A
Resolution: 1 kHz, 1 Hz with Option 1E8
RF Output: +10 to −90 dBm 1 to 20 GHz
+13 to −90 dBm 10 MHz to 1 GHz
Resolution: 0.01 dB
Accuracy: ±1 dB, −4 dBm to maximum power
Harmonics: −55 dBc
Nonharmonic Spurious: −60 dBc
Phase Noise: −86 dBc/Hz at 10 kHz offset at 6 GHz
Modulation: AM, FM, Pulse
Size: 4/8 MMS module HP 70340A; 1/8 MMS module HP 70341A
Weight: Net, <9 kg (20 lb) HP 70340A; <4 kg (10 lb) HP 70341A

Ordering Information

HP 70340A Modular Signal Generator	$29,500
HP 70341A Frequency Extension Module	$6,000
Opt 1E1 Add Output Step Attenuator	$2,000
Opt 1E2 Internal Pulse Modulation Source	$1,500
Opt 1E8 1 Hz Frequency Resolution	$2,000
Opt 1E9 3.5-mm RF Output Connector	$500

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

MMS PRODUCTS

HP 70000 Modular Measurement System

Microwave Transition Analyzer

- dc to 40 GHz with two channels
- Pulsed RF: Magnitude, phase, and frequency profiling of pulses
- CW signals: Time waveforms plus magnitude and phase of harmonics
- Internally triggered
- Frequency and power sweeps
- 1 ps delta time accuracy

HP 71500A Microwave Transition Analyzer

DESIGNED FOR HP-IB SYSTEMS

HP 71500A Microwave Transition Analyzer

The HP 71500A microwave transition analyzer is a two-channel, sampler-based instrument for measurements from dc to 40 GHz. It consists of the HP 70820A microwave transition analyzer module and an HP 70004A color display/mainframe.

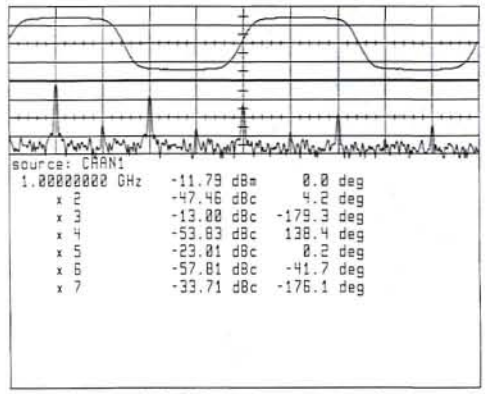
The instrument makes continuous wave and pulsed RF measurements, specializing in measuring fast magnitude and phase transitions. Performance specifications include 1 ps delta time accuracy, 10 ps rise and fall time, and internal triggering to 40 GHz. You can measure phase settling, rise and fall times, on/off ratios, time delay, switching time, peak and average power, group delay, and more.

The microwave transition analyzer incorporates measurement functions from many instruments: The oscilloscope, vector network analyzer, vector voltmeter, spectrum analyzer, modulation domain analyzer, frequency counter, and peak power meter. Compact modular measurement system (MMS) format makes the HP 71500A ideal for use in ATE systems or anywhere that downsizing and measurement versatility is required. Optimal performance requires use of a synthesized source, which is ordered separately.

Nonlinear Microwave Analysis

With 40-GHz internal triggering, you can directly view nonlinear effects in the time domain. A fast Fourier transform (FFT) display simultaneously shows the signal and its harmonics in the frequency domain. Results are also presented in waveform and tabular (numerical) formats, allowing you to verify the performance of microwave devices modeled with nonlinear CAE tools.

Simultaneously Display Time and FFT



Simultaneous time and FFT display let you see microwave distortion. Results can be compared easily to CAE simulations.

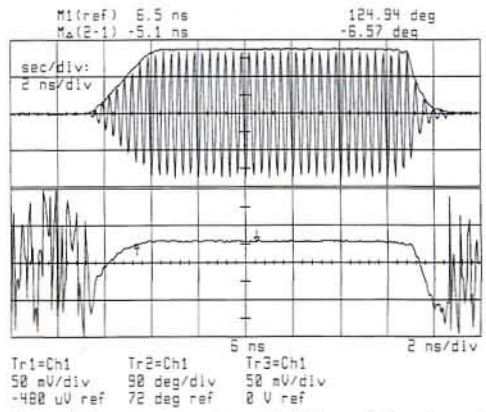
Pulsed Component Test

To measure components such as switched pulsed amplifiers, traveling wave tubes, and active RF switches, the microwave transition analyzer offers four ways of viewing pulsed RF signals:

- Real format, an RF waveform display similar to that of an oscilloscope
- Magnitude format, an RF envelope display with linear scaling
- Log magnitude format, an RF envelope display with log scaling
- Phase format, a display of RF phase versus time in the pulse

The analyzer measures signals with pulse widths to 100 ps. Triggering on the pulse envelope stabilizes waveforms for making rise and fall time measurements. You can directly measure video feedthrough on the RF carrier, because the microwave transition analyzer can separate and remove the video feedthrough without external filters.

Measure Fast Pulses



Magnitude and phase versus time of a 12-ns-wide pulse of RF. Log magnitude is also available.

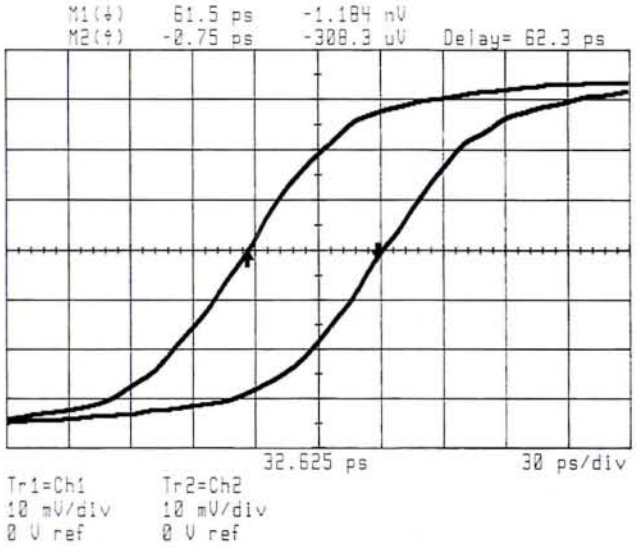
For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

Digital Design

Designers of digital integrated circuits and monolithic microwave integrated circuits (MMICs) can use the HP 71500A microwave transition analyzer to model and characterize devices.

Capabilities for high-frequency measurements in the time domain include 1-ps delta time accuracy and internal triggering to 40 GHz. Phase triggering and noise filtering allow you to measure signals as low as −60 dBm (220 μV rms). Viewing events prior to the trigger can be done easily without delay lines. You also have the benefit of simultaneously viewing the time domain waveform and the frequency domain spectrum, including the phase relationship between the signal and its harmonics.

Accurate Delay Measurements

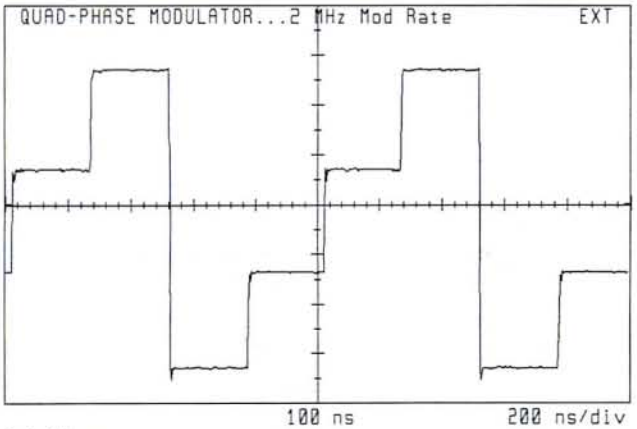


Measure delay through a logic device with 1-ps accuracy.

Communications Test

In the testing of high-speed communication systems, the microwave transition analyzer can be used with an external controller to measure the group delay of receivers. The system measures the group delay of satellites and other high-speed communication systems that use phase shift keying (PSK), narrowband FM, and other digital modulation techniques.

Characterize Modulation Versus Time

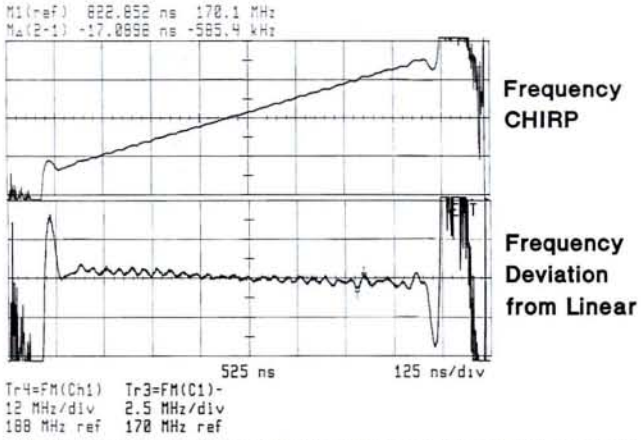


The four phase states of a quad-phase modulator can be viewed easily.

Radar Test

You can test synthesized radar systems with measurements such as deviation from linear chirp. The microwave transition analyzer displays amplitude, phase, and frequency versus time for modulation rates to greater than 1 GHz. Maximum frequency deviation is equal to 500 divided by the time span in seconds.

Verify System Performance



Extensive user math functions allow you to easily characterize your radar system. The microwave transition analyzer is ideal for verifying the output of the HP FASS system.

More Information

Detailed specification and application materials are available in a variety of formats. To order any of the following free of charge, contact your local HP sales office listed on page 665.

Color Brochure	Lit. #5091-0791E
Videos:	
Microwave Design in Radar and Communications	p/n 90454T
Switched and Pulsed RF Component Testing	p/n 90453T
Product Notes:	
A Versatile Measurement Set for Bench and Test (70820-1)	Lit. #5952-2543
Measure 25 ps Transitions in Switched and Pulsed Microwave Component Testing (70820-2)	Lit. #5952-2546
Picosecond Delta Time Accuracy (70820-3)	Lit. #5952-2545
Technical Data Sheet	
Specifications and complete ordering information	Lit. #5091-0792E
Catalog	
Modular Measurement System Catalog	Lit. #5091-4897E
Menu Map (revision 1.01)	Lit. #5091-3764E

Ordering Information

	Price
HP 71500A Microwave Transition Analyzer System	$43,200
Opt 003 Add Tutorial Kit	+$2,600
Opt 910 Add Extra Set User's Manuals	+$250
Opt 915 Add Service Manuals	+$200
HP 70820A Microwave Transition Analyzer Module	$32,500
Opt 003 Add Tutorial Kit	+$2,600
Opt 910 Add Extra Set User's Manuals	+$200
Opt 915 Add Service Manuals	+$150
Opt W30 Extended Repair Service (see page 636)	+$815

MMS PRODUCTS

HP 70000 Modular Measurement System

Spectrum Analyzers

- High performance
- Modular flexibility
- HP 8566B code compatibility

HP 70000 Series

DESIGNED FOR HP-IB SYSTEMS

HP 70000 Series Spectrum Analyzers

Four factory-configured analyzers cover the RF and microwave frequency range:

- HP 71100C for 100 Hz to 2.9 GHz
- HP 71200C for 50 kHz to 22 GHz, either preselected or without preselection, offering the maximum flexibility with optional preamplifiers and preselectors
- HP 71209A for 100 Hz to 26.5 GHz, preselected with optional preselection bypass and wide IF outputs, offering sensitivity of −128 dBm at 26.5 GHz
- HP 71210C for 100 Hz to 22 GHz, with a dynamically tracking preselector for maximum amplitude accuracy in swept measurements, offering sensitivity of −133 dBm at 22 GHz

All four systems include the HP 70004A color display and mainframe, allowing data storage on pocket-sized memory cards. A hardkey panel provides the most commonly used spectrum analyzer functions. Digital persistence in the color display simulates the variable intensities of an analog display without sacrificing the storage, computation, and plotting capabilities of the digital instrument. This feature allows you to extract information from complex modulation signals such as TV-pulsed RF and FM.

Code Compatibility with the HP 8566B

To ease the transition to a high-performance ATE analyzer with the support and configuration benefits of modularity, all of the HP 70000 Series spectrum analyzers offer code compatibility with the HP 8566B microwave spectrum analyzer. For more information, ask for product note 70900-1.

Flexibility for Automated Systems

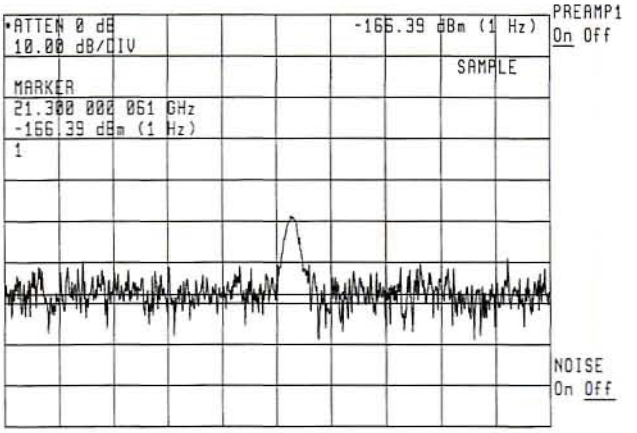
With the HP 70000 Series spectrum analyzers, you can customize your automated test system for your current needs and then expand it as your needs increase. By combining the analyzers with accessory modules, switch matrixes, and application software, you can build a system with just the right performance. For example, add a digitizer for radar testing, tracking generators and a vector voltmeter for component testing, preamplifiers for spurious testing and surveillance applications, and an external mixer interface module (standard on the HP 71209A) for millimeter measurements.

Hewlett-Packard also offers a series of design tools to help you build custom modules. These include MSIB interface software, module development design guides (electrical, mechanical, and electromagnetic compatibility, or EMC), communication design guides (bus protocol and interface, display interface), and four module prototype kits with hardware for one- to four-slot modules.

Performance that Gives You the Competitive Edge

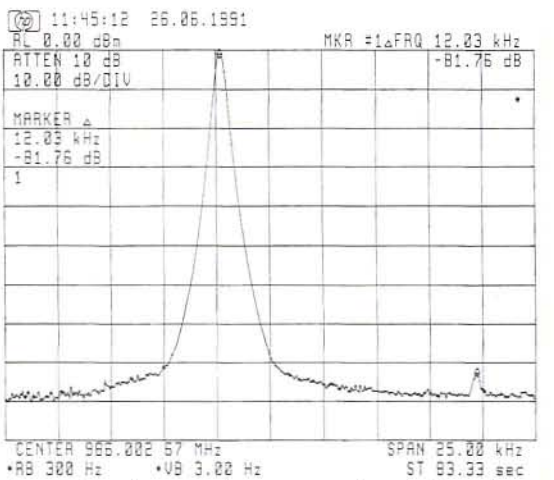
The synthesized performance of HP 70000 series spectrum analyzers gives you optimum performance for use in the lab and manufacturing and in integrated test systems.

- Sensitivity of −133 dBm at 22 GHz or −130 GHz at 26.5 GHz helps to measure even the lowest-level signals. With sensitivities like these, you can increase the resolution bandwidth to speed up your measurement, while still getting the sensitivity needed.



Excellent sensitivity allows you to measure extremely low-level signals.

- Display fidelity of ±0.7 dB allows you to accurately measure amplitude anywhere within the 90-dB calibrated display range without time-consuming IF substitution techniques.
- Resolution bandwidths as narrow as 10 Hz and available in 10 percent increments allow you to optimize your measurements for maximum throughput.
- Excellent close-in phase noise (for example, 105 dBc at 1 kHz) improves your ability to make measurements in closely spaced signals.



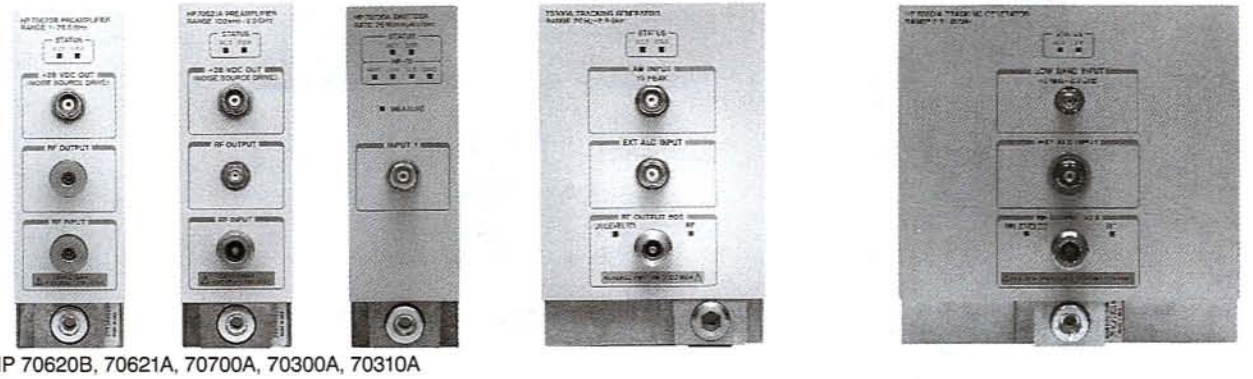
Low phase noise allows you to measure adjacent channel power of high-performance communication systems.

- Two-tone spurious-free dynamic range of 95 dB allows accurate measurements over demanding amplitude extremes.
- Oven-controlled reference oscillator gives 0.1-ppm frequency accuracy and stability over temperature and time.

Selected specifications for these spectrum analyzers are found on page 249.

Free MMS Catalog

A complete list of all MMS products with full descriptions, specifications, and services is available. For a free copy of the new *HP 70000 Modular Measurement System* catalog, contact your local HP sales and support office listed on page 665. Ask for HP p/n 5091-4897E.



HP 70620B, 70621A, 70700A, 70300A, 70310A

HP 70620 Series Preamplifiers

Boost the sensitivity of any HP 70000 series spectrum analyzer by 15 to 25 dB using the HP 70621A preamplifier (100 kHz to 2.9 GHz) or the HP 70620B preamplifier (1 to 26.5 GHz; 100 kHz to 26.5 GHz with Option 001). For RF applications, a −134 dBm sensitivity improves to −156 dBm, and for microwave applications, a −133 dBm sensitivity improves to −150 dBm at 22 GHz. See page 249 for sensitivity specifications with individual spectrum analyzers.

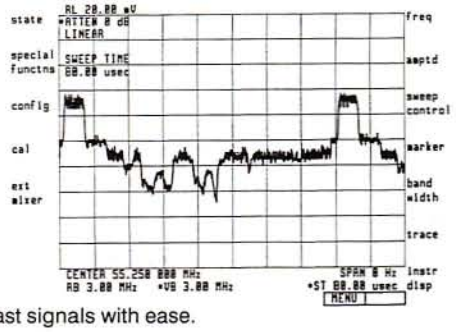
System noise figure can be better than 8 dB to 2.9 GHz, 11 dB to 12.8 GHz, and 14 dB at higher frequencies. You can dramatically reduce the test time for spurious measurements because the low system noise figure lets you use a wider-resolution bandwidth, yet achieve the same sensitivity. Sweep times can improve up to a factor of 100 for each decade increase in bandwidth.

The preamplifier modules also provide a drive signal for an external excess noise source, allowing you to measure the noise figures of amplifiers and other devices.

HP 70700A Digitizer

The HP 70700A digitizer module adds precision digitizing capability to the modular measurement system. Integrated into an HP 70000 series spectrum analyzer, it improves the system's ability to analyze signals in the time domain. A high sampling rate allows recovery of fast pulses, limited only by the bandwidth of the spectrum analyzer signal path.

This module can also be used as a standalone digitizing oscilloscope, transient analyzer, or waveform recorder. Up to 8 digitizers can be operated synchronously without loss in performance. A special feature, Random Event Capture, stores randomly occurring events as they happen, complete with pre-trigger data and timing information.



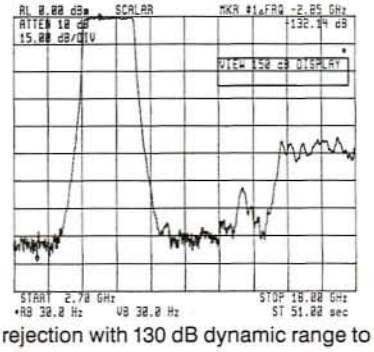
Digitize fast signals with ease.

HP 70700A Specification Summary

Maximum Sampling Rate: 20 Msamples per second
Amplitude Resolution: 10 bits
Harmonic and Spurious Distortion: ≥ 50 dB at 1 MHz; ≥ 45 dBc at 10 MHz
Bandwidth: 10 MHz single shot; > 35 MHz analog (3 dB)
Waveform Memory: 262,144 (256K) 10-bit words
Data Transfer Rate: 60 kB/s (nominal)
Swept Frequency Span: 15 ms to 335 s with 800-point trace
Fixed Frequency (zero span): 80 μs to 335 s with 800-point trace
Displayed Digitizing Resolution: 0.12 dB
Note: Specification changes to HP 70000 spectrum analyzer with HP 70700A

HP 70300A and 70301A Tracking Generators

The HP 70300A RF and HP 70301A microwave tracking generators add high-performance scalar network analysis capabilities to the modular measurement system for component and sub-assembly testing. They can be combined with HP 70000 series spectrum analyzers, synthesizers, vector voltmeters, and power meters to create a component test workstation for scalar, vector, and signal analysis measurements. The tracking generators give you stimulus-response capability to measure gain, frequency response, and return loss. Use the HP 70301A with an HP 71209A or 71210C spectrum analyzer for a scalar dynamic range of > 130 dB from 2.7 to 18 GHz for high-isolation measurements. Together, the tracking generators provide continuous frequency coverage from 10 MHz to 18 GHz.



Measure filter rejection with 130 dB dynamic range to 18 GHz.

HP 70300A and 70310A Specification Summary

	HP 70300A	HP 70301A
Frequency Range	20 Hz to 2.9 GHz	2.7 to 18 GHz
Frequency Accuracy (≤10 MHz span)	±[(freq × ref) + 1% span + 15 Hz]	±[(freq × ref) + 1% span + 15 Hz]
Amplitude Accuracy (20° − 30° C)		
Absolute	±0.75 dB at 300 MHz	±0.5 dB at 2.7 GHz
Flatness	±0.5 dB	±1.0 dB
TG Feedthrough with HP 70908A Front End	< −138 dBm	< −130 dBm

Free MMS Catalog

A complete listing of all MMS products with full descriptions, specifications, and services is available. For a free copy of the new *HP 70000 Modular Measurement System* catalog, contact your local HP sales office listed on page 665. Ask for HP p/n 5091-4897E.

Ordering Information

	Price
HP 70300A Tracking Generator Module, 20 Hz to 2.9 GHz	$13,100
HP 70301A Tracking Generator Module, 2.7 to 18 GHz	$27,400
HP 70620B Preamplifier Module, 1 to 26.5 GHz	$8,600
Opt 001 100 kHz to 26.5 GHz	+$4,840
HP 70621A Preamplifier Module, 100 kHz to 2.9 GHz	$5,275
HP 70700A Digitizer Module	$8,600

For the most current prices and product information, contact your local Hewlett-Packard sales office, see page 665.

MMS PRODUCTS

HP 70000 Modular Measurement System

Instruments and Systems

HP 71150C and 71250C

DESIGNED FOR HP-IB SYSTEMS

HP 71150C and 71250C GSM Transmitter Testers

The HP 71150C and 71250C systems are fully configured, high-performance test stations for characterizing Pan-European digital cellular radio transmitters. The systems are based on HP 70000 Series spectrum analyzers and allow time- and frequency-domain testing of base and mobile station transmitters. The HP 71150C has a frequency range of 100 Hz to 2.9 GHz; the HP 71250C has a frequency range of 100 Hz to 22 GHz.

Both systems make all the transmitter tests required by the Groupe Speciale Mobile (GSM) 11.20 and 11.10 specifications. The systems include the HP 11836B GSM personality, a downloadable program that provides the systems with softkeys for making GSM measurements quickly and completely. A patented algorithm accurately measures phase and frequency errors of the 0.3 Gaussian minimum shift key (GMSK) modulation signal.

The GSM transmitter testers run all measurement software—an external controller is not required, but can be used in automatic systems. Test data is displayed in graphical, tabular, and swept display formats. For more information, see the modular measurement system (MMS) catalog described on page 88.

HP 71600 Series Gigabit Error-Rate Testers

The HP 71600 Series offers a flexible approach to high-speed digital testing. The HP 71601A and 71603A provide complete solutions for error performance analysis to 1 and 3 Gbit/s. They include a pattern generator, error detector, synthesized clock source, and display. The HP 71602A and 71604A are pattern generators operating to 1 and 3 Gbit/s. They include a pattern generator, synthesized clock source, and display. (See page 556.)

HP 71400C and 71401C Lightwave Signal Analyzers

The HP 71400C and 71401C combine an HP 70000 Series spectrum analyzer with a sensitive, wide-bandwidth optical receiver module. The result is an instrument for analyzing lightwave communication signals and systems. The HP 71400C has a frequency range of 100 kHz to 22 GHz; the HP 71401C has a frequency range of 100 kHz to 2.9 GHz. Displayed average noise level is better than −60 dBm (optical) in a 10-Hz resolution bandwidth. Modules are available for both systems to cover wavelength ranges of 1200 to 1600 nm and 750 to 850 nm. (See page 570.)

HP 70100A Power Meter

The HP 70100A is a single-channel power meter with features and capabilities similar to those of the HP 437B, but using only half the rack space (one slot). Accuracy is specified as ±0.5 percent in linear mode and ±0.02 dB in logarithmic mode. (See page 172.)

HP 70110A Digital Multimeter

The HP 70110A is a high-speed (1450 readings per second), two-slot module providing 3½ to 6½ digits of resolution while measuring dc and ac volts, two-wire and four-wire Ω, dc and ac current, frequency, and period. Basic dc accuracy is 5 ppm with a common mode rejection of over 90 dB. Options allow for several multiplexing configurations.

HP 70120A Universal Counter

The HP 70120A is a three-input counter with 100 MHz, 200 MHz, and 2.4 GHz inputs. This full-featured universal counter has a minimum sensitivity of 100 mv p-p, with a built-in TCXO. The counter provides 60 measurements per second and has external arming and gating available. The module is one slot wide.

HP 70138A Vector Voltmeter

The HP 70138A is a two-channel tuned receiver that adds magnitude and phase measurements to the HP 70000 system, with a sensitivity of 10 μV for measurements on very small signals. Standard inputs are high impedance (100 kHz to 1 GHz). Option 050 provides 50-Ω inputs (300 kHz to 2 GHz). The module is similar to the HP 8508A, but uses one-third the rack space (two slots). (See page 291.)

HP 70703A Digitizing Oscilloscope

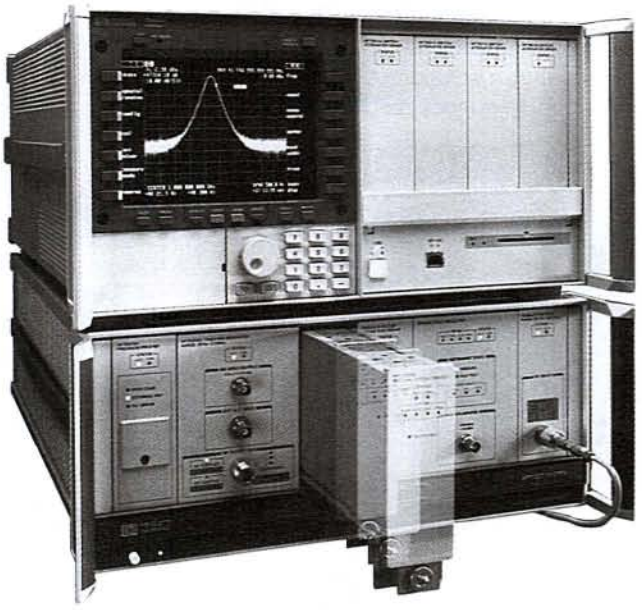
The HP 70703A is a four-channel oscilloscope that provides simultaneous sampling on two channels with a repetitive bandwidth of 500 MHz. The oscilloscope offers up to 40 dB of isolation between channels, with accuracies better than 1.5 percent. The module is two slots wide.

Free MMS Catalog

A complete list of all MMS products with full descriptions, specifications, and services is available. For a free copy of the new *HP 70000 Modular Measurement System* catalog, contact your local HP sales and support office listed on page 665. Ask for HP p/n 5091-4897E.

Ordering Information	Price
HP 70100A Power Meter Module	$31,000
HP 70110A Digital Multimeter	$4,250
HP 70120A Universal Counter	$5,100
HP 70138A Vector Voltmeter Module	$6,345
HP 70703A Digitizing Oscilloscope	$8,800
HP 71150A GSM Transmitter Tester, 100 Hz to 2.9 GHz	$99,200
HP 71250A GSM Transmitter Tester, 100 Hz to 22 GHz	$130,700
HP 71400C Lightwave Signal Analyzer, 100 kHz to 22 GHz	$104,950
HP 71401C Lightwave Signal Analyzer, 100 kHz to 2.9 GHz	$75,900
HP 71601A Gigabit Error Performance Analyzer, 50 Mbit/s to 1 Gbit/s	$64,300
HP 71602A Gigabit Pattern Generator, 50 Mbit/s to 1 Gbit/s	$41,600
HP 71603A Gigabit Error Performance Analyzer, 100 Mbit/s to 3 Gbit/s	$99,500
HP 71603B Gigabit Error Performance Analyzer	$110,000
HP 71604A Gigabit Pattern Generator, 100 Mbit/s to 3 Gbit/s	$71,500
HP 71604B Gigabit Pattern Generator	$76,000

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.



HP 70611A

HP 70611A Attenuator/Switch Driver

HP now offers designers of modular measurement system products a switch controller in the MMS format. The HP 70611A attenuator/switch driver is ideally suited to drive test-station interface modules that have been designed to include HP 84940A driver cards.

When mated with HP 84940A driver cards, the HP 70611A can control up to 248 (total) RF and microwave devices through either the modular system interface bus (MSIB) or the HP-IB (see Figure 1). One HP 84940A driver card, which has the capacity to drive up to 31 electromagnetic switches or attenuator switch sections, may be incorporated directly within the HP 70611A. Or, up to eight of the driver cards may be located remotely at the end user's test station.

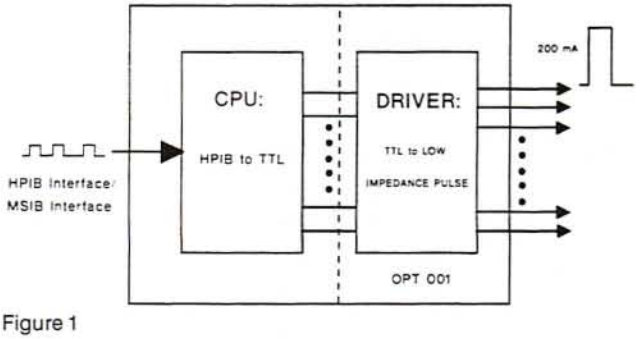


Figure 1

In addition to providing ATE designers with an expandable and convenient remote interface to their test stations, the HP 70611A attenuator/switch driver features a manual interface that can be customized by the user. This manual interface, which is realized through any MMS display, allows the end user to select pulse widths, to enable or disable switch settings, to create custom menus with labels, and to automatically select predefined switch states.

Accessories

HP offers a full line of switches and attenuators for use with the HP 70611A attenuator/switch driver. Custom switching solutions are also available that incorporate driver controller and microwave hardware into custom rack mounted boxes or MMS modules.

HP 70612A

HP 70612 and 70613 Series Switch Matrixes

This family of standard interface modules gives the designer of MMS products an off-the-shelf solution to problems of interconnection. The HP 70612 and 70613 are 1 × 6 and 2 × 5 common highway switch matrixes (see Figure 2) available in different frequency bands covering dc to 26.5 GHz. The matrixes come in 2-slot MMS modules.

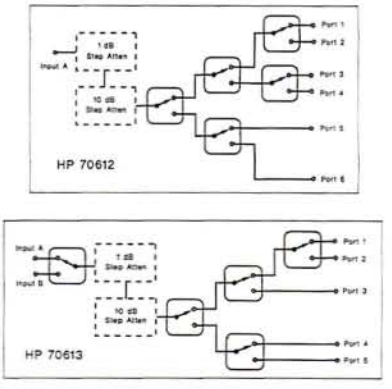


Figure 2

In addition to routing signals between sources and devices under test, the switch matrixes feature attenuator options for adjusting signal strengths from 0 to 110 dB in 1 dB steps. Input ports terminated in 50 ohms, front-panel indicators that alert the user to current switch status, and front-panel 3.5 mm connectors are standard. Rear-panel inputs are available.

These switch matrixes can be controlled remotely via the modular system interface bus (MSIB) or the HP-IB. A manual interface, created with any MMS display, allows users to specify alphanumeric labels for multiple switch states and to recall these predefined states using the labels. Up to 217 additional devices can be controlled remotely by an HP 70612 or 70613 using HP 84940A driver cards installed in other interface modules at remote locations. Option 011 for the HP 70612 and 70613 deletes the MSIB/HP-IB interface card (CPU). The resulting module contains only microwave hardware and an HP 84940A driver card, and it is designed to be controlled by an HP 70611A.

Along with the standard interface boxes, HP offers the ATE test-set designer custom rack-mount and MMS-compatible interface modules containing hardware such as switches, attenuators, detectors, couplers, indicators, and amplifiers. Information on these products can be found on page 376.

MMS PRODUCTS

HP 70000 Modular Measurement System

HP 71707A, 71708A

- Microwave Downconverter for phase noise measurements
- AM noise detection
- Specified spurious performance

HP 71707A

NEW

HP 71707A Microwave Downconverter

The HP 71707A Microwave Downconverter translates microwave signals to RF frequencies for use with the HP 3048A Phase Noise Measurement System. The HP 71707A provides state-of-the-art noise floor performance for microwave phase noise measurements. In addition, it provides specified spurious performance and a dc coupled tuning port with variable sensitivity for phase locking to your microwave source.

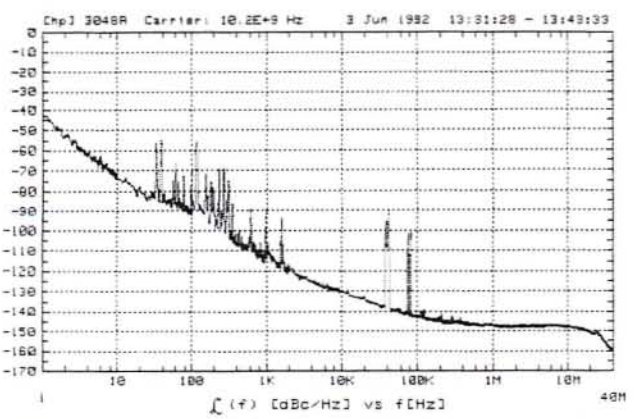
Specifications Summary

Downconverter

Frequency range: 1.5 GHz to 26.5 GHz
Input power: −40 dBm min, +30 dBm max
IF output
Frequency range: 5 MHz to 1200 MHz
Level: 0 to +5 dBm
Local oscillator
Frequency range: 2.4 GHz to 25.8 GHz
Frequency resolution: 600 MHz

Where noted the following specifications apply to both the HP 71707A Microwave Downconverter and the HP 71708A Microwave Source.

Spectral Purity: Phase noise performance varies with tuning sensitivity. The graph below shows typical phase noise performance for a tuning sensitivity of 0.05 ppm/V.



Typical phase noise and spurious of HP 71707A and HP 71708A at 10.2 GHz

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Microwave source with excellent phase noise
- Output frequency range 2.4 to 25.8 GHz
- Frequency resolution of 600 MHz
- Optional frequency resolution of 0.1 Hz

HP 71708A

NEW

HP 71708A Microwave Source

The HP 71708A Microwave Source makes an excellent LO substitute for your radar system, phase noise measurement system, or test source for microwave receiver testing. It provides the lowest phase noise of any commercially available microwave source and provides up to +16 dBm of output power. The standard HP 71708A has a frequency resolution of 600 MHz. If additional frequency resolution is required, Option 002 and an HP 8662A synthesized signal generator can be added to provide a frequency resolution of 0.1 Hz.

Specifications Summary

RF Output

Frequency range: 2.4 GHz to 25.8 GHz
Frequency resolution: 600 MHz
Output level range:
2.4 to 6.6 GHz: 0 to +16 dBm
7.2 to 25.8 GHz: 0 to +10 dBm
Absolute level accuracy:
2.4 to 6.6 GHz: ±2 dB @ +16 dBm
±3 dB < +16 dBm
≥7.2 GHz: ±3 dB

Supplemental Characteristics (HP 71707A and HP 71708A)

Typical Tuning Sensitivity: 0.05 ppm/V, 1 ppm/V, 20 ppm/V
Typical Tuning Port Voltage Range: ± 5 V
Typical Tuning Port Input Impedance: 2 kΩ

General (HP 71707A and HP 71708A)

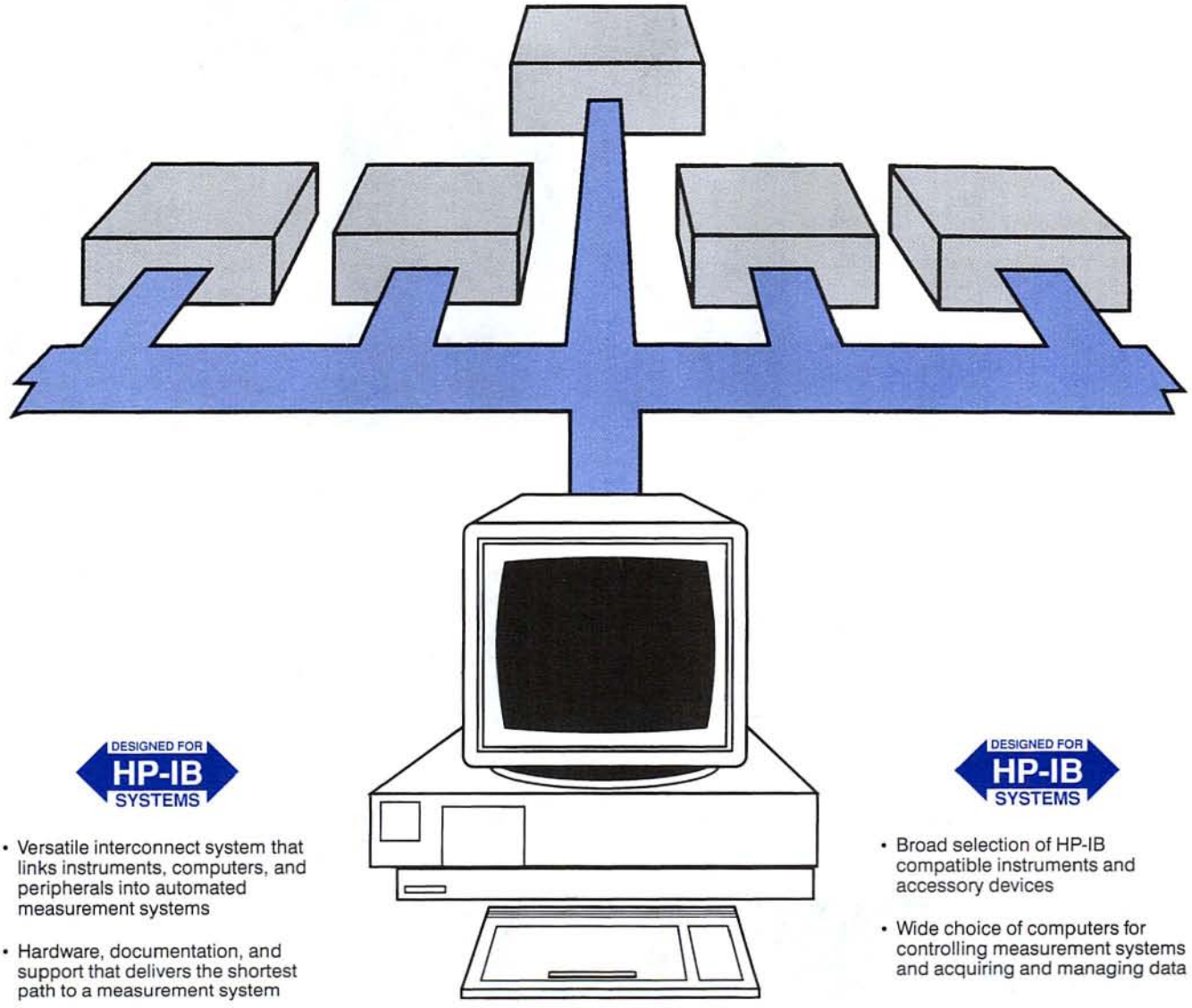
Environmental Temperature: Operational, 0° to +55° C; storage, −40° to +75° C
Humidity: Operational, 0 to 95% relative humidity at 45° C
Calibration Interval: One year recommended
Power: 260 W maximum (provided by the HP 70004A)
Weight: HP 71707A: 28.75 kg (63.3 lb); HP 71708A: 26.8 kg (58.9 lb), with Opt 002 29.3 kg (64.5 lb)
Size: 425.4 mm W × 222 mm H × 526 mm D (16.75 in × 8.74 in × 20.7 in)

Ordering Information

	Price
HP 71707A Microwave Downconverter includes HP 70427A Microwave Downconverter Module and HP 70004A Color Display/Mainframe.	$70,700
HP 71708A Microwave Source includes HP 70428A Microwave Source Module and HP 70004A Color Display/Mainframe.	$60,700
Opt 002 0.1 Hz Frequency Resolution (requires HP 8662A synthesized signal generator)	+$25,000

DESIGNED FOR HP-IB SYSTEMS

Versatile Interconnect System for Instruments and Controllers



DESIGNED FOR HP-IB SYSTEMS

- Versatile interconnect system that links instruments, computers, and peripherals into automated measurement systems
- Hardware, documentation, and support that delivers the shortest path to a measurement system

DESIGNED FOR HP-IB SYSTEMS

- Broad selection of HP-IB compatible instruments and accessory devices
- Wide choice of computers for controlling measurement systems and acquiring and managing data

Advantages of HP-IB Systems

There are many applications where the measurement power of interactive instruments can be further enhanced by desktop computers or minicomputers. Operating in a remote mode can provide more exact, error-corrected results than conventional manual operation techniques.

The following three major parameters combine to reduce significantly the engineering development costs of configuring measurement systems:

1. The Hewlett-Packard Interface Bus, also known as HP-IB.
2. Distributed computing through the growing number of "smart" instruments with internal microprocessors.
3. The broad choice of computers ranging from friendly, easy-to-program desktop computers to more sophisticated computer systems capable of managing multistation instrument clusters and complex databases.

Relationship Between HP-IB and Other Interface Standards

Hewlett-Packard is committed to the overall advancement of measurement technology and has for some time been working to simplify and standardize instrumentation interfacing. An example of such an effort is the involvement with the HP-IB from its inception at Hewlett-Packard to its present status as a world instrumentation interface standard (IEEE 488.1-1987 and IEC 625-1).

In mid-1972, Hewlett-Packard began to participate in various international standardization bodies. The U.S. Advisory Committee, composed of diverse interests represented by both users and manufacturers, first established initial goals, then adopted the interface concept used by the HP Interface Bus as an appropriate starting point. A draft document was subsequently written and evaluated by members of the committee, then submitted as the U.S. Proposal to the IEC (International Electrotechnical Commission) Working Group in the autumn of 1972. Since then, the interface definition has undergone a number of minor changes to accommodate various needs at the international level.

In September 1974, the parent technical committee, IEC TC66, approved the main interface draft document for a formal ballot among the member nations of the IEC. Balloting took place in 1976, and IEC recommendation 625-1 was adopted. The IEC recommendation is totally compatible with the present definition of the HP-IB.

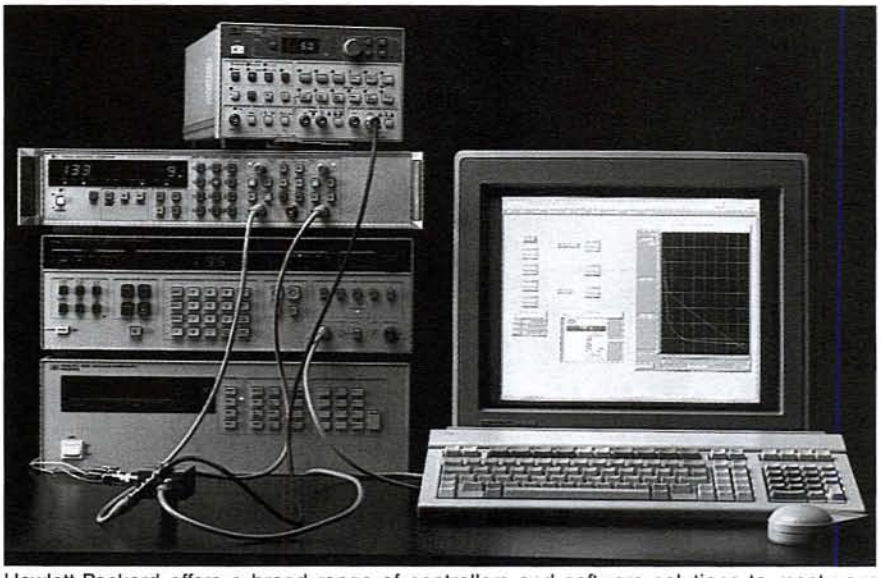
Meanwhile, the IEEE Standards Board approved IEEE Standard 488-1975 "Digital Interface for Programmable Instrumentation," first published in 1975 and again published in 1978 with minor editorial changes as IEEE Standard 488-1978. The IEEE standard is also fully compatible with the HP-IB. In January 1976, the American National Standards Institute adopted the IEEE Standard and published it initially as ANSI Standard MC 1.1.

MMS PRODUCTS

Hewlett-Packard Interface Bus (cont'd)

Versatile Interconnect System for Instruments and Controllers

The standardized interface concept is now widely accepted. Hundreds of manufacturers in more than 14 countries offer thousands of products that use the HP-IB concepts articulated in IEEE-488. As more instrumentation interface standards evolve from the HP-IB, we will clearly indicate the relationship of the Hewlett-Packard Interface Bus to those standards, just as we have done with ANSI/IEEE Standard 488 and IEC Publication 625-1.



Hewlett-Packard offers a broad range of controllers and software solutions to meet your measurement automation needs.

Why the HP Interface Bus Name?

As the list of HP products available with the "new digital interface" grew, our customers sought a convenient way to identify those products having the interface capability. In response, in 1974 we adopted the name "Hewlett-Packard Interface Bus" or simply "HP-IB." We will continue to use the identifying name and this symbol:

Both are used with appropriate HP products to identify their interface capabilities.

The Hewlett-Packard Interface Bus fully complies with IEEE Standard 488. As such, it incorporates the mechanical, electrical, and functional specifications of the standard. A fourth and vital element of any interface system is the operational aspect of a product at both the human-machine interface and the machine-machine interface at the HP-IB port. HP-IB capability provides additional user benefits that are beyond the scope of IEEE Standard 488. Typical user conveniences include high-level language implementation of interface functions, underscored program codes on instrument front panels for easy programming, convenient data output formats, and designed-in learn modes. In addition, we provide complete support documentation in the form of programming and interfacing guides, application notes, and operators' manuals that illustrate the added benefits for users of products with HP-IB capability.

Single-Source Systems Approach

The decision to use a system instead of conventional manual methods must be based on an engineering evaluation of benefits versus costs. The many benefits associated with a systems approach include the following:

- More consistent results in repeated measurements because a system is not subject to operator fatigue
- Greater throughput because systems are generally faster
- More thorough testing because system speed allows more parameters to be measured in a shorter time
- Results expressed in engineering or scientific units because many systems controllers are capable of online data manipulation
- Greater accuracy because system errors can be measured automatically, stored, and accounted for in the results
- Adaptive data acquisition so that a system can be programmed to branch to other measurements to help pinpoint an abnormal condition
- Measurement results stored in computer memory or on hard copy

It is our objective to make the integration of instrumentation systems easier by providing instruments and computers designed for systems applications. Computers are designed with HP-IB options that allow easy hookup to the bus and incorporate easy-to-use bus commands in their software. HP's policy when designing HP-IB compatible instruments is to eliminate interfacing ambiguities associated with controllers and instruments operating per the ANSI/IEEE and IEC standards by adopting guidelines for consistent interface design.

Proper training on system components is very important for efficient use of any interface system. Therefore, we offer training at sales and service offices worldwide on HP desktop computers, computer systems, and instruments as they relate to the HP-IB. In the area of HP-IB support documentation, we offer general interface technical descriptions, operating and service manuals with programming information, instrument/controller introductory operating guides, quick reference guides, and application notes.

Technical assistance during system development is available at most local HP sales and service offices, from resident systems engineers who specialize in desktop computers, computer systems, and instruments.

Automation provides the speed needed for many environments. This R-Series controller can be rack mounted in only 7 inches of space.

How the HP-IB Operates

All active interface circuitry is contained within the various HP-IB devices, and the interconnecting cable (containing 16 signal lines) is entirely passive. The cable's role is limited to that of interconnecting all devices in parallel so that any one device can transfer data to one or more other participating devices.

Every participating device (instrument, controller, accessory module) must be able to perform at least one of the roles of TALKER, LISTENER, or CONTROLLER. A TALKER can transmit data to other devices via the bus, and a LISTENER can receive data from other devices via the bus. Some devices can perform both roles. For example, a programmable instrument can LISTEN to receive its control instructions and TALK to send its measurement results.

A minimum HP-IB system consists of one TALKER and one LISTENER, without a CONTROLLER. In this configuration, data transfer is limited to direct transfer between one device manually set to "talk only" and one or more devices manually set to "listen only" for example, a measuring instrument talking to a printer for semi-automatic data logging).

A CONTROLLER manages the operation of the bus system primarily by designating which devices are to send and receive data, and it can also command specific actions within other devices.

The full flexibility and power of the HP-IB become more apparent, however, when one device that can serve as CONTROLLER/TALKER/LISTENER (e.g., calculator or computer) is interconnected with other devices that may be either TALKERS or LISTENERS, or both (e.g., frequency synthesizers, counters, power meters, relay actuators, displays, printers), depending on the application. An HP-IB *controller* participates in the measurement by being programmed to schedule measurement tasks, set up individual devices so that they can perform these tasks, monitor the progress of the measurement as it proceeds, and interpret the results of the measurement. Hewlett-Packard offers controllers that can be programmed in high-level languages such as BASIC, FORTRAN, HPLC, and Pascal.

HP-IB Connections and Structure

The HP-IB has a party-line structure. All devices on the bus are connected in parallel. The 16 signal lines within the HP-IB cable are grouped into three clusters according to their functions:

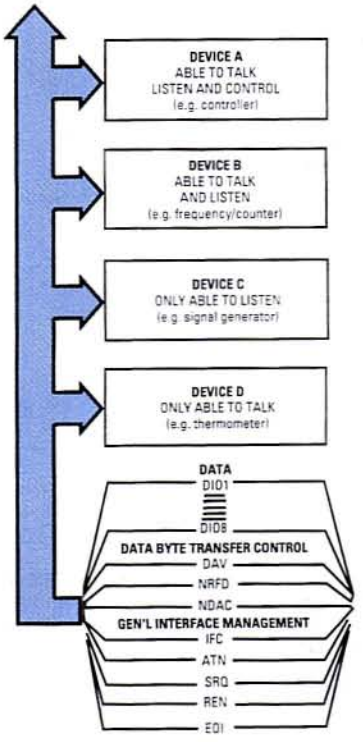
1. Data Bus (8 signal lines)
2. Data Byte Transfer Control Bus (3 signal lines)
3. General Interface Management Bus (5 signal lines)

The Data Bus consists of eight signal lines that carry data in bit-parallel, byte-serial format across the interface. These signal lines carry addresses, program data, measurement data, universal commands, and status bytes to and from devices interconnected in a system. Identification of the type of data present on the DIO signal lines is indicated by the ATN (attention) signal. When the ATN signal is true (asserted), either addresses or universal commands are present on the data bus and all connected devices are required to monitor the DIO lines. When the ATN message is false, device-dependent data (e.g., programming data) is carried between devices previously addressed to talk and listen.

Data transfer uses a set of three signal lines: DAV (data valid), NRFD (not ready for data), and NDAC (not data accepted). These signals operate in an interlocked handshake mode. Two signal lines, NRFD and NDAC, are each connected in a logical AND (wired OR) to all devices connected to the interface. The DAV signal is sent by the talker and received by potential listeners. The NRFD and NDAC signals are sent by potential listeners and received by the talker.

The General Interface Management Lines manage the bus for an orderly flow of messages. The IFC (interface clear) message places the interface sytem in a known quiescent state. SRQ (service request) is used by a device to indicate the need for attention or service and to request an interruption of the current sequence of events. REN (remote enable) is used to select between two alternate sources of device program data. EOI (end or identify) is used to indicate the end of a multiple byte transfer sequence or, in conjunction with ATN, to execute a polling sequence.

It is not possible in this limited space to go into detail on each signal line's role. But you should note that every HP-IB device need not be able to respond to all the lines. As a practical and cost-effective matter, each HP-IB device usually responds only to those lines that are pertinent to its typical function on the bus. (Details are covered in each device's operating manual.)



Interface connections and bus structure

HP-IB and IEEE 488.2

In June of 1987, the IEEE approved a new standard for programmable instruments called IEEE Std. 488.2-1987 Codes, Formats, Protocols, and Common Commands. It works with the IEEE Standard Digital Interface for Programmable Instrumentation, IEEE 488-1978 (now 488.1). HP-IB is Hewlett-Packard's implementation of IEEE 488.1. IEC 625-2 has been revised to match IEEE 488.2.

As with IEEE 488.1, Hewlett-Packard was active in the development of IEEE 488.2. Many of the new HP instruments introduced this year already follow this new standard, and many more HP instruments to be introduced in the near future will also follow IEEE 488.2.

This new standard addresses issues involved with sending messages between devices on the bus. Its features include:

- A required minimum set of IEEE 488.1 capabilities
- Reliable transfer of complete messages between a computer and an instrument
- A precise description of the syntax in those messages
- A set of commands useful in all instruments
- Common status reporting capability using serial poll
- Techniques for guaranteeing synchronization of application programs with instrument functions
- A way of automatically assigning addresses

The desired benefit from these features is to make the job of an instrument system designer easier. IEEE 488 standardized the electrical and mechanical interface. This new standard ensures compatibility at the next higher level.

MMS PRODUCTS

Hewlett-Packard Interface Bus (cont'd)

Versatile Interface Bus for Instruments and Controllers

DESIGNED FOR HP-IB SYSTEMS

488.1 Requirements

The IEEE 488.2 Standard requires that each device provide a minimum set of 488.1 interface capabilities. Each device must be able to source and accept bytes, talk and listen, do service request, and respond to device clear.

IEEE 488.2 allows more freedom by making other capabilities optional. However, it requires a minimum capability when these functions are implemented. This applies to the Remote Local, Parallel Poll, Device Trigger, and Controller capabilities.

Message Exchange

IEEE 488.1 provides a reliable means of transferring bytes between a talker and a listener. In addition, devices need a reliable means of transferring programming commands and measurement results. IEEE 488.2 provides this means.

Syntax

IEEE 488.2 requires that devices listen in a "forgiving" manner. However, the level of forgiveness is precisely defined. The meaning of every data byte is well defined, while several characters sometimes have the same meaning.

Although the listening syntax is forgiving, an instrument is required to talk precisely. Talking precisely greatly increases the chances of a message being accepted by any controller.

Common Commands

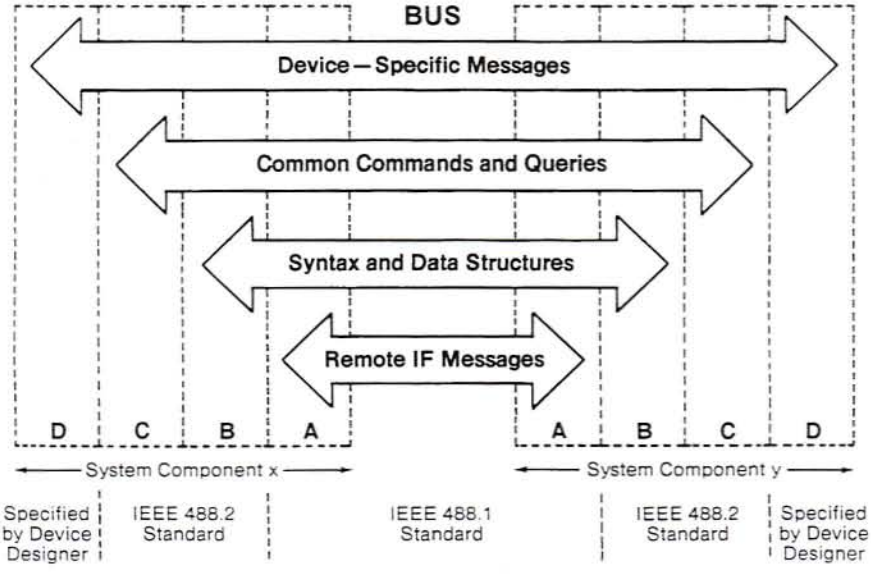
Certain functions are useful across all types of instruments. IEEE 488.2 defines a set of commands that all instruments must implement. Required commands include identifying the instrument by manufacturer and model number, resetting the instrument to a known state, and performing a self-test.

Other commands that are useful in some instruments are also described in the standard. They are included so that, if the functions are implemented, they will be done in standard ways. For example, there are commands for calibration, triggering, macros, and passing control. There are a total of 13 required commands and 26 optional commands.

Status Reporting

IEEE 488.1 exactly describes how the Request Service (RQS) message behaves, but it says very little about the status byte, STB. The meanings of the bits are left to the designer. Some instruments clear the status byte after a serial poll, others do not. Many instruments allow the programmer to configure what causes a service request, but here, too, the techniques for doing so are varied.

IEEE 488.2 describes a hierarchical status reporting model in which the contents of other data structures are summarized in the status byte. It does not specify the exact meaning of all of the bits in the status byte. However, it does describe the meaning of two more of the bits, Message Available (MAV) and Event Status (ESB).



This diagram shows the relationship between the IEEE-448.1 standard and IEEE 488.2 standard. The IEEE 488.2 standard expands and complements IEEE 488.1 by addressing issues involved with sending messages between devices on the bus. Layer D represents device functions, layer C represents common system functions, layer B represents message communications functions, and layer A represents interface functions. Layers D, C and B contain IEEE 488.1 device-dependent messages and layer A contains IEEE 488.1 interface messages.

Synchronization

Many instruments can accept commands faster than they can execute them. Although this feature can improve system throughput, it also creates a need to know when the instrument actually completes all of its commands. IEEE 488.2 requires three common commands that enable the application program to detect when all pending operations are complete.

Future

Codes, formats, protocols, and common commands cover new ground for instrument-to-computer communication. Most of the concepts involved can be used on any physical interface whether HP-IB, RS-232, or VME. If a new physical interface should displace or co-exist with HP-IB, the syntax of messages, the common commands, the status reporting, and the synchronization techniques can all survive.

HP-IB Training and Support

To assist you in configuring HP-IB measurement systems, Hewlett-Packard has field salespeople trained in electronic instruments, desktop computers, and computer systems. Also available for technical consultation are computing controller systems engineers and HP-IB instrumentation specialists.

An HP-IB training course on HP-IB controllers and instruments is available. Courses are conducted at a convenient HP location. Some courses can be taught at your site with special arrangements.

HP-IB Service and Warranty

Hewlett-Packard has dedicated measurement system servicepeople who perform on-site maintenance of HP instrumentation on customer-configured systems as well as HP-configured systems. Service contract coverage is available to meet your specific measurement system service needs and can be tailored to include extended warranty, calibration, and extended hours of coverage. Contact your local sales and service office for further information on HP-IB service contract information.

Every HP-IB device and HP-configured system carries a standard Hewlett-Packard warranty appropriate to that product. The warranty period for each product will be provided on request at the time of sale and is specified in documentation supplied with the product. Hewlett-Packard takes responsibility for standard HP-IB systems performing as specified. However, software or interfacing that has not been provided by Hewlett-Packard as part of a standard system delivered by Hewlett-Packard is not covered by this warranty.

In all cases, overall operational responsibility for those HP-IB *systems assembled by a customer* from individual HP-IB devices rests with the customer.

HP-IB Specifications Summary

Interconnect Devices

Up to 15 maximum on one continuous bus.

Interconnection Path

Star or linear bus network; total transmission path length 2 meters times number of devices or 20 meters, whichever is less. Operating distances can be extended; see page 125.

Message Transfer Scheme

Byte-serial, bit-parallel asynchronous data transfer using locked 3-wire handshake technique.

Data Rate

One megabyte per second maximum over limited distance; 250 to 500 KB/s typical over full transmission path (actual data rate depends on individual device characteristics).

Address Capability

Primary addresses, 31 TALK and 31 LISTEN; secondary (2-byte) addresses, 961 TALK and 961 LISTEN. Maximum of 1 TALKER and up to 14 LISTENERS at a time.

Control Shift

In systems with more than one controller, only one can be active at a time. A currently active controller can pass control to another, but only the designated system controller can assume control over others.

Interface Circuits

Driver and receiver circuits are TTL-compatible.

HP-IB Interface Functions

HP-IB functions are the predefined capabilities that can be designed into an HP-IB device. These capabilities and their alphanumeric codes are summarized in the table. Because the codes completely describe interface capability and are therefore particularly useful to system designers and specifiers, they frequently appear in technical data and on system components. On HP system-ready products the capabilities are listed near the HP-IB connector, and they are included in the specifications for most of the HP-IB products in this catalog.

HP-IB Reference Publications

- *Tutorial Description of the Hewlett-Packard Interface Bus.* This 118-page reference chronicles the development of byte-serial, bit-parallel interface system standards, describes their relationship to HP-IB, presents a working overview of HP-IB, and includes useful information. Published by Hewlett-Packard, part number 5021-1927.
- *ANSI/IEEE 488.1-1987, Digital Interface for Programmable Instrumentation,* and *IEEE Std. 488.2-1987, Codes, Formats, Protocols, and Common Commands,* published by the Institute of Electrical and Electronics Engineers, 345 East 47th Street, New York, NY 10017.
- *IEC 625-1, An Interface System for Programmable Measuring Apparatus (Byte Serial Bit Parallel)* and *IEC 625-2 Codes, Formats, Protocols, and Common Commands,* published by the International Electrotechnical Commission, 1 rue de Varembe, 1211 Geneva 20, Switzerland.

HP-IB Interface Capability Codes for HP Products

Interface Function	Basic Code	Capability Code	
Source Handshake	SH	SH0	No capability
		SH1	Full capability
Acceptor Handshake	AH	AH0	No capability
		AH1	Full capability
Talker (Extended Talker)	T(TE)	T(TE)0	No capability
		T(TE)1	Basic talker, serial poll, talk only
		T(TE)2	Basic talker, serial poll
		T(TE)3	Basic talker, talk only
		T(TE)4	Basic talker
		T(TE)5	Basic talker, serial poll, talk only, unadresses if MLA[1]
		T(TE)6	Basic talker, serial poll, unadresses if MLA[1]
		T(TE)7	Basic talker, talk only, unadresses if MLA[1]
		T(TE)8	Basic talker, unaddresses if MLA[1]
Listener (Extended Listener)	L(LE)	L(LE)0	No capability
		L(LE)1	Basic listener, listen only
		L(LE)2	Basic listener
		L(LE)3	Basic listener, listen only, unaddresses if MTA[2]
		L(LE)4	Basic listener, unaddresses if MTA[2]
Service Request	SR	SR0	No capability
		SR1	Full capability
Remote Local	RL	RL0	No capability
		RL1	Full capability
		RL2	No local lockout
Parallel Poll	PP	PP0	No capability
		PP1	Remote configuration
		PP2	Local configuration
Device Clear	DC	DC0	No capability
		DC1	Full capability
		DC2	Omit selective device clear
Device Trigger	DT	DT0	No capability
		DT1	Full capability
Driver Electronics	E	E1	Open collector (250Kb/s max)
		E2	Tri state (1Mb/s max)
Controller[3]	C	C0	No capability
		C1	System controller
		C2	Send IFC and take charge
		C3	Send REN
		C4	Respond to SRQ
		C5	Send interface messages, receive control, pass control to self, parallel poll, take control synchronously

[1] MLA: My Listen Address
[2] MTA: My Talk Address
[3] There are 29 controller levels. These are the more significant levels.

MMS PRODUCTS
Switching and Control

Whether you are designing a small, medium, or large test system, Hewlett-Packard's switch family will provide you with long-lasting quality, reliability, and performance. Hewlett-Packard's switch products are used in a variety of testing applications such as switching dc to 26.5 GHz signals. Hewlett-Packard offers dedicated switches and modular systems that include instrumentation. Whatever your application, the ability to make accurate and reliable connections from instruments to test points is critical. Hewlett-Packard's family of switch products integrates easily into any test system.

Hewlett-Packard Knows Switches!

Hewlett-Packard has been designing and manufacturing switch products for more than 20 years. We understand the special requirements of a switch in a test system. In the design of our products, we have addressed important issues such as signal integrity, automation, fixturing, and ease of use. The result is a wide range of switch products that gives you a choice—all with the quality, reliability, and performance you expect from Hewlett-Packard.

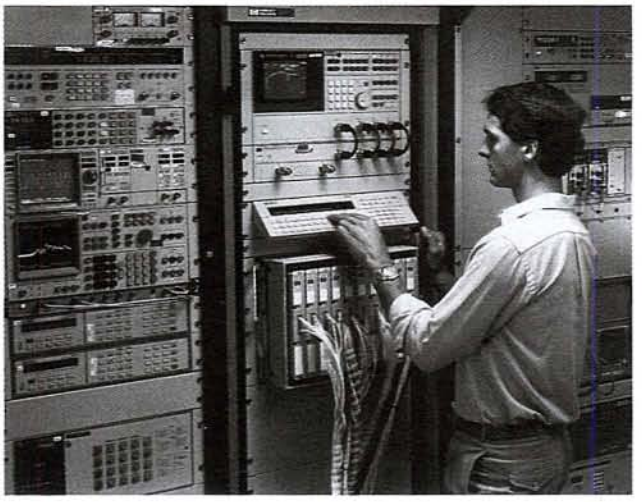
A Low-Cost System

For many devices, only a few points require testing. Usually, the test system operator connects two or three instruments to different points on the device under test (DUT). By adding an HP 3488A Switch/Control Unit to your test system, you eliminate manual operations in test procedures. This reduces test time and eliminates chances for error. The savings you realize from an automated test procedure makes it easy to justify investing in an HP 3488A.

A Versatile System of Medium Size

Medium-size systems typically require three to six instruments testing 10 to 100 test points. The instrumentation takes up rack space, and manual tests are difficult to run. The HP 75000 Series B Mainframe reduces your rack space requirements and makes it easy for you to automate your test system. The unit provides instrumentation along with a broad line of switch modules—all in one mainframe. Your costs and development time are reduced with a test system built around the Series B.

A High-Performance System of Large Size



In a large test system, there may be more than one DUT, requiring different test fixtures, instruments, and switches. In addition, a large number of cables and wires are used. Many stimulus and response measurements need to be made, requiring signals to go to and from instruments and the DUT simultaneously. With multiple instruments and multiple points to be tested, you need a dedicated computer to control the test process. The HP 3235A Switch/Test Unit makes it easy for you integrate large test systems and relieves you of much of the design and documentation effort. The unit includes a multitude of switch modules, high-performance instrumentation, fixturing, and built-in intelligence. The HP 3235A is the right product for applications requiring high-performance switching and a large number of test points.

Modular Measurement System (MMS)

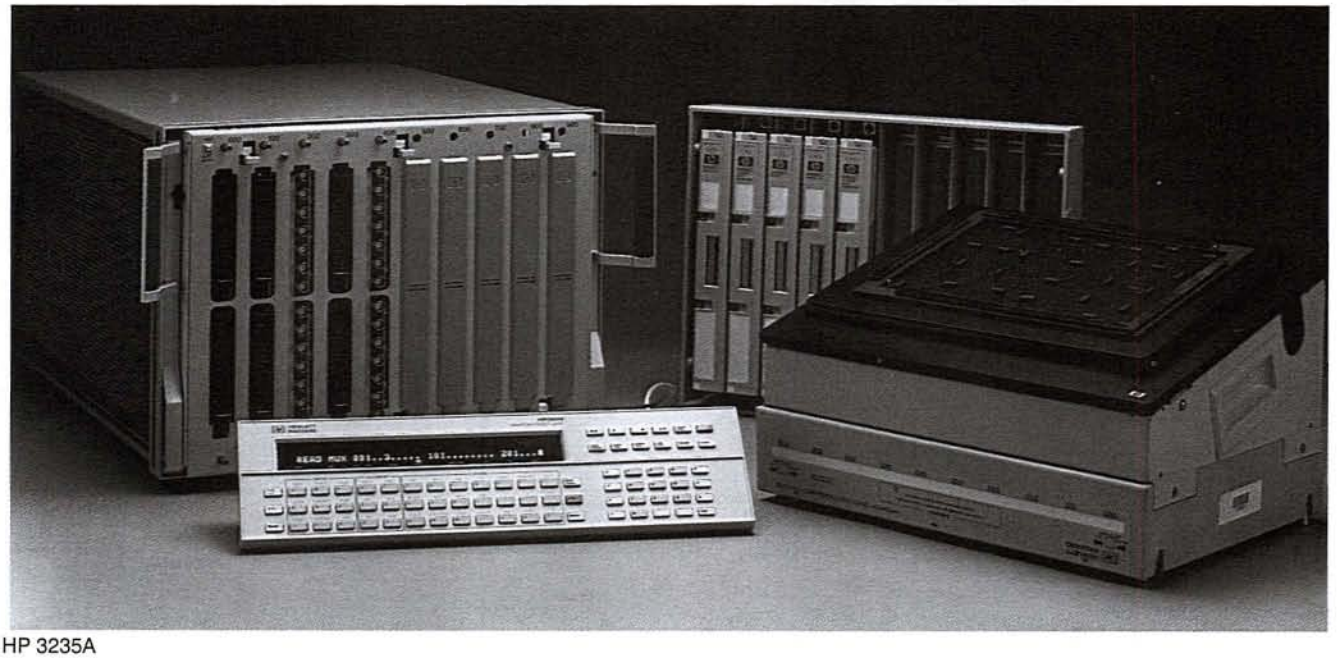
For ATE configurations that employ the HP 70000 modular measurement system, the HP 70611A MMS attenuator/switch driver module fills a critical need for programmable control of signal switching. The switch module supplies drive power for HP step attenuators and coaxial switches. It controls up to eight HP 84940A driver cards, each of which can drive up to 31 switches. The HP 70611A also extends Hewlett-Packard's custom switch matrix capability from traditional HP-IB rack-and-stack to the versatile, more space efficient MMS.

The HP 70612 and 70613 interface modules give the MMS designer an off-the-shelf solution to the problem of how to connect sources, test equipment, and DUTs. Internal high-performance coaxial switches are configured for 1x6 and 2x5 options with service from dc to 6.5 and 26.5 GHz. Each interface module contains an attenuator/switch driver that can control up to seven additional HP 84940A switch driver cards.

The MMS display provides a powerful manual interface that can be easily customized for the HP 70611, 70612, and 70613 modules. See page 95 for more information.

- For medium to large systems
- 10-slot, intelligent cardcage
- 20-switch modules for dc to 26.5 GHz signals
- DMM, ac/dc source, 4-channel D/A digital I/O, breadboard modules
- Quick interconnect fixture
- Control panel for debugging

DESIGNED FOR HP-IB SYSTEMS



HP 3235A

HP 3235A Switch/Test Unit

The HP 3235A Switch/Test Unit reduces test development of HP-IB test systems by providing high-performance, off-the-shelf switching and interfacing to a wide variety of devices under test (DUT).

The Switch/Test Unit routes signals between the DUT and source/receiver instruments such as digital multimeters, counters, signal sources, and analyzers.

Speed your test system development with:
- Off-the-shelf tools
- Easy programming
- Reduced cabling

Increase your test system throughput with:
- Local intelligence
- Plug-in digital multimeter module
- Internal bus structure
- Quick Interconnect Fixture

Reconfigurable Architecture

The HP 3235A chassis is a 10-slot cardcage driven by a 16-bit processor backed with 256k of firmware. You control the cardcage over HP-IB using high-level commands for easy programming. Twenty different switch modules in various matrix and multiplexer topologies switch signals up to 10 amperes and from dc to 26.5 GHz. Also available are digital I/O, breadboard, 4-channel D/A, DMM, and ac/dc source modules that are true "instruments on a card."

For applications demanding numerous switch points, up to seven 10-slot HP 3235E Extenders can be slaved to the HP 3235A mainframe. A total of 20,480 two-wire analog points can be controlled from one HP-IB address.

The Quick Interconnect Fixture allows easy reconfiguration of the test system for different devices. Operator errors are also reduced by minimizing the number of connections to be made before starting a new test.

Four analog and two trigger buses link the switch and instrumentation modules. These internal paths provide a "soft-wired" connection that can be redefined by your test software. Analog signals are routed conveniently from a multiplexer to the digital multimeter (DMM) module during scanning. Or, a trigger generated by the digital I/O module can be routed to the DMM module.

To aid in system setup and debugging, a control panel with a full alphanumeric keypad and electro-luminescent display is available.

Intelligence of a Computer

The powerful firmware of the HP 3235A instructs the plug-in modules with high-level commands from the host computer. Storage and recall of hundreds of HP 3235A setups saves sending command sequences from the computer. HP BASIC language commands in the mainframe, such as IF . . . THEN and FOR . . . NEXT, plus variables and math functions, keep computer-to-switch interactions to a minimum, thereby increasing throughput. You can use up to 480 Kbytes of mainframe memory for downloaded subroutines and stored values. Downloaded programs, including user-defined data conversions or setups, execute rapidly.

Complete Modularity Means In-Rack Service

The HP 3235A is completely serviceable in-rack, so you never need to remove the cardcage. All assemblies, including power supply, controller, and HP-IB, remove easily because of the modular design.

Simple Operational Verification Before Your Test

The HP 3235A offers three levels of internal self-test as well as a fixtured functional test for individual plug-in modules. The fixtured test uses diagnostic terminal blocks that attach to the modules. These diagnostic fixtures, together with the internal DMM module, verify the integrity of the relay contacts in your system.

HP 3235A Plug-In Modules

A full array of functional plug-in modules is available for the HP 3235A 10-slot mainframe or the HP 3235E 10-slot extender.

MMS PRODUCTS
Switching and Control (cont'd)
HP 3235A

Low-Frequency Relay Multiplexers

These modules can be used either as input or output multiplexers to switch signals to and from a DUT. The multiplexers are 2-wire, switching both High and Low. They have different voltage- and current-switching capabilities, and use different relay types. The HP 34501T/34502T/34507T can also be used with thermocouples.

	HP 34501	HP 34502	HP 34507	HP 34511	HP 34515
Max voltage (ac rms)	250 Vdc 250 Vac	125 Vdc 90 Vac	250 Vdc 250 Vac	130 Vdc 130 Vac	1000 Vdc 1000 Vac
Max current	2 A	25 mA	100 mA	1 A	1 A
No. of Channels	32	32	32	64	10
Relay type	Armature	Reed	Mercury	Armature	Reed
Thermal offset	<3 μV	<3 μV	<20 μV	<7 μV	<30 μV

High-Frequency Relay Multiplexers

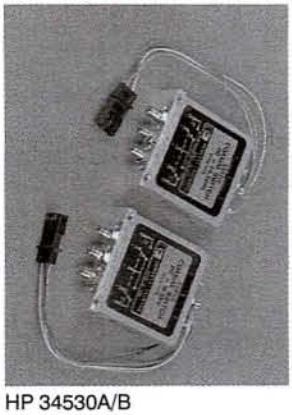
These multiplexers provide broadband switching of high-frequency analog or digital signals. The HP 34504 switches both the center conductor and the shield. In the HP 34505 and HP 34508, the 3 multiplexer banks are isolated from each other and from ground, preventing ground loops.

High-Frequency Relay Multiplexers

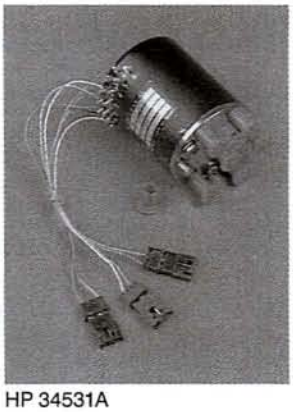
	HP 34504	HP 34505	HP 34508
Bandwidth	100 MHz	1.3 GHz	1.3 GHz
Number of channels	Dual 1×6	Two 1×4 One 1×3	Two 1 × 4 One 1×3
Impedance	50 Ω	50 Ω	75 Ω
Max voltage (ac rms)	42 Vdc 30 Vac	42 Vdc 30 Vac	42 Vdc 30 Vac
Max current	1 A	1 A	1 A
Switched shield	Yes	No	No

Microwave Switches

These 50-Ω coaxial switches provide excellent electrical performance from dc to microwave frequencies. The HP 34530A goes to 18 GHz, while the HP 34530B goes to 26.5 GHz. The HP 34531A/B 18 GHz multiplexers are configured as 1×6. The HP 34531B has internal 50-Ω terminations for the open channels, while the HP 34531A does not. All of these microwave switches use SMA connectors. A variety of rack-mounting kits are available. Up to four HP 34530A/B 3-port switches can also be mounted in the HP 34530T terminal block kit.



HP 34530A/B



HP 34531A

Relay Matrix Modules

These matrix cards come in a variety of configurations, densities, and bandwidths. For the highest density, consider the HP 34511M or the HP 34516M/N. If low leakage is a requirement, the HP 34512C features 10 pA/volt leakage, 2 pA/V typical. For higher bandwidth applications, look at the HP 34506 Switched Shield Matrix. Finally, for very high-frequency applications, consider using the HP 34513C or the HP 34514C General Purpose RF relay modules (described in a later section) to build up your own custom high-frequency matrices. Special cable kits allow many of these modules to expand into larger matrix configurations.

Relay Matrix Modules

	HP 34501M	HP 34506	HP 34511M	HP 34512	HP 34516
Crosspoints	32	32	64	32	256
Matrix configuration	4×8	4×8	8×8 4×16	4×8	8×32 4×64
Bandwidth	1 MHz	30 MHz	1 MHz	30 MHz	1 MHz
Max voltage (ac rms)	42 Vdc 30 Vac	42 Vdc 30 Vac	130 Vdc 130 Vac	250 Vdc 170 Vac	42 Vdc 30 Vac
Max current	2 A	1 A	1 A	1 A	1 A
Connectors	2-wire	Coaxial	2-wire	Triaxial	2-wire
Switched shield	No	Yes	No	Yes	No

General Purpose Relay Modules

There are several general-purpose modules available for different applications. The HP 34503 has 16 Form C relays. The HP 34510 has 8, but can switch 10 amps per relay. The HP 34513 and HP 34514 are building blocks, allowing you to build up custom-switching topologies to fit your requirements. These cards contain 32 independently operated double-pole/double-throw high-frequency relays. All contacts are brought out to board-mounted SMB connectors. Interconnections between relays are made via coaxial cables.

General-Purpose Relay Modules

	HP 34503	HP 34510	HP 34513	HP 34514
Number of relays	16	8	32	32
Contact config.	SPDT (Form C)	SPDT (Form C)	DPDT	DPDT
Max voltage (ac rms)	250 Vdc 250 Vac	125 Vdc 250 Vac	42 Vdc 30 Vac	42 Vdc 30 Vac
Max current	3A	10 A	1 A	1 A
Bandwidth	1 MHz	1 MHz	1 GHz	300 MHz
Use	General-Purpose	Power Actuator	50 Ω RF Switching	75 Ω RF Switching

Digital I/O Modules

The HP 34509 has a total of 32 open-drain MOS FET outputs, which can switch voltages up to 42 V and currents up to 0.5 A. This card also contains 2 internal power supplies of 15 V and 28 V, making the module ideal for driving relay coils or other devices. This card is also used in conjunction with the HP 34530 and HP 34531 microwave switches.

The HP 34522 is a 32-bit digital I/O module, featuring 32 bi-directional TTL-compatible data lines, 8 edge-triggered interrupt lines, 16 high-power FET outputs, and a read/write rate > 40 kHz. The 32 data lines are configured as four 8-bit ports, each with its own handshake lines. Each port can be operated independently as a read or write port, or can be combined to handle 16- or 32-bit parallel data.

Analog Source Cards

The HP 34521 AC/DC Source Card offers 24-bit (6.5-digit) resolution in the dc voltage mode, highly accurate amplitudes in the ac voltage mode, and versatile high-speed outputs in the arbitrary waveform mode. Maximum voltage output is ±10 volts; maximum frequency is 1 MHz. Standard ac outputs include sine, square, and triangle waveforms, with variable duty cycle on both triangle and square waves. AC outputs are generated by direct digital synthesis, which provides high accuracy and resolution down to 0.001 Hz. Arbitrary waveform memory depth is 2048 bytes. Arbitrary waveforms can be generated at a full 1 MHz bandwidth.

The HP 34524 contains 4 completely independent 14-bit plus sign digital-to-analog converters (DAC). In the voltage mode, each DAC can supply ±10.24 volts. In current mode, each can provide ±20.16 mA. Because the 4 DACs are isolated from each other, they can be connected in series or parallel for greater output voltages or currents.

Breadboard Module (HP 34523)

The breadboard module is a convenient way to incorporate special-purpose circuits into your test system. This module lets you interface directly to the HP 3235A's backplane control signals and backplane analog and trigger buses.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

6.5-Digit Multimeter Module (HP 34520)

With the DMM module, you can integrate a high-performance system multimeter into your test system without extensive cabling and software programming. The DMM module offers 7 functions:

dc Voltage (90-day, Tcal ±5° C)

Range	Best 6.5-digit accuracy[1] ± (% of reading + volts)	Input resistance
30 mV	0.0053% + 5.40 μV	>10 GΩ
300 mV	0.0038% + 5.7 μV	>10 GΩ
3.0 V	0.003% + 8 μV	>10 GΩ
30 V	0.0048% + 220 μV	10 MΩ ± 1%
250 V	0.0063% + 70 μV	10 MΩ ± 1%

dc Current (90-day, Tcal ±5° C)

Range	Best 6.5-digit accuracy[1] ± (% of reading + amps)	Max. burden voltage at full scale
300 μA	0.025% + 15.4 nA	0.35 V
3 mA	0.025% + 15.4 nA	0.35 V
30 mA	0.025% + 1.54 μA	0.35 V
300 mA	0.088% + 25.4 μA	0.6 V
1.5 A	0.088% + 654 μA	1 V

Resistance (2- and 4-wire Ω)[2] (90-day, Tcal ±5° C)

Range	Best 6.5-digit accuracy[1] ± (% of reading + Ω)	Current output
30 Ω	0.0078% + 5.4 mΩ	1 mA
300 Ω	0.0058% + 5.7 mΩ	1 mA
3 kΩ	0.0048% + 9 mΩ	1 mA
30 kΩ	0.0048% + 90 mΩ	100 μA
300 kΩ	0.006% + 1 Ω	10 μA
3 MΩ	0.008% + 15 Ω	1 μA
30 MΩ	0.032% + 830 Ω	100 nA
300 MΩ[3]	2.5% + 100 kΩ	100 nA
3 GΩ[3]	25% + 1 MΩ	100 nA

[1] After 1-hour warmup, integration time 100 PLC. Tcal is the temperature of the calibration environment between 18 and 28° C.
[2] For 2-wire Ω, add 200 MΩ to count error specifications.
[3] For 2-wire Ω, only accuracy is specified following auto-cal (ACAL), under stable conditions (±1° C).

ac Voltage (RMS ac and RMS ac+dc)

acV Bandwidth: 20 Hz to 1 MHz
Crest Factor: 3.5 to 1 at fullscale
Common Mode Rejection: With 1 kΩ imbalance in the low lead, dc to 60 Hz
Guarded: >86dB
Non-Guarded: >66dB

ac Volts (90 day, Tcal ± 5° C)

Range	(100 Hz to 20 kHz) Best 5½-digit accuracy[4] ± (% of reading + % of range) ac coupled	dc coupled	Input impedance
30 mV	0.15% + 0.0441%	0.19% + 0.169%	1 MΩ ± 1% shunted by >90 pF
300 mV	0.15% + 0.0441%	0.19% + 0.169%	
3.0 V	0.15% + 0.0441%	0.19% + 0.169%	
30 V	0.15% + 0.0441%	0.19% + 0.169%	
300 V	0.21% + 0.053%	0.25% + 0.203%	

[4] Accuracy specified for sine wave inputs, >10% of range. dc component <10% of ac component after one-hour warmup and within one week of ACAL. ac band set to <400 Hz.

ac Current (RMS ac and RMS ac+dc)

acI Bandwidth: 20 Hz to 100 kHz
Crest Factor: 3.5 to 1 at full scale

Frequency and Period

Measures the frequency or period of the ac component of the ac or dc coupled voltage or current input. The counter uses a reciprocal counting technique to give constant resolution independent of input frequency.

Frequency Range: 10 Hz to 1.5 MHz (voltage input)
10 Hz to 100 kHz (current input)
Period Range: 0.1 s to 667 ns (voltage input)
0.1 s to 3.33 us (current input)
Sensitivity: 10 mV rms or 100 μA rms (sinewave)
Triggering: Triggers and counts on zero crossings

SimPlate Board Test Fixture (HP 34597A)

The HP 34597A SimPlate Board Test Fixture is a vacuum-actuated bed-of-nails test fixture kit for the HP 3235A Switch/Test Unit. SimPlate and the HP 3235A are tools developed for your "rack-and-stack" functional test systems. Unlike an edge connector test, SimPlate gives you access to all component leads to provide more functional test flexibility and improved fault isolation. Because of its unique single-plate design, SimPlate can provide the close-tolerance probing required for interfacing to Surface-mount technology (SMT) boards.

SimPlate is delivered as a kit that you must drill, wire, and assemble. Its components are designed to probe printed circuit boards from a single side, with test pads as small as 0.030-inch diameter on 0.050-inch centers. Probes, receptacles, and additional HP 3235A terminal blocks are ordered separately.

General

Environmental
Operating temperature: 0° to 55° C (32° to 130° F)
Storage temperature: −40° −75° C (−40° −165° F)
Humidity range: 95% R.H., 0° to 40° C (32° −10° F)
Power Line Voltage: 90 to 132 V (115 V) or 192 to 264 (230 V) switch-selectable 47 to 66 Hz. Fused at 5A (115 V) or 2.5 A (230 V).
Size
HP 3235 Cardcage: 310 mm H (without feet) × 426 mm W × 594 mm D (12.2 in × 16.8 in × 23.4 in)
Height with feet: 325 mm (12.8 in)
Depth with terminal blocks: 693 mm (27.3 in)

Weight	Net	Shipping
HP 3235 Cardcage (max.)	21 kg (46 lb)	28 kg (62 lb)
Each module (max.)	5.5 kg (12 lb)	6.6 kg (14.6 lb)

Ordering Information

	Price
HP 3235A Switch/Test Unit	$6,300
Opt 560 Add System Expansion Card	$500
Opt 580 HP-IB Controller	+$800
Opt 590 Add Quick Interconnect Fixture	+$1,050
Opt 908 Rack Mount Kit (HP p/n 03235-80908)	+$130
HP 3235E Switch/Test Unit Extender	$5,250
HP 34550A Control Panel	$840
HP 34551A Control Panel Rack Mount Kit	$80

Plug-in Accessories are supplied with your choice of terminal blocks. "A" suffix designates solder lugs, "B" designates screw terminals, "C" deletes the terminal block, "M" and "N" designate matrices, and "T" measures thermocouples. Prices below are for the "B" suffix.

HP 34501A/B/M/T 32-Channel Armature Relay Mux/Matrix	$1,600 - 2,160
HP 34502A/B/M/T 32-Channel Reed Relay Mux/Matrix	$1,600 - 2,160
HP 34503A/B General-Purpose Relay Module	$1,170 - 1,350
HP 34504A/B/C Switched-Shield Coax Mux	$1,870 - 2,310
HP 34505A/B/C 50-Ω RF Mux	$1,580 - 2,040
HP 34506A Switched-Shield Coax Matrix	$2,390
HP 34506B Switched-Shield Coax Matrix	$2,620
HP 34506C Switched-Shield Coax Matrix	$2,160
HP 34507A/B/M/T 32-Channel Mercury Relay Mux/Matrix	$1,990 - 2,450
HP 34508A/B/C 75-Ω RF Mux	$1,750 - 2,280
HP 34509A/B/C 32-Channel Relay Driver Module	$1,250 - 1,540
HP 34510B 10-amp, 8-Channel Power Actuator	$1,040
HP 34511B 64-Channel Relay Mux/Matrix	$3,000
HP 34511M 64-Channel Relay Mux/Matrix	$3,130
HP 34512C Switched-Shield Triaxial Matrix	$3,480
HP 34513C General-Purpose 50-Ω RF Module	$3,480
HP 34514C General-Purpose 75-Ω RF Module	$3,840
HP 34515B 10-Channel 1000-Volt Mux	$2,520
HP 34516M/N 256-Crosspoint Matrix	$5,850
HP 34520A 6.5-Digit Multimeter Module	$3,450
HP 34520B 6.5-Digit Multimeter Module	$3,670
HP 34521A ac/dc Source Module	$3,390
HP 34521B ac/dc Source Module	$3,560
HP 34522A 32-Bit Digital I/O Module	$1,580
HP 34522B 32-Bit Digital I/O Module	$1,790
HP 34523A/B Breadboard Module	$530/720
HP 34524A/B 4-Channel D/A Converter Module	$2,210/2,390
HP 34530A/B Microwave Switch	$760/870
HP 34531A/B 1×6 Microwave Switch	$1,510/1,800

MMS PRODUCTS
Computer-Aided Test
HP 3488A

- dc–26.5 GHz signal switching
- Matrix, multiplexer, and general purpose relays
- Digital I/O control and actuation
- Up to 50 channels
- 40 configuration storage registers
- 11 switch and control modules

HP 3488A

DESIGNED FOR HP-IB SYSTEMS

HP 3488A Switch/Control Unit

The HP 3488A Switch/Control Unit brings versatile, HP-IB programmable switching to tests requiring multi-channel measurements. The HP 3488A provides signal switching with the integrity and isolation needed for high-performance production test systems. It also offers a flexible, low-cost interconnection for automating experiments on the bench and for developing tests in the lab. The HP 3488A is designed to hold up to 5 of the following switch and control modules:

- 10-channel relay multiplexer
- 10-channel general purpose relay
- Dual 4-channel VHF switch
- 4 × 4 matrix switch
- 16-bit digital input/output
- Breadboard
- 3-channel 18 GHz switch
- 7-channel form-C relay
- 2-channel microwave switch
- 1.3 GHz 50 and 75 Ω multiplexers

Flexible Switching

The HP 3488A is an economical approach to flexible switching through plug-in modules. You can select the right combination of switching functions to meet both performance and budget needs. Testing is simplified by having one solution for connections of low-level DVM inputs, high-level dc and ac power, and microwave signals to 26.5 GHz. Additional devices, such as microwave relays and programmable attenuators, are easily controlled with digital I/O functions. Custom circuitry can also be implemented on breadboard modules.

Versatile Performance

The HP 3488A can store up to 40 complete switch configurations for convenient recall in automated test programs. Switch operation can be done with multiple relay closures or with selectable channels in a break-before-make mode. Break-before-make and recallable switch configurations can be combined in a programmable scan list. The HP 3488A uses removable screw terminal connectors that provide easily interchangeable wiring for each test. Built-in self-test assures proper operation.

Multiplexer (Option 010/HP 44470A)

Option 010 is a 10-channel multiplexer for scanning or multiple signal connections. Channels switch 2 wires (Hi and Lo) with 2PST relays for DVM inputs and other signals up to 250V and 2A. This module can also be used to multiplex signals to other switching functions, such as the matrix module.

General Purpose Relay (Option 011/HP 44471A)

This module consists of 10 SPST independent relays for general signal switching and control of external devices. Quality connections make this module ideal for switching signals when multiplexing is not required, or for supplying switchable power to the device under test.

VHF Switch (Option 012/HP 44472A)

The VHF module provides broadband switching for high-frequency and pulse signals. The 2 independent groups of bidirectional 1 × 4 switches can be used for signals from dc to 300 MHz. All channels have 50-Ω characteristic impedance and are break-before-make within a group of 4 channels. Each group is isolated from the other and from ground to prevent ground loops. Excellent isolation makes this module ideal for high-frequency signal analyzer measurements requiring a large dynamic range.

Matrix Switch (Option 013/HP 44473A)

Option 013 offers highly flexible switching with a 4 × 4, 2-wire matrix. Any combination of 4 input channels may be connected to any combination of 4 output channels. Each cross point or node in the matrix uses a 2PST relay to switch 2 lines (Hi and Lo) at a time. Multiple 4 × 4 modules can be connected to form larger matrices. Multiplexers can be used in conjunction with this module to effectively expand the number of inputs and outputs of the matrix.

Digital I/O (Option 014/HP 44474A)

This module offers 16 very flexible bidirectional I/O lines and 4 TTL-compatible handshake lines for sensing and control of external devices. The digital inputs can be used to sense contact closures to ground. Each channel provides current sinks for remote switching of external relays, such as the HP 33311 series coaxial switches.

Breadboard (Option 015/HP 44475A)

The breadboard module provides a convenient way to implement custom circuits and special functions that interface directly to the HP 3488A's backplane control signals.

Microwave Switch (Option 016/HP 44476A)

This microwave switch furnishes 3 independent SPST 50-Ω coaxial switches with excellent performance from dc to 18 GHz. The 3 mm SMA connector allows you to easily connect cables for multiple system configurations.

Form-C Relay (Option 017/HP 44477A)

This module provides 7 separate SPDT channels for general purpose switching and control of external devices. Using a power supply, the module can drive programmable attenuators and non-HP coaxial switches.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

Microwave Switch (Option 018/HP 44476B)

The module brings multi-port 50 Ω coaxial switching to your test system. The module can mount any two HP 3331XX coaxial switches. The HP coaxial relays come in 3-, 4-, and 5-port configurations—different switches for a variety of applications. HP coaxial switches that can be used are:

HP Coaxial Switch	Port	Frequency
HP 33311B/Opt 011	3	dc to 18 GHz
HP 33311C/Opt 011	3	dc to 26.5 GHz
HP 33312B/Opt 011	4	dc to 18 GHz
HP 33312C/Opt 011	4	dc to 26.5 GHz
HP 33313B/Opt 011	5	dc to 18 GHz
HP 33313C/Opt 011	5	dc to 26.5 GHz

1.3 GHz 50 =Ω Multiplexer (Option 019/HP 44478A)
1.3 GHz 75 =Ω Multiplexer (Option 020/HP 44478B)

These modules bring bi-directional switching of signals from dc to 1.3 GHz, with high-channel isolation (>55 dB @ 1 GHz). Each module consists of 2 groups of 1×4 multiplexers. All test connections are made to BNCs on the module's edge. Off-channels can be resistively terminated.

Specifications for:
Option 010/HP 44470A Multiplexer
Option 011/HP 44471A General Purpose Relay
Option 013/HP 44473A Matrix Switch and
Option 017/HP 44477A Form-C Relay Switch Modules

Input Characteristics

Maximum Voltage (terminal-terminal or terminal-chassis): 250 V dc, 250 Vac rms, 350 Vac peak
Maximum Current: 2 A dc, 2 A ac rms
Maximum Power: 60 W dc, 500 VA ac
Thermal Offset: < 3 μV
dc Isolation (40°C, 60% RH)
Channel-channel, open channel: $>10^{11}$ Ω

ac Isolation/Performance

(50 Ω termination)	100 kHz	1 MHz	10 MHz
Insertion Loss (dB)	<0.30	<0.35	<0.90
Crosstalk (dB)	< −73	< −53	< −33

Specifications for Option 012/HP 44472A VHF Switch Module

Input Characteristics

Maximum Voltage
Center-center, center-low: 250 Vdc, 30 Vac rms, 42 Vac peak
Low-chassis, low-low: 42 V dc
Maximum Current (per channel): 30 mA dc, 300 mA ac rms
Thermal Offset: <15 μV per channel
Characteristic Impedance: 50 Ω

ac Isolation/Performance

	30 MHz	100 MHz	300 MHz
Crosstalk (dB) Channel-Channel	< −100	< −85	< −65
Group-Group	< −85	< −85	< −50
Insertion Loss (dB)	<0.5	<0.75	<1.25
VSWR	<1.06	<1.12	<1.43

All channels break-before-make within a group of 4 channels.

Specifications for Option 014/HP 44474A Digital I/O Module

I/O Lines

Maximum Voltage: +30 Vdc (line-chassis)
Output Characteristics: V (high) ≥2.4 V; V (low) ≤0.4 V
I (low) Maximum: 125 mA @ V (low) ≤1.25 V; fused at 250 mA
Input Characteristics: V (high) ≥2 V; V (low) ≤0.8 V
External Increment: Advances HP 3488A to next programmed configuration on falling edge of TTL pulse
Channel Closed: Indicates completion of new configuration; TTL pulse

Specifications for Option 016/HP 44476A Microwave Switch Module

Frequency Range: dc to 18 GHz
Isolation: >90 dB
Impedance: 50 Ω
Insertion Loss: <0.05 dB
SWR: 1.40

Specifications for Option 018/HP 44476B Microwave Switch Module

Refer to HP 3331XX product specifications.

Specifications for Option 019/HP 44478A and Option 020/HP 44478B 1.3 GHz Multiplexers

Input Characteristics

Maximum Voltage: 42 V dc + ac Peak
Maximum Current per Channel: 1 A DC or AC rms
Maximum Power per Channel: 24 W, 24 VA, or 44 dBm
Impedance: 50 Ω (Opt 019/HP 44478A)
75 Ω (Opt 020/HP 44478B)

ac Performance

	≤10 MHz	≤100 MHz	≤500 MHz	≤1.3 GHz
Insertion Loss (dB) ≤(40° C, 95% RH)	<0.3	<0.7	<1.5	<3.0
≤(25° C, 40% RH), (Typ.)	<0.2	<0.5	<1.1	<1.9
Crosstalk (dB) Channel-Channel Channel-Common	< −90	< −80	< −65	< −55
Group-Group, Module-Module	< −90	< −80	< −70	< −60
VSWR	<1.2	<1.25	<1.35	<1.55

General Specifications

Environmental: Temperature: 0° to 55° C (32° to 130° F); humidity: 95%, 0° to 40° C (32° to 105° F)
Power: 86 to 132 V/195 to 250 V, switch-selectable; 48 to 440 Hz; 18 VA
Interface: HP-IB
Size: 89 mm H (without feet) × 425 mm W × 292 mm D (3.5 in × 16.75 in × 11.5 in). Allow 76 mm (3 in) additional depth for wiring.
Weight: Net, 8.5 kg (18.75 lb); shipping, 16 kg (35.25 lb)
Connectors: Removable screw terminal connector. Each terminal accepts 18 to 26 gauge (16 to 40 mils) wire, with strain relief for wiring.
Opt 012/HP 44472A VHF switch: BNC connectors
Opt 016/HP 44476A and Opt 018/HP 44476B microwave switch: SMA connectors

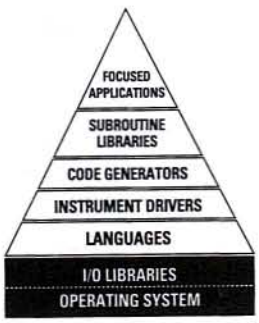
Ordering Information

	Price
HP 3488A Switch/Control Unit	$1,895
Switch Modules-Includes Terminal Connectors	
Opt 010/HP 44470A 10-Channel Relay Multiplexer Module	+$550
Opt 011/HP 44471A 10-Channel General Purpose Relay Module	+$550
Opt 012/HP 44472A Dual 4-Channel VHF Switch Module	+$780
Opt 013/HP 44473A 4 × 4 Matrix Switch Module	+$670
Opt 014/HP 44474A 16-Bit Digital Input/Output Module	+$550
Opt 015/HP 44475A Breadboard Module	+$220
Opt 016/HP 44476A Microwave Switch Module	+$2,540
Opt 017/HP 44477A Form-C Relay Module	+$550
Opt 018/HP 44476B Microwave Switch Module	+$550
Opt 019/HP 44478A 1.3 GHz 50 Ω Mux	+$1,000
Opt 020/HP 44478B 1.3 GHz 75 Ω Mux	+$1,080
Rackmounting and Manuals	
Opt 401 Side Handle Kit (HP p/n 5061-1171)	+$50
Opt 907 Front Handle Kit (HP p/n 5061-1170)	+$60
Opt 908 Rack Flange Kit (HP p/n 5061-1168)	+$40
Opt 909 Rack Flange with Handles (HP p/n 5061-1169)	+$90
Opt 910 Extra Operating and Service Manuals	+$110
Opt W30 Three-Year Hardware Support	+$60

TEST SOFTWARE & DEVELOPMENT TOOLS
Overview

Test Software Development Tools

Software development is a key issue in developing automated test systems. Hewlett-Packard has a range of software development tools designed to reduce the time, cost, and complexity of developing test and measurement software applications. The simple model below positions the various types of software tools HP has to offer. The products are covered in detail on page 109 through the end of this section.



TEST & MEASUREMENT SOFTWARE MODEL

Test and Measurement Software Model

Software needs depend on a variety of factors. Computer platform and operating system preference, data analysis and presentation needs, operator interface requirements, instrumentation control and measurement specifics, and programming experience of the developer are all factors that have to do with which approach is most productive in developing test software.

The base of this model contains platform software, namely the operating system and I/O device drivers, on which other computer-aided test software can be developed. Above this is a section that contains various types of development tools and finally at the top are application-focused solutions.

As you move your way up the triangle, more and more of the end application solution is provided until you have almost a turnkey application. These turnkey applications tend to have little flexibility, while the language approach can be used to do just about anything. Let's review the HP software products per this model.

Operating Systems

HP has software tools for the MS-DOS/MS Windows, HP BASIC, and HP-UX environments. This allows you to select the tools that best meet your company's computing standards and the needs of the specific application.

I/O Libraries and Utilities

Depending on the platform chosen there is a solution for accessing devices over a variety of interfaces. Examples of these are the HP-IB for Windows and DOS Command Library/Interface for the PC (page 114), the Device I/O Library for HP-UX (page 114), and the integrated I/O libraries of HP BASIC (page 109). Software tools such as ITG II (page 113) also have support integrated in for embedded VXI control.

Languages

A unique contribution HP makes to the test and measurement community is providing a language family optimized for these types of applications, HP BASIC (page 109). It is available across MS-DOS, MS Windows, HP BASIC, and HP-UX environments. HP software tools such as ITG II (page 113), HP VEE (page 116), and HP-IB for Windows and MS-DOS also support working with generic programming languages to develop test applications.

HP VEE (page 116) offers a graphical way to program applications, using visual objects to represent data collection, analysis, or presentation. The result is a complete graphical solution, similar to a block diagram, which required no textual-based programming.

Instrument Drivers

Throughout the catalog you will find a symbol that looks like this.

This shows that the instrument has a HP instrument driver that is supplied with software tools such as HP ITG (page 111) and HP VEE (page 116). This driver simplifies the programming of that instrument to a point-and-click with a mouse metaphor. HP instrument drivers are unique in the industry in that they include more functionality of the instrument than provided by other software packages. A menu-driven driver writing tool is also available to create new drivers. This tool makes it very simple to create custom drivers for your instruments.

Code Generators and Subroutine Libraries

Code generators are designed to assist software developers who program in traditional languages such as MS C, QuickC for Windows, QuickBASIC, and HP BASIC family products. They use a graphics environment to simplify the code development process as well as the compile/link/edit process. HP ITG II for MS-DOS/MS Windows (page 113) and HP ITG for HP BASIC are such software tools.

Subroutine libraries provide additional capabilities, especially when they are peaked to a particular industry focus. Being able to perform analysis on acquired data, displaying it, and building user interfaces with dialog boxes and displays are examples of areas where subroutine libraries can help. HP VEE (page 116), HP BASIC Plus (page 110), HP ITG II (page 113), and Instrument BASIC for Windows (page 112) are HP software tools that assist in this area.

Focused Applications

There are applications where a specific set of hardware and/or software can be clearly defined to meet the need. In these cases HP provides turnkey applications software that is closely tied to the hardware. Examples are EMI test, data acquisition, lightwave polarization analysis, dynamic signal analysis (DSA), and cellular radio test. You will find these focused applications throughout the catalog along with the instrumentation. Another example of an application-focused area is manufacturing test. Here HP offers FTM (page 111), a test executive that uses a forms-based approach to building test programs.

HP BASIC: The Premier Language for Measurement Automation

Virtually any computer language could be used to create a test program—but some approaches are easier than others. HP BASIC is a computer language that is *optimized* for use by the test professional. Providing the best features of general-purpose computer languages, HP BASIC includes many test-oriented features.

Features

- I/O libraries integrated within HP BASIC, as opposed to the add-on I/O libraries used by other languages. As a result, HP BASIC presents no hidden costs and is much easier to use.
- Unified I/O, a concept that permits a common approach to instrument control, no matter what interface you use. For example, the OUTPUT 707;"*RST" command resets an instrument on the HP-IB interface. Unified I/O allows the same approach to RS-232; the only change is in the interface code. Using RS-232, the command is OUTPUT 8;"*RST".
- End-of-line syntax checking. HP BASIC checks the syntax of every line—as you type it in. Typing errors are identified immediately; there's no need to run or compile the program to find them.
- Automatic use of direct memory access (DMA) if DMA hardware is available. This characteristic provides the highest performance I/O possible.
- Support of separate context subprograms. This support allows you to develop modular, reusable code segments that can be loaded or unloaded during program execution. This increases programmer productivity, since code modules are easily reused, shared, or updated.
- Full interrupt processing with 15 levels of software prioritization.
- Advanced commands for analysis, such as complex data types and matrix manipulation. These commands are not found in conventional languages.
- Powerful graphics commands that allow quick development of sophisticated graphics displays—usually much faster than that afforded by conventional languages. HP BASIC's graphics capability has recently been enhanced with the addition of HP BASIC Plus, an extension to HP BASIC that permits the rapid creation of graphical user interfaces. See the following page for more information on HP BASIC Plus.
- Excellent HP support and documentation. Most instruments (from all vendors) come with sample programs written in HP BASIC.
- Ease of use that lets you show results quickly. However, HP BASIC has the power and sophistication for the most complex test programs.

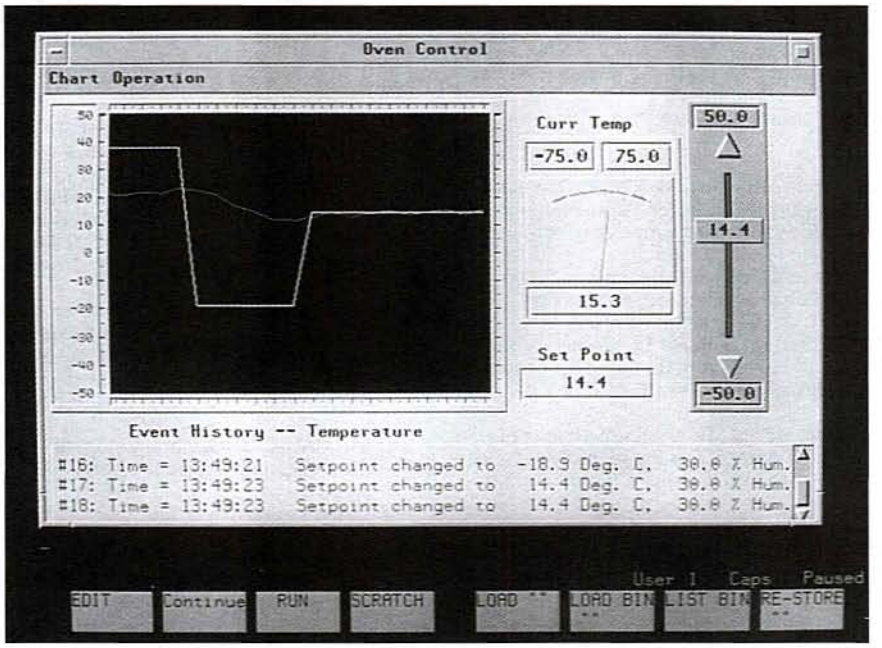
HP BASIC: A Family of Products

HP BASIC is a family of products supported on many different computer platforms and operating systems. The broad support of HP BASIC lets you leverage your HP BASIC skills and programs across all the platforms. Platform-to-platform compatibility is very good when moving up in the family. The HP BASIC family includes:

- **I BASIC**, a restricted subset of HP BASIC running in "smart" instruments such as those in the VXI family. I BASIC is often used to control other instruments in a test system or to execute a complete test program in one instrument. Program development, sophisticated operator interfaces, and complex data analysis are usually executed in a supervisory computer that uses a more powerful version of HP BASIC.
- **Instrument BASIC for Windows**, an expanded subset of HP BASIC, that runs on industry-standard PCs using Microsoft Windows. Instrument BASIC for Windows includes the most commonly used commands from HP BASIC plus all the human-interface tools from HP BASIC Plus.
- **HP BASIC/DOS**, a fully compatible version of HP BASIC, that runs on a measurement coprocessor in a PC. This configuration gives the lowest-priced fully functional HP BASIC platform. Added capability in multiprocessing and deterministic response are also features of the coprocessor approach.
- **HP BASIC/Workstation**, the mainstay of the HP BASIC family. Running on HP 9000 Series 300 workstations, this version gives full access to the language plus the highest I/O performance. HP BASIC/WS, product number 98616B/L, is described on page 118 along with HP 9000 Series 300 instrument controllers.
- **HP BASIC/UX** runs on HP 900 Series 300 and 400 UNIX workstations. This version retains all the features of HP BASIC, but also gives the programmer access to multitasking, networking, and the vast amounts of software associated with UNIX. This version includes a compiler. The product number of HP BASIC/UX is E2040A/L.

HP BASIC Accessory Products

- **HP BASIC compiler**, a product for users of HP BASIC/WS who desire the faster execution and security provided by a compiler. The product number of the HP BASIC compiler is 98618B, and the compiler is explained in HP publication number 5952-3072.
- **DOS File System**, a binary system that gives HP BASIC/WS devices the ability to read and write DOS-formatted disks. The DOS File System is for users of HP BASIC/WS who want to share data with PCs. The product number of the file system is 98616D, and the product is explained in HP publication number 5091-4787.
- **SRM-UX**, a networking scheme that allows multiple HP BASIC workstations to share resources such as disks and printers. (SRM stands for Shared Resource Manager.) SRM/UX software allows the use of a UNIX workstation as the SRM server and is an excellent growth path for users wanting to link SRM systems to UNIX networks. The product number of SRM-UX is E2085A, and the product is explained in HP publication number 5091-0533E.



Human-Interface Graphics Commands and Online Help

HP BASIC Plus adds 2 important new features to HP BASIC: human-interface graphics commands and online help.

HP BASIC Plus provides 29 new commands to help you create crisp, bright human-interface graphics more easily than ever. One HP BASIC Plus command creates a strip chart that would require over 100 lines of code in another language. In addition, with one line of code you can create a wide variety of operator-interface graphics, including:

- Dialog boxes
- Data-display objects
- Text-display objects
- Input devices
- Menu-creation objects

Each of these categories includes a wide range of choices. For example, 7 types of dialog boxes are provided, including boxes for information, questions, warnings, and errors. Data-display objects include an XY graph, a strip chart, a meter, and a bar display.

All of the graphics objects feature a wide range of attribute settings so you can customize them. The core set of attributes includes the object's position on the screen, its background color, and its size. Most of the objects have about 15 core attributes.

In addition to a large set of core attributes, many of the objects have specific attributes of their own. For example, the strip-chart object has over 30 additional attributes, including the number of channels displayed, the color assigned to each channel, the number of points displayed, the number of points in the display buffer, and how the display is updated.

With HP BASIC Plus, it's easy to create a graphical user interface that is more sophisticated than HP BASIC users could ever create before.

It's also easy to integrate these commands into your existing programs. You will need to upgrade your system to HP BASIC 6.2 and you'll need an additional 900 Kbytes of RAM to run HP BASIC Plus. Using the commands is as easy as typing in a new line of HP BASIC. HP BASIC Plus is loaded as a binary and can be stored as a part of your system; once you've loaded and stored HP BASIC Plus, you don't have to include a special set of subprograms in each of your programs.

In addition, since HP BASIC Plus is an HP BASIC binary, you get the advantages of very high-throughput graphics and very responsive menu and dialog box selections.

Online Help for HP BASIC

HP BASIC Plus also provides online help for all HP BASIC keywords. Now, the *HP BASIC Quick Reference Guide* information for HP BASIC keywords is at your finger tips, so it's easier than ever to use HP BASIC. You can access information directly by keyword name or find the correct keyword by using the keyword dictionary. In addition, you can copy simple examples from online help directly into the HP BASIC editor.

System Requirements

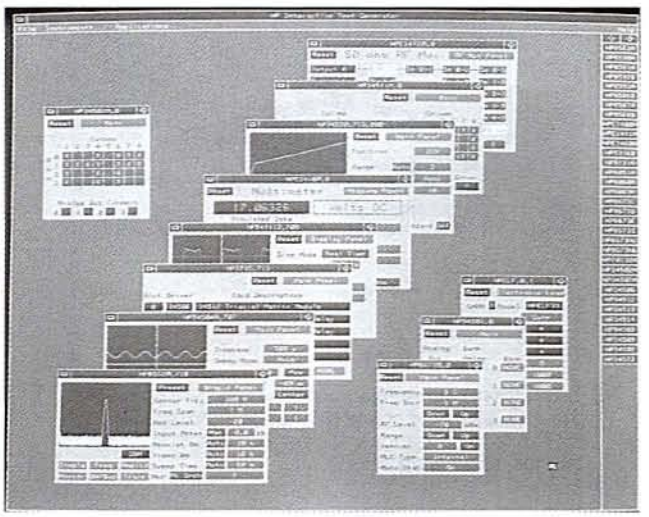
HP BASIC Plus requires a Series 300 controller or any controller that supports HP BASIC/UX (i.e., selected Series 300 and Series 400 controllers). It also requires: HP BASIC 6.2 or later; 900 KB RAM (which means you need at least a 2-MB system); and 3 MB space on your hard disk.

Ordering Information

	Price
HP E2160A HP BASIC Plus License-to-Use	$350
Opt AA0 Media and Manuals for HP BASIC Plus Running on HP BASIC/UX. Includes ¼-in Tape and Manual Set.	$100
Opt AA8 Media and Manuals for HP BASIC Plus Running on HP BASIC/WS Controllers or for HP BASIC on the DOS Measurement Coprocessor Products. Includes 3½-in Disks and Manual Set.	$100
Opt AA9 Media and Manuals for HP BASIC Plus Running on the DOS Measurement Coprocessor Products. Includes DOS-Format 1.2-Mbyte 5¼-in Disks and Manual Set.	$100
Opt AAF Media and Manuals for HP BASIC Plus Running on HP BASIC/UX. Includes CD ROM and Manual Set.	$100
Opt AAH Media and Manuals for HP BASIC Plus Running on HP BASIC/UX. Includes DAT Tape and Manual Set.	$100

HP BASIC Plus is also available as option AGU for many of the HP 9000 Series 300 controller bundles and for many of the PC 300 bundles.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.



HP ITG for HP BASIC

Powerful Instrument Drivers and Virtual Front Panels

HP Interactive Test Generator (ITG) for HP BASIC accelerates your test development by providing powerful instrument control tools that integrate into the HP BASIC test development environment. Designed for test engineers, regardless of their programming skill, HP ITG reduces test development with onscreen instrument panels. Menu selections made with the press of a mouse prescribe settings of instruments and initiate and display measurements. HP ITG also automatically generates the code necessary to perform these tasks in your test program.

Powerful Instrument Drivers

HP instrument drivers are designed to give you the full power available in your instrumentation. Additionally, they contain the links between functions, ensuring that the driver reacts just as the front panel of the instrument does. This ensures that you have remote access to all the power of your instruments and that the software generated in HP ITG will execute with a minimum of errors.

Protected Software Investment

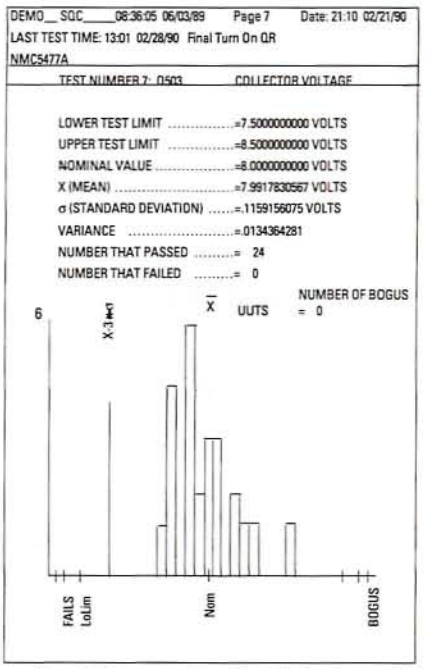
Because software development can easily cost as much as the instrumentation in a test system, protecting that software investment is as important as minimizing it.

The software generated with HP ITG for HP BASIC integrates into your existing HP BASIC test software. Whether you use custom programs or HP Functional Test Manager software to create new applications, HP ITG serves as an easy and efficient tool for developing the measurement-specific part of your test.

Front Panels for VXI and MMS Instruments

HP ITG is particularly well suited for VXI and MMS control. HP ITG gives users interactive front panels that do not exist on the actual instruments. Additionally, full-functionality drivers ensure that you can get the most out of your VXI and MMS instrumentation.

Ordering Information	Price
HP E2000A Interactive Test Generator (includes software and manuals)	$995
Opt AA0 Software on ¼-in Tape Cartridge (for HP BASIC/UX only)	$0
Opt AA7 Software on 5¼-in DOS Disk	$0
Opt AA8 Software on 3½-in LIF Disk	$0
HP E2001A Instrument Drivers (one set includes all)	$495
Opt AA0 Software on ¼-in Tape Cartridge (For HP BASIC/UX only)	$0
Opt AA7 Software on 5¼-in DOS Disk	$0
Opt AA8 Software on 3½-in LIF Disk	$0



Informative histograms identify why tests are failing.

HP Functional Test Manager Software

A Framework for Functional Test Programs

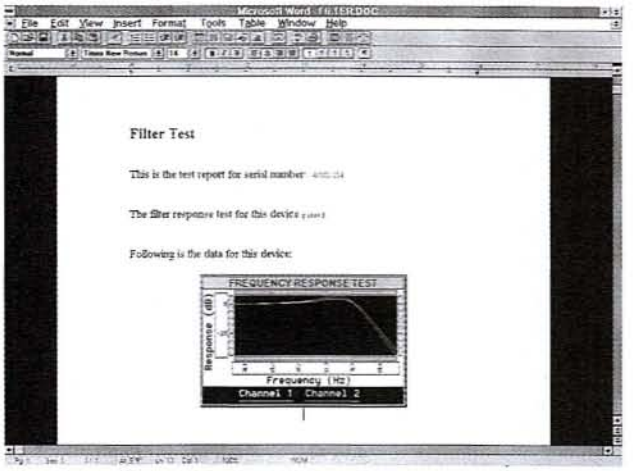
HP Functional Test Manager (FTM) software lets you significantly reduce your software development time and gives you the tools to improve your test process. The FTM software is focused on functional testing of subassemblies and assemblies and is a logical companion to VXI hardware in production test applications.

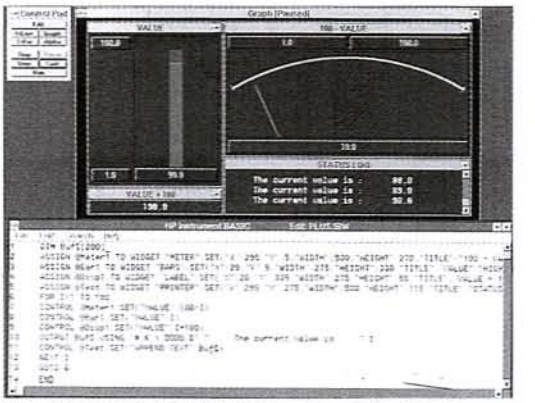
With FTM, you can quickly write, debug, and document functional test software. FTM does this via a standard development environment, standard operator interface, an instrument control framework, end-of-test reports, and a predefined data management scheme. Having saved time in the development of the test software, FTM then includes statistical quality-control tools and on-demand reporting capabilities. These tools condense what is normally an overwhelming number of test results into insights that can help you improve your test process.

FTM is written in HP BASIC and runs on HP BASIC/WS, HP BASIC/UX, and on a PC using HP measurement coprocessors. For more information, ask for the HP FTM data sheet, p/n 5954-9691.

Ordering Information	Price
HP 34806G Functional Test Manager License-to-Use	$3,450
Opt AA0 Media and Manuals for HP FTM Running on HP BASIC/UX. Includes ¼-in tape and manual set.	$1,500
Opt AA8 Media and Manuals for HP FTM Running on HP BASIC/WS Controllers or for HP BASIC on the DOS Measurement Coprocessor Products. Includes 3½-in Disks and Manual Set.	$1,500
HP 34806G + 24D HP FTM training class must be ordered separately.	$1,300

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.





Now it's simple to create XY graphs, strip charts, control panels, gauges, sliders, buttons, pull-down menus, and dialog boxes.

Instrument BASIC for Windows

Makes You More Productive and More Persuasive

Spend enough time with any programming language and you'll eventually get what you want out of it. But it takes time. Lots of it. But Instrument BASIC for Windows gives you the tools to get your measurement results fast, then present them persuasively. Consider what you get:

- Complete set of example programs that illustrate I/O, graphics, and reporting features
- First measurement-specific Windows language for PCs
- Ability to make your programs user-friendly, with XY graphs, stripcharts, gauges, sliders, buttons, pull-down menus, control panels, and dialog boxes
- Easy-to-use and consistent Windows interface
- Easy exchange of data and graphics between Windows applications—ideal for reports and analyses

The First Measurement-Specific PC Language with Built-In Shortcuts

If you're a scientist or engineer involved in test development, you need to get to your destination quickly. Unfortunately, you face a long and winding road through a generic programming language.

Sound like a trip you've taken a few times? Then get ready for HP Instrument BASIC for Windows. It is, without a doubt, the single most stunning improvement in programming for measurement results.

You Get a Whole Library of Editable Sample Programs to Speed Up Your Work

All too often, programming with a generic language is a tedious process that involves writing hundreds, if not thousands, of lines of code.

But Instrument BASIC for Windows comes with a complete set of editable measurement programs to get you started. Just paste them into your program and edit as needed, knowing full well you've just saved umpteen keystrokes. Try writing a subroutine in your current language that sends string commands to an oscilloscope or spectrum analyzer, receives an array of measured values, and plots an XY graph.

Better yet, don't. Unless you've got a few hours to kill.

Create Friendly Control Panels and Presentation-Quality Reports

As if writing code isn't enough, often you've got to figure out how to make your program usable by others.

Instrument BASIC for Windows lets you create handy XY graphs, strip charts, control panels, instrument gauges, sliders, custom pull-down menus, and even dialog boxes for error messages or warnings. All to make sure nothing gets in the way of the measurement results you're after. No matter who's running the program. And you have the power to communicate and analyze your test results in new and meaningful ways. You'll share data with other Windows applications, putting dazzling presentation capabilities right in your grasp. For example, paste an XY graph in a word processor document to add the kind of pizzazz words alone can't express. Or pop your results into a spreadsheet to provide meaningful analysis.

Get Your Free Evaluation Copy Right Away

If you think using Instrument BASIC for Windows sounds easy, getting your hands on a free evaluation copy is even easier. Just call our toll-free number.

What will the evaluation version let you do? Just about everything. You'll see what an incredible time-saver our complete set of editable sample programs can be by using them to write real measurement-specific programs.

You'll experience the joy of using a language that actually responds to the way you think about measurement problems. And you'll be able to preview the benefits of Windows—including sharing data, graphics, and the DOS world's most intuitive interface.

In short, it'll simply blow the doors off of whatever language you're using now.

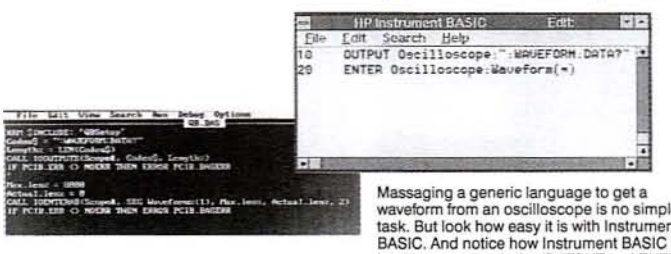
Curious? Then call HP DIRECT at 800 452-4844 and order your free evaluation copy of Instrument BASIC for Windows today. Because if you're looking for a vehicle to take you where you need to go, it only makes sense to test drive it first.

Ordering Information

	Price
HP E2200A Instrument BASIC for Windows	$395

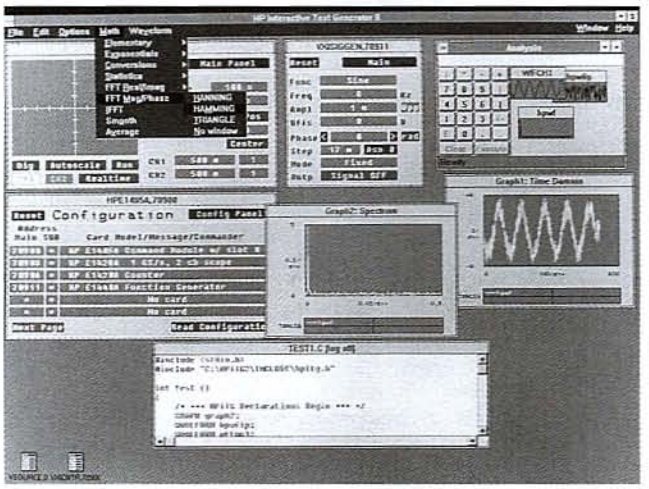
Windows 3.0 or higher is required to run the purchased version and the evaluation copy. The purchased version of Instrument BASIC for Windows works with RS-232 and HP-IB instruments. For the latter, you need an HP-IB interface card. System requirements include a Microsoft mouse (or compatible point device), 4 MB extended memory, either one 1.2 MB 5¼-in or one 3½-in floppy drive, and a hard drive with 3 MB of free space.

☎ For off-the-shelf shipment, call 800-452-4844.



Massaging a generic language to get a waveform from an oscilloscope is no simple task. But look how easy it is with Instrument BASIC. And notice how Instrument BASIC has intuitive commands like OUTPUT and ENTER.

- Large library of sophisticated instrument drivers
- Interactive driver writing tool to create new drivers
- Built-in graphics for easy display of measurement results
- Built-in data analysis tools
- Programmer's tools helpful in program creation
- Support for the most popular programming languages



HP E2020B Interactive Test Generator II

Test Program Development Tools with the Power and Flexibility of Windows

Writing your own test applications has always been the easiest way to ensure that you'll have the power and flexibility you need in your test programs. But developing good software takes time. Now, with HP ITG II (Interactive Test Generator II), you can take advantage of sophisticated program development capabilities to help speed the development process, while still maintaining the performance that brought you to your programming language in the first place.

HP ITG II is a Windows-based software tool that assists you in the creation of test software. HP ITG II helps you in the development of your test applications using traditional programming languages by providing facilities for the creation of the instrument control and measurement, data analysis, and data display portions of test programs.

Instrument Drivers

The core of HP ITG II is its library of highly sophisticated and functionally complete instrument drivers, featuring graphical front panel displays. HP instrument drivers are unlike any other drivers in the industry. While most drivers offer a *small subset* of the available programmatic functions of an instrument, HP drivers implement *almost all* of an instrument's available features, leaving out only those considered less important in an automated program.

Look for this symbol throughout the catalog. It indicates HP instruments with available HP instrument drivers.

Driver Writing Tool

HP ITG II includes a Driver Writing tool (DWT) which facilitates the development of new instrument drivers without the need to know the details of HP's driver writing language. We'll ask the questions, you just fill in the blanks.

Graphics

HP ITG II graphics offer you a simple, intuitive way to create up to 4-trace XY plots with linear or logarithmic axes, automatic or user-adjustable scaling, custom labeling and title creation, and, in the interactive mode, the ability to set up to two markers with delta display. HP ITG II also allows easy creation of histograms, with custom labeling and graticules.

Analysis

In addition to HP ITG II instrument control and data display features, the product also offers a wide range of the most asked-for data analysis routines. When data is moved into the analysis window, variables are automatically created, eliminating the need to account for such details as data types and array sizes.

File I/O

HP ITG II features a wide range of file formats including ASCII, 16-bit Integer, Floating-Point, DaDisp Waveform, Lotus, and HP ITG II internal waveform type.

Programmer's Tools

In order to simplify the process of creating programs using HP ITG II, the software is supplied with a tool kit group that will help you simplify your test development effort. This group automates the complex *generate code—compile—link—execute/test* cycle.

Windows Integration

HP ITG II is a full Windows 3 application in the most complete sense. From its user interface, to its Windows Help system, to its inclusion of run-time libraries as Dynamic Link Libraries (DLLs), to its ability to allow control of its drivers via DDE, HP ITG II is a true partner in the Windows 3 world. This partnership expands HP ITG II's usefulness and flexibility and assures that you'll never be trapped by your application's lack of features.

Programming Languages Supported

- HP Instrument BASIC for Windows
- Microsoft C Versions 5.1, 6.0, and 6.0ax
- Microsoft C + Software Developer's Kit Version 3.x (for development of Windows programs)
- Microsoft QuickC for Windows Version 1.0
- Microsoft QuickC Versions 2.0, 2.5
- Microsoft QuickBASIC Version 4.5

Try Before You Buy: HP ITG II Evaluation Disk

More than just a "demo disk," the HP ITG II evaluation disk gives you a real working version of the HP ITG II development system as well as several sample instrument drivers. Runtime libraries are not included. To order your free evaluation disk, call HP DIRECT at (800) 452-4844.

Configuration Information

Requires MS Windows 3.0 or 3.1; a 286 or better system with at least 4 MB of RAM; a 1.44-MB or 1.2-MB floppy disk; EGA or VGA display. HP-IB interface card required. Supports HP 82335, HP 82990, or NI PCII series cards.

Ordering Information

	Price
HP E2020B Interactive Test Generator II	$1,495 ☎
(must specify one of the following options)	
Opt AA6 Software on 5¼-in Disks	$0
Opt AA8 Software on 3½-in Disks	$0

☎ For off-the-shelf shipment, call 800-452-4844.

HP 82335 Family of PC HP-IB Products for Windows and DOS

The HP 82335 family consists of the HP 82335B HP-IB for Windows and DOS, the 82335U software upgrade product, and the HP 82335I HP-IB interface card.

These products allow you to inexpensively add HP-IB instrument control capability to your personal computer. The HP 82335B includes the HP-IB interface card and software for creating HP-IB instrument control programs in both the Windows and DOS programming environments utilizing all the most popular PC programming languages and development tools.

Four Ways to Control HP-IB Devices

A DLL for Windows Programming

The HP 82335B allows you to create HP-IB instrument control programs in both Windows and DOS. The HP-IB dynamic link library (DLL) is included for use with ALL Windows-based programming languages like Visual Basic, Quick C for Windows, and Turbo Pascal for Windows. The HP-IB (DLL) can also be used with Windows software development environments like Realizer and Toolbook and some Windows applications like Excel.

DOS Command Library for DOS Programming

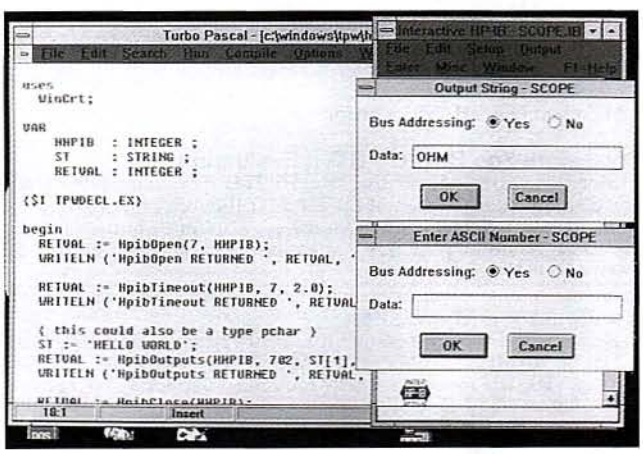
HP-IB commands are also provided for inclusion with all of the most popular DOS-based programming languages like QuickBASIC, Quick C, and Turbo Pascal.

The HP-IB DDE Server

The HP-IB DDE server lets you control and acquire instrument data directly into standard Windows applications like spreadsheets and word processors. Any Windows application that conforms to Microsoft's Dynamic Data Exchange (DDE) protocol and includes an embedded macro language can use this feature. For a more detailed explanation of the DDE server, please ask for application note number 1219-1.

The HP-IB Interactive Environment

The HP-IB Interactive Environment is a Windows-based application that supplies complete interaction with HP-IB devices via pull-down menus and dialog boxes. This application lets you try out instrument commands before you enter them in your program, acquire data, and control the bus. In short, it is a great debugging tool.



Printers and Plotters

The HP 82335B and HP 82335U include the HP-IB peripheral driver which allows you to redirect output from both the COM (Serial) and LPT (Parallel) ports to an HP-IB printer or plotter.

System Requirements

For DOS operation, the HP 82335B and HP 82335U must have at least 256 K of system memory available and be running DOS 3.1 or later.

For operation with Windows 3.0 or later, your PC should have at least an 80286 processor (an 80386 or more powerful processor is recommended) and at least 2 MB of memory (4 MB is recommended).

Supported Languages

Vectra BASIC	3.11, 3.22
GW BASIC	3.11, 3.22
BASICA	3.11, 3.22
Microsoft QuickBASIC	4.0, 4.5
Microsoft Compiled BASIC	6.0, 7.0, 7.1
Microsoft Pascal	3.32, 4.0
Borland Turbo Pascal	4.0, 5.0, 5.5, 6.0
Microsoft C	4.0, 5.0, 5.1, 6.0
Microsoft Quick C	1.01, 2.0, 2.5
Microsoft Quick C/MASM	2.01, 2.5
Borland Turbo C	2.0
Borland Turbo C++	1.0
Borland C++	2.0
QBASIC	1.0

Also supported is any Windows language that can call an external DLL. For example:
Microsoft Visual Basic
Microsoft Quick C for Windows
Microsoft Software Developers Kit
Borland Turbo Pascal for Windows
Borland C++

Ordering Information	Price
HP 82335B HP-IB for Windows and DOS (includes interface card, software, and manuals)	$525
HP 82335U Software Upgrade	$165
HP 82335I HP-IB Interface Card	$395

Note: The HP 82335U can be used as a software upgrade for the HP 82990A, HP 82990E, and HP 82335A products.

HP E2080A LIF Utilities for the PC

The HP E2080A provides a convenient way to transfer files between the HP LIF and MS-DOS disk formats while also providing other useful LIF disk utilities for the PC. For example:

- LIF to DOS copy
- DOS to LIF copy
- LIF catalog
- LIF purge file
- Zero LIF disk
- LIF disk status
- LIF hex dump
- LIF initialize

All of the utilities are accessible from a very friendly main menu, including mouse support. All of the above features can also be executed in batch mode from the DOS command line.

The HP E2080A requires DOS 3.0 or later and at least 256 K of system memory to operate. The E2080A supports the HP 88500, HP 82990, and HP 82335 HP-IB interface cards.

Ordering Information	Price
HP E2080A LIF Utilities for the PC	$195

HP 82300D and HP 82324B Measurement Coprocessors

The HP 82300D and HP 82324B measurement coprocessors combine hardware and software in one complete, ready-to-install product. In terms of hardware standpoint, they are I/O cards, designed for an IBM-AT or compatible, that plug into a PC's standard ISA or EISA bus. With their own operating system, processor, HP-IB port, and RAM, they can operate independently of the PC after it is booted.

In terms of software, these measurement coprocessors bring together the power of the HP BASIC language, which is designed specifically for computer-aided test, and the flexibility of the MS-DOS operating system, opening up access to the vast array of MS-DOS application programs that can be used with your test application.

Major features and benefits of HP's measurement coprocessors include:

- Multi-Com: Allows bidirectional passing of data or commands between the measurement coprocessor, the MS-DOS application, and the operator. Data being collected by the test program can be automatically placed in an MS-DOS application.
- Multiprocessing: Up to 3 coprocessors can be used in a PC simultaneously, for increased throughput and cost savings.
- HP BASIC Language: This is fully compatible with the HP BASIC that runs on HP 9000 Series 3000 workstations, and with HP-UX. It is the most powerful and versatile instrument-control language available. A large number of T&M applications that run on it are also available.
- Foreground/background: Allows the HP BASIC program to run independently in background, controlling the instruments while your MS-DOS application is running in the foreground. This improves throughput and allows full use of the PC.
- Built-in HP-IB port: Fully integrated with the features listed above.

	HP 82300D	HP 82324B
Processor	68000	68030
Clock rate	8 MHz	16 MHz
Maximum memory	4 MB	8 MB
DMA	No	Yes
Floating point	No	Optional

The following optional DIO I/O cards are also available: the HP 82306A GPIO, the HP 82307A GPIO Cable 4.6M, and the HP 50963A Shared Resource Manager.

PC-300 Controllers

A PC-300 controller combines an HP Vectra personal computer with a measurement coprocessor to provide a complete turnkey PC instrument-controller solution.

PC-313CM

A Vectra 396s/20 with 2 MB of RAM, a 1.4 MB, 3½-in floppy disk drive, a 52 or 120 MB hard disk drive, two serial interfaces, a parallel interface, integrated super VGA color graphics and display, an HP measurement coprocessor (optional high-performance measurement coprocessor) with integrated HP-IB, and HP BASIC and MS-DOS preinstalled to make start-up simple and easy. See page 123 for more details.

PC-300 Control Integration

Fully integrated PC controller solutions are available through Hewlett-Packard Field Merging centers. Any HP Vectra and HP measurement coprocessor (or high-performance measurement coprocessor) software and hardware can be integrated, tested, and shipped as a complete solution. For more information, contact your local HP sales office and reference D1865A PC Controller integration service.

Multiprocessing

To increase throughput and flexibility, you can add up to three measurement coprocessors to a single PC. In this configuration, each of the four processors (one PC and three measurement coprocessors) can operate independently and simultaneously without performance degradation. Also, the processors can communicate with each other and with the PC, which gives you access to their data and application programs. This configuration has tremendous productivity advantages, and the potential to create highly efficient, custom-designed systems.

Ordering Information	Price
HP 82300D Measurement Coprocessor	$1,695
HP 82303A RAM Expansion Kit for HP 82300D (512 KB)	$150
HP 82305A RAM Expansion Board for HP 82300D	$495
HP 82324B High-Performance Measurement Coprocessor	$2,895
Opt 102 Add 1 MB of RAM (total, 2 MB)	+$450
Opt 104 Substitute 4 MB RAM Board	+$1,350
Opt 882 Floating-Point Unit, Installed	+$500
HP 82325A 1-MB RAM Board	$500
HP 82326A 4-MB RAM Board	$2,000
HP 82327A Floating-Point Unit	$500
HP 82333F PC-313CM Instrument Controller (see page 123 for more details)	$5,325

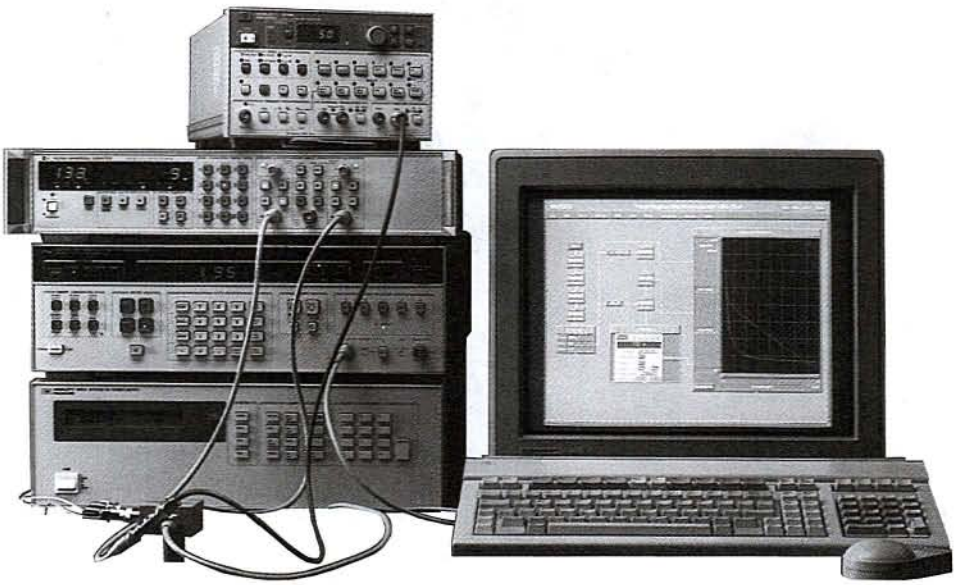
For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

TEST SOFTWARE & DEVELOPMENT TOOLS

Graphical Programming Tools

HP VEE-Engine, HP VEE-Test

- Collect, analyze, and present data without writing code
- Reduce software development time up to 80 percent
- Integrate with programs in C and HP BASIC
- Available on HP-UX Workstations



HP VEE-Engine, HP VEE-Test

Create Programs Faster

HP VEE is a problem-solving environment that lets you create complete engineering solutions without writing code, thereby saving you considerable time and effort.

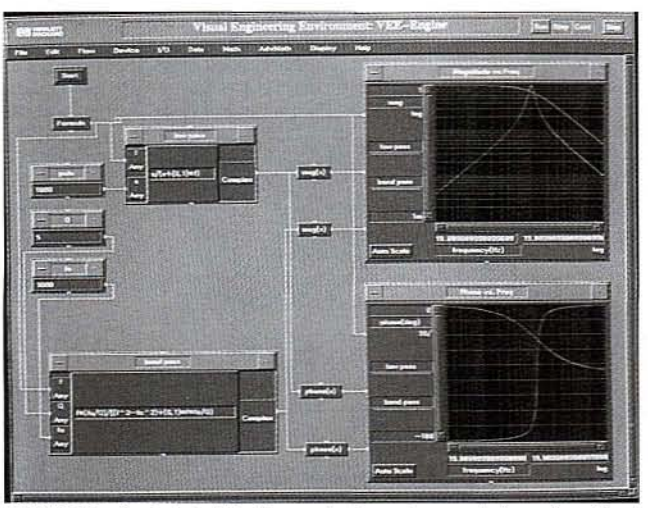
To use, you simply choose any of the extensive set of visual objects, including those for data collection, analysis, or presentation. You then link the objects to define the flow of data through them. The result is a complete graphical solution, similar to a block diagram, which required no code.

Because the block-diagram approach to defining and solving problems is more intuitive than computer programming, you will be able to create solutions faster and focus on results sooner.

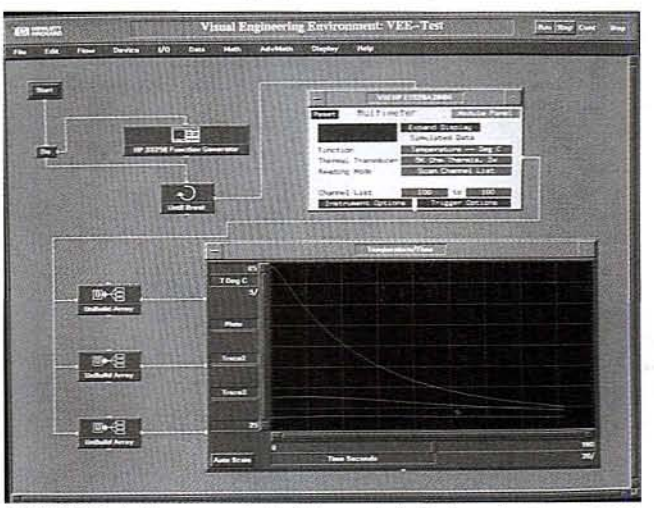
General Purpose and Test

HP VEE consists of two products: HP VEE-Engine and HP VEE-Test. HP VEE-Engine allows engineers and scientists to analyze and present data already acquired from files or programs, or to generate it mathematically. HP VEE-Test adds specific capabilities for test and measurement applications, including instrument control and device I/O. HP VEE-Test also exists in a "run-only" form allowing customers to execute models created with HP VEE-Test.

From mathematical modeling of engineering problems to complete test and measurement solutions, HP VEE is designed for the programmer and non-programmer alike. HP VEE's ease of use appeals to those who don't have the time for complicated programming rules and time-consuming program coding. In addition to its visual nature, HP VEE shields users from rules of syntax and data types as much as possible, and automatically converts data in some cases. HP VEE's completeness ensures that a wide range of solutions can be successfully created—from simple prototype software to sophisticated models with custom graphical user interfaces.



HP VEE-Engine is ideal for the analysis and presentation of resident data.

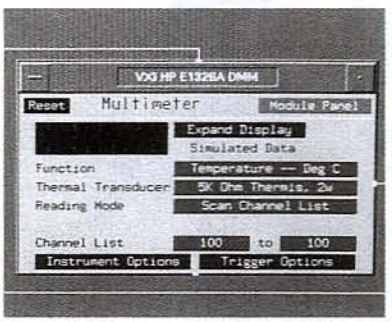


HP VEE-Test allows you to build complete test and measurement solutions.

Functionally Complete

HP VEE provides visual objects that aid in the collection, analysis, and presentation of data. Further capabilities are provided for data storage, flow, modularity, debugging, documentation, and the creation of custom user interfaces.

Data Collection



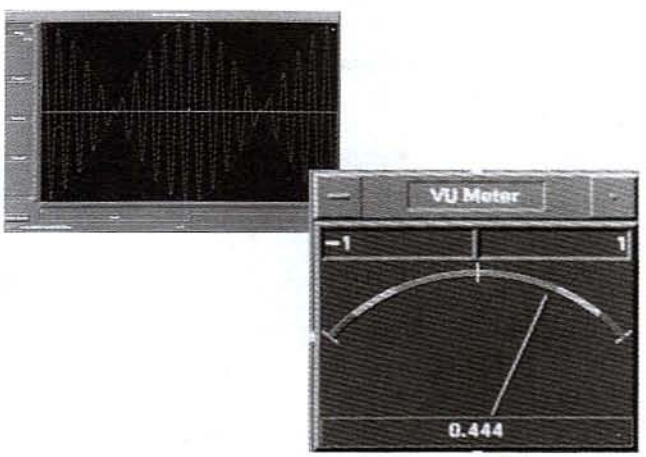
Instrument drivers facilitate the control and data gathering from instruments.

With HP VEE-Test, you have a choice of utilizing any of the over 260 HP instrument drivers (the same as those used with HP ITG), or using direct I/O to any instrument or device on the HP-IB, RS-232, or GPIO bus. The instrument drivers are easy-to-use soft front panels through which you set up and control a specific HP instrument. Direct I/O adds flexibility and throughput by allowing you to define instrument commands and I/O transactions interactively to any device on the supported interfaces.

Data Analysis

HP VEE provides a comprehensive set of objects for analyzing and handling data. Objects are available for the most commonly used math operations, as well as for custom formulas, calculus, regression analysis, probability, statistics, and more. The most commonly used engineering functions are also represented in HP VEE as individual objects. Fast Fourier tranforms, data filtering, digital signal processing, distributions, and more are provided in easy-to-use and easy-to-access objects to save both time and effort.

Data Presentation

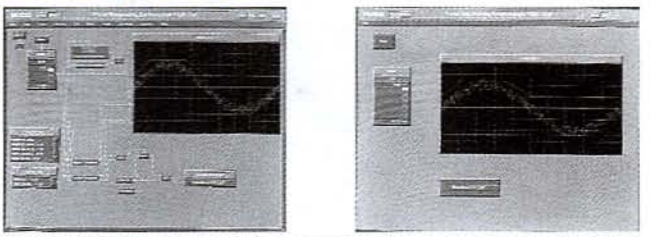


A large number of customizable objects is available for data display and presentation.

Able to display data textually or graphically, HP VEE provides a comprehensive set of objects along with the option to customize them. You can choose from XY plots, Y plots, strip charts, polar plots, complex plane, waveforms, and a number of frequency spectrums.

Each display object is designed to allow clear and accurate readouts of data. Markers are available to mark points on a curve and display their value. Data curves can be zoomed in or out, and a number of panel layouts and grid types can be chosen to display the data effectively.

Expanding Your Power



Optional views of the solution allow you to create custom graphical user interfaces.

HP VEE provides additional capabilities to create sophisticated solutions, including:

- Flow control objects and conditionals
- Data manipulation and control objects
- The capability to create custom user interfaces and secure them
- Visual debugging tools
- Documenting objects and features
- Extensive online help

In addition, with the power to bridge into HP-UX applications and programs, HP VEE lets you integrate existing programs, tune your applications when necessary, and access the versatility and power of HP-UX. For more information please consult HP VEE 2.0 technical data sheet (5091-4784EUS) and the HP VEE 2.0 product brochure (5091-4785E).

System Requirements

Computers: HP VEE is supported on HP 9000 series 300, 400, and 700 workstations. Minimum RAM required is 8 MB, recommended is 12-16 MB.

Operating System: HP VEE is supported on the HP-UX platform, version 8.0 or later, running X11 Windows v. 4.

Graphics: HP VEE runs on color display systems. Six-plane systems or greater are recommended.

Terminals/Diskless: HP VEE can run on diskless clusters and HP 700/X terminals.

Peripherals: For screen printouts, HP LaserJet with minimum 2 MB RAM or HP PaintJet printers are recommended. Output from display objects may also be sent to a plotter.

Ordering Information	Price
HP VEE-Engine (HP E2100B for Series 300/400; HP E2101B for series 700) for the license-to-use	$895
Optional media and documentation	$50 each
HP VEE-Test (HP E2110B for series 300/400; HP E2111B for series 700) for the license-to-use	$5,900
Optional media and documentation	$50 each
Trade-in allowance for prior purchases of HP VEE-Engine	−$800
HP VEE-Test/Run Only (HP E2115B for Series 300/400; HP E2116B for Series 700) for the license-to-use	$1,750
Optional media	$50 each

Note: HP VEE-Engine is not a run-only environment to HP VEE-Test. HP VEE-Test solutions which use I/O objects will NOT run on HP VEE-Engine.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

SYSTEM CONTROLLERS
Overview

A Wide Range of Instrument Controllers

Hewlett-Packard offers the widest range of instrument controllers in the industry. Each controller system has been optimized to meet the needs of test and measurement customers.

Controller solutions are available for price-sensitive users as well as for applications that require the absolute highest performance from the instrument controller. You can choose the operating system, computer hardware platform, and form factor that best meets the requirements of your test systems.

HP offers instrument controllers based on two industry standard operating systems: MS-DOS and HP-UX.* (HP-UX is HP's implementation of UNIX). The most powerful instrument control environment, HP BASIC (also known as Rocky Mountain BASIC or RMB), is available as well.

DOS-Based Controllers

HP offers solutions for situations where it is desirable to use DOS-based PCs as instrument controllers. These solutions allow the PC to perform simple or sophisticated instrument control tasks while taking advantage of PC standards such as MS-DOS languages and Microsoft Windows.

A variety of instrument tools for Windows are available from HP to help simplify your Windows-based instrument control tasks (see page 112), and an HP-IB interface and I/O library provide support for both DOS languages and Windows.

HP Measurement Coprocessors turn a PC into a powerful instrument controller running HP BASIC, and allow the test program to run in the background and communicate with DOS applications running in the foreground. They can also turn a PC into a multiprocessing controller, saving both time and capital expense.

HP-UX–Based Controllers

High-performance UNIX workstations are quickly becoming the standard platform for computer-aided design and other engineering applications. Hewlett-Packard's HP-UX offers complete UNIX implementation with selected enhancements added to provide HP-UX with necessary features for use within the test and measurement environment.

HP-UX has been enhanced to provide high-performance device I/O capabilities. A Standard Instrument Control Library (SICL) has been developed to provide a common programming interface for device I/O capabilities for C language developers.

HP-UX has also been extended to minimize interrupt response time. Real-time extensions have been included in HP-UX allowing users to specify which programs to run with special priority.

Access to powerful standard networking capabilities and database tools are also readily available within HP-UX.

A number of highly productive environments and programming languages are available for the development of your instrument control applications. HP's Visual Engineering Environment is an example of a highly productive environment that allows users to collect, analyze, and visually present data without programming (see page 116).

HP BASIC Controllers

An HP controller with the HP BASIC language combines a highly productive environment for the development and execution of test and measurement applications with unsurpassed I/O capabilities (see page 109).

The HP BASIC environment is available on three general platforms: HP BASIC/DOS for use with HP Measurement Coprocessors (see page 115), HP BASIC/UX for use with HP-UX–based controllers (see page 109), and HP BASIC/WS for high-performance operation as a dedicated instrument controller (see page 109). Furthermore, an HP BASIC subset is available for Windows to bring this productive BASIC environment to PCs (see page 112).

A Variety of Form Factors

Hewlett-Packard offers controller products in three general packages to allow you to apply the appropriate mix of CPU, mass storage, display integration, and expandability to meet the needs of your test systems.

Modular Controllers

HP controller products are packaged for easy rackmounting. Modular systems such as Vectra personal computers, HP 9000 Models 362 and 382, and HP 9000 Model 745 controllers, incorporate internal mass storage and expansion slots within their packages. External monitors and keyboards complete the controller system (see page 119).

Integrated, Rackmountable Controllers

The R/Series of controller products offer a highly integrated product including an attached keyboard and display system within its rackmountable package (see page 121).

Embedded VXI Controllers

The V/Series of embedded VXI controllers integrate required functionality into small modules for use within C-sized VXI mainframes (see page 120).

HP 9000 Series 300 Controllers

The HP 9000 Series 300 family of instrument controllers is available in a variety of configurations with a wide range of performance. Hewlett-Packard's latest offerings take full advantage of Motorola MC68030 and MC68040 microprocessors. The HP BASIC/WS and HP-UX operating systems are both supported for use with the Series 300 controller systems, and both HP BASIC/UX and HP VEE-Test may be added to HP-UX–based systems to provide the best combination of a standard UNIX operating system and sophisticated instrument control environments.

The Series 300 Models 362 and 382 controllers have been designed from the ground up to meet your test engineering needs. These systems offer excellent performance, flexibility, and features at an affordable price. As part of the HP 9000 Series 300 family, these controllers feature object code compatibility with existing MC68000-based systems. Furthermore, these products support your existing I/O interfaces based on DIO and DIO-II interface architectures.

The Model 362 controller is based upon Motorola's MC68030 microprocessor running at 25 MHz, while the Model 382 is based upon the MC68040 also running at 25 MHz. The Model 362 offers 6 MIPS performance, ideal for cost-sensitive applications. The Model 382 offers 22 MIPS performance, for the more challenging instrument control applications.

The Model 362 uses standard parity RAM available in SIMM modules and is easily expanded to 16 MB. The Model 382 uses ECC RAM in SIMM modules and is expandable to 32 MB. RS-232C, HP-IB (IEEE-488), two-channel DMA, LAN (AUI and ThinLAN), SCSI, HP Parallel, audio, HP-HIL interfaces as well as graphics subsystem and a single DIO interface slot are built into the rackmountable package. Also included in the package is internal mass storage including a 3½-in floppy disk drive and a variety of hard disk choices. In addition to the single DIO slot built into the base configuration, DIO and DIO-II direct connect expanders are also available.

To better meet the economic and physical requirements of the test and measurement market, the Model 362 controller features a low-cost, rackmountable, 14-in, color VGA monitor with 640 × 480 pixel resolution. The Model 382, which also supports the same 14-in display system as the Model 362, is also available with a 16-in, 1024 × 768 pixel resolution or 19-in, 1280 × 1024 pixel resolution color display system to address the need for more sophisticated graphical human interfaces.

The Model 362 controller has been designed to address the need for a low-cost, high-performance HP BASIC/WS system. This controller also supports HP Pascal Workstation and other third-party operating environments, but does not provide support for the HP-UX operating system. The Model 382, with its higher performance processor and larger RAM capacities, supports the same operating environments as the Model 362 and also supports the HP-UX operating system.

The Model 380 controller provides performance equal to the Model 382, but is offered in a package consistent with previous Series 300 controllers. This system also provides support for a larger variety of display system choices and greater RAM capacity than the Model 382. The Model 380 comes standard with HP-IB, RS-232, HP-Parallel, LAN, HP-HIL, and either Fast Disc Interface (HP-IB) or SCSI disk interface. This controller starts with 16 MB ECC RAM and is expandable to 128 MB.

HP 9000 Series 700 Controllers

The HP 9000 Series 700 family of instrument controllers offers a wide variety of configurations and unprecedented performance characteristics designed specifically for instrument control applications. HP's latest offering takes full advantage of Hewlett-Packard's PA-RISC microprocessor architecture.

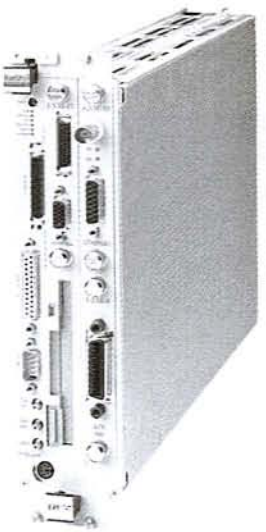
The Model 745 Workstation Controller leverages HP's advances in RISC (Reduced Instuction Set Computing) technology to deliver exceptional computational performance in a rackmountable form factor. This system utilizes an HP PA-RISC microprocessor running at 50 MHz and offers 60 MIPS, 60 SPEC marks performance for applications demanding extensive data manipulation and analysis.

The Model 745 comes standard with 16 MB of ECC RAM and is expandable to 128 MB using low-cost SIMM modules. HP-IB (IEEE-488), RS-232, SCSI, LAN, HP Parallel, audio, HP-HIL, and color graphics display interfaces are included standard on the main processor board. Four additional EISA slots are provided for additional interfaces.

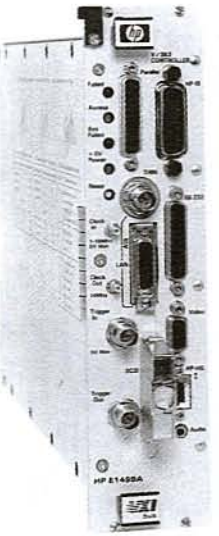
The rackmountable Model 745 package includes two front access, mass storage devices—such as floppy disk, DAT tape, or CD ROM mechanism—and an additional area for a hard disk drive is included in the standard package.

A variety of high-performance display system choices is available for the Model 745. These color display systems are offered in a 1024 × 768 pixel resolution using a 16-in color monitor or a 1280 × 1024 pixel resolution display using a 19-in color monitor.

SYSTEM CONTROLLERS
Embedded VXI Controllers



RadiSys
EPC-7 Controller



HP V/382 Controller

RadiSys EPC-7 Controller

The RadiSys EPC-7 Embedded VXI Controller combines PC compatibility with VXI functionality. This C-sized, two-slot controller provides high-performance operation of an Intel i486 processor and complete compatibility with external PCs.

Standard interfaces include serial, parallel, SCSI, and keyboard. Three custom expansion slots are also provided to allow you to custom tailor this system to meet your test system needs. Interfaces such as HP-IB (IEEE 488) and LAN are available for use within these expansion slots.

Either VGA or Super VGA display interfaces and monitors may be added to the base configuration to provide PC-compatible graphics.

The EPC-7 controller includes a built-in 3½-in floppy disk drive and optional hard disk drive with up to 240 MB capacity.

This controller is a fully functional PC that supports MS-DOS, Microsoft Windows, and a variety of PC-based applications (such as HP ITG) designed for instrument control (see page 113).

Furthermore, direct VXI backplane support has been incorporated into MS-DOS to allow this controller to fully utilize the high-performance capabilities of VXI.

HP V/382 Controller

The HP V/382 Embedded VXI Controller offers workstation performance in an integrated C-sized package. This two-slot system provides the exceptional performance of the latest Motorola MC68040 processor and complete compatibility with external HP Series 300 controllers.

A wealth of standard interfaces is provided, including HP-IB, LAN, RS-232, SCSI, and a choice of high-performance color graphics. These graphics systems begin with PC-like VGA displays and continue through high-performance 1280 × 1024 pixel resolution graphics usually found in graphics workstations.

The HP V/382 supports the same revision of HP-UX, HP's enhanced version of UNIX, and HP BASIC/WS operating systems as external HP Series 300 controllers to ensure application portability.

Direct VXI backplane support has been incorporated into these operating systems to provide high-performance data transfers between instruments and the controller.

HP R Series Integrated Controllers

For test systems that occupy the minimal amount of rack space or are transportable, Hewlett-Packard offers the R-Series integrated, rackmountable controllers. These fully integrated controllers provide the power of a HP 9000 Series 300 controller in a 7-in package that includes the display, attached keyboard, 3½-in floppy disk, internal hard disk, and interface slots.

Easy to Rackmount

HP R Series controllers can be rackmounted into standard 19-in test racks as easily as instruments using the same type of mounting hardware. These systems require only 7 in of vertical rack space while modular controller systems require between 20 and 25 in. Furthermore, modular controllers require specialized rackmounting hardware for displays and keyboard.

Easy to Transport

HP R Series controllers are perfect for systems that perform tests in different locations. These systems are complete and compact and allow the test system to be moved without having to juggle separate components or wrestle with cables.

Quick to Get Up and Running

HP R Series controllers, like all HP controllers with internal mass storage, are delivered with their operating systems preloaded on the internal disk. The only tasks required to get a new test system up and running are connecting the instruments and loading the application software.

Compatible

HP R Series controllers are fully compatible with other HP Series 300 controllers and software. These systems provide four DIO I/O slots and one DIO accessory slot that accommodates HP's DIO interface and expansion cards. Application software developed on other HP Series 300 controllers will run on the HP R Series systems because they are based on the same system architecture as other HP Series 300 systems.

Versatile

HP R Series controllers can be used to develop and execute test programs. There are configurations for HP BASIC/WS applications as well as HP-UX applications written in HP BASIC/UX or C language.

Rugged

HP R Series controllers have been tested extensively to comply with stringent regulatory specifications. They are built to operate in the most difficult testing environments.

HP R Series Configurations

The HP R/362 provides excellent performance for HP BASIC/WS test system applications. The main processor board used is identical to the Modular Model 362 configuration discussed earlier, but it has been repackaged into the HP R Series form factor.

The HP R/382 and R/382U controllers provide extra computational power for high-performance applications that need additional data handling and analysis capabilities. These systems are based on the identical processor technology used in HP Model 382 configurations in the HP R Series form factor.

SYSTEM CONTROLLERS
Controller Comparison

Controller Comparison

	HP PC-313 Controller	HP 9000 Controllers						Radisys	
	386S/20 PC-313CM	362	380	382	745	R/362	R/382 R/382U	V/382	EPC-7
Operating system									
MS-DOS	X								X
HP BASIC/WS		X	X	X		X	X	X	
HP-UX			X	X	X		X	X	
HP BASIC support									
HP BASIC/DOS	X								
HP BASIC/WS		X	X	X		X	X	X	
HP BASIC/UX			X	X			X	X	
Processor									
Main processor	80386SX	68030	68040	68040	PA-RISC	68030	68040	68040	80486
Clock speed (MHz)	20	25	25	25	50	25	25	25	33/50
Math coprocessor	80387SX	68882[1]			Built-in	68882[1]			Built-in
Clock speed (MHz)	20	25				25			33/50
Memory capacity									
PC memory (std/max)	2 to 16 MB								2 to 64 MB
SIMM memory (std/max)	1 to 4/8 MB[2]	2 to 16 MB[6]	8 to 128 MB[4]	4 to 32 MB[7]	16 to 128 MB[7]	2 to 16 MB[6]	4 to 32 MB[7]	4 to 32 MB[7]	
Display systems[3]									
640 × 480 VGA	C	C		C		G	G	C	C
800 × 600	C								C
1024 × 768	C[5]		M/C	C	C			C	C
1280 × 1024			M/C	C	C			C	
Available slots									
ISA cards (std/max)	5/5								
EISA cards					4/4				
DIO I/O cards (std/max)	2/2[2]	1/9	2/10	1/9		4/4	4/4	0/0	
Expander support		X	X	X					
Expansion module (std/max)									1/1
Performance									
MIPS		6	20	20	60	6	20	20	14/20
Specmarks		2	11	11	60	2	11	11	

[1] MC68882 math coprocessor available as an option. MC68882 required for HP-UX or BASIC/UX operation.

[2] Only supported from HP Measurement Coprocessors (HP 82324B, HP 82300D). Only available for use with HP BASIC/DOS.

[3] Resolution specified is in pixels. M=monochrome, C=color, G=gray scale.

[4] ECC RAM standard, expandable to 128 MB using four 32-MB modules.

[5] Available as an option.

[6] Uses standard HP Vectra 486 Parity SIMM memory, p/n D2381A, D2156A, D2152A.

[7] Uses standard ECC SIMM memory.

Bundled Instrument Control Systems

Several bundled systems are available to simplify ordering the best instrument controller for your application. All bundled systems listed below are localized for a variety of international uses. For more information, contact your local Hewlett-Packard sales office.

HP BASIC/WS Controllers[1]

HP BASIC/WS	362	382	R/362	R/382	V/382
HP part number	A2240A	A2241A	A1314A	A1319A	E1499A
Internal hard disk	52/210/420	52/210/420	52/420	52/420	N/A
Internal flexible disk	3½-in	3½-in	3½-in	3½-in	N/A
Touchscreen			[2]	[2]	
Display type	Color	Color	Gray scale	Gray scale	Color
Price	$6,050	$7,895	$10,490	$11,990	$13,300

Controller bundles are available for HP BASIC/WS operation. These systems provide the highest performance HP BASIC operation with a variety of price and performance choices.

HP-UX, HP BASIC/UX Controllers[1]

HP-UX	382[3]	745	R/382U[3]	V/382
HP part number	A2242A	A2637A	A1324A	E1499A
Internal hard disk	210/420	520/1G	420	N/A
Internal flexible disk	3½-in	3½-in	3½-in	N/A
Touchscreen			[2]	
Display type	Color	Color	Gray scale	Color
Display resolution	640 × 480 or 1024 × 768 or 1280 × 1024	800 × 600 or 1024 × 768 or 1280 × 1024	640 × 480	640 × 480 or 1024 × 768 or 1280 × 1024
Price	$9,120	$18,490	$16,990	$13,300

Bundled PC Instrument Control Systems

Fully integrated PC controller solutions are available through the Hewlett-Packard field merging centers. Any HP Vectra and HP Measurement Coprocessor (or high-performance Measurement Coprocessor) software and hardware can be integrated, tested, and shipped as a complete solution. For more information, contact your local HP sales office and reference D1865A PC Controller integration.

PC-313 Instrument Controller[4]

HP BASIC/DOS	PC-313CM
HP part number	82333F
Internal hard disk	52/120 MB
SVGA display type	Color
Price[5]	$5,750

Hewlett-Packard offers the PC-313 instrument controller as a fully integrated PC-based instrument controller solution. Included standard is a 3½-in disk drive, HP Measurement Coprocessor with built-in HP-IB, 2 MB of RAM, HP BASIC and MS-DOS preinstalled on a 50-MB hard disk drive (optional 120-MB disk drive is available), and Super VGA color graphics.

[1]Systems for HP BASIC/WS and HP-UX may be ordered for the V/382. For more information, please contact your local HP sales office.
[2]Available as an option
[3]There are two bundled solutions that offer the best of HP-UX and HP BASIC/UX. These bundles include both HP-UX and HP BASIC/UX licenses-to-use. All HP BASIC/UX bundled systems also offer the option of a 210-MB or 420-MB disk drive with HP-UX and HP BASIC/UX installed and optimized for operation. Bundled prices listed do not include disk options.
[4]For more information on PC-based controllers, please see page 115
[5]Opt 050 substitutes the HP 82324B High-Performance Measurement Coprocessor for the HP 82300D Measurement Coprocessor

HEWLETT-PACKARD INTERFACE BUS

Interconnect Systems and Cables

HP 59306A, 59307A, 59401A, 59501B, 10833A/B/C/D, 10834A

HP 59306A

DESIGNED FOR HP-IB SYSTEMS

HP 59307A

DESIGNED FOR HP-IB SYSTEMS

HP 59501B

DESIGNED FOR HP-IB SYSTEMS

HP-IB Accessory Modules

Modules in the HP 59300, 59400 and 59500 Series are ideal building blocks to extend the measurement capabilities of instruments. Modules can be interconnected via the HP-IB to HP measuring instruments, signal sources, and recording devices capable of operating directly on the HP-IB. In addition, these modules frequently serve to interconnect with devices which are not themselves capable of direct HP-IB operation.

HP 59306A Relay Actuator

Six Form-C relays provide control of external devices either manually from front panel pushbuttons or remotely from the HP-IB. Relay contacts are specified to switch 28 V dc or 115 V ac at 0.5 A. Each relay can be programmed independently or multiple relays can be switched together. Front panel pushbuttons light to indicate the state of each relay.

The HP 59306A is ideal for providing control of microwave coaxial switches (HP 8761A/B) as well as control of microwave programmable step attenuators (HP 8494 through 8496G/H) using external dc power supplies.

HP 59307A Dual VHF Switch

This module provides two single-pole 4-throw switches controlled from front panel pushbuttons or remotely from the HP-IB. The HP 59307A is a dc to 500-MHz 50 Ω switch designed to maintain fast pulse transition times. The switches are independent and bidirectional for optimum use in multiplexing 50 Ω signal lines into measuring instruments. The HP 59307A is ideal to switch a standard delay, frequency, or voltage into a measurement loop for purposes of system calibration.

HP 59501B Power Supply Programmer (isolated DAC)

This single-channel digital-to-analog converter can control a wide range of power supplies (output voltage, or current), as well as other analog programmable devices. It may also be used as a low level signal source, depending on the speed of the controller. It has two output ranges: 0 −1 and 0 −10 V dc in unipolar mode; −1 to +1 and −10 to +10 V dc in bipolar mode. Photo-isolators electrically separate HP-IB control and data lines from power supply circuitry by up to 600 V dc. (For additional details see page 476).

Model	Description	Dimensions – max. height × width × depth mm (inches)	Net Weight kg (lb)	Shipping Weight kg (lb)	Price
HP 59306A	Relay Actuator	101.6 × 212.9 × 294.6 (4 × 8.38 × 11.6)	2.64 (5.87)	3.23 (7.18)	$2,500
HP 59307A	VHF Switch	101.6 × 212.9 × 294.6 (4 × 8.38 × 11.6)	2.64 (5.87)	3.23 (7.18)	$2,100
HP 59501B	Power Supply Programmer	101.6 × 212.9 × 294.6 (4 × 8.38 × 11.6)	2.61 (5.80)	3.17 (7.04)	$1,250

HP 10833A/B/C/D

HP 10834A

HP-IB Interconnection Cables

Cables for interconnecting HP-IB devices are available in four lengths. The connector block at both ends of the cable has a plug on one side and a matching receptacle on the other so that several cables may be conveniently "stacked" in parallel, thus simplifying system interconnection. Lock screws securely mount each connector block to an HP-IB instrument or to another connector block.

NOTE: Cables are not always included with HP-IB devices, particularly those that connect directly to an HP controller. (The HP-IB interface for HP controllers provides the necessary cable and connector.) Product listings in this catalog should be checked to see if HP-IB cables are furnished.

HP 10833 cables feature an improved shielding design to help reduce RFI levels in systems. This series of cables has significantly lower radiated emissions than previous HP-IB cables.

The HP 10834A is a shielded HP-IB to HP-IB adapter. It provides additional clearance (approximately 2.3 cm) between the HP-IB cable and the rear panel of the instrument. This allows easier access to switches, cables, and other connectors in close proximity to the connector.

Ordering Information	Price
HP 10833A HP-IB Cable, 1 m (3.3 ft)	$80
HP 10833B HP-IB Cable, 2 m (6.6 ft)	$90
HP 10833C HP-IB Cable, 4 m (13.2 ft)	$100
HP 10833D HP-IB Cable, 0.5 m (1.6 ft)	$80
HP 10834A Adapter	$31

☎ For off-the-shelf shipment, call 800-452-4844.

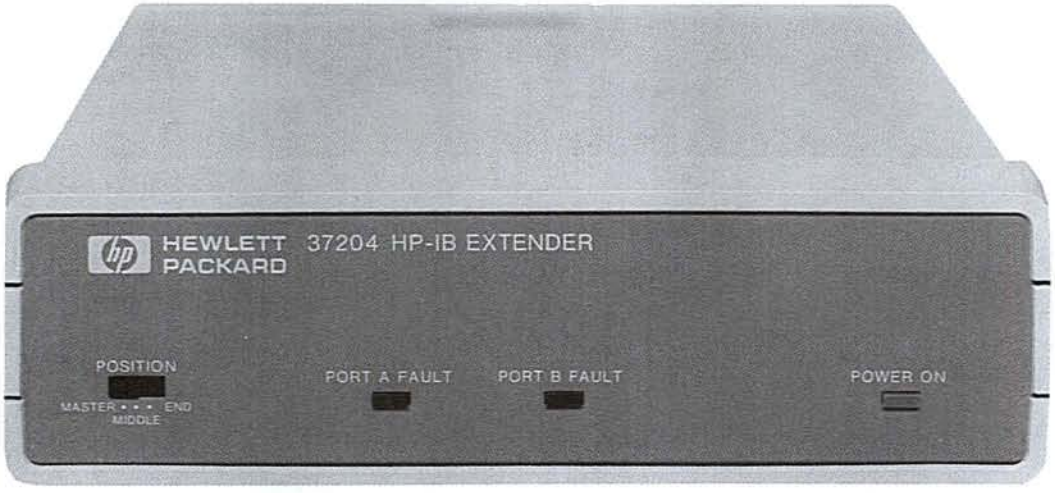
For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HEWLETT-PACKARD INTERFACE BUS

Versatile Interconnect System for Instruments and Controllers

HP 37204A/B

- HP-IB extension up to 1,250 m (up to 3,000 m with fiber-optic cable)
- Data transfer rate up to 60 KB
- Cost-effective multi-drop capability; up to 30 remote sites
- Installation usually needs no software changes
- 100 percent error-free operation
- Industry-standard ST, FC and SMA fiber-optic connectors; fiber sizes from 50/125 to 100/140 μm



HP 37204A/B

DESIGNED FOR HP-IB SYSTEMS

HP 37204A Multi-Point HP-IB Extender

The HP 37204A extends the distance between HP interface bus (IB) devices beyond the 2-m limit. Users can link up to 31 HP 37204As (one per site) to achieve a multi-point system. Each link can be up to 1,250 m long (3,000 m with fiber-optic cable) and mixing of coaxial and fiber-optic links is allowable. Once installed, extenders operate automatically and transparently. Usually, programs can remain unchanged. Error correction ensures 100 percent data integrity. Partial HP-IB operation can continue after link failure by invoking truncation.

The HP 37204A supports all IEEE-488 functions, but might slow the response to a parallel poll beyond the 2 μs limit. Extenders are listen-always devices that handshake data from a talker to all sites; if there is no addressed listener, the extender handshakes with itself. Because extenders limit the speed of all bus traffic to 60 KB/s maximum, extenders should be located on a separate HP-IB from disk/tape drives.

The table below shows examples of maximum speed against the number of extenders in a system. Note: If any coaxial link exceeds 250 m, the speed of all links in the system is 1/10 normal.

Average Inter-Extender Cable Length	Number of Extenders per Chain		
	2	3	5
100 m: coaxial cable	54 KB/s	26 KB/s	14 KB/s
optical fiber	52 KB/s	25 KB/s	13 KB/s
500 m: coaxial cable	5.9 KB/s	2.8 KB/s	1.4 KB/s
optical fiber	36 KB/s	17 KB/s	9 KB/s

HP 37204B Multi-Point HP-IB Extender

The HP 37204B is only for supported configurations of HP 256X/268X printers and HP 3000 computers.

Specifications

Maximum Distance: 1,250 m per link (coaxial cable); 3,000 m per link (fiber-optic cable)
Maximum Speed: 60 KB
Power Requirements: 100, 120, 220, 240 V ac +5/−10%, 48 to 66 Hz, 10 VA max
Size: 212 mm W × 71 mm H × 254 mm D (8.3 in × 2.8 in × 10 in)
Weight: 1.72 kg (3.8 lb)
Temperature: 0° to 50° C (operating); −40° to +70° C (storage)
Humidity: 5% to 95% noncondensing
Altitude: Up to 4,600 m (15,000 ft)
Compliance: UL 478 and 114 listed
CSA 22.2 No 220-1986 certified
Complies with IEC 435 and 380
Verified to FCC part 15 level B
Complies with FTZ 1046-84

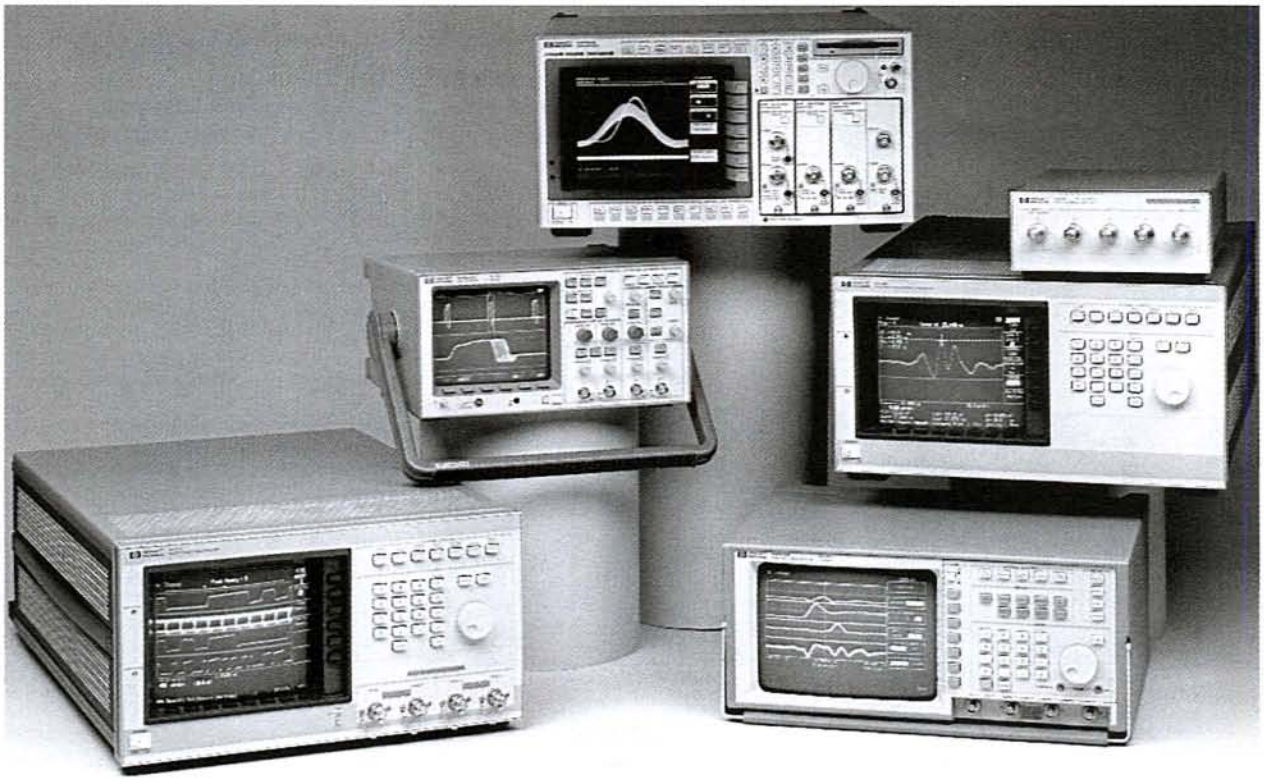
Ordering Information

	Price
HP 37204A Equipped with Dual Coaxial Ports.	$1,500
Opt 003 Fiber-Optic Interface, SMA Type 905 Connectors. For end extenders.	+$620
Opt 004 Fiber-Optic Interface, SMA Type 905 Connectors. For middle extenders in a multi-point system.	+$1,150
Opt 013 Fiber-Optic Interface, ST Connectors. For end extenders.	+$620
Opt 014 Fiber-Optic Interface, ST Connectors. For middle extenders in a multi-point system.	+$1,150
Opt 023 Fiber-Optic Interfaces, FC Connectors. For end extenders.	+$620
Opt 024 Fiber-Optic Interface, FC Connectors. For middle extenders in a multi-point system.	+$1,150
HP 37204B: Equipped with Dual Coaxial Ports	$1,780
Option common to HP 37204A and HP 37204B	
Opt 305 Standard 19-in Rack Mount Adapter; holds one or two HP 37204A/Bs	+$155

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales

OSCILLOSCOPES
Digitizing Oscilloscopes



Oscilloscopes

The Beginning of the Digital Scope Era

In the early 1980s, the electronics industry began to discover that analog scopes were often inadequate to analyze signals from modern circuits. Recognizing this, HP decided to focus its oscilloscope development entirely on digital architectures. The first product arising from this decision was the HP 54100A, the world's first general-purpose, 1-GHz bandwidth digitizing oscilloscope, which was introduced in 1985. Since that time, the electronics world has followed this shift to digital scopes, and the majority of scopes purchased today are digital.

Why Digital?

This conversion from analog to digital results in a more productive work environment for you. Digital scopes provide advantages such as:

- Capture and display of transient single-shot signals such as glitches
- Observation of signals occurring before the trigger event
- Automatic measurements with highly repeatable results and accuracy unheard of in analog scopes
- Waveform storage
- Computer I/O and hard-copy printout

These and other digital scope advantages provide you with the benefit of better and more quantitative information. By providing you with a better understanding of your signals, HP digital scopes allow you to make better decisions at every stage of design—from conceptualization to production and testing, through troubleshooting.

Why Hewlett-Packard?

Since "going digital," HP has continued to develop and to refine the concept of the digital oscilloscope. The HP 54100A/D boasted many firsts in the world of scopes: the first menu-driven user interface, the first pattern and glitch trigger, and the first direct hard-copy mode, among others. This tradition of innovation expanded with the introduction of color displays in 1986, of normalized and calibrated TDR measurements in 1987, and of 2-GSa/s sampling in 1988 and 4-GSa/s in 1992; it continues today.

HP now offers a complete line of digital scopes that spans the application spectrum from low-cost, general-purpose use to high-performance analysis. HP's focus on meeting your automation and measurement needs results in complete solutions that help you understand your designs and solve problems better than ever before. HP is more than oscilloscopes, too: a complete line of test equipment, application-based seminars and training materials, and the most knowledgeable sales force in the industry give you the security of knowing that your test needs will be met.

Choosing the Right Scope: Selection Criteria

In selecting the right HP digital scope for your needs, first consider the signals you're likely to examine.

What Is Your Signal's Frequency?

In general, your oscilloscope's bandwidth should be at least three times greater than the maximum frequency component of your signal. This maximum component can be estimated with the following formula:

$$\text{Frequency} = \frac{0.35}{\text{Signal rise time } (t_r)}$$

You can then determine how accurate a measurement the scope will provide by comparing the scope rise time and the fastest rise time in your signal, using the following equation:

$$\text{Measured } t_r = \sqrt{(\text{Scope } t_r)^2 + (\text{Signal } t_r)^2}$$

The result of the equation gives you the rise time the scope will display. For example, a 250-MHz scope (rise time of 1.4 ns) should accurately measure a signal with a 4.2-ns rise time with an error of less than 5 percent. In short, the higher the ratio of scope bandwidth to signal bandwidth, the lower the error.

Does the Signal Occur Just Once, or Is the Signal Repetitive?

For single-shot events, a digital scope's sampling rate should typically be at least 10 times faster than the bandwidth of the signal you want to examine. The resulting sample density reduces the possibility of viewing aliased versions of the actual signal and is usually sufficient for you to recognize the waveform captured. Some HP scopes are specially designed for single-shot applications. These scopes employ digital signal-processing techniques that virtually eliminate the possibility of aliasing, and they provide accurate voltage and timing measurements with sample rates as low as four times the signal's bandwidth.

Repetitive signals can be characterized over many acquisition cycles; therefore, the digitizing rate of the scope is often not as important. If your signals are normally repetitive, look at the bandwidth you need instead of the sample rate. It may be that the sample rate of a less expensive digital scope is just right for you.

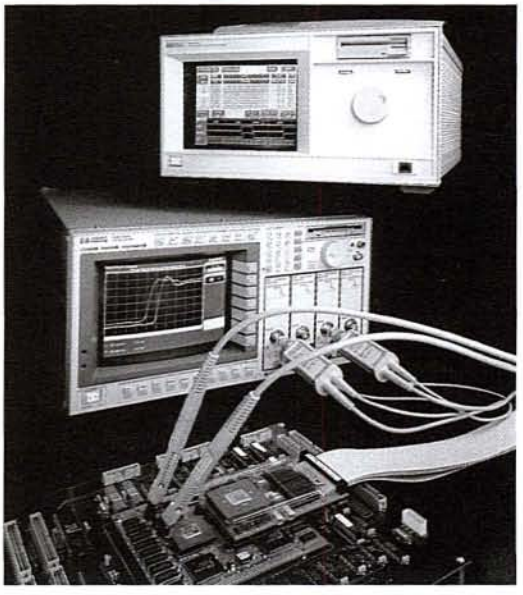
What's Your Application?

Digital scopes are used in a variety of ways, and HP has a complete line of products to fit your needs. From the troubleshooter working around 100 MHz, to the ATE operator testing at 500 MHz, to the research and development engineer performing high-speed digital microwave component analysis, there's an HP oscilloscope that fits. By providing the right level of price and performance, HP helps you understand your signals better.

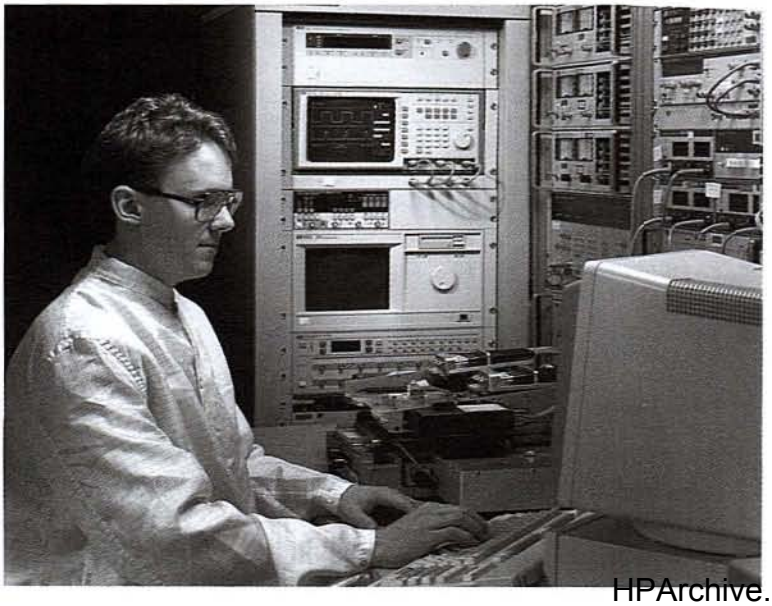
Analog scope users have long valued the feel and versatility of analog scopes for troubleshooting, especially for lower-frequency applications. Troubleshooters often look for unusual or unexpected signals, and the ability to quickly set up and adjust the scope to find a signal is crucial. The HP 54600 Series of scopes fits into this troubleshooting mold, providing extremely fast update rates, an analog-like human interface, and the digital features needed to quickly find signal problems. If that sounds right for you, find out more about the HP 54600 Series on the following pages.

Many engineers find themselves looking for a scope both to capture more complex digital signals and to perform general analysis on those signals. Capturing digital signals and the glitches found with them is a difficult triggering task, but HP has the answer. The HP 54500 Series' state-of-the-art digital triggering capabilities isolate and capture aberrations and glitches on a signal, and the 54500 Series has the processing power to measure and analyze the signals found—all at an affordable price. HP 54500 Series oscilloscopes provide a broad range of solutions, with up to 1-GSa/s sampling rates and bandwidths of up to 500 MHz. The family also fits well into ATE environments—an HP-IB interface with understandable programming commands is standard.

High-speed signal analysis requires the highest level of performance available. Accuracy and repeatability become primary concerns; you must have confidence in your oscilloscope's ability to capture the signal and analyze the data precisely. HP is recognized for leadership in high-frequency measurement technology. This reputation extends to the digital scope market, where HP 54100 Series and HP 54700 Series oscilloscopes offer the ultimate in measurement performance. From the 4-GSa/s single-shot performance on the two channels of the HP 54720A, to the 50-GHz repetitive bandwidth of the HP 54124A, to the 64-K memory depth on the four-channel HP 54112D, HP has the scope with the power and accuracy you need to obtain the best possible information about your signals under test.



From troubleshooting to general automated measurement or from high-speed digital design and debugging to high-performance analysis, HP has the oscilloscope solution you need to understand your signals better. See the following pages for more information on each of the HP scope families.



OSCILLOSCOPES
HP Digitizing Oscilloscopes (cont'd)

Compare the Features

Whether you need pinpoint vertical resolution or lightning-fast signal capture, Hewlett-Packard's digitizing oscilloscopes provide a powerful set of features and capabilities in an easy-to-use package.

Here's a look at how the various models compare in terms of features, capabilities, and price.

Specifications for the HP Family of Digitizing Oscilloscopes

	HP 54600A/ HP 54601A	HP 54602A	HP 54501A	HP 54503A	HP 54504A	HP 54505B/ HP 54506B	HP 54510B/ HP 54512B	HP 16500A Mainframe with 16532A
Bandwidth: Repetitive Singleshot	100 MHz 2 MHz	150 MHz 2 MHz	100 MHz 1 MHz	500 MHz 2 MHz	400 MHz 50 MHz	300 MHz 125 MHz	300 MHz 250 MHz	250 MHz 250 MHz
Time interval accuracy: Repetitive Singleshot	±200 ps N/A	±200 ps N/A	±1 ns N/A	±100 ps N/A	±250 ps ±1 ns	±100 ps ±300 ps	±100 ps ±150 ps	±150 ps ±150 ps
Channels	HP 54600A:2 HP 54601A:4 (2 + 2)	4 (2 + 2)	4 (2 + 2)	4	2	2/4	2/4	2 to 18
Digitizing rate	20 MSa/s		10 MSa/s	20 MSa/s	200 MSa/s	500 MSa/s	1 GSa/s	1 GSa/s
Memory/ channel	4K samples		1K samples	1K samples	2K samples	8K samples		8K samples
Vertical resolution	8 bits		8 bits, 10 bits with averaging					8 bits, 10 bits with averaging
Input voltage ranges	2 mV/div to 5 V/div		5 mV/div to 5 V/div	1 mV/div to 5 V/div				16 mV to 40 V full scale in 1, 2, 4 increments
Input Z, coupling	1 MΩ, ac, dc, ground		1 MΩ, ac, dc	1 MΩ, 50 Ω; ac, dc				1 MΩ, 50 Ω; ac, dc
Pulse parameter measurements	Yes		Yes					Yes
Waveform math	A+B, A−B, XY, invert		A+B, A−B, A×B, A vs. B, invert, magnify			A+B, A−B, A×B, A vs. B, integrate, differentiate, invert, magnify, FFT		A+B, A−B
Other analysis functions	Autostore, peak detect, averaging		Variable and infinite persistence, averaging, envelope					Infinite persistence, averaging
Waveform storage	2 pixel (additional memories with optional module)		2 pixel, 4 waveform			2 pixel, 4 waveform, 650 multiple		Built-in floppy disk
Trigger enhancements	Edge, autolevel, HF/LF reject, noise reject, TV field and line		Edge, pattern, state, glitch, delay by event or time, time-qualified pattern, TV					Edge, pattern, delay by event, immediate, trigger from built-in logic analyzer
Instant hard-copy and disk support	HP printers and plotters, Epson-compatible printers, Centronics printers		HP graphics printers	HP graphics printers and plotters				HP and Epson-compatible printers; 2 built-in disk drives
Other	Fast update rate, delayed sweep, roll mode, HP-IB and RS-232 I/O options, optional test and benchtop automation modules		Measurement statistics and limit test, dual time-base windowing, scroll mode			Measurement statistics and limit test, waveform compare, mask generation, sequential single-shot acquisition pan and zoom		Logic analysis, high-speed timing, pattern generation, multiple time bases (optional)
For more information, order publication number	HP 5091-2221 EUS HP 5091-2222 EUS HP 5091-2223 EUS	HP 5091-4128 EUS	HP 5954-2679D	HP 5959-8795D	HP 5091-0353 EUS	HP 5091-4113 EUS		HP 5091-2195 EUS
Price	HP 54600A: $2,495 HP 54601A: $2,895	$3,270	$4,500	$6,300	$6,750	$8,350 (HP 54505B) $13,990 (HP 54506B)	$13,990 (HP 54510B) $17,990 (HP 54512B)	$16,700 to $93,200

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

Specifications (continued)

	HP 54710A or HP 54720A System with Plug-Ins[1]				HP 54100A/D and HP 54110D	HP 54111D/ HP 54112D	HP 54121T/HP 54122T/ HP 54123T/HP 54124T
	HP 54711A	HP 54712A	HP 54713A	HP 54721A			
Bandwidth:							
Repetitive	1.5 GHz	1.1 GHz	500 MHz	1.1 GHz	1 GHz	500 MHz/100 MHz	20 GHz/12.4 GHz/ 34 GHz/50 GHz
Singleshot	N/A	N/A	500 MHz	1.1 GHz	N/A	500 MHz/100 MHz	N/A
Time interval accuracy:							
Repetitive	±30 ps				±100 ps	±100 ps/500 ps	±10 ps
Singleshot	N/A		±100 ps	±50 ps	N/A	±300 ps/500 ps	N/A
Channels	HP 54710A:2[2] HP 54720A:4[2]			HP 54710A:1[2] HP 54720A:2[2]	2	2/4	4
Digitizing rate	2 GSa/s			4 GSa/s	40 MSa/s	1 GSa/s/ 400 MSa/s	N/A
Memory/ channel	16K samples			32K samples	1K samples	8K samples/ 64K samples	1K samples
Vertical resolution	8 bits, 12 bits with averaging				7 bits, 10 bits with averaging	6 bits, 8 bits with averaging	12 bits, 14 bits with averaging
Input voltage ranges	2 mV/div to 1 V/div	1 mV/div to 1 V/div	1 mV/div to 5 V/div	1 mV/div to 1 V/div	10 mV/div to 1 V/div	5 mV/div to 5 V/div[4]	1 to 80 mV/div[5]
Input Z, coupling	50 Ω, dc	50 Ω, dc, ac	50 Ω, 1 MΩ, dc, ac	50 Ω, dc, ac	50 Ω, 10 kΩ, 1 MΩ pods	1 MΩ, 50 Ω ac, dc	50 Ω
Pulse parameter measurements	Yes				Yes		Yes
Waveform math	+, −, ÷, ×, A vs. B, integrate, differentiate, min, max, magnify, invert				A+B, A−B, A vs. B, invert	A+B, A−B, invert, A vs. B	A+B, A−B, A vs. B, min, max, invert, only
Other analysis functions	Variable and infinite persistence, averaging, digital BW limit, interpolation				Variable and infinite persistence, averaging		Variable and infinite persistence, averaging
Waveform storage	1 pixel, 4 waveform, and floppy disk				2 pixel, 4 waveform	2 pixel, 4 repetitive, 4 single-shot waveform	2 pixel, 4 waveform
Trigger enhancements	Edge, pattern, state, time-qualified pattern, glitch, delay by time or events				Edge, pattern, state, digital delay by event and time, time-qualified pattern[3]		2.5-GHz edge trigger, 18 GHz with HP 54118A
Instant hard-copy and disk support	HP printers, Epson printers, built-in 3½-inch flexible disk				HP printers and plotters		HP graphic printers and plotters
Other	Color display, color hard-copy, measurement statistics, pan and zoom				Color display and color hard copy	Color display and color hard copy	Built-in histograms, TDR/TDT[6], color display, and color hard copy
For more information, order publication number	HP 5091-3593 EUS				HP 5954-2659D		HP 5952-7084D and HP 5952-1171D
Price	$32,400 to $58,900				$17,900 (HP 54100A) $22,900 (HP 54100D) $24,900 (HP 54110D)	$30,900 (HP 54111D) $25,900 (HP 54112D)	$31,600 (HP 54121T) $33,900 (HP 54122T) $37,900 (HP 54123T) $46,200 (HP 54124T)

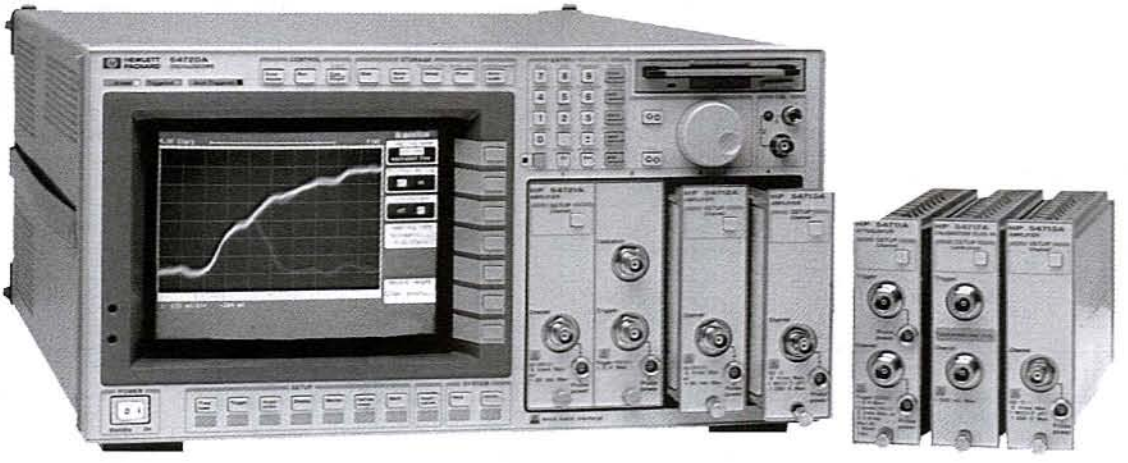
[1] Price is for fully loaded mainframe, excluding HP 54710A trigger slots
[2] One channel per plug-in. The number shown is the maximum configuration using that plug-in in the mainframe indicated.
[3] Except HP 54100A and 54112D
[4] 1 mV to 4 mV/div available on HP 54111D at limited bandwidth.
[5] 1 mV to 2.4 V per division for HP 54122T
[6] No TDR/TDT in HP 54122T

OSCILLOSCOPES

Digitizing Oscilloscopes

HP 54710A, 54720A

- 4-GSa/s sampling rate on two channels
- 50-ps time-interval accuracy, real-time (RT) mode
- 1.5-GHz bandwidth, equivalent-time (ET) mode
- Modular design
- 3½-in MS-DOS®-compatible disk drive
- Flash ROM firmware memory



NEW

DESIGNED FOR HP-IB SYSTEMS

A unique technology called sample-and-filter is responsible for the unprecedented performance of the HP 54720A.

HP 54720A and HP 54710A 4-GSa/s Modular Oscilloscopes

When You Have Only One Chance, You Need the Most Accurate Real-Time Oscilloscope

When an electronic or electrical event occurs only once, you need to capture and analyze the parametric nature of the event accurately the first time. The high sample rate, the industry-leading accuracy, and the powerful features of the HP 54720A and HP 54710A give you the clearest picture of the event possible.

The HP 54700 Series: Key Contributions

- Four channels with 2-GSa/s ADCs and 16-K memory channel (HP 54720A)
- Two channels with 4-GSa/s ADCs and 32-K memory channel (HP 54720A)
- Two channels with 2-GSa/s ADCs and 16-K memory channel (HP 54710A)
- One channel with 4-GSa/s ADCs and 32-K memory channel (HP 54710A)
- 8 bits vertical resolution (RT)
- 9 to 12 bits vertical resolution with averaging
- 1% vertical gain accuracy
- ±30-ps time interval measurement accuracy (ET)
- 500-ps glitch capture
- Advanced logic triggering
- User-selectable sample rate and memory depth
- High, 177 waveforms/s max capture and display update rate

A Scope You Configure Today . . . Enhance Tomorrow

Because of the modularity, you choose the combination of preamplification, gain vernier, attenuation, trigger pickoff, external trigger, input coupling, and impedance that provides you with optimum accuracy. The powerful hardware can be enhanced by upgrading the scope's firmware via a 3½-inch disk drive and flash ROM. Seven blank menu keys are reserved to easily accommodate new and innovative features that you receive free with Option +UA8, the software update service. There is even one key that will provide application-specific measurements.

MS-DOS® is a U.S. registered trademark of Microsoft Corporation.

A Scope That Was Designed for You

Understand Your High-Speed Digital System Problems

In digital logic designs, analog problems—such as glitches, ground bounce, timing violations, reflections, ringing, and crosstalk—are becoming more difficult to solve as computer architecture complexity and MIPS increase.

Capture all narrow glitches with a 500-ps glitch trigger. Then accurately analyze whether the glitch has the capability of violating a logic threshold. Measure glitch amplitude and pulse width more accurately than ever before with a 4-GSa/s sample rate and a 1.1-GHz bandwidth.

Utilize the HP 54720A's four channels, deep memory, and pre-trigger acquisition to locate the cause of a glitch. Trigger the HP 54720A with a logic analyzer for added diagnostic capability.

Improve the reliability of your fastest CMOS designs by making precise amplitude and duration measurements on worst-case ground bounce caused by intermittent simultaneous switching.

The 50-ps single-shot time interval accuracy will help you trouble-shoot clock skew problems.

Faithfully Reproduce and Nonintrusively Load Your DUT's Signal

Probes must faithfully reproduce the signal under test and not load the device that generates the signal. With 2.5-GHz bandwidth and 0.6-pF input capacitance, the HP 54701A measures signals more accurately and introduces less loading than any other active probe.

Capture and Analyze Your High-Energy Physics Phenomena

At 4 GSa/s, the higher frequency harmonics of the phenomena you are investigating can now be accurately measured. With nonvolatile memory backup and fast re-trigger time, feel secure that you will capture, record, and transfer your data with ample integrity.

Investigate Fast Rise Time ESD Pulses with Confidence

Characterize ESD waveforms with greater confidence because the 4-GSa/s sample rate provides greater insight about higher frequency components in the pulse.

Discover Unseen Characteristics of Your Laser's Impulse Response

With 4 GSa/s, 32 K memory depth, and fast throughput, you can capture and analyze a larger number of slow-rep rate laser pulses more accurately than ever before possible.

HP 54710A and HP 54720A System Specifications

SPECIFICATION	HP 54700 Series with HP 54711A	HP 54700 Series with HP 54712A	HP 54700 Series with HP 54713A	HP 54700 Series with HP 54721A
Time Base				
Time base scale (full screen is 10 div)	100 ps/div to 1 s/div			
Time base position range Pre-trigger Post-trigger	0 to −1 s, or one full-scale screen width (whichever is larger) 0 to 1 s, or one full-scale screen width (whichever is larger)			
Time Interval Measurement Accuracy[1] Real time Equivalent time (16 averages)	< ±0.2 sample interval ±0.007% of Δ Time–marker reading < ±30 ps ±0.007% of Δ Time–marker reading			
Time interval measurement resolution	1 ps			
Maximum sampling rate Real time Equivalent time	2 GSa/s 500 MSa/s	2 GSa/s 500 MSa/s	2 GSa/s 500 MSa/s	4 GSa/s 500 MSa/s
Maximum waveform record length/ plug-in	16,384 points	16,384 points	16,384 points	32,768 points
Channel				
Number of channels	1	1	1	1
Number of slots	1	1	1	2
Bandwidth (− 3dB)[1]	dc to > 1.5 GHz	dc to > 1.1 GHz	dc to > 500 MHz	dc to > 1.1 GHz
Bandwidth to HP 54701A probe tip (−3dB)[1]:	dc to > 1.3 GHz	dc to > 1 GHz	dc to > 500 MHz	dc to > 1 GHz
Channel scale Minimum Maximum	20 mV/div 1 V/div	10 mV/div 1 V/div	7 mV/div 5 V/div	10 mV/div 1 V/div
Vertical resolution (full scale is 8 divisions)	8 bits, up to 12 bits with averaging			
dc gain accuracy (best accuracy calibration)	< ±1% of full screen at full resolution channel scale			
Offset accuracy (best accuracy calibration)	< ±0.5% of offset setting ±1% of full screen at full resolution channel scale	< ±0.5% of offset setting ±1% of full screen at full resolution channel scale	< ±0.5% of offset setting ±2% of full screen at full resolution channel scale	< ± 0.5% of offset setting ±1% of full screen at full resolution channel scale
dc voltage measurement accuracy (single marker)[1]	± gain accuracy ± offset accuracy			
RMS noise	< 300 μV	< 350 μV	< 350 μV	< 350 μV
Input resistance[1]	50 Ω ±1.5%	50 Ω ±1.5%	50 Ω ±1% 1 MΩ (@ ~7 pF) ±1%	50 Ω ±1.5%
Input coupling	dc	dc, ac (34 KHz)	dc, ac (90 or 450 Hz)	dc, ac (34 KHz)
Probe power	Yes	Yes	Yes	Yes

SPECIFICATION	HP 54700 Series with HP 54711A	HP 54700 Series with HP 54712A	HP 54700 Series with HP 54713A	HP 54700 Series with HP 54721A	
Trigger					
Type	External trigger	Internal	Internal	Internal	External trigger
Modes	Edge (all plug-ins). Glitch, pattern, state, delay by time, delay by events (all plug-ins except HP 54711A).				
Trigger sensitivity[1]					
High sensitivity	dc to 100 MHz: 40 mVpp increasing linearly to 200 mVpp @ 2.5 GHz	0.3 div @ 1 GHz, 0.1 div @ 100 MHz	0.3 div @ 500 MHz, 0.1 div @ 100 MHz	0.3 div @ 1 GHz, 0.1 div @ 100 MHz	20 mVpp @ 1 GHz, 6 mVpp @ 100 MHz
Normal sensitivity	dc to 100 MHz: 40 mVpp increasing linearly to 200 mVpp @ 2.0 GHz	1.5 div @ 1 GHz, 0.5 div @100 MHz	1 div @ 500 MHz, 0.5 div @ 100 MHz	1.5 div @ 1 GHz, 0.5 div @ 100 MHz	90 mVpp @ 1 GHz, 30 mVpp @ 100 MHz
Noise reject	N/A	3.0 div @ 1 GHz, 1 div @ 100 MHz	3.0 div @ 500 MHz, 1 div @ 100 MHz	3.0 div @ 1 GHz, 1 div @ 100 MHz	150 mVpp @ 1 GHz, 60 mVpp @ 100 MHz
Minimum pulse width at normal sensitivity[1]	<200 ps @ 200 mVpp	< = 500 ps @ > = 1 div	< = 500 ps @ > = 1 div	< = 500 ps @ > = 1 div	< = 500 ps @ > = 60 mVpp
RMS jitter	< 6 ps ± 0.01% of delay setting				
External probe power	Yes	See channel	See channel	See channel	Yes

[1] Only the characteristics designated with a superscript 1 [1] are specified performance.

OSCILLOSCOPES
Digitizing Oscilloscopes (cont'd)
HP 54710A, 54720A

Configuration Information

The following table provides a recommended minimum ordering configuration for various applications. This table should serve as a starting point to understand the configuration that would be best for you. Actual needs may vary from user to user.

Application	Benefit	Features	Ordering Configuration
ECL and BiCMOS troubleshooting	Capture events in RT prior to a glitch to determine root cause.	2 channels at 4-GSa/s or 4 channels at 2 GSa/s for RT debugging	1 HP 54720A, 4 HP 54713A, 2 HP 54721A, 4 HP 54701A
ECL and BiCMOS characterization (edge speeds > 1 ns)	Accurately characterize repetitive events during component evaluation.	2 channels with 1-GHz ET bandwidth to probe tip	1 HP 54720A, 2 HP 54712A, 2 HP 54701A
ECL characterization (edge speeds > 700 ps)	Accurately characterize repetitive events during component evaluation.	2 channels with 1.3-GHz ET bandwidth to probe tip or 1.5-GHz ET bandwidth to coax	1 HP 54720A, 2 HP 54711A, 2 HP 54701A or HP 54006A
CMOS troubleshooting	Capture events in RT prior to a glitch to determine root cause.	4 channels at 500-MHz bandwidth to probe tip, sampled at 2 GSa/s	1 HP 54720A, 4 HP 54713A, 4 HP 54701A
CMOS characterization	Accurately characterize repetitive events during component evaluation.	2 channels at 1-GHz ET bandwidth to probe tip or 1.1-GHz ET bandwidth to coax	1 HP 54720A, 2 HP 54712A, 2 HP 54701A
High-speed digital communications hardware design	Highest sample rate for RT analysis of eye diagrams and very accurate for ET analysis.	1 channel at 4 GSa/s for RT analysis of eye patterns and pulses	1 HP 54710A, 1 HP 54721A, 1 HP 54701A
ESD test	Capture and analyze with the greatest accuracy, transient ESD pulses.	1 channel at 1-GHz RT bandwidth sampled at 4 GSa/s	1 HP 54710A, 1 HP 54721A, 1 HP 54701A
Laser research	Capture, with the highest sample rate, the largest number of laser pulses in RT.	1 channel at 1-GHz RT bandwidth sampled at 4 GSa/s and 32 K memory	1 HP 54710A, 1 HP 54721A
Deepest memory	Capture, at the highest sample rate, the most amount of time preceding an intermittent error condition.	2 channels with 32-K memory depth	1 HP 54720A, 2 HP 54721A, and probes as necessary
Highest analog bandwidth and sample rate coincidentally	The most accurate RT analysis on 2 channels, simultaneously acquired.	2 channels with 1-GHz RT bandwidth sampled at 4 GSa/s each	1 HP 54720A, 2 HP 54721A, and probes as necessary
Maximum ET bandwidth and number of channels	The most accurate characterization on 4 channels for repetitive signals.	4 channels at 1.5-GHz ET bandwidth	1 HP 54720A, 4 HP 54711A, and probes as necessary
Maximum number of RT channels with highest analog bandwidth	Highest sample rate for RT measurements on 4 channels for properly bandwidth-limited signals.	4 channels at 2 GSa/s, with the widest analog bandwidth of 1.5 GHz	1 HP 54720A, 4 HP 54711A, and probes as necessary
Maximum number of RT channels with 4:1 sample rate to bandwidth ratio	Most accurate RT analysis on 4 simultaneously acquired channels.	4 channels with 500-MHz RT bandwidth sampled at 2 GSa/s	1 HP 54720A, 4 HP 54713A, and probes as necessary
Same configuration as the HP 54100 or HP 54110D	For compatibility with existing test systems.	2 channels with 1-GHz ET bandwidth, plus 2 triggers	1 HP 54710A, 2 HP 54712A, 2 HP 54718A
Same configuration as HP 54111D	For compatibility with existing test systems.	2 channels with 500-MHz RT bandwidth, plus 2 triggers	1 HP 54710A, 2 HP 54713A, 2 HP 54718A

ET = Equivalent-time data acquisition; RT = Real-time data acquisition

HP 54701A 2.5-GHz Active Probe

The HP 54701A, 2.5-GHz, 0.6-pF active probe extends the performance of the HP 54700 Series to the noncoaxial probing environment.

HP 54701A 2.5-GHz Active Probe

Ordering Information — Price

Oscilloscope mainframes

HP 54720A Dual-Channel, 4-GSa/s Real-Time Modular Oscilloscope Mainframe — $42,900

HP 54710A Dual-Channel, 2 GSa/s Real-Time Modular Oscilloscope Mainframe — $29,900

Opt 002 Training Kit Including a PC Board, a Demo Guide, and a Power Supply — $900

Opt +NAO One Month Free Notification Service for All System Software Upgrades (recommend ordering a quantity of twelve with each mainframe order). — $0/month

Both modular mainframes include:
Operating system software with license agreement; operating manual set, including a quick-start guide, a user's guide and a reference; programming manual set, including a quick-start guide, a programmer's guide, reference, and quick reference; power cord

Plug-ins

HP 54711A 50 Ω Attenuator Plug-In with External Trigger (1.5-GHz Bandwidth with HP 54710A/20A) — $4,000

HP 54712A 50 Ω Amplifier Plug-In with Internal Trigger (1-GHz Bandwidth with HP 54710A/20A) — $3,500

HP 54713A 50 Ω/1-MΩ Amplifier Plug-In with Internal Trigger (500-MHz Bandwidth with HP 54710A/20A) — $2,500

HP 54717A Calibration Plug-In (to Perform Yearly Mainframe Calibration) — $2,400

HP 54718A Trigger Plug-In (Extends the ability of the HP 54710A to allow you to use slots 3 and 4 for logic triggering) — $1,900

HP 54721A 2-Wide Amplifier Plug-In (4 GSa/s Sample Rate and 1-GHz Bandwidth with HP 54710A/20A) — $4,700

Each plug-in also includes: operating, programming, and service manual inserts.
The HP 54713A includes a 500-MHz passive probe (HP 10430A).
The HP 54711A plug-in includes two N-type (m) to SMA (f) adapters (HP p/n 1250-1250).
The HP 54717A includes two N-type (m) to BNC (f) adapters (HP 1250-0780).
The HP 54717A and HP 54718A plug-ins require no manuals. See the mainframe service manual.

Accessories

HP 54006A 6-GHz Passive Probe — $1,040

HP 10430A 500-MHz, 6.5-pF Passive Probe (1 m) — $175

HP 10441A 500-MHz, 9-pF Passive Probe (2 m) — $175

HP 54701A 2.5-GHz Active Probe — $2,300

The HP 54701A active probe includes:
N-type (f) to BNC (m) adapter (HP p/n 1250-0077)
Walking stick ground (HP p/n 5960-2491)
One standard replacement probe tip (HP p/n 5081-7735)
Two sharp probe tips (HP p/n 5081-7734)
Five probe tip sockets (HP p/n 1251-5185)
4-in (10.16-cm) ground lead (HP p/n 01123-61302)
2-in (50.08-cm) ground lead (HP p/n 01650-82103)
200 Ω signal lead (HP p/n 54701-81301)
User and service guide (HP p/n 54701-90901)
Plastic box with foam liner (HP p/n 54701-45501)

HP 10087A HP 54710A–to–HP 54720A Upgrade Service — $15,900

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- 50/34-GHz, 34/20-GHz, 20/12.4-GHz, and 12.4/10-GHz bandwidths
- 0.25-ps timing resolution
- 2.5-GHz edge trigger
- 10-ps ± 0.1% reading time interval accuracy
- Time domain reflectometry
- Normalization for removing test-system errors

DESIGNED FOR HP-IB SYSTEMS

The HP 54120 Series of high-bandwidth digitizing oscilloscopes, featuring digital feedback sampling for repeatable, accurate, and operator-independent measurement results.

HP 54120 Series High-Bandwidth Digitizing Oscilloscopes

The HP 54120 Series of digitizing oscilloscopes combines high bandwidth, a time domain reflectometer (HP 54121, HP 54123T, and HP 54124T only), four input channels, and superb stability in an easy-to-use, fully programmable oscilloscope that needs no manual loop gain adjustment. Whether your application involves a high-speed digital device, interconnect or circuit characterization, high-speed telecom analysis, or microwave design, the HP 54120 Series of digitizing oscilloscopes gives you a new confidence in state-of-the-art measurements.

Key Contributions

The HP 54120 Series oscilloscopes offer:

- dc to 50-GHz bandwidth (HP 54124T), 7.0-ps rise time
- dc to 34-GHz bandwidth (HP 54123T), 10.3-ps rise time
- dc to 20-GHz bandwidth (HP 54121T), 17.5-ps rise time
- dc to 12.4-GHz bandwidth (HP 54122T), 28.2-ps rise time
- 10-ps time interval accuracy
- 10 ps per division to 1 s per division
- 0.4% vertical accuracy
- 32-μV vertical resolution
- 1 mV per division to 80 mV per division (HP 54121T, HP 54123T, and HP 54124T)
- 1 mV per division to 2.4 V per division (HP 54122T)
- Fully HP-IB programmable
- Four input channels
- Step generator with 35-ps rise time and 1% flatness (HP 54121T, HP 54123T, and HP 54124T)
- Reflection (TDR)/transmission (TDT) normalization* (HP 54121T, HP 54123T, and HP 54124T)
- Time and voltage histograms

Picosecond Measurements

The HP 54120 family offers 0.25-ps time interval resolution and 10-ps time interval accuracy (1 ps typical). Combined with wide bandwidth, these features reduce the scopes' contribution to errors in digital timing measurements in semiconductor and computer applications.

Quantify Noise and Jitter

Time and voltage histograms, which quantify noise and jitter measurements, characterize the eye patterns in data communications applications. Eye height and width and the location of one and zero are easily found with histograms. And with no loop gain control, you can obtain repeatable results that do not vary between operators or between scopes over the entire input dynamic range of the oscilloscope.

Eliminate Reflections with TDR

Ringing and waveform distortion can be reduced or eliminated by using time domain reflectometry to locate and remove discontinuities in transmission line systems. Normalization allows analysis at a user-defined rise time for modeling discontinuities at speed.

*Normalization uses the Bracewell transform, which is under license from Stanford University.

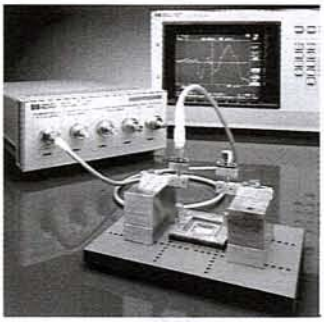
OSCILLOSCOPES

Accessories for the HP 54120 Series Digitizing Oscilloscopes

HP 54006A, 54007A, 54008A, 54118A

HP 54118A 18-GHz trigger

HP 83440C/D lightwave detector O/E converters with the HP 54124T scope



Inter-Continental Microwave TDR launching probes

HP 54008A 20-GHz delay line

HP 54007A RF accessory kit

PicoSecond Pulse Labs Model 4015B

Hewlett-Packard has a large number of accessories for use with wideband digital sampling oscilloscopes. These accessories will help you build a multi-gigahertz system tailored to your unique needs.

HP 54118A, 500-MHz to 18-GHz Trigger

Simple/Stable Triggering at Microwave Frequencies

For applications requiring more than 2.5-GHz trigger bandwidth, use the HP 54118A 18-GHz trigger. The HP 54118A gives your HP 54120 Series oscilloscope true event triggering from 500 MHz to 18 GHz, with less than 1.7 ps of rms jitter at 18 GHz. This powerful and versatile accessory extends the oscilloscope's measurement capabilities to applications in lightwave communications, pulsed RF, gigabit logic, pseudo-random bit-stream eye patterns, and other microwave signals.

HP 83441A/B/D SONET/SDH Reference Receivers HP 83440C/D Nonamplified Lightwave Receivers HP 83442A and HP 11982A Amplified Lightwave Receivers

Wide-Range Optical-to-Electrical Converters for Characterizing SONET/SDH Optical Waveforms

Optical pulse and eye diagram measurements are easy with a variety of HP lightwave receivers. Designed especially for use with high-speed single-shot and sampling oscilloscopes, the HP 83441 Series receivers provide the sensitivity and bandwidth necessary for pulse parameter measurements on SONET/SDH optical waveforms. The HP 83440 Series of nonamplified lightwave converters provides exceptional pulse response and up to 32-GHz bandwidth to measure pulse parameters on high-speed optical signals. The HP 83442A and HP 11982A amplified receivers make pulse parameter measurements on optical signals that require amplification. See pages 574 to 575 of this catalog for additional information.

Launching and Probing Solutions from Inter-Continental Microwave (ICM)

ICM offers both fixed- and variable-spacing 50-Ω TDR/TDT probe assemblies for launching a TDR pulse into transmission systems under test, such as in a PC board trace. These probes can be handheld or placed in a manipulator. The model A0112322 probe adjusts for spacings between 0.05 inch and 0.176 inch; the A0113734 probe adjusts between 0.14 inch and 1.0 inch. ICM also offers a universal test platform (UTP-3000) with accessories for component and package measurements. Contact Dr. Werner Scheurch at ICM, 1515 Wyatt Dr., Santa Clara, CA 95054-1524; (408) 727-1596.

HP 54008A 22-ns Delay Line

Viewing the Trigger Signal

The HP 54008A delay line provides 22 ns of delay with a usable frequency response of 20 GHz. By adding this accessory to your HP 54120 oscilloscope system, you will be able to view the trigger event. The HP 54008A has enough delay to view the trigger event with the HP 54118A trigger installed in the trigger path also.

HP 54007A Accessory Kit

Low-Loss Measurements for HP 54120 Oscilloscope Systems

The HP 54007A Accessory Kit provides an assortment of parts with 3.5-mm connectors for low-loss measurements. This kit is highly recommended for low-loss reflection and transmission measurements. It also includes semi-rigid coax, formed for use with the HP 11667B power splitter.

Contents of the HP 54007A Accessory Kit

17-in (43.18 cm) cable, APC 3.5 (f-f)	17-in (43.18 cm) cable, APC 3.5 (m-f)
Coaxial short, APC 3.5 (f)	Coaxial short, APC 3.5 mm (m)
50-Ω termination, APC 3.5 (m)	50-Ω termination, APC 3.5 (f)
7.5-cm "airline," APC 3.5 (m-f)	Power splitter, APC 3.5 mm (f)
6-cm semi-rigid "L," SMA (m-m)	3-cm semi-rigid "L," SMA (m-m)
6-dB attenuator, APC 3.5 (m-f)	40-dB attenuator, APC 3.5 (m-f)
Adapter, APC 3.5 mm (m-m)	

Picosecond Pulse Labs 4015B

15-ps, 9 V External TDR or TDT Source

The PicoSecond Pulse Labs model 4015B pulse generator extends the TDR/TDT performance of the HP 54120 Series oscilloscopes. The pulse generator produces a 15-ps fall time with an amplitude of 9 V, which can be triggered by any HP 54120 Series TDR step generator. Contact Dr. Jim Andrews at PSPL, P.O. Box 44, Boulder, CO 80306; (303)443-1249.

HP 54120 Series Specifications*

Vertical

	HP 54121T	HP 54122T	HP 54123T	HP 54124T
dc-coupled bandwidth (−3 dB)				
High bandwidth				
Channel 1	18.0 GHz	12.4 GHz	20.0 GHz	20.0 GHz
Channel 2	20.0 GHz	12.4 GHz	34.0 GHz	34.0 GHz
Channel 3, 4	20.0 GHz	12.4 GHz	34.0 GHz	50.0 GHz
Low bandwidth				
Channel 1	12.4 GHz	10.0 GHz	12.4 GHz	12.4 GHz
Channel 2	12.4 GHz	10.0 GHz	18.0 GHz	18.0 GHz
Channel 3, 4	12.4 GHz	10.0 GHz	18.0 GHz	26.5 GHz
Rise time (calculated)				
High bandwidth				
Channel 1	19.4 ps	28.2 ps	17.5 ps	17.5 ps
Channel 2	17.5 ps	28.2 ps	10.3 ps	10.3 ps
Channel 3, 4	17.5 ps	28.2 ps	10.3 ps	7.0 ps
Low bandwidth				
Channel 1	28.2 ps	35.0 ps	28.2 ps	28.2 ps
Channel 2	28.2 ps	35.0 ps	19.4 ps	19.4 ps
Channel 3, 4	28.2 ps	35.0 ps	19.4 ps	13.2 ps
Noise (RMS)				
High bandwidth	2 mV	2 mV	2 mV	2 mV
Low bandwidth	1 mV	1 mV	1 mV	1 mV
dc accuracy (single voltage marker)	Average mode: ± 0.4% of full-scale or marker reading (whichever is greater), ± 2 mV × attenuation factor			
Dynamic range	± 320 mV relative to channel offset	± 320 mV × attenuation factor	± 320 mV relative to channel offset	± 320 mV relative to channel offset
Connectors	3.5 mm (m)	3.5 mm (m)	3.5 mm (m)	3.5 mm (m) and 2.4 mm (m)

TDR System (except HP 54122T)

	Oscilloscope/ TDR Performance	Normalized Characteristics
Rise time	< 45 ps	Adjustable from larger of 10 ps or 0.08 × time/div to 5 × time/div
Flatness	< +1%, after 1 ns from edge; < +5%, −3% to 1 ns from edge	< 0.1%
Low level	0 V ± 2 mV	+ 200 mV ± 2 mV
High level	0 V ± 2 mV	+ 200 mV ± 2 mV

Time Base

Scale factor	10 ps/div to 1 s/div
Time interval accuracy (dual marker)	<10 ps ± 0.1% of reading
Time interval resolution	0.25 ps or 0.02 div, whichever is larger
Time base delay	16 ns to the smaller of 1000 screen diameters or 10 s

External Trigger Input

Sensitivity	40 mVpp from dc to 100 MHz, increasing linearly to 200 mVpp from 100 MHz to 2.5 GHz
Pulse width	200 ps > 200 mV
High frequency reject	Trigger bandwidth reduced to approximately 100 MHz
Trigger and time base jitter (RMS)	< 2.5 ps + 5E-5 × delay setting
Connector	3.5 mm (m)

*For additional information on specifications, see the feature comparison chart on page 129 or the data sheets, HP p/n 5952-7084(D) and 5952-1171(D).

Items Included in Product Purchase

HP 54120B Includes:
Color mainframe, interface cable, power cord, and service manual for the HP 54120B

All HP 54120 Series Test Sets Include:
Operating and programming and service manuals

The HP 54121A, HP 54122A, or HP 54123A Test Sets Include:
Five adapters, APC-3.5 (f-f) (p/n 5061-5311)
Five coaxial shorts, SMA (m) (p/n 0960-0055)
One anti-static mat with wrist strap (p/n 9300-1484)

The HP 54124A Test Set Includes:
Three adapters, APC-3.5 (f-f) (p/n 5061-5311)
Three coaxial shorts, SMA (m) (p/n 0960-0055)
Two adapters, 2.4 mm (f-f) (p/n 11900B)
Two coaxial caps, 2.4 mm (p/n 54124-24101)
One anti-static mat with wrist strap (p/n 9300-1484)

RF Accessories Included with the HP 54121T, HP 54123T, or HP 54124T (p/n 54121-68701):
Five 20-dB attenuators, APC-3.5 (f-m) (HP 33340C Opt 020)
Three 50-Ω cables, SMA (m-m) (p/n 8120-4948)
Two SMA (m) to BNC (f) adapters (p/n 1250-1200)
One 50-Ω termination, SMA (m) (p/n 1250-2153)
One 50-Ω termination, SMA (f) (p/n 1250-2151)
One coaxial short, SMA (f) (p/n 1250-2152)

RF Accessories Included with the HP 54122T (p/n 54122-68701):
One 20-dB attenuator, APC 3.5 (f-m) (p/n 33340C Opt 020)
Three 50-Ω cables, SMA (m-m) (p/n 8120-4948)
Five SMA (m) to BNC (f) adapters (p/n 1250-1200)

Ordering Information

	Price
HP 54120B Digitizing Oscilloscope Mainframe	$13,000
HP 54121A 20-GHz Four-Channel Test Set	$18,600
Opt 090 Delete RF Accessories	−$1,800
HP 54123A 34-GHz Four-Channel Test Set	$24,900
Opt 090 Delete RF Accessories	−$1,800
HP 54124A 50-GHz Four-Channel Test Set	$33,200
Opt 090 Delete RF Accessories	−$1,800
HP 54122A 12.4-GHz Four-Channel Test Set	$20,900
Opt 090 Delete RF Accessories	−$700

HP 54121T, 54122T, 54123T, 54124T Digitizing Oscilloscope Systems
All HP 54120 Series digitizing oscilloscope systems consist of the HP 54120B and an HP 54120 Series test set.

HP 54121T 20-GHz Digitizing Oscilloscope	$31,600
Opt 090 Delete RF Accessories	−$1,800
HP 54123T 34-GHz Digitizing Oscilloscope	$37,900
Opt 090 Delete RF Accessories	−$1,800
HP 54124T 50-GHz Digitizing Oscilloscope	$46,200
Opt 090 Delete RF Accessories	−$1,800
HP 54122T 12.4-GHz Digitizing Oscilloscope	$33,900
Opt 090 Delete RF Accessories	−$700

Accessories

HP 54006A 6-GHz Resistive Divider Probe	$1,040
HP 54007A RF Accessory Kit	$5,700
HP 54008A 22-GHz Delay Line	$ 2,600
HP 54118A 18-GHz Trigger	$10,300
Opt 090 Delete RF Accessories	−$1,250
HP 10086A ECL Terminator	$637

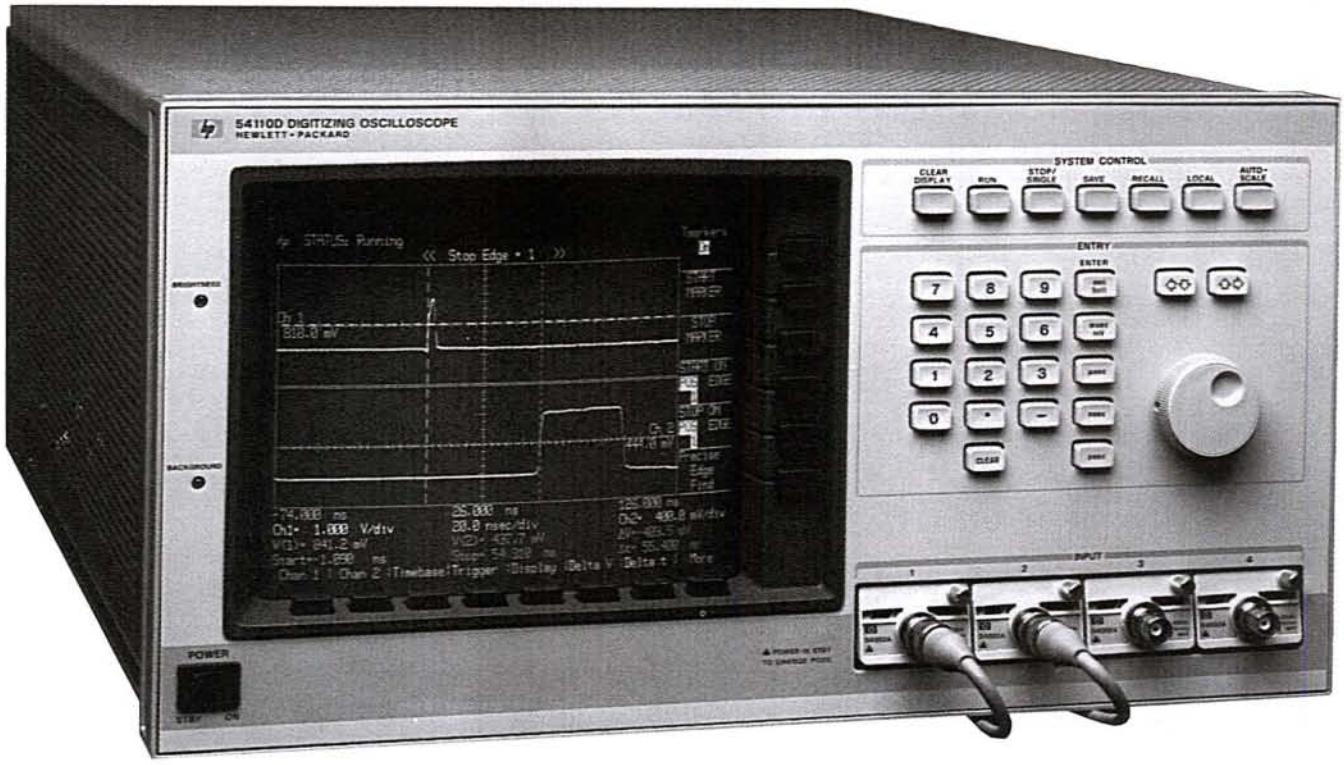
For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

OSCILLOSCOPES

Digitizing Oscilloscopes

HP 54100A/D, 54110D

- 1-GHz bandwidth
- Auto pulse parameter and time interval measurements
- Digital storage
- Available with color or monochrome display
- Pre-trigger viewing
- Logic triggering capability



HP 54110D

DESIGNED FOR HP-IB SYSTEMS

HP 54100A/D and HP 54110D Digitizing Oscilloscopes

As the speeds of analog and digital logic continue to increase, board and system designers need to pay even closer attention to high-frequency and transmission-line characteristics of their circuits. Design requirements are rigorous. Subnanosecond technology creates narrow and elusive pulses.

When a monochrome display is preferred, for example in a totally automatic test application, choose the HP 54100A or HP 54100D oscilloscope. These units require less rack height (7 in) than the HP 54110D (8.75 in) and have all of the same measurement features and specifications. The HP 54100A has one external trigger input, while the HP 54100D and HP 54110D have two.

High Bandwidth

The HP 54100 and 54110 unite a powerful 1-GHz bandwidth with a random repetitive sampling technique for viewing rarely occurring narrow waveforms. These oscilloscopes have 0.002 percent time base accuracy and 10 ps resolution for confident measurements of critical timing parameters in high-speed circuitry.

With random repetitive sampling, you can capture waveforms that occur thousands of screen diameters before the trigger event. This gives an effective memory depth of millions of bytes for finding causes of failures that occur long before the trigger.

High Resolution

Analyze perturbations within a waveform with high resolution. With vertical magnification and waveform averaging, small signal details can be viewed and measured with 10 bits of effective resolution.

Flexible Analysis

Only the HP 54100A/D and HP 54110D allow the display of either vertical channel versus the other. The 1-GHz bandwidth makes this feature valuable in measuring high-speed I-V device characteristics and transfer functions high-speed converters.

A Choice of Input Pods and Probes

The HP 54100 and 54110 inputs are configured with removable pods that can be chosen according to the application. Pods can be changed quickly and easily, and they occupy a minimum of storage space.

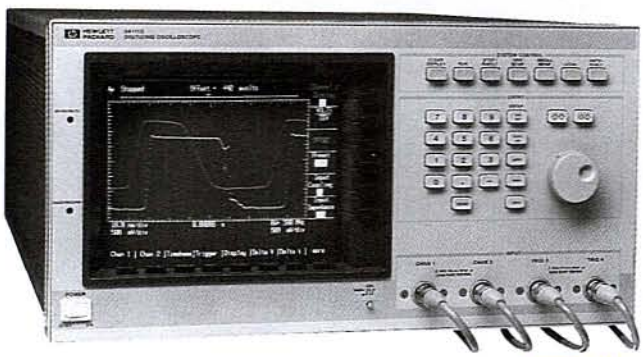
- 50-Ω inputs and probes for a wide variety of environments, without the expense of amplifier plug-ins
- 1-GHz miniature active probes for densely packed, high-speed logic circuits
- 1-M Ω probes for circuits sensitive to resistive loading
- 50-Ω BNC inputs for measurements where terminated lines are important
- 100:1 probes for extended dynamic range

For more information on the HP 54100/110 probing system, please refer to page 154.

Ordering Information	Price
HP 54100A 1-GHz Digitizing Oscilloscope	$17,900
HP 54100D 1-GHz Digitizing Oscilloscope.	$22,900
HP 54110D 1-GHz Digitizing Oscilloscope with Color Display	$24,900
Input Pods and Probes	
HP 54001A 1-GHz Miniature Active Probe Pod	$830
HP 54002A 50 Ω BNC Input Pod	$160
HP 54003A 1 M Ω 10:1 Probe Pod	$720

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- 2-GSa/s transient sample rate
- 500-MHz repetitive bandwidth



HP 54111D

DESIGNED FOR HP-IB SYSTEMS

Capture high-speed transient events with the 2-GSa/s sample rate of the HP 54111D.

- 64-K memory depth per channel
- Quad 400-MSa/s sample rate

HP 54112D

DESIGNED FOR HP-IB SYSTEMS

Record 160 μs on four channels at 400 MSa/s with the HP 54112D.

Time Domain Analysis of Transient Events

No longer do you need a manual analog storage oscilloscope to capture high-speed single-shot phenomena found in applications such as high-speed ECL and CMOS design, high-speed pulse analysis, nuclear test studies, plasma discharge, high-voltage arcing, high-frequency bursts, high-speed semiconductor design, laser and high-energy research, data communications, and computer-aided testing. The HP 54111D and the HP 54112D are two high-speed oscilloscopes that retain all of the key features and user friendliness of the HP 54100 Series scopes. These features include automatic measurements, autoscaling, cursors, functional color display, scroll, zoom, and memory bar.

HP 54111D High-Speed General-Purpose Scope

With 2 GSa/s on one channel or 1 GSa/s on two channels, the HP 54111D gives you the ability to characterize fast single-shot events. And—with random repetitive sampling, up to 500-MHz bandwidth, flexible input coupling, and wide dynamic range—the HP 54111D is an excellent general-purpose high-performance scope for viewing and analyzing a variety of signals in many applications.

HP 54111D Specifications

	Single Shot 1 Channel	Single Shot 1 Channel	Repetitive
Channels	2	1	2
Sample rate	1 GSa/s	2 GSa/s	1 GSa/s
Memory depth/ channel	8 K	16 K	501
Bandwidth	250 MHz	500 MHz	500 MHz
Vertical resolution	8 bits at 25 MHz 7 bits at 100 MHz 6 bits at 250 MHz	8 bits at 50 MHz 7 bits at 200 MHz 6 bits at 500 MHz	6 bits 8 bits with averaging
Vertical gain accuracy	2% of full scale	2% of full scale	2% of full scale
dc offset accuracy	±1.5% of setting ±0.2 div	±1.5% of setting ±0.2 div	±1.5% of setting ±0.2 div
Voltage measurement accuracy (single marker)	± gain accuracy ± offset accuracy ± resolution	± gain accuracy ± offset accuracy ± resolution	± gain accuracy ± offset accuracy ± resolution
Single-channel time measurement accuracy			
Single shot	±300 ps ±0.03% of reading	±300 ps ±0.03% of reading	±300 ps ±0.03% of reading
Repetitive	±100 ps ±0.03% of reading	±100 ps ±0.03% of reading	±100 ps ±0.03% of reading

Ordering Information

	Price
HP 54111D 2-GSa/s Digitizing Oscilloscope	$30,900
Opt +W30 Extended Repair Service (see page 636)	$575

HP 54112D Deep-Memory General-Purpose Scope

The HP 54112D is a 400-MSa/s, four-channel digitizing scope with 64-K memory depth per channel. The HP 54112D has many general-purpose features: flexible signal conditioning, pre-trigger viewing, infinite persistence, and logic triggering. It is exceptional at recording very long records of high-speed events found in many high-speed digital and high-energy physics applications.

HP 54112D Specifications

	Single Shot	Repetitive
Channels	4	4
Sample rate	400 MSa/s	400 MSa/s
Memory depth/channel	64 K	501
Bandwidth	100 MHz	100 MHz
Vertical resolution	6 bits	6 bits 8 bits with averaging
Vertical gain accuracy	2% of full scale	2% of full scale
dc offset accuracy	±1.5% of setting ±0.2 div	±1.5% of setting ±0.2 div
Voltage measurement accuracy (single marker)	± gain accuracy ± offset accuracy ± resolution	± gain accuracy ± offset accuracy ± resolution
Single-channel time measurement accuracy	±500 ps ±0.002% of reading	±500 ps ±0.002% of reading

Ordering Information

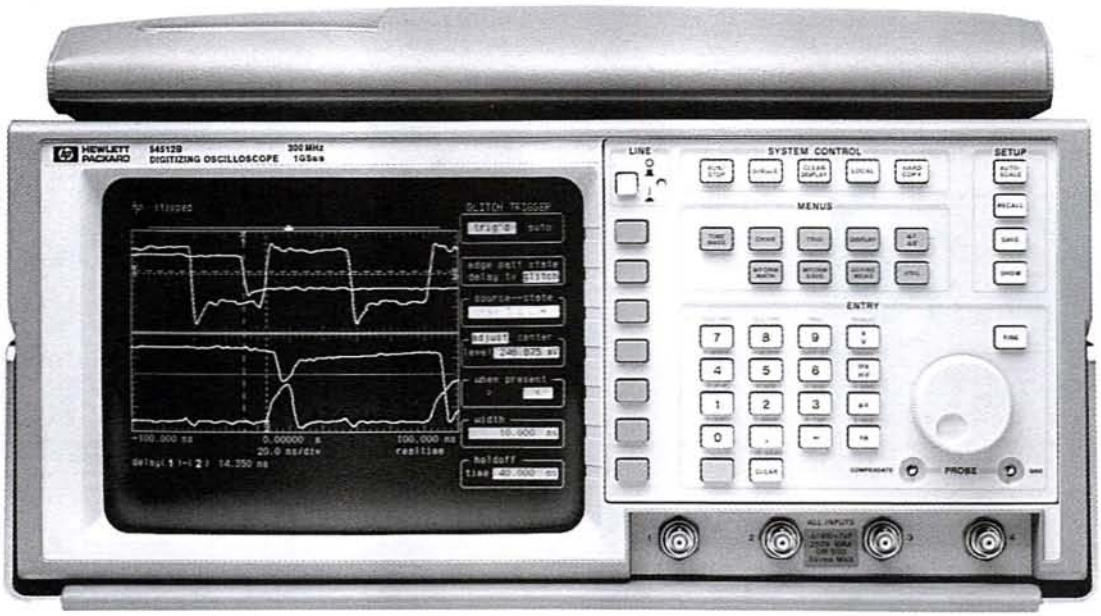
	Price
HP 54112D Four-Channel, 64-K Memory per Channel Digitizing Oscilloscope	$25,900
Opt +W30 Extended Repair Service (see page 636)	$575

For additional information on specifications, see feature comparison chart on page 129 or the data sheet, HP p/n 5954-2659(D).

OSCILLOSCOPES

General-Purpose Oscilloscopes

HP 54501A, 54503A, 54504A, 54505B, 54506B, 54510B, 54512B



HP 54501A, 54503A, 54504A, 54505B, 54506B, 54510B, 54512B

NEW

DESIGNED FOR HP-IB SYSTEMS

HP 54500 Family of Digitizing Oscilloscopes

The HP 54500 Series of digitizing oscilloscopes offers you the performance you need at a price you can afford. The HP 54500 Series has features and functions that were previously available only in considerably higher-priced instruments. Like HP's other digitizing oscilloscopes, the HP 54500 Series offers features such as autoscale, pushbutton hard copy, automatic measurements, nonvolatile setup and waveform memories, and full HP-IB programmability. In addition, the new HP 54505B, 54506B, 54510B, and 54512B add features to help you get your job done quickly.

Reduce Hardware Design and Troubleshooting Time with HP 54500 Series Oscilloscopes

These powerful oscilloscopes speed hardware design and debugging with performance to match your needs. HP's advanced logic triggering is a standard feature in the HP 54500 family. Use it to trigger on a wide variety of user-specified conditions. Trigger on edge, pattern, state, or trigger after delay to capture such elusive events as timing violations or transient bus phenomena. Some of the products within the HP 54500 family (see the table below) also offer glitch triggering to isolate and trigger on a glitch as narrow as 1.75 ns. To pinpoint infrequent events and determine their cause, use HP's advanced logic triggering in conjunction with up to four channels to quickly isolate anomalies. Triggering on an anomaly will allow you to probe other points within the system during the failure condition to understand the cause of the problem quickly.

Characterize Your Signals Accurately

Speed your characterization by using the automatic measuring capabilities offered by the HP 54500 family of oscilloscopes. You have a choice of 17 measurements based on standard or user-definable thresholds. Use measurement statistics to continuously display the maximum, minimum, and mean value for each measurement. Also available for characterization are the automask generator and waveform compare mode (see the table below). Put a reference wave-form onscreen and have the scope build a pass-fail mask around it, with a test tolerance that you specify. Use the compare mode to test incoming waveforms against the mask. If the signal fails, the scope will store the failed waveform, with a time-date stamp, to either internal memory or an external printer or plotter. The fast Fourier transforms (FFTs) available on the new HP 54505B, 54506B, 54510B, and 54512B oscilloscopes are also useful tools for characterizing signals. With the high sample rate of these oscilloscopes, you can now analyze your signal by using a single-shot FFT.

If you are characterizing several events separated in time, the sequential single-shot capability allows you to capture the pulses without dead time in between. You can then analyze the pulses individually or all together in normal, averaged, or envelope mode.

The HP 54500 Series of Digitizing Oscilloscopes

	HP 54501A	HP 54503A	HP 54504A	HP 54505B/HP 54506B	HP 54510B/HP 54512B
Bandwidth					
Repetitive	100 MHz	500 MHz	400 MHz	300 MHz	300 MHz
Single shot	1 MHz	2 MHz	50 MHz	125 MHz	250 MHz
Sample rate	10 MSa/s	20 MSa/s	200 MSa/s	500 MSa/s	1 GSa/s
No. of channels	4 (2+2)	4	2	2/4	2/4
Memory/channel	501 samples	501 samples	2001 samples	8001 samples	8001 samples
Dual timebase window	Yes	Yes	Yes	No	No
Pan and zoom	No	No	No	Yes	Yes
Advanced logic trigger	Yes	Yes	Yes	Yes	Yes
Glitch trigger	No	No	No	Yes	Yes
Measurement limit test	Yes	Yes	Yes	Yes	Yes
Mask generator	No	No	No	Yes	Yes
Waveform compare	No	No	No	Yes	Yes
Sequential single shot	No	No	No	Yes	Yes
Automatic hard copy	Yes	Yes	Yes	Yes	Yes
See page no.	141	141	140	139	139

HP 54505B, 54506B, 54510B, and 54512B Oscilloscopes

The HP 54510B and HP 54512B digitizing oscilloscopes have two and four channels, respectively, sampling all channels simultaneously at a maximum rate of 1 GSa/s with 8000 samples of memory depth per channel. The HP 54505B and HP 54506B have two and four channels, respectively, sampling all channels simultaneously at a maximum rate of 500 MSa/s with 8000 samples of memory depth per channel. These scopes retain all the key features and user friendliness of the other HP 54500 Series oscilloscopes. Many new features are included: FFTs, sequential single shot, glitch trigger, automatic mask generation, and waveform compare. These digitizing oscilloscopes are affordable, high-performance oscilloscopes for applications such as advanced hardware design and troubleshooting, high-energy research, and manufacturing test.

HP 54505B, 54506B, 54510B, and 54512B Specifications and Characteristics

Acquisition System

Maximum sample rate	HP 54510B, 54512B: 1 GSa/s on all channels HP 54505B, 54506B: 500 MSa/s on all channels
Record length	8001 points (real time) 501 points (repetitive)
Real-time bandwidth	HP 54510B, 54512B: 250 MHz HP 54505B, 54506B: 125 MHz
Resolution	8 bits (10 bits via HP-IB with averaging)

Vertical (Voltage)

Repetitive bandwidth	300 MHz	
Number of channels (simultaneous acquisition)	HP 54506B, 54512B: 4 HP 54505B, 54510B: 2	
Sensitivity[1]	1 mV/div to 5 V/div	
dc gain accuracy	±1.25% of full scale	
Input R (selectable)	1 MΩ ±1% or 50 Ω ±1%	
Input C	7 pF nominal	
Input coupling	ac, dc	
Maximum input	1 MΩ: ±250 V [dc + peak ac (< 10 kHz)] 50 Ω: 5 V rms	
Switchable bandwidth	ac-coupled lower: ≤10 Hz	
Limits (−3 dB frequency)	LF reject lower: 400 Hz Bandwidth limit: 30 MHz	
Channel to channel isolation (channels at equal sensitivity)	dc to 50 MHz: 40 dB 50 MHz to 300 MHz: 30 dB	
Offset range	**Vertical sensitivity**	**Available offset**
	1 mV to 50 mV per division	±2 V
	> 50 mV to 250 mV per division	±10 V
	> 250 mV to 1.25 V per division	±50 V
	>1.25 V to 5 V per division	±250 V
Offset accuracy	±(1% of channel offset + 2% of full scale)	
Voltage measurement accuracy (dc)[1]		
Dual cursor	±[(1.25%)(full scale) + (0.032) (V per division)]	
Single cursor	±[(1.25%)(full scale) + (offset accuracy) + (0.016)(V per division)]	

Horizontal (Time)

Time base range	1 ns/div to 5 s/div
Resolution	20 ps
Δ Time accuracy	
Repetitive:	±[(0.005%)(Δ Time) + (2E-6)(delay setting) + (100 ps)]
Real time:[2]	HP 54510B, 54512B: ±[(0.005%)(Δ Time) + (2E-6)(delay setting) + (150 ps)] HP 54505B, 54506B: ±[(0.005%)(Δ Time) + (2E-6)(delay setting) + (300 ps)]
Delay range	
Post-trigger	10,000 × (s per division)
Pre-trigger	Time per division — Available delay
	1 ns to 50 ns per division
	HP 54510B, 54512B — −8 μs
	HP 54505B, 54506B — −16 μs
	100 ns to 5 s per division — −160 × (s per division)

Trigger

Sensitivity	
Internal	dc to 100 MHz: 0.5 division 100 MHz to 300 MHz: 1.0 division
External	HP 54505B, 54510B: 100 mVpp into 50 Ω
Pulse width (minimum)	
Internal	1.75 ns
External	2.8 ns
Level range	
Internal	± 1.5 × full scale from center screen
External	± 2 V

FFTs

	Frequency Range[3]	**Frequency Resolution**
HP 54510B, 54512B	dc to 500 MHz	1.22 mHz to 1.95 MHz (real-time acquisition)
HP 54505B, 54506B	dc to 250 MHz	1.22 mHz to 975 kHz (real-time acquisition)
Displayed frequency	Display is from dc to a selectable upper frequency in steps from 5 Hz to 500 MHz (real-time acquisition) for the HP 54510B and HP 54512B and from 5 Hz to 250 MHz (real-time acquisition) for the HP 54505B and HP 54506B.	
Frequency accuracy	[(sample frequency/2)(8192) + (0.0001)(signal frequency)]	
Signal to noise	55–65 dB. Noise floor can be reduced by averaging the time domain waveform or increasing the number of points in the time record.	

[1] Magnification is used below 7 mV per division range. Below 7 mV per division full scale is defined as 56 mV.
[2] For bandwidth limited signals, t_r = 1.4 × sample interval.
[3] FFT amplitude readings are affected by input amplifier rolloff above 300 MHz.

Ordering Information

The HP 54505B and 54510B digitizing oscilloscopes come with two HP 10431A 10:1 probes (10 MΩ) and the HP 54506B and 54512B come with four HP 10431A 10:1 probes (10 MΩ). All of these oscilloscopes come with a front-panel manual, a programming manual, a service manual, a miniature probe to BNC male adapter, a power cord, and a three-year warranty.

	Price
HP 54505B 500 MSa/s, Two-Channel Oscilloscope	$8,350
HP 54506B 500 MSa/s, Four-Channel Oscilloscope	$13,990
HP 54510B 1 GSa/s, Two-Channel Oscilloscope	$11,950
HP 54512B 1 GSa/s, Four-Channel Oscilloscope	$17,990
Opt 908 Rack-Mount Kit (HP p/n 5061-6175)	$250
Opt 910 Additional Front Panel, Programming and Service Manuals	$75
Opt 090 Delete two Probes (HP 54505B, 54510B)	−$340
Opt 090 Delete four Probes (HP 54506B, 54512B)	−$680

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

OSCILLOSCOPES
General Purpose Oscilloscopes
HP 54504A

HP 54504A 400 MHz, 200 MSa/s Oscilloscope

The HP 54504A is a 400 MHz, 200 MSa/s sample rate, 2-channel oscilloscope designed for both repetitive and single-shot signals. In repetitive mode, the HP 54504A has 400 MHz bandwidth. In real-time mode, its 200 MSa/s sample rate provides a single-shot bandwidth of 50 MHz. Like other members of the HP 54500 family, the HP 54504A has all the digitizing advantages of oscilloscopes that are much higher in price. Its high repetitive/single-shot bandwidth, ease of use, HP-IB programmability, and HP 54500 family general-purpose features make it a powerful tool for both manual and automated test applications.

HP 54504A Specifications and Characteristics

Vertical (voltage)

	Real-time	Repetitive
Bandwidth (−3 dB) dc-coupled	dc to 50 MHz	dc to 400 MHz[1,3]
Switchable bandwidth limits	ac-coupled lower −3 dB freq.: 10 Hz LF reject lower −3 dB freq.: 450 Hz Bandwidth limit: dc to 30 MHz	
Rise time[2]	7.0 ns	875 ps
Number of channels	2 (simultaneous)	
Vertical sensitivity range	1 mV/div to 5 V/div	
Vertical gain accuracy (dc)[3,4]	±1.50% of full scale	
Vertical resolution[4]	±0.4% of full scale (8 bit A/D) ±0.1% of full scale (10 bits with ≥ 8 averages)	
Maximum sample rate	200 MSa/s	25 MSa/s
Waveform record length[5]	Normal: 501 points Extended: 2001 points	Time/div: 5 ns to 5 s/div, 2 ns/div, 1 ns/div Rec length: 501 pts, 401 pts, 201 pts
Input R (selectable)	1 MΩ ±1% or 50 Ω ±1%	
Input C	7 pF nominal	
Input coupling	ac, dc	
Maximum input voltage	1 MΩ: ±250 V [dc + peak ac (<10 kHz)] 50 Ω: 5 V rms	
Offset range	Vertical sensitivity: 1 to 50 mV/div; >50 to 250 mV/div; >250 mV to 1.25 V/div; >1.25 to 5V/div Available offset: ±2 V; ±10 V; ±50 V; ±250 V	
Offset accuracy[4]	±(+1.0% of ch. offset + 2% of full scale)	
Dynamic range	±1.5 × full scale from center of screen	
Channel-to-channel isolation (with channels at equal sensitivity)	40 dB: dc to 50 MHz N/A: 50 to 400 MHz	40 dB: dc to 50 MHz 30 dB: 50 to 400 MHz
Voltage measurement accuracy (dc)[3,4]		
Dual cursor:	±(1.5% of full scale + 0.032 × V/div)	
Single cursor:	±(1.5% of full scale + offset accuracy + 0.016 × V/div)	

Horizontal (time)

	Real-time	Repetitive
Time base range	1 ns/div to 5 s/div	
Time base reference accuracy	0.01%	
Maximum time base resolution	50 ps	
Delta-t accuracy	±(2% × s/div + 0.01% × delta t + 1 ns)	±(2% × s/div + 0.01% × delta t + 250 ps)
Delay range (post-trigger)	Time/div setting: 50 ms to 5 s/div; 100 µs to 20 ms/div; 1 ns to 50 µs/div Available delay: 40 × (s/div); 1s; 10,000 × (s/div)	
Delay range (pre-trigger)	All time/div settings: −40 × (s/div) Time/div setting: 1µs to 5 s/div; 10 ns to 500 ns/div; 1 ns to 5 ns/div Available delay: −40 × (s/div); −80 µs; −10,000 × (s/div)	

Triggering

Internal trigger coupling	Line trigger Low-frequency reject (−3dB 50 KHz)	
Trigger sensitivity[4]		
Internal:		
dc to 50 MHz	0.5 div	0.5 div
50 MHz to 100 MHz	not applicable	0.5 div
100 MHz to 400 MHz	not applicable	1.25 div
External:		
dc to 250 MHz	100 mV peak-to-peak into 50 Ω	
Trigger pulse width (minimum):		
Internal:	14.0 ns	1.75 ns
External:	2.8 ns	2.8 ns
Trigger level range	Internal: ±1.5 × full scale from center of screen External: ±2V	

Power Requirements: Voltage: 115/230 Vac, −25% to +15% 48 to 66 Hz. Power 350.VA maximum.
Weight: Net: approximately 10 kg (22 lb). Shipping: approximately 20 kg (44 lb).
Size: 422.3 mm W × 194.3 mm H × 355.6 mm D (16.62 in × 7.65 in × 14 in)—does not include front panel protrusions
Specifications valid for temperature range ±10° C from software calibration temperature with 8 or more averages selected.

[1]Upper bandwidth reduces by 2.5 MHz for each °C above +35° C.
[2]Rise times are calculated from:

$$t_r = \frac{0.35}{\text{bandwidth}}$$

[3]Vertical gain accuracy decreases 0.08% per °C from software calibration temperature.
[4]Expansion is used below 7 mV/div range so vertical resolution and accuracies are correspondingly reduced. Below 7mV/div full scale is defined as 56 mV.
[5]On time/div settings 1 µs/div and slower, bandwidth in repetitive mode is 50 MHz.
[6]Available over HP-IB waveform record length is:
Real-time normal: 500 points; extended: 2000 points.
Repetitive 10 ns to 5 s/div: 1024 pts.
5 ns/div: 1000 pts.
2 ns/div: 400 pts.
1 ns/div: 200 pts.

Ordering Information

The HP 54504A oscilloscope comes complete with two HP 10430A 10:1 10 MΩ probes, a front panel manual, a programming manual, a service manual, a power cord, and a three-year warranty.

	Price
HP 54504A Digitizing Oscilloscope	$6,750 ☎
Opt 908 Rack Mount Kit (5061-6175)	+$250
Opt 910 Additional Front-Panel, Programming, and Service Manual (54504-90901, 54504-90902, 54504-90903)	+$75
Opt 090 Delete Probes	−$200

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 54501A, HP 54503A Oscilloscopes

The HP 54501A and HP 54503A are four-channel oscilloscopes designed primarily for repetitive signal applications. Like all HP 54500 Series oscilloscopes, these units feature two-channel simultaneous sampling, ease of use, dual-time-base windowing, advanced logic triggering, automatic measurements, and full HP-IB programmability, making them powerful tools for both manual and automatic measurements.

The HP 54501A is a 100-MHz, four-channel oscilloscope with a 2 + 2 channel configuration. It offers the powerful digitizing features of the HP 54500 Series, including advanced logic triggering, at a very low price.

The HP 54503A is a 500-MHz, four-channel oscilloscope with four full-featured attenuators. It has the two-channel sampling and repetitive bandwidth of other oscilloscopes that are much higher in price.

Specifications and Characteristics

	HP 54503A	HP 54501A
Vertical (voltage)		
Bandwidth (−3dB) dc-coupled		
Repetitive:	dc to 500 MHz[1]	dc to 100 MHz
Single-shot: (based on 10 points per period of input signal)	dc to 2 MHz	dc to 1 MHz
Switchable bandwidth limits (−3db)		
ac-coupled	10 Hz	10 Hz
LF reject	450 Hz	
BW limit	30 MHz	
Rise time Calculated from rise time = 0.35/BW	700 ps	3.5 ns
Number of channels[2]	4	4 (2 + 2) Channels 2 and 3 are limited attenuator inputs, optimized for digital signals.
Vertical sensitivity range	1 mV/div to 5 V/div	5 mV/div to 5 V/div
Vertical gain accuracy (dc)[3,4]	±1.25%	±1.5%
Vertical resolution[3]	± 0.4% (8-bit A/D) ± 0.1% (10 bits via HP-IB with averaging)	
Maximum sample rate	20 MSa/s	10 MSa/s
Waveform record length	501 points (display) 1024 points (via HP-IB)	
Input R	1 MΩ or 50 Ω (selectable)	1 MΩ
Input C	7 pF nominal	16 pF nominal
Input coupling	ac, dc	
Maximum input voltage	1 MΩ: ± 250 V [dc + peak ac <10 Hz] 50 Ω: 5 V rms	
Offset range	Vertical sensitivity/div: / Available offset:	Vertical sensitivity/div: / Available offset:
	1 mV to 50 mV ± 2 V 50 mV to 250 mV ± 10 V 250 V to 1.25 V ± 50 V 1.25 V to 5 V ± 250 V	5 mV to 50 mV ±2 V 0.1 V to 1 V ±20 V 1 V to 5 V ±200 V
Offset accuracy[3]	± (2% of full scale +0.5% of offset)	± (2.5% of full scale +2% of offset)
Dynamic range (for dc + peak ac input)	±12 divisions from center of screen	±16 divisions from center of screen
Channel-to-channel isolation (with channels at equal sensitivity)	40 dB: dc to 100 M Hz 30 dB: 100 to 500 MHz	40 dB: dc to 20 MHz 30 dB: 20 to 100 MHz
Horizontal (time)		
Time base range	200 ps/div to 5 s/div	2 ns/div to 5 s/div
Time base reference accuracy	0.005%	
Maximum time base resolution	20 ps	100 ps

	Time/div setting:	Available delay:	Time/div setting:	Available delay:
Delay range (post-trigger)	50 ms to 5 s 100 µs to 20 ms 200 ps to 50 µs	40 (s/div) 1 s 10,000 (s/div)	50 ms to 5 s 100 µs to 20 ms 2 ns to 50 µs	40 (s/div) 1 s 10,000 (s/div)
Delay range (pre-trigger)	5 µs to 5s 10 ns to 2 µs 200 ps to 5 ns	−40 (s/div) −100 µs −10,000 (s/div)	10 µs to 5s 20 ns to 5 µs 2 ns to 10 ns	−40 (s/div) −200 µs −10,000 (s/div)

Triggering

Trigger sensitivity				
≤5 mV/div	dc to 100 MHz	2.5 mV	dc to 20 MHz	4 mV
	100 to 500 MHz	6 mV	20 to 100 MHz	10 mV
> 5 mV/div	dc to 100 MHz	(0.063) full scale	dc to 20 MHz	(0.05) full scale
	100 to 500 MHz	(0.156) full scale	20 to 100 MHz	(0.125) full scale
Trigger pulse width (minimum)	1.5 ns		7 ns	
Trigger level range	±12 div from center of screen		±6 div from center of screen	

Power Requirements: Voltage: 115/230 Vac, −25% to +15% 48 to 66 Hz. Power: 350 VA maximum.
Weight: Net, approximately 10 kg (22 lb); shipping, approximately 20 kg (44 lb).
Size: 422.3 mm W × 194.3 mm H × 355.6 mm D (16.62 in × 7.65 in × 14 in); does not include front panel protrusions

Specifications valid for temperature range ±10° C from software calibration temperature with eight averages selected and channel(s) in sensitivity range 1, 2, or 5.

[1]Upper bandwidth reduces by 2.5 MHz for each degree centigrade above +35° C.
[2]Simultaneous acquisition on two channels. Channels 1 and 4 are acquired simultaneously. If four channels are used, data is acquired alternately by channels 1 and 4, and then 2 and 3.
[3]Expansion is used below 7 mV/div range so vertical resolution and accuracies are correspondingly reduced.
[4]Accuracy reduces by ±0.08% for each degree centigrade away from software calibration temperature.

HP 54503A Telecommunications Test Masks

Make telecom mask template measurements to ANSI, CCITT, and ISDN standards without using Mylar overlays. HP 54503A automates many of the mask measurements that are time-consuming with analog oscilloscopes. Pass-fail accuracy and repeatability are improved through the use of automatic measurements, eliminating human error.

HP 54503A Telecommunications Test Masks Features

- Sixteen standard telecom signal mask templates stored in ROM
- Positive and negative templates
- Automatic triggering on positive "isolated ones"[5] in live traffic for many standard telecom signals
- Automatic best-fit of test signals to positive mask templates
- Automatic pass-fail comparison of mask templates with corresponding input signals
- Automatic storage, printing, or plotting of failed signals
- User-defined pass-fail tolerance

For more information on this option and for a technical data sheet, contact your local HP sales office (see page 665).

[5]For the HP 54503A Option 001, the term "isolated ones" is defined as a pulse sequence of at least two zeros followed by a one, followed by at least two zeros.

Ordering Information

The HP 54501A and HP 54503A oscilloscopes come complete with two probes; operating, programming, and service manuals; a power cord; and a three-year warranty.

The HP 54501A includes HP 10432A 10:1 10 MΩ probes. The HP 54503A includes HP 10430A 10:1 1 MΩ probes.

	Price
HP 54501A Oscilloscope	$4,500
HP 54503A Oscilloscope	$6,300
Opt 908 Rack Mount Kit (5061-6175)	$250
Opt 910 Additional Front Panel, Programming, Manual and Service Manual (HP 54501A: 54501-90901, 54501-90906, 54501-90907) (HP 54503A: 54503-90901, 54503-90902, 54503-90908)	$75
Opt 090 Delete Probes	−$200

For off-the-shelf shipment, call 800-452-4844.

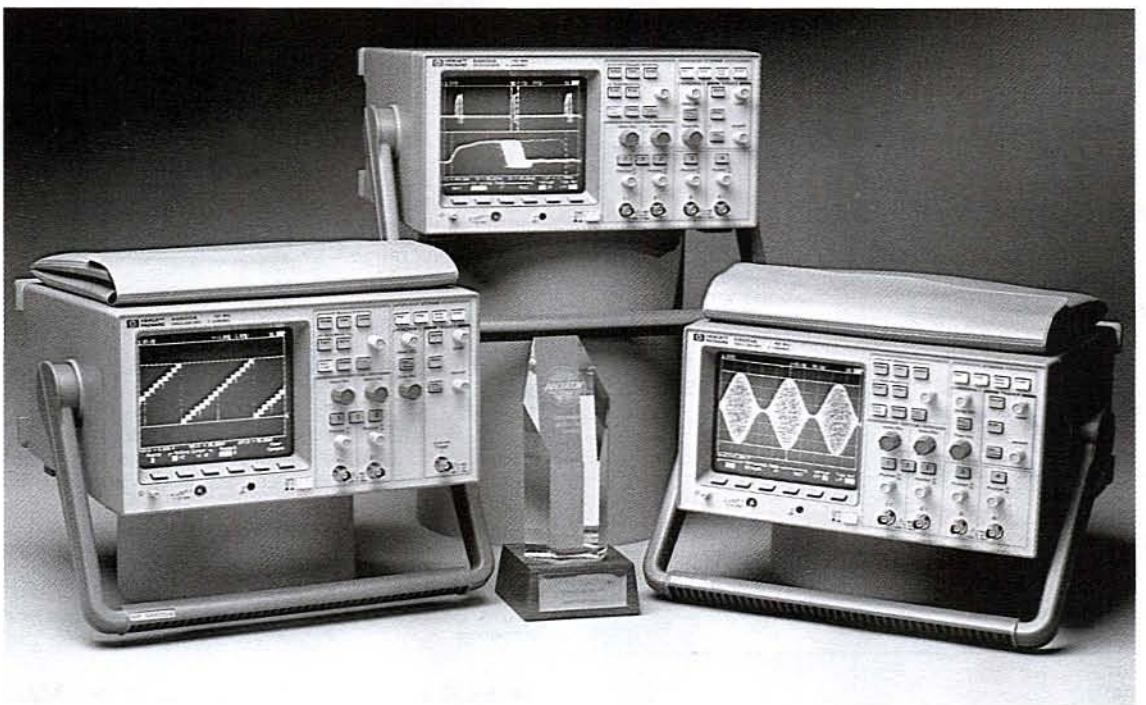
For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

OSCILLOSCOPES

General Purpose and Troubleshooting

HP 54600 Series

- Up to 150-MHz bandwidth
- Analog look and feel
- Automatic and cursor-based measurements of frequency, time, and voltage
- Waveform storage
- Plug-in modules for hard copy, remote programming, and enhanced testing
- 3-year warranty with optional 2-year extension



HP 54600A 2-Channel and HP 54601A and 54602A 4-Channel Oscilloscopes

The HP 54600 family of oscilloscopes offers you the comfortable feel of analog scopes and the measurement power of digital scopes, all at a price you can afford. This family of oscilloscopes gives you the ability to view waveforms you can't see with your analog scope, and they provide the familiar controls and interactive displays you've grown accustomed to. To solve your most difficult test problems, the scope provides powerful digital features, such as pre-trigger viewing, waveform storage, and measurement automation.

This combination of analog feel and digital power enhances your troubleshooting ability. You can expect bright, crisp displays of your most demanding signals at all sweep speeds and delayed sweep magnifications. Storage for glitch and transient analysis is as simple as pressing a button. Pre-trigger viewing lets you view events that an analog scope would miss.

This new class of oscilloscopes, made possible through HP's advanced integrated circuit technology, presents this power in a small, lightweight package and at a price that fits your budget. The oscilloscopes' unique three-processor architecture helps re-create the feel of analog scopes while still giving you access to advanced measurement capabilities. The display update rate of over one million points per second provides a display with unprecedented interactivity. For example, AM-modulated waveforms and other rapidly changing signals are shown onscreen with the detail and fidelity you expect.

Three Models: One is Right for You

The two-channel, 100-MHz HP 54600A is ideally suited for production, field service, and educational applications, where its simple controls let you quickly find your problems. The four-channel, 100-MHz HP 54601A fits well into research and development labs and applications where complex digital circuits are designed and tested. The four-channel HP 54602A provides 150-MHz bandwidth on channels 1 and 2, and 250-MHz bandwidth on limited-attenuation channels 3 and 4. This additional bandwidth lets you look at signals that tax 100-MHz scopes. You can even look at and trigger on fast digital signals with rise times down to 1.4 ns, helping you find glitches and other unwanted signal components.

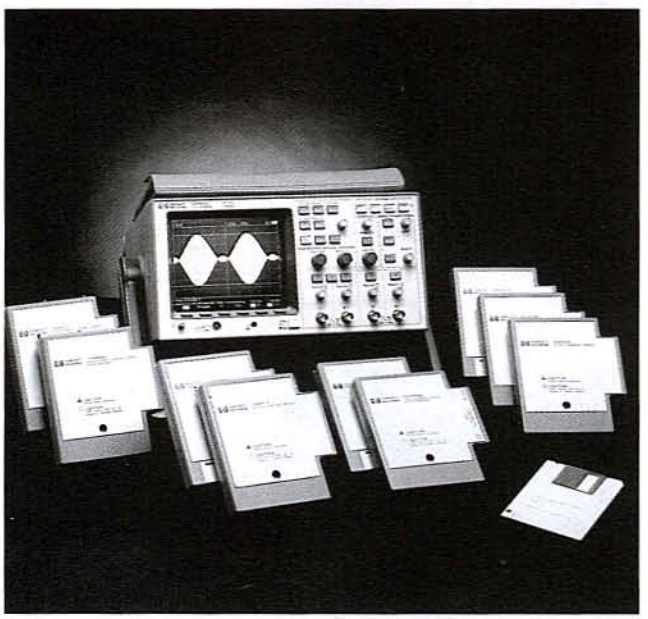
A Full Family of Benchtop Automation Products

The HP 54600 Series oscilloscopes are only part of a comprehensive line of test products. You'll find the answer to your general-purpose test and troubleshooting needs among the solutions offered in the family of test solution products. Optional plug-on modules add remote programming (HP-IB and RS-232 versions) and hard-copy output; for more complete measurement solutions, try:

- HP 54655A and 54656A Test Automation Modules. Design your test boundaries and create a test sequence—at your bench!
- HP 54657A and 54658A Measurement/Storage Modules. Add measurements, mask testing, and up to 100 waveform memory locations with this module.
- HP 54653A ScopeLink software. This easy-to-use package lets you use your PC to view waveforms, store scope and module setups, and much more.

For more information an any of these products in the HP 54600 family, see the modules and accessories sections on the following pages.

- Hard-copy output to printer or plotter
- Remote instrument control
- Enhanced automatic measurements
- Extended waveform storage and math operations
- Custom test-sequence creation and operation



HP 54600 Series Oscilloscopes

The HP 54600 Series scopes use a complete range of optional interface modules for hard-copy output, remote programmability, and, perhaps most importantly, custom test functionality. These modules plug onto the back of any HP 54600 Series scope and turn a great manual scope into a benchtop automation tool. You can create a true measurement solution for your specific test and measurement needs. No other scope in its class can offer these capabilites—and the price is right!

HP 54650A HP-IB Interface Module

This module provides full remote control and hard-copy output to HP-IB printers and plotters. Programming is in accordance with IEEE 488.2. An operating and programming manual and disk with programming examples are included.

HP 54651A RS-232 Interface Module

This module provides full remote control and hard-copy output to RS-232 printers and plotters. The module supports printers that are Epson FX-80 or HP-PCL compatible. An operating and programming manual and disk with programming examples are included.

HP 54652A Parallel Interface Module

This module provides the lowest-cost hard-copy solution in the HP 54600 family. Printers supported include those that are Epson FX-80 or HP-PCL compatible. An operating note is included.

HP 54655A and 54656A Test Automation Modules

The HP 54655A (HP-IB) and 54656A (RS-232) Test Automation Modules provide you with an automated test station that can sit on your bench. The Test Automation Modules add built-in pass/fail testing with conditional branching and operator prompts to any oscilloscope in the HP 54600 family. With these modules, an unskilled operator can perform exacting measurements by simply following the instructions listed on the scope's display. All of these abilities add up to a powerful benchtop test solution—and it can all be created without a computer!

Mask Template Testing

The Test Automation Module's test abilities are based on waveform mask templates, waveform envelopes that define a test area. The module lets you build up to 40 masks and up to 100 test-sequence steps that you define to create your custom test. Each step consists of a scope configuration, test mask, custom branching instructions, and custom labels and messages. The combination of sequencing and branching based on test results allows you to re-create your test flowchart with the scope and module combination. You end up with a reliable and repeatable path to automated testing, and you create that test in the comfortable environment of your test bench.

Mask Template Generation and Editing

The Test Automation Modules can automatically generate your test masks. Two methods make mask generation simple:

- Automask with tolerance limit. This method uses your known good waveform and applies a user-defined voltage tolerance to the waveform, generating a mask with the tolerance built-in.
- Automask with Autostore. You can use Autostore, the HP 54600 family's infinite persistence mode, to create an envelope from your waveform. Automask then creates the mask template from the Autostore data.

The built-in mask editor lets you refine your Automask template, or you can use the editor to create your own precision mask.

Once the test sequence has been defined, it remains safely stored in the module's nonvolatile RAM. You can use HP ScopeLink software to copy sequences to other scopes, for constructing multiple-test stations, or for storage of multiple sequences.

Two Interface Versions

The HP 54655A Test Automation Module provides an HP-IB interface, and is well suited for applications involving controllers. The module performs many tasks previously left to the computer, speeding throughput and improving productivity.

The HP 54656A RS-232 version of the Test Automation Module provides you with additional features for external I/O. External switches can be connected to the module to allow remote switching through a test sequence. In addition, the HP 54656A has five user-definable output lines that can be uniquely configured for each step. Use these lines to drive buzzers, indicator lights, or even switches in your test fixture.

Even with all this test power, each module gives you the full functionality and programmability of the standard HP-IB and RS-232 interface modules.

The HP 54655A and 54656A are both supplied with an operating and programming manual, user's guide, and a disk with programming examples. In addition, the HP 54656A RS-232 version includes a 9- to 25-pin adapter cable and an RJ-45 connector with 10 ft (about 3 m) of cable for use with the I/O lines.

OSCILLOSCOPES

General Purpose and Troubleshooting (cont'd)

HP 54600 Series Test and Interface Modules

HP 54657A HP-IB and 54658A RS-232 Measurement/Storage Modules

The HP 54657A and 54658A Measurement/Storage Modules bring enhanced measurement and storage power to your HP 54600 scope. You can even create and monitor a mask-based test by using the modules' new mask template test capabilities. A list of the added features includes:

- Up to 100 nonvolatile trace memories
- New automatic measurements with user-defined levels
- New channel-to-channel delay and phase measurements
- Real-time clock for time- and date-tagging of hard copy and stored traces
- Unattended pass/fail signal monitoring

New Automatic Measurements and Waveform Math

The Measurement/Storage Module adds such new measurement capabilities as:

- Amplitude, pulse overshoot and preshoot, delay, and phase angle
- 10/90%, 20/80%, and user-defined voltage thresholds for rise time and fall time measurements
- New measurement formats of percentage and phase angle
- Waveform multiplication, differentiation, and integration

Now you can make your measurement in the format you desire. No more manual calculations!

More Trace Storage

The module adds 3 nonvolatile trace storage locations and 64 K of trace memory to the HP 54600 scope. The module uses a data compression technique for storage in that 64 K, allowing storage for up to 96 additional waveforms.

Unattended Signal Monitoring

The Measurement/Storage Module simplifies circuit analysis and debugging by comparing your live signal to a test template you create. If the scope detects a failure, it can perform one of three tasks:

- Store the failing trace to memory, along with the time and date of the failure
- Print the trace (with time and date) on a printer
- Note the failure and maintain pass/fail statistics while continuing the test

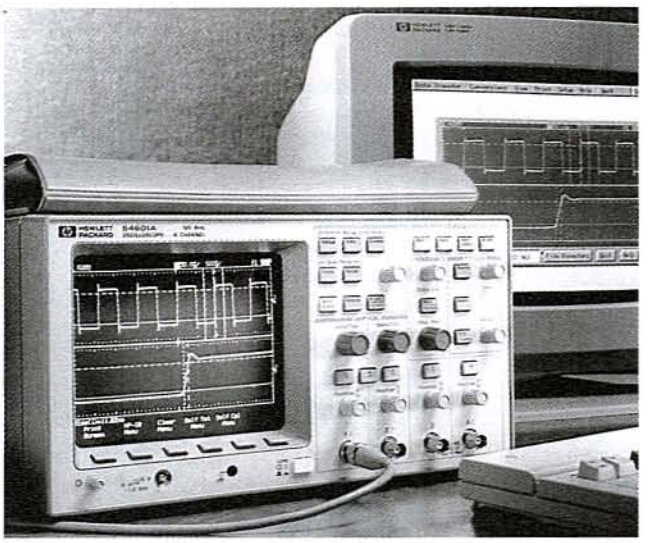
Built-in mask generation and editing software make creating your test template simple. Once your mask and test are created, you can leave it in the module's nonvolatile memory or store it to a PC with HP ScopeLink software. This new capability lets you easily run tests to characterize your circuits, whether for a short time or overnight. You can even use the Measurement/Storage Module in conjunction with a PC for enhanced throughput and to take advantage of the new measurements.

FFT – A New Measurement Dimension

The Measurement/Storage Module now has the ability to give you frequency information for your input waveforms. Fast Fourier Transform (FFT) capability now allows you to find and identify unusual waveform frequency components. FFT also allows you to check the fidelity of your signal or compare it to other similar-looking waveforms.

The Measurement/Storage Module's FFT capability includes frequency and amplitude cursors (with both dBm and dBv scaling), which let you make quick, accurate measurements. You can choose between Hanning, flattop, exponential, and rectangular windows, and you can select the number of points to include in the FFT calculation.

The HP 54657A and the HP 54658A include an operating and programming manual and a disk with programming examples.



HP 54653A ScopeLink Software

The HP 54653A ScopeLink software package provides a simple communications link between your personal computer and the HP 54600 family of oscilloscopes. ScopeLink lets you transfer scope screen images, waveform data, front-panel setups, and even custom test information via an HP-IB or RS-232C interface. All you need is a PC-compatible computer, interface cable, and your HP 54600 Series scope to transfer information such as:

- **Screen images.** Screen images can be transferred to a PC for storage, viewing, and printing. HP ScopeLink software can even convert the image to TIFF or PCX formats for annotation and placement in many popular word processing and desktop publishing applications.
- **Waveform data.** Data about the waveform can be transferred in time and voltage pairs to a PC and saved in ASCII format for general usage. HP ScopeLink software can also save in formats compatible with Lotus® 1-2-3® and DADiSP, allowing you to perform additional data analysis.
- **Instrument setups.** Scope setups can be transferred to your PC for storage and recalled later. You can store setups for several different tests or configure multiple scopes with the setup created on a master unit.
- **Test automation sequences.** HP ScopeLink software has the capability to send and receive complete sequences from the Test Automation Module. Build your test with one scope and module, save the sequence with ScopeLink, and duplicate the test in other scopes—it's easy! HP ScopeLink software also allows you to write-protect your sequence after you send it to the scope.
- **Telecom test templates.** HP ScopeLink software comes with a series of 21 templates for testing to CCITT, ANSI, and DS-1 standards. Waveforms with rates up to 8 Mb/s can be tested.

HP ScopeLink software also provides imaging, data transfer, and setup transfer for the HP 54500 Series oscilloscopes, and its imaging capability will work with the HP 1650 Series logic analyzers and the HP 16500A logic analysis system.

HP ScopeLink software is supplied on both 3½- and 5¼-in disks, and a user's guide is included.

Other HP 54600 Series Oscilloscope Accessories

HP 54654A Operator's Training Kit (Opt 103 to HP 54600 Series Scopes)

The operator's training kit consists of a training signal board and lab workbook. The signal board provides 12 signals that show various operating modes and features of an HP 54600 Series oscilloscope. After completing the labs, the user can operate the scope and make measurements with no extra training. This kit is ideal for the educational environment and can also be an excellent tool for training new employees. The operator's training kit comes with signal board, manual, and 9 V battery, all contained in an attractive case.

HP 10098A Pouch and Front Panel Cover (Opt 101 to HP 54600 Series scopes)

The pouch provides probe and accessory storage on top of the scope and is easily removable for rackmounting. The front panel cover provides sturdy protection of the front panel display and knobs when transporting the scope.

HP 10079A Oscilloscope Camera

The HP 10079A camera is designed for use with any HP 54600 Series oscilloscope. When a printer or plotter is unavailable or undesirable, or when your HP 54600 Series scope has no interface module, this camera offers a simple means of waveform recording. The HP 10079A camera uses Polaroid Type 667 film and includes an operating manual.

HP 5041-9409 Carrying Case (Opt 104 to HP 54600 Series Scopes)

The HP 5041-9409 carrying case makes transporting and shipping your HP 54600 Series oscilloscope safe and simple. A scope, optional module, and other accessories fit neatly inside the padded shell of hard plastic, and the case is lockable for shipment.

HP 85901A Portable ac Power Source

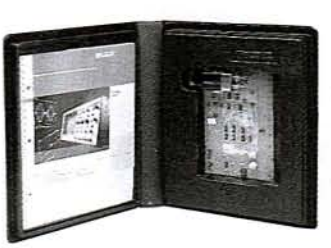
This portable power source includes a battery and power inverter. The source will power an HP 54600 Series scope for at least 2 hours, and its inverter may be used in cases where 12-Vdc power is available externally.

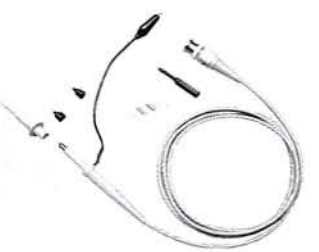
Two-Year Warranty Extension (Opt W50)

Option W50 for HP 54600 Series scopes extends the normal three-year warranty for an additional two years, giving you five years of worry-free operation.

HP Journal, February 1991

The *HP Journal* is a bimonthly publication recognizing technical contributions made by HP employees. The February 1991 issue discusses the development process and technical structure of the HP 54600 Series scope. To receive a copy, contact your local HP sales office.





OSCILLOSCOPES

General-Purpose and Troubleshooting

HP 54600 Series

Performance Characteristics

Vertical system

Channels 1 and 2	2 mV/div to 5 V/div
Accuracy[1]	±1.5%
Vernier accuracy[1]	Fully calibrated; ±3%
Bandwidth (−3dB), ac-coupled	dc to 100/150 MHz[5] 10 Hz to 100/150 MHz[5]
Rise time	<3.5/2.33 ns[5] (calculated)
Coupling	dc, ac, and ground
Channels 3 and 4	0.1 and 0.5 V/div
Accuracy[1]	±1.5%
Bandwidth (−3dB)	dc to 100/250 MHz[5]
Rise time	<3.5/1.4 ns[5] (calculated)
Coupling	dc and ground
Math functions	CH 1 ± CH 2
Cursor accuracy[1,2]	
Single cursor	Vertical accuracy ±1.2% of full scale ±0.5% of position value
Dual cursor	Vertical accuracy ±0.4% of full scale
Bandwidth limit (channels 1 and 2)	≃20 MHz
Inversion	CH 1 and CH 2
CMRR	≃20 dB at 50 MHz
Dynamic range	±8 div from center screen
Input R&C	1 MΩ, ≃13 pf
Maximum input	400 V (dc + peak ac)

Horizontal system

Sweep speeds, main and delayed	5 s/div to 2 ns/div
Accuracy	±0.01%
Resolution	100 ps
Vernier accuracy	±0.05%
Cursory accuracy (t and 1/t)[3]	±0.01% ±0.2% of full scale ±200 ps
Delay jitter	10 ppm
Pre-trigger delay (negative time)	10 div
Post-trigger delay (trigger to start of sweep)	At least 2560 div or 50 ms. Not to exceed 100 s.

Delayed sweep

Main sweep	Delayed sweep
5 s/div to 10 ms/div	Up to 200 × main
5 ms/div and faster	Up to 2 ns/div

Trigger system

Sensitivity all channels	dc to 25 MHz, 0.35 div or 3.5 mV
Channels 1 and 2	dc to 100/150 MHz[4], 1 div or 10 mV
Channels 3 and 4	dc to 100/250 MHz[5], 1 div or 10 mV
Sources	HP 54601A and 54602A: Channels 1, 2, 3, 4, or line. HP 54600A: Channels 1, 2, line, and external.
Coupling	ac, dc, LF reject, HF reject, and noise reject. LF & HF: −3db at 50 kHz.
Modes	Auto, Autolevel, Normal, Single, and TV
TV triggering	TV line and field. Requires 0.5 div of composite sync for stable display (Channels 1 and 2).
Holdoff	Adjustable from 200 ns to 13 s

External trigger (HP 54600A only)

Range sensitivity	±18 V dc to 25 MHz: 50 mV dc to 100 MHz: 100 mV
Coupling	dc, HF reject and noise reject
Input R&C	1 MΩ, ≃ 13 pF
Maximum input	400 V (dc + peak ac)

X-Y operation

Z-blanking	TTL high-blanks trace
Bandwidth	X and Y same as vertical system
Phase difference	±3° at 100 kHz

Display system

Display	7-in raster CRT
Resolution	255 vertical × 500 horizontal points
Controls	Front-panel intensity control
Graticule	8 × 10 grid or frame
Autostore	Saves previous sweeps in half-bright display and the most recent sweep in full-bright display

Acquisition system

Max sample rate	20 MSa/s
Resolution	8 bits
Simultaneous channels	Channels 1 and 2 or channels 3 and 4
Record length	4,000 points (2,000 points single shot)
Max update rate	1,000,000 points/s
Single shot Bandwidth	2 MHz, single channel 1 MHz, dual channel
Peak detect	50-ns glitch capture (100-ns dual channel) at sweep speeds of 50 μs/div and greater
Average	Number of averages selectable from 8, 64, 256

Advanced functions

Automatic measurements	Continuously updated
Voltage	Vavg, Vrms, Vpp, Vtop, Vbase, Vmin, and Vmax
Time	Frequency, period, +width, −width, duty cycle, rise time, and fall time
Cursors	Manually or automatically placed
Setup functions	
Autoscale	Sets the vertical and horizontal deflection and the trigger level
Save/recall	16 front-panel setups
Trace memory	2 volatile pixel memories
TV functions	
Line counting	Delay time calibrated in NTSC and PAL line numbers
HP 54602A only: All-field trigger (both fields selected)	Oscilloscope triggers on the vertical sync pulse in both fields, allowing use with noninterlaced video

General

Power requirements	
Line voltage range	100 Vac to 240 Vac
Line voltage selection	Automatic
Line frequency	45 Hz to 440 Hz
Max power consumption	220 VA
Environmental characteristics	Meets the requirements of MIL-T-28800D for type III, class 3, style D equipment as described later in this table
Ambient temperature	
Operating	−10° C to +55° C
Nonoperating	−51° C to +71° C
Humidity[4]	
Operating	95% RH at 40° C for 24 h
Nonoperating	90% RH at 65° C for 24 h
Altitude	
Operating	To 4,500 m (15,000 ft)
Nonoperating	To 15,000 m (50,000 ft)
EMI (Commercial) EMI (MIL-T-28800D)	Meets FTZ 1046 class B
CE01, CE03, CE07	Full limits
CS01, CS02, CS06	Full limits
RE01	15 dB relaxtion to 20 kHz; exceptioned from 20 kHz to 50 kHz
RE02 With Opt 002 installed	Full limits of class A1c and A1f
Without Opt 002 installed	10-dB relaxation from 14 kHz to 100 kHz
RS02	Exceptioned
RS03 With Opt 001 installed	Slight trace shift from 80 MHz to 200 MHz
Vibration	Operating 15 min along each of the 3 major axes; 0.025-in peak-to-peak displacement, 10 Hz to 55 Hz in 1-min cycles. Held for 10 min at 55 Hz (4 g at 55 Hz).
Shock	Operating 30 g, 1/2 sine, 11-ms duration, 3 shocks/axis along major axis. Total of 18 shocks.
Size (excluding handle)	
Width	322 mm (12.7 in)
Height	172 mm (6.8 in)
Depth	317 mm (12.5 in)
Weight	6.2 kg (14 lbs)
Safety	CSA certification, IEC 348

[1] Temperature is ±10° C from calibration.
[2] Use full scale of 80 mV for 2 mV/div and 5 mV/div ranges.
[3] Use full scale of 50 ns for 2 ns/div.
[4] Tested to Hewlett-Packard environmental specification section 758 for class B-1 products.
[5] Second number is characteristic for the HP 54602A only.

HP 54655A and 54656A Test Automation Modules Operating Characteristics

The characteristics that follow apply to HP 54600 Series oscilloscopes with the module installed.

Trace memories	2, nonvolatile

Step sequencing

Number of steps	100, nonvolatile
Instrument setup	Entire front-panel setup. When mask template testing is used, automatic measurements will not be displayed.
Messages	Label (60 characters); pass, fail min, and fail max messages (30 characters each)
Branching	Branch based on the test result of pass, fail min, or fail max.
Operator-access permission	None: Mode allows use of only soft keys for sequencing. Adjust: Mode allows use of soft keys, V/div knobs, position knobs, delay knob, and time/div knob. All: Mode allows use of all keys and knobs.
Sequencing control	3 soft keys control the sequencing: Next, Previous, and Reset.
Editing	Copy a single step or mask template to a destination step.

Mask template testing

Number of mask templates	40, nonvolatile
Mask template generation	Automask generates mask templates from Autostore data with variable tolerance; mask editor allows pixel-by-pixel editing and line-drawing editing; smooth mask function performs a running average of 3 pixels.
Test region	Pixel-by-pixel selectable
Adjust mode	Adjustment mode is optimized for fastest screen update; some of the displayed data may not be tested.
Fail region	Inside: Signal fails if it falls inside the region bounded by the max and min limit line. Outside: Signal fails if it falls outside the region bounded by the max and min limit lines.
Failure indication	Failure-zone indicator shows where the signal fails the mask template.

Hard-copy output

Printer/plotter supported	HP ThinkJet, HP QuietJet, HP PaintJet, or HP LaserJet printer; HP-GL–compatible plotter. HP 54656A only: Epson FX-80 or compatible printer.

RS-232 configurations

Connector type	With adapter cable connected, the end of the cable is a 25-pin DTE port. A printer cable is required to connect to either hard-copy devices or computer.
Protocols	XON/XOFF, hard wire
Data bits	8
Stop bits	1
Parity	None
Baud rates	1200, 2400, 9600, 19200

Programmability

All instrument settings and operating modes may be remotely programmed via RS-232 or HP-IB (IEEE 488).

Input/output (HP 54656A only)

Input lines	2 lines for remote control of the Next, Previous, and Reset functions during sequencing.
Output lines	5 output lines definable in each step. Selections are on, off, pulse at start of step, pulse at end of step, pass, fail, fail min, and fail max. Output level is 0–5 V; output resistance is 120 Ω max. Output current is ≃24 mA.

HP 54657A and 54658A Measurement/Storage Modules Operating Characteristics

The characteristics that follow apply to HP 54600 Series oscilloscopes with the module installed.

Automatic measurements

Voltage	Vamp, Vavg, Vrms, Vpp, Vpre, Vovr, Vtop, Vbase, Vmin, and Vmax
Time	Delay, duty cycle, frequency, period, phase angle, rise time, fall time, +width, and −width
Thresholds	User selectable among 10%/90%, 20%/80%, or absolute voltage levels
Measurement formats	Voltage, time, percentage, and phase angle
Waveform math functions	Addition, subtraction, multiplication, differentiation, integration, and FFT.

Mask template testing

Number of mask templates	2, nonvolatile
Mask generation	Automask generates mask template from displayed data with variable tolerance. Mask editor allows pixel-by-pixel editing.
Test region	Pixel-by-pixel resolution
Fail region	Inside: Signal fails if it falls inside the region bounded by the max and min limit lines. Outside: Signal fails if it falls outside the region bounded by the limit lines.
Failure indication	Failure-zone indicator shows where the signal fails the mask template.

Trace memory (all nonvolatile)

Locations 1–3	High-speed storage without compression
Locations 4–100	Storage with compression; number of traces is a function of complexity. Storage time is approximately 7 s.
Real-time clock	24-h format with battery backup. Can be set from front panel.

Hard-copy output

Printer/plotter supported	HP ThinkJet, HP QuietJet, HP PaintJet, or HP LaserJet printer; HP-GL–compatible plotters. HP 54658A only: Epson FX-80 or compatible printer

Programmability

All instrument settings and operating modes may be remotely programmed via RS-232 or HP-IB (IEEE 488).

RS-232 configurations (HP 54658A only)

Connector type	25-pin DTE port; a printer cable is required to connect with hard-copy devices or with a computer.
Protocols	XON/XOFF, hard wire
Data bits	8
Stop bits	1
Parity	None
Baud rates	1200, 2400, 9600, 19200

OSCILLOSCOPES

General Purpose and Troubleshooting

HP 54600 Series

Ordering Information	Price
HP 54600A Two-Channel, 100-MHz Oscilloscope Includes two 1.5 m 10X probes (10071A), operating and service manual, and line cord.	$2,495
HP 54601A Four-Channel, 100-MHz Oscilloscope Includes two 1.5 m 10X probes (10071A), operating and service manual, and line cord.	$2,895
HP 54602A Four-Channel, 150-MHz Oscilloscope Includes two 1.5 m 10X probes (10071A), operating and service manual, and line cord.	$3,270
Accessories	
HP 54650A HP-IB Interface Module	$475
HP 54651A RS-232 Interface Module	$475
HP 54652A Parallel Interface Module	$275
HP 54653A ScopeLink Software	$200
HP 54654A Operator's Training Kit	$200
HP 54655A Test Automation Module with HP-IB Interface	$750
HP 54656A Test Automation Module with RS-232 Interface	$800
HP 54657A Measurement/Storage Module with HP-IB Interface	$750
HP 54658A Measurement/Storage Module with RS-232 Interface	$750
HP 10079A CRT Trace Camera	$595
HP 10070A 1.5 m 1X Probe	$55
HP 85901A ac Power Source	$1,290
Options	
Opt 101 Accessory Pouch and Front-Panel Cover (HP 10098A)	$50
Opt 102 Two Additional 10071A Probes (HP 54601A, 54602A only)	$110
Opt 103 Operator's Training Kit (HP 54654A) Consists of a training signal board and lab workbook. After completing these labs, an operator will be able to make measurements and operate the oscilloscope without any additional training.	$200
Opt 104 Carrying Case (HP 5041-9409) Designed to protect the oscilloscope for shipment or for checking as airline baggage.	$290
Opt 105 ScopeLink Software (HP 54653A) MS-DOS* software that interfaces the scope (with either HP-IB or RS-232 module installed) to a PC for storage, analysis, or easy integration of waveform data into desktop publishing software.	$200
Opt 090 Delete Probes	−$110
Opt 908 Rackmount Kit (HP 5062-7345) 7-in EIA standard rack	$255
Opt W50 Additional Two-Year Warranty (for a total of five years)	
HP 54600A	$45
HP 54601A	$45
HP 54602A	$85

MS-DOS® is a U.S. registered trademark of Microsoft Corporation.

For off-the-shelf shipment, call 800-452-4844.

For the Educators

These oscilloscopes are ideally suited for classroom use. Contact your local Hewlett-Packard sales office for details on specific education discount programs.

HP 54600 Interfacing and Hard Copy Output Information

Compatibility Chart

The following table describes the devices supported by the HP 54600 Series oscilloscopes

	HP-IB modules	RS-232 modules	Parallel modules
HP-PCL Printers	Yes	Yes	Yes
HP-GL Plotters	Yes	Yes	N/A
Epson Printers (FX-80 or Compatible)	Yes	Yes	Yes
Computers	Yes	Yes	N/A

Ordering Information	Price
HP Printers and Plotters	
HP 2225A ThinkJet Printer	$595
HP 2227A QuietJet Printer	$849
HP 33481A LaserJet IIIP Printer	$1,595
HP 7440A Color Pro Plotter	$1,395
HP 7475A Plotter	$1,995
HP-IB Cables	
HP 10833A 1 m Cable	$80
HP 10833B 2 m Cable	$90
HP 10833C 4 m Cable	$100
HP 10833D 0.5 m Cable	$80
RS-232 Cables	
For connection to printers and plotters:	
HP 13242G 5 m, 25 Pin (M) to 25 Pin (M)	$49
HP 17255M 1.5 m, 25 Pin (M) to 25 Pin (M)	$44
For connection to IBM PC/XT computers:	
HP 17255D 1.5 m, 25 Pin (M) to 25 Pin (F)	$44
HP 92219J 5 m, 25 Pin (M) to 25 Pin (F)	$61
For connection to HP Vectra computers:	
HP 24542G 3 m, 25 Pin (M) to 9 Pin (F)	$45
Parallel Cable	
HP 92284A Cable	$39

- Modular construction
- Improved electrical performance
- Accessories

HP 10400A Miniature Probe Family

The HP 10400A miniature probe family offers modular construction, improved reliability, and superior electrical performance over our previous mini-probes. Modular construction allows individual replacement of probe tips, cables, and chassis assemblies, cutting down on probe replacement and repair costs. An extra tip is included for quick repair. Improved cable and strain-relief design increase reliability. Electrical performance is also improved by reducing the probe shunt capacitance and increasing the input resistance, which load the circuit under test.

The HP 10400A mini-probe family also features accessories (see below) including a ground lead utilizing a ferrite bead for reduced ringing on pulse tops, and an IC grabber that allows easy connection of a single probe to many IC packages without fear of shorting adjacent pins.

Oscilloscope/Miniature Probe Compatibility and Probe Characteristics

HP oscilloscope/ logic analyzer	HP probe model	Approx. overall length in meters (ft)	Division ratio	Input R	Approx. shunt capacitance	Compensates oscilloscope input	Max[1] dc volts	Price	
Same as HP 10431A but without probe identification 54502A, 54503A, 54504A, 54510A	**10430A**	1 m (3.3)	10:1	1 MΩ	6.5 pF	1 M 6 to 9 pF	450	$175	☎
54111D, 54112D	**10431A[2]**	1 m (3.3)	10:1	1 MΩ	6.5 pF	1 M 6 to 9 pF	450	$175	☎
1631A/D, 1715A, 1722A, 1725A, 1726A, 1727A, 1805/09A, 54200/201, 54501A, 5185	**10432A[3]**	1 m (3.3)	10:1	10 MΩ	7.5 pF	1 M 10 to 16 pF	450	$175	☎
1631A/D, 16530/31, 5185, 54003A, 54200/201, 54501A	**10433A**	2 m (6.6)	10:1	10 MΩ	10 pF	1 M 10 to 16 pF	450	$175	☎
1740A, 1741A, 1742A, 1743A, 1744A, 1745A, 1746A	**10434A**	1 m (3.3)	10:1	10 MΩ	8.5 pF	1 M 18 to 22 pF	450	$135	☎
1631A/D, 1715/22/25/26/27, 1805/09, 54200/201, 5185	**10435A[3]**	1 m (3.3)	10:1	1 MΩ	7.5 pF	1 M 10 to 16 pF	450	$165	☎
1740/41/42/43/44/45/46	**10436A**	2 m (6.6)	10:1	10 MΩ	11 pF	1 M 18 to 22 pF	450	$130	☎
For oscilloscopes with 50 Ω inputs	**10437A**	2 m (6.6)	1:1	50 Ω				$125	☎
All scopes with high Z inputs (may reduce bandwidth)	**10438A** **10439A**	1 m (3.3) 2 m (6.6)	1:1 1:1		40 pF 64 pF		450 450	$100 $105	☎
1631A/D, 1715A, 1722A, 1725A, 1726A, 1727A, 1805/09A, 1950A, 54112D[4], 54003A, 54111D[4], 54200/201A/D[4], 54502A, 54503A, 54504A, 54510A	**10440A**	2 m (6.6)	100:1	10 MΩ	2.5 pF	1 M 6 to 14 pF	450	$175	☎
54111D, 54112D, 54502A, 54503A, 54504A, 54510A	**10441A[2]**	2 m (6.6)	10:1	1 MΩ	9.0 pF	1 M 6 to 9 pF	450	$175	☎
For oscilloscopes with 50 Ω inputs	**10442A** **10443A**	2 m (6.6)	10:1 20:1	500 Ω 1000 Ω	1.2 pF		10 15	$135	☎

[1]Maximum input voltage may be limited by scope input maximum voltage.
[2]Has probe identification pin
[3]The HP 54201A/D can use the HP 10432A or HP 10435A probes for the vertical inputs, but the HP 10435A probe must be used for trigger inputs.
[4]For vertical inputs only

☎ For off-the-shelf shipment, call 800-452-4844.

OSCILLOSCOPES
Oscilloscope Probes and Accessories (cont'd)

HP 10400A Family Accessories
Each HP 10400A family probe is shipped with one general-purpose grabber, one IC grabber, and one ground lead. An accessory package is also included, which contains 4 grounding spanners (for close grounds at the probe tip), 1 probe barrel insulator, 1 adjustment screwdriver, and 8 colored cable markers.

The included IC grabber fits DIPs with 0.1-in pin spacing (standard) and up to 0.9-in package width. It is handy for connecting the mini-probe tip to a single DIP pin. Construction prevents shorting adjacent pins during hookup. For applications where several adjacent DIP pins must be probed, the HP 10024A accessory can be used (see page 153).

HP 10450A SMT Probe Accessory Kit
Assorted accessories include 10 SMT lead grabbers that interface the HP 10400 Series miniature probes to fine pitch circuitry.

Replacement Probe Tip Assemblies

Probe	Tip color	HP part number	Price
HP 10430A	white	5061-6145	$10
HP 10431A	white	5061-6145	$10
HP 10432A	red	5061-6151	$10
HP 10433A	blue	5061-6146	$10
HP 10434A	brown	5061-6147	$10
HP 10435A	green	5061-6147	$10
HP 10436A	orange	5061-6152	$10
HP 10437A	black	5061-6149	$10
HP 10438A	black	5061-6149	$10
HP 10439A	black	5061-6149	$10
HP 10440A	yellow	5061-6148	$10
HP 10441A	purple	5061-6153	$10

Other HP 10400 Series Probe Accessories

General-Purpose Grabber/Hook Tip	$10
Integrated Circuit Grabber	$10
Ground Lead	$5
Accessory Package: 4 grounding spanners, 1 probe barrel insulator, 1 adjustment tool, 8 colored wire markers	$10

HP 10070A and HP 10071A Probes for HP 54600 Series Oscilloscopes.
The HP 10070A is a 1:1 probe, 1.5 m in length, that is designed for use with the HP 54600A and HP 54601A oscilloscopes.

The HP 10071A is a 10:1 voltage divider probe, 1.5 m in length, that can be used with the HP 54600A and HP 54601A oscilloscopes.

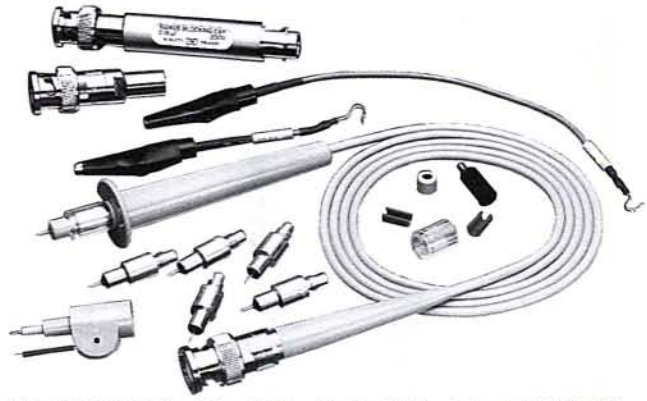
HP 10072A SMT Probe Accessory Kit
Assorted accessories include 10 SMT lead grabbers that interface the HP 10070 Series probes to fine pitch circuitry.

HP 10002A

HP 10002A 1000 V 50:1 Voltage Divider Probe
The HP 10002A voltage divider probe is a general-purpose probe for use with instruments that have a bandwidth of less than 40 MHz with an input impedance of 1 M Ω shunted by approximately 7 to 55 pF. The probe is rated at 1000 V peak.

HP 10020A Resistive Divider Probe Kit
The HP 10020A Resistive Divider Probe Kit is a signal-probing system for measuring fast transition signals in high-impedance systems. It is designed for use with 50 Ω input oscilloscopes, but may be used with other than 50 Ω systems if a 50 Ω feedthrough termination (HP 10100C) is used. The extremely low input RC of the 10020A provides high-fidelity measurements of fast transition signals.

Probe Length (overall): 1.2 m (4 ft)
Weight: Net, 0.45 kg (1 lb); shipping, 1.4 kg (3 lb)
Accessories Supplied: HP 10240B blocking capacitor, BNC adapter tip, 6-32 adapter tip, alligator tip, probe handle, cable assy's 5.1 cm (2 in) & 15.2 cm (6 in) ground, spanner tip, insulating caps, colored sleeves



The HP 10020A Resistive Divider Probe Kit (includes HP 10240B)

HP 10020A Resistive Dividers

Division ratio	Input R* (Ω)	Division accuracy	Max V** (rms)	Input C (pF)
1:1	50	—	6	—
5:1	250	±3%	9	<0.7
10:1	500	±3%	12	<0.7
20:1	1000	±3%	15	<0.7
50:1	2500	±3%	25	<0.7
100:1	5000	±3%	35	<0.7

*When terminated in 50 Ω
**Limited by power dissipation of resistive element

HP 10240B Blocking Capacitor
The HP 10240B blocking capacitor is a probing accessory that provides ac coupling while maintaining a 50 Ω system. This capacitor is designed for use with the HP 10020A resistive divider probe kit, and it is included with the kit. It can also be used with any probe that must be terminated in 50 Ω.

Characteristics
Capacitance: 0.18 μF
Maximum Voltage: ±200 Vdc
Reflection: Under 12% when driven by a 150 ps rise time step in a 50 Ω system
Sag: Approximately 10% per μs (1% in 100 ns)
Connectors: BNC

HP 1124A 100 MHz Active Divider Probe
The HP 1124A active divider probe provides high-voltage, general-purpose probing capabilities for instruments having 50 Ω inputs without selectable high-impedance inputs. This 10 M Ω 10 pF probe allows direct measurements of 100 V, in the 100:1 division ratio mode, from dc to 100 MHz. In the 10:1 division ratio mode, input voltage range is ±10 V. Power is supplied by instruments with probe power jacks or the HP 11899A probe power supply.

HP 1124A Specifications

(Measured when connected to a 50 Ω load)
Bandwidth: (measured from a terminated 50 Ω source) dc-coupled, dc to 100 MHz; ac-coupled, 2 Hz to 100 MHz.
Pulse Response: (measured from a terminated 50 Ω source) transition time, <3.5 ns; perturbations, 5% peak-to-peak. Measured with pulse transition time of >2.5 ns.
Attenuation Ratio: 10:1 ±5%; 100:1 ±5%
Dynamic Range: × 10, ±10 V; × 100, ±100 V
Input RC: 10 MΩ shunted by ≈ 10 pF
Maximum Safe Input
dc-coupled: × 10, ±300 V (dc + peak ac) ≤100 MHz; × 100, ±500 V (dc + peak ac) ≤100 MHz
ac-coupled: × 10, ±300 V (dc + peak ac) ≤100 MHz; dc component must not exceed ±200 V; × 100, ±500 V (dc + peak ac) ≤100 MHz; dc component must not exceed ±200 V.
Accessories Supplied: One 20.3 cm (8 in) ground lead, one retractable hook tip, and two probe tip insulating caps
Power: Supplied by instruments with probe power jacks or the HP 11899A probe power supply.
Length: 1.5 m (5 ft) overall

HP 1137A High-Voltage Divider Probe

The HP 1137A 1000:1 high-voltage divider probe is designed for use with any oscilloscope having input resistance of 1 MΩ (±1%) and input capacitance between 6 and 50 pF. The HP 1137A is a 1000:1 divider probe with 5 KV (Acorde) max input voltage.

Operating Characteristics

Maximum Input Voltage: dc voltage 5 kV; ac voltage 5 kV rms (0 to 250 kHz), 2.5 kV rms (250 kHz to 1 MHz)
Input Impedance: 500 MΩ shunted by 3 pF (approximate)
Bandwidth: 1 MHz
Rise Time: Approximately 350 ns (calculated from: $t_r = 0.35/\text{bandwidth}$)
Temperature Coefficient: ± 0.02% of reading per degree C
Division Ratio Accuracy: ± 1.5% of reading (see note)
Compensation Range: For input capacitance of 6 to 50 pF
Crest Factor: 2 or less

Note: Characteristic applies for operation between 0° and 55° C, at less than 85% relative humidity. Above 40° C, at 85% to 95% relative humidity, add additional 10% of reading.

General

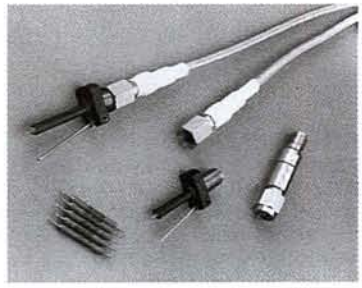
Operating Modes:
1 MΩ mode, for oscilloscope impedance of 1 MΩ ± 1%
10 MΩ mode (optional), for input impedance of 10 MΩ ± 1%
Operating Temperature Range: 0° to 55° C
Storage Temperature Range: −20° to 70° C
Cable Length: 1.5 m
Accessories: Trimmer adjustment tool included

Ordering Information

	Price
HP 10002A 1000V 50:1 Voltage Divider Probe	$385
HP 10020A Resistive Divider Probe Kit	$735
HP 10070A 1:1 Probe	$55
HP 10071A 10:1 Probe	$55
HP 10072A SMI Probe Accessory Kit	N/A
HP 10240B Blocking Capacitor	$55
HP 10450A SMI Probe Accessory Kit (for HP 10400-Series probes)	N/A
HP 1124A 100 MHz Active Probe	$585
HP 1137A 1000:1 High Voltage Divider Probe	$205
HP 54701A 2.5-GHz, 0.6-pF Active Probe	$2,300
HP 1143A Probe Offset and Power Module	$1,200
HP 54006A 6-GHz Passive Divider Probe	$1,040

HP 54701A 2.5-GHz, 0.6-pF Active Probe

The HP 54701A 2.5-GHz, 10:1 active probe provides ultra-low loading on a device-under-test because of its low 0.6-pF capacitive loading and its high 100 kΩ resistive loading. Its 200 Vac maximum input voltage, ±12 kV ESD tolerance, and replaceable probe tips make the HP 54701A the most reliable active probe ever manufactured. The HP 1143A probe offset and power module provides power for two HP 54700-series probes with any instrument with a 50 Ω input resistance. The power supply is not required if the probe is used with the HP 54700-series scopes.



HP 54006A 6-GHz Passive Divider Probe

Probing multi-GHz systems with the HP 54006A 10:1, 500 Ω, and 20:1, 1 kΩ resistive divider probes lets you access circuit nodes that do not have a coaxial connector. These probes let you see the signal at points, such as the output of a gate without disturbing it because of its low 0.25 pF input capacitance.

Cascade Microtech Probing Stations

On wafer, IC package, and MCM probing solutions, extend high-speed oscilloscope/TDR measurements into high-density environments. High bandwidth 50 Ω launchers are available for use with HP 54120 TDR products for interconnect signal integrity analysis, as well as resistive divider probes for measurements on signals from active devices using the HP 54700 Series and HP 54120 Series scopes. Contact Cascade Microtech, Inc., 14255 SW Brigadoon Ct., Beaverton, Oregon 97005. Telephone: (503) 626-8245.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

OSCILLOSCOPES
Oscilloscope Probes and Accessories (cont'd)

- dc to 200 MHz probe bandwidth
- ± 200 V (dc + peak ac) maximum voltage without attenuators
- 3000:1 CMRR at 1 MHz
- Low dc thermal drift
- 10X, 100X attenuators
- dc offset and dc reject
- Remote-control input coupling and offset
- Superior tolerance to ESD
- Rugged construction

HP 1141A, 1142A

HP 1141A Accessories

HP 1141A Differential Probe

The HP 1141A is a 1X FET differential probe with 200 MHz bandwidth and 3000:1 CMRR (Common Mode Rejection Ratio). The probe has a high-input resistance of 1 MΩ and low-input capacitance of 7 pF to minimize circuit loading. The HP 1141A must be used with the HP 1142A probe control and power module. It is designed for use with instruments having 50 ohm inputs.

The HP 1142A probe control and power module controls input coupling modes dc, dc with variable offset, and dc reject. The offset capability allows viewing of very small signals on large dc components without attenuating ac low-frequency components or causing sag from ac coupling. In automated test applications coupling modes and dc offset can be controlled remotely.

Two attenuators, 10X and 100X, are provided to expand the linear differential input range to ±30 V.

Operating Characteristics

Bandwidth: dc to 200 MHz (−3 dB)
Rise Time: 1.75 ns (calculated by $t_r = \frac{0.35}{\text{bandwidth}}$)

CMRR: 3000:1 @ 1 MHz
dc Vertical Accuracy: 2% (1X), 4% (with attenuators)
Linear Differential Input Range: ±0.3 V (1X)
±3.0 V (10X)
±30 V (100X)

Common Mode Operating Range
dc: ±20 V (1X), ±200 V (10X), ±500 V (100X)
dc to 30 Hz: Linearly decreased to 30 Hz value
30 Hz to 200 MHz: ±0.5 V (1X), ±5 V (10X), ±50 V (100X) (voltages are peak voltage)
dc offset: ±20 V (1X), ±200 V (10X), ±500 V (100X)
Maximum input voltage (without damage): 200 V dc + peak ac (1X), 500 V dc + peak ac (10X, 100X), common or differential modes

Input Coupling: dc, dc with variable offset, dc reject, and ac (dc and dc reject are selected by pushing buttons on the 1142A; ac coupling is provided via an adapter that attaches to the probe tip).
ac Coupling Low-Frequency Response: 15 Hz (1X), 1.5 Hz (with attenuators) (−3 dB)
Input RC: 1 MΩ shunted by approximately 7 pF (1X)
Output: Designed to drive 50 Ω instruments or high-impedance instruments terminated with a 50 Ω feedthrough termination.

General

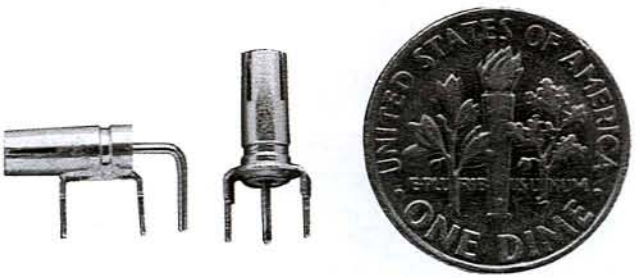
Power Requirement: 90 to 132 Vac/198 to 264 Vac, 47 to 440 Hz, 25 VA max
Temperature: Nonoperating: −40° to 70° C; operating: 0° to 55° C
Altitude: Nonoperating: up to 15,300 m (50,000 ft); operating: up to 4,600 m (15,000 ft)
Humidity: Nonoperating: 90% relative @ 65° C; operating: 95% relative @ 40° C
Cable Length: 1.5 m (5.2 ft)

Ordering Information

	Price
HP 1141A Differential Probe Includes 10X and 100X voltage attenuators, ac coupler, 5 probe leads, 2 probe clips, operating and service manual, calibration adapter, ground lead, and one-year warranty.	$1,675
HP 1142A Probe Control and Power Module Includes power cord and one-year warranty.	$820

Note: Models HP 1141A and 1142A must be used together.

☎ For off-the-shelf shipment, call 800-452-4844.



HP 1250-2427 PC Board Horizontal Mini Probe Socket

The HP 1250-2427 PC board mini probe socket is ideal for breadboard-circuit applications in which it is desirable to make a reliable circuit connection between the mini probe tip and a test circuit. (Soldering the tip itself into place is not recommended.) The HP 1250-2427 is also useful in production PC-board applications as an oscilloscope test point. The probe plugs into the socket parallel to the PC board (replaces p/n 1250-1737).

HP 1250-2428 PC Board Vertical Mini Probe Socket

The HP 1250-2428 is similar to the 1250-2427 (above), except that it is designed for attaching the probe to the board vertically rather than horizontally (replaces p/n 1250-1918).

HP 10024A/10211A IC Test Clip

The HP 10024A IC test clip provides easy probing of 14- and 16-pin dual in-line packages and includes 4 insulated circuit interface pins. Additional circuit interface pins are available (see Ordering Information) in packages of 12 pins. Each pin has a tip on each end so that probes such as those on HP logic analyzers can be connected for fast, functional checks of circuit operation.

The HP 10211A dip clip is similar in operation to the HP 10024A, but accesses 24-pin dual in-line package IC.

Probe Accessories

Terminations

HP 10100C: 50 Ω ±1% BNC (male) to BNC (female) feedthrough termination.

Standard Probe Tip Adapters

HP 10229A Hook Tip Adapter: Retractable pincer tip provides firm connection to circuit nodes. Recommended accessory for HP 10020A resistive divider kit.

Ordering Information	Price
HP 1250-2427 PC Board Mini Probe Socket	$3.20
HP 1250-2428 PC Board Mini Probe Socket (vertical)	$3.20
HP 10024A IC Test Clip (with 4 circuit interface pins)	$45
HP 10024-69501 Interface Pin Kit for HP 10024A (includes 12 interface pins)	$60
HP 1250-1454 BNC-to-Mini Probe Adapter	$15
HP 10211A Dip Clip	$85
HP 10229A Retractable Hook Tip Adapter	$28
HP 10100C 50 Ω Feedthrough Termination	$55

Transportation Accessories

The following transportation accessories are available for the HP 54500 Series and HP 16500 Series:

HP 1540-1066 Soft Carrying Case	$150
HP 9211-2645 Transit Case	$430
HP 5061-6183 Front-Panel Cover	$40

Testmobiles

Three testmobiles are available for HP oscilloscopes and logic analyzers:

HP 1180A

This inexpensive testmobile is designed for HP 54500 and HP 54200 Series digitizing oscilloscopes and for HP 1630 and 1650 Series logic analyzers.

HP 1182A

This new testmobile is similar to the HP 1180A, but provides two more inches of tilt-tray width and 5¾ more inches of tilt-tray depth.

HP 1181A

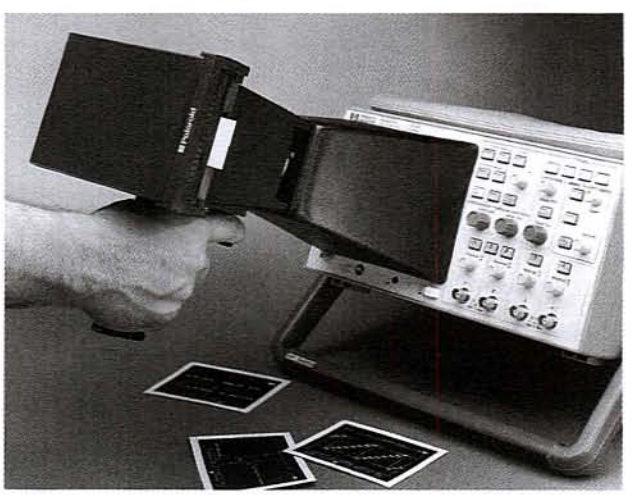
The HP 1181A testmobile is for larger instruments, such as the HP 54100 Series oscilloscopes. With a tilt-tray that is 22-in wide and 26-in long, and a total weight capacity of up to 226.8 kg (500 lb), this cart can handle your large system requirements.

See page 634 for detailed information.

HP 1181A HP 1180A HP 1182A

HP 10079A Camera

The HP 10079A camera is designed for use with HP 54600 Series oscilloscopes. When a printer or plotter is not readily available, or your HP 54600 Series scope is not equipped with a hard-copy interface module, this camera offers a simple solution for recording waveforms. The HP 10079A uses Polaroid Type 667 film.

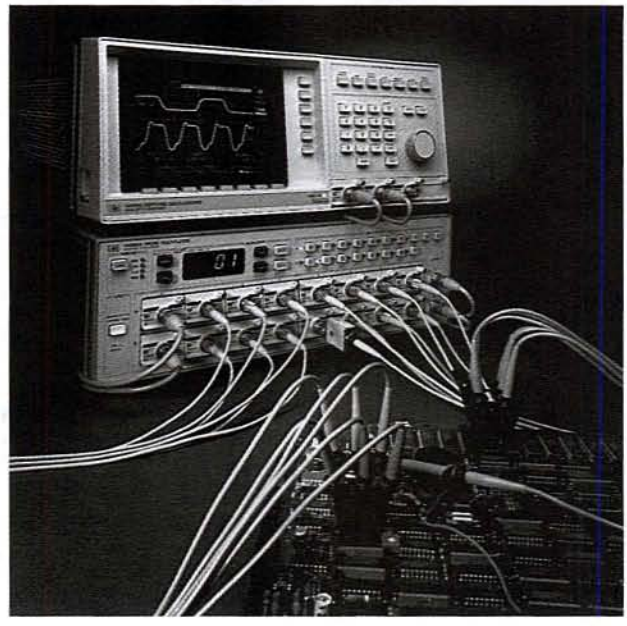


Ordering Information	Price
HP 10079A Camera	$595

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

OSCILLOSCOPES
Oscilloscope Probes and Accessories (cont'd)

- Clamped or unclamped video output
- Trigger output for line and frame
- For most standard broadcast composite video systems
- Compatible with most analog and digitizing scopes



HP 1133A TV/Video Sync Pod

The HP 1133A TV/video sync pod is an accessory that provides users with TV sync triggering for most analog or digitizing oscilloscopes. It features clamped or unclamped video outputs that can be viewed on the oscilloscope's vertical channels and trigger outputs that can synchronize the oscilloscope to video frame and individual lines.

The pod itself is packaged in a case approximately 14 × 14 × 4.5 cm (5.5 × 5.5 × 1.75 in) and is powered by a separate ac power module. The pod features a loop-through input (two-female BNC) that can be driven from a 75 Ω source, or, for probing high impedance circuits, from a 1 to 10 MΩ probe. The loop-through feature allows a 75 Ω signal to be looped through the TV/video pod, then connected to a video monitor or other 75 Ω device. Clamped or unclamped video outputs are designed to drive a high impedance probe (1 to 10 MΩ) connected to the oscilloscope input.

The HP 1133A is compatible with broadcast standards M, N, C, B, G, H, I, D, K, K1, and L systems.

Characteristics

Video Input: ac coupled with an RC of 1 M Ω shunted by approximately 10 pF
Bandwidth: Approximately 10 MHz
Maximum Input Voltage: 40 V (dc plus peak ac)
Frame output is phase locked to the leading edge of the third field synchronizing pulse on field one, to the leading edge of the second pulse on field two. Frame output goes high on field one, and low on field two. There is a switch for positive or negative sync pulse polarity. A gain control adjusts for signal amplitude at BNC input. Gain from input BNC to unclamped output is approximately 2.5 to 50.

Ordering Information

Note: The 1133A must be ordered with a power supply option.

HP 1133A TV/Video Sync Pod	$335
Opt ABA Power Supply for U.S.A., 120 V, nema 515P plug	$0
Opt ABB Power Supply for Europe, 220 V CEE7-VII plug	$0
Opt ABG Power Supply for Australia, China	$0
Opt ABJ Power Supply for Japan, 100 V nema 515P plug	$0
Opt ABU Power Supply for United Kingdom, 240 V BS1363 Plug	$0

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 54300A Probe Multiplexer

Multi-Input Tool for 50 Ω Instrumentation

The HP 54300A is a programmable, dual 8:1 probe multiplexer designed to expand the input capability of instrumentation with 50 Ω inputs. Its unique strength is its configurability. The user may select from three different input pods: two high-frequency, high-impedance probes, or a 50 Ω BNC input for terminated line applications.

The HP 54300A features full HP-IB programmability as well as simple front-panel control. It has internal nonvolatile memory for storing lists of switching steps. Switch lists can be advanced step-by-step from a front-panel button, over the HP-IB (i.e., IEEE-488) or, for data logging applications, through a TTL pulse entered at the rear panel.

HP 54001A 1 GHz Active Mini-Probe Pod

This pod, with its built-in probe, offers 1 GHz bandwidth with 10 kΩ/2 pF input loading. It uses HP's mini-tip probe for easy access in compact circuits, and features both high bandwidth and high impedance at the probe tip.

HP 54002A 50 Ω BNC Pod

This pod should be used with terminated 50 Ω systems. Output from the multiplexer using this pod is <2 dB down at >1 GHz. The 54002A is also useful with divider probes such as the HP 10020A.

HP 54003A 300 MHz 1 MΩ Probe Pod

This pod, with a 10:1 detachable mini-tip probe, has 1 MΩ resistive and 8 pF capacitive loading. It is valuable when resistance is a more significant loading factor than capacitance, such as in operational amplifier measurements. If desired, the probe can be removed from its pod to provide a 1 MΩ approximately 10 pF BNC input.

Ordering Information

	Price
HP 54300A Dual 8:1 Probe Multiplexer Includes one operating and programming manual. Each HP 54300 accepts up to 16 input pods in any combination. Pods must be ordered separately.	$8,900
Opt 908 Rack Mount Flange Kit	+$35
HP 54001A 1 GHz Miniature Active Probe Pod	$830
HP 54002A 50 Ω BNC Input Pod	$160
HP 54003A 1 MΩ 10:1 Probe Pod	$720

- Floating and guarded inputs
- dc to 3-kHz bandwidth, 33.3-kHz sampling rate
- Three channels with simultaneous sampling
- 12-bit resolution, 1000-word buffer/channel
- Six trigger modes with up to 100% pre-trigger capture
- Full programmability and data transfer over HP-IB

HP 7090A

DESIGNED FOR HP-IB SYSTEMS

HP 7090A Measurement Plotting System

The HP 7090A is designed for low-frequency measurements, analysis, and documentation. It merges several technologies—waveform recording, digital plotting, and analog recording—to provide a powerful solution to a broad range of measurement applications. In addition, the HP 7090A is a high-performance digital plotter. It is ideal for a graphics dump from a smart instrument or as part of an HP-IB system. The HP 7090A annotates setup conditions, date and time, selected data points from memory, and trigger information. It draws user-defined axes and grids, eliminating the need for preprinted graph paper.

Simultaneous sampling on each of three channels, 12-bit resolution, bandwidth of dc to 3 kHz (33.3 k samples/s maximum), and 1000-word memory per channel allow high-resolution measurement, storage, and display. The HP 7090A has six trigger modes, which allow virtually any signal change to initiate signal capture—even decaying repetitive signals such as faults in a power line voltage or in a transducer's carrier. Combined with pre-trigger capability, these trigger modes make the HP 7090A ideal for turn-on/turn-off characterization, fault monitoring, and mechanical motion analysis.

Applications

Capturing Low Frequency Electrical Transients

General diagnostic monitoring and fault monitoring (capturing pre-trigger data for intermittent failures) are natural applications for the HP 7090A.

Measuring Phase Relationships

Simultaneous sampling on all channels is ideal for measuring current/voltage phase relationships in power systems.

Mechanical Testing

Applications where transducers convert velocity, acceleration, force temperature, or torque to voltage are a good fit for the HP 7090A. The flexible triggering makes it useful for one-shot electromechanical events such as clutch and mechanism engagement.

Electromechanical Control Systems

The HP 7090A can measure the response of a system to a stimulus to determine damping ratio and the natural frequency of the control system.

Material Testing

The HP 7090A can record classic stress-strain curves, particularly those obtained from destructive testing. View and rescale data stored in the buffer even after the sample is destroyed.

HP 17090 Measurement Graphics Software

HP 17090 measurement graphics software lets you access the full capabilities of the HP 7090A and integrate them into computer system applications. This software is compatible with HP Series 200 and 300 computers. HP 17090 software helps you use the HP 7090A's features easily and efficiently, and it provides storage, annotation, and data transformation capabilities not available on the HP 7090A unit alone.

HP 7090A Specification Summary

Inputs
Channels: 3
Type: Floating, guarded
Sensitivity: 5 mV to 100 V full scale
Zero offset: ±2 × full scale or ±100 V max
Impedance: 1 MΩ, shunted by 45 pF (nominal)
Maximum input: 200 V dc or peak
Common mode rejection ratio: 140 dB dc; 100 dB ac at 60 Hz with 1 kΩ unbalance in LOW terminal (at 25°C)
Electrical Accuracy (at 25° C, ±1 scale offset maximum:)
±0.55% of reading, ± 0.26% of range at 5 mV full scale decreasing to 0.15% of range at 500 mV and above
Temperature Coefficient:
±0.1% of reading, ±0.044% of range/degree C at 5 mV decreasing to 0.012% of range/degree C at 500 mV and above
Timebase
Buffer mode: 30 ms to 24 h
Direct mode: 1 s to 24 h
Accuracy: ±0.1%
Dynamic Performance
Slewing speed (nominal)
Direct mode: 127 cm/s (50 in/s)
Plotting mode: 75 cm/s (30 in/s)
Acceleration (nominal): 2 g constant
Bandwidth (≥ 3dB): 3 kHz for all full-scale ranges ≥ 20 mV, 2.6 kHz for all full-scale ranges < 20 mV
Trigger Characteristics
Internal trigger: Inside or outside window to capture repetitive signals, inside resets with each reverse transition; above or below level, selectable over the full-scale range in 1.0% of range increments (nominal); source, channel 1
External trigger: BNC connector, TTL level or contact closure to ground
Manual trigger: Available from front-panel controls
Display: Up to 100% pre-trigger capture, up to 24-hour post-trigger delay before measurement start
Plotter Characteristics
Writing system: Six-pen carousel with automatic pen capping. Fiber-tip pens for paper or transparencies
Media types: Paper and overhead transparency film, A4/A (210 × 297 mm/8½ × 11 in), or A3/B (297 x 420 mm/11 × 17 in); switch selectable.
Size: 575.0 mm W × 205.5 mm H × 465.0 mm D (2.6 in × 8.1 in × 18.3 in)
Weight: Net, 15.7 kg (34.5 lb); shipping, 23.6 kg (51.9 lb)
Power requirements: 100, 120, 220, 240 V ac −10%, +5%, 48 to 66 Hz

Ordering Information

	Price
HP 7090A Measurement Plotting System	$5,800 ☎
Opt 0B1 (Duplicate Set of Manuals)	+$115
HP 17090 A/B/C Measurement Graphics Software	$700
Opt 630 (3½-in disk)	$0
Opt 655 (5¼-in disk)	$0

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office, see page 165.

DIGITAL MULTIMETERS
General Information

HP offers a full line of Digital Multimeters.

Digital Multimeters

Hewlett-Packard offers a wide range of digital multimeters (DMMs) for test and measurement. HP has a DMM with the measurement capability you need for data acquisition, production, test or research.

The combination of precise measurement and versatile configuration in HP DMMs gives you meaningful measurements of your product or process. This allows you to interpret results and make decisions that improve productivity and quality. You can perform dc and ac tests of voltage and current, and measure resistance using two or four terminals. Frequency and period measurements are also available on some models.

Applications in calibration and metrology/standards labs need the accuracy and stability of the HP 3458A. Its digitizing capabilities also allow you to use it in high-resolution digitizing applications.

Computer-aided production testing requires a wide variety of functions, resolutions, and speeds. The HP 3457A fits those needs.

The HP 34401A is a highly cost-effective solution for both bench and system applications, providing high performance and versatility in a 6½-digit DMM. For portable troubleshooting, the HP E2300 series of handheld multimeters offers you HP quality in a 3½-digit handheld.

Measurement Performance Tradeoffs

In some applications, measurement speed is the most important requirement. Other applications demand high accuracy, high resolution, and excellent noise rejection. Often what you need lies somewhere in between. Innovative integration techniques used in most of HP's DMMs let you trade speed for resolution, which adds measurement flexibility.

HP's integrating DMMs offer the fastest reading rates available with power-line-related noise rejection. Integration selection (number of power-line cycles) is the key to performance tradeoffs. For example, reading rates are maximized by decreasing resolution and the number of power-line cycles. Conversely, accuracy and resolution are improved by increasing the number of power-line cycles. In short, HP allows you to choose the resolution, accuracy, and noise rejection you need, while maximizing measurement speed.

High Throughput Reduces Test Time

For system applications, you can increase throughput using system DMMs like the HP 3458A. This DMM is HP's throughput leader when you must change functions and ranges often to obtain all of your measurements. The ability to change functions and ranges quickly while taking measurements is a good index of measurement throughput. Several of HP's system DMMs share this strength to help you improve your throughput and your profits.

Most of HP's system DMMs have a Voltmeter Complete pulse output for incrementing channels on external scanners or switches, without the delay of a computer command. An external trigger input is ideal for synchronizing your DMM to your measurement. Interrupt capability allows your system to run more efficiently, since your computer need only provide control when requested by the DMM. Flexible triggering lets you properly synchronize measurements with your device-under-test.

Features such as pass/fail limit testing (in the HP 3457A, HP 34401A, and HP 3458A), program memory, and reading storage minimize computer interaction with the DMM and can help you speed up your system.

Low Cost of Ownership

In addition to flexibility and multiple functions, HP digital multimeters (DMMs) are noted for reliability. From concept to implementation, every phase of design and manufacture has resulted in extremely reliable products. This reliability is reflected in system uptime and total cost of ownership. We offer electronic no-pots calibration to maximize your uptime. Modular design and self-test capabilities keep repair time and cost to a minimum.

The reliability of HP system DMMs is such that we offer three years of hardware support at a low cost. You can expect HP reliability and support to keep your system up and running for a long time. Because of HP's commitment to quality, you can reduce your total cost of ownership.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

	HP 3458A page 160	HP 3457A page 162	HP 34401A page 158	HP 3478A page 164	HP 3456A page 166	HP 3455A page 167	HP 3466A page 167	HP E2377A/ E2378A page 169
dc voltage								
Basic 1 yr accuracy (parts per million)	8 (4) (Opt 002)	25	35	60	23	130	300	3000
Resolution (nanovolts)	10	10	100	100	100	1000	1000	100,000
Maximum reading rate (readings per second)	100,000	1,350	1000	90	330	24	4.7	2
Maximum range (volts)	1000	1000 (HP 44497A)	1000	300	1000	1000	1200	1000
Resistance								
Basic 1 yr accuracy (percent)	0.001%	0.001%	0.01%	0.016%	0.04%	0.005%	0.03%	0.7%
Resolution (microhms)	10	10	100	100	100	1	1000	100,000
ac voltage								
Basic 1 yr accuracy (percent)	0.009%	0.21%	0.09%	0.22%	0.18%	0.14%	0.4%	1.0%
Bandwidth	1 Hz–10 MHz	20 Hz–1 MHz	3 Hz–300 kHz	20 Hz–300 kHz	20 Hz–250 kHz	30 Hz–1 MHz	20 Hz–100 kHz	40 Hz–1 kHz
Functions	dc & ac V, 2- & 4-wire Ω, offset-compensated Ω, dc & ac I, frequency, period, math, test-sequence storage, ratio, 20 KB reading memory, digitizing, & HP-IB	dc & ac V, 2- & 4-wire Ω, offset-compensated Ω, dc & ac I, frequency, period, math, test-sequence storage, 6 KB reading memory, & HP-IB	dc & ac V, dc & ac I, 2- & 4-wire Ω, frequency, period, continuity, diode test, reading hold, dB, dBm, null, min/max, pass/fail, ratio, 512 rdg. storage, HP-IB, RS-232	dc & ac V, 2- & 4-wire Ω, dc & ac I, & HP-IB	dc & ac V, 2- & 4-wire Ω, offset-compensated Ω, math, ratio, test sequence storage, 64 KB reading memory, & HP-IB.	dc & ac V, 2- & 4-wire Ω, math & HP-IB	dc & ac V, 2-wire Ω, ohms zero adjust, dc & ac I, diode test, battery/ac power	dc & ac V, dc & ac I, 2-wire Ω, diode test, audible continuity, temp (K-type), & data hold
Options	Opt 001 Expanded reading memory to 148 KB Opt 002 High stability (4 ppm/yr) Opt 005 Waveform analysis library Opt 700 CIIL language Opt W30 3-yr hardware support	Opt 700 CIIL language Opt W30 3-yr hardware support 44497A 1000 V attenuator 44491A Armature relay mux 44492A Reed relay mux	Opt W50 5-yr Hardware Support	Opt W30 3-yr hardware support	Opt 050 Noise rejection for 50 Hz Opt 060 Noise rejection for 60 Hz Opt 401 High ac accuracy Opt W30 3-yr hardware support	Opt 001 Average converter	Opt 001 ac power only Opt 002 Rack & stack case	E2301A Surface thermo-couple probe K-type E2302A Airflow thermo-couple probe K-type E2303A Thermo-couple probe adapter E2304A Carrying case E2305A Replacement test leads
Digits	8½	6½	6½	5½	6½	6½	4½	3½
Price	$6,595	$3,260	$995	$1,295	$6,395	$8,695	$1,995	$169/189

DIGITAL MULTIMETERS

Low-Cost 6½-Digit Multimeter

HP 34401A

- 11 measurement functions
- 1000 V maximum input
- 15 ppm basic dc accuracy
- 1000 readings per second
- HP-IB and RS-232 standard
- 512-reading memory
- SCPI commands standard

HP 34401A shown with optional accessory pouch.

HP 34401A Digital Multimeter

The HP 34401A digital multimeter establishes a new price/performance standard by offering such features as 6½ digits of resolution, 1000 readings per second, and 15 ppm basic dc accuracy at a surprisingly affordable price. The HP 34401A has been designed for superior performance while providing the flexibility to meet both your present and future needs.

Great Bench Performance

The clear, logical front panel of the HP 34401A allows you to easily select all primary measurement functions. Traditional "bench" functions, such as continuity and diode test, are included. Math functions, such as NULL, dB, dBm, limit test, and min/max/avg are easily selected. A simple menu scheme gives you access to powerful advanced features, such as the ability to store up to 512 readings in internal memory. Measurement results are displayed on a bright, high-visibility readout. A rugged case ensures survival even under the toughest conditions, and the optional accessory pouch makes it easy to pack up and go with the HP 34401A.

Superior Performance in Your System

The HP 34401A can take up to 1000 readings per second, but throughput is more than just a set of measurements on a fixed range and function. The HP 34401A is designed to make up to 50 range/function changes per second: you won't have to wait for your multimeter to catch up with your test. Both HP-IB and RS-232 are standard, letting you select the interface that best meets your needs. The HP 34401A responds to 3 different command languages. It accepts SCPI commands (Standard Commands for Programmable Instruments), which ensures present and future compatibility. It also responds to commands for the HP 3478A and the Fluke 8840A, thereby protecting your software investment with backward compatibility. Drivers are also available for both National Instruments Labview and Hewlett-Packard's ITG software.

Abbreviated Technical Specifications

dc Voltage

Input Characteristics

Range	Maximum reading (6½ digits)	Resolution in digits			Input resistance
		6½	5½	4½	
100 mV	120.0000	100 nV	1 μV	10 μV	10 MΩ or > 10 GΩ
1 V	1.200000	1 μV	10 μV	100 μV	10 MΩ or > 10 GΩ
10 V	12.00000	10 μV	100 μV	1 mV	10 MΩ or > 10 GΩ
100 V	120.0000	100 μV	1 mV	10 mV	10 MΩ
1000 V	1050.000	1 mV	10 mV	100 mV	10 MΩ

Input Protection: >1000 V on all ranges
Measurement Accuracy: ±(% of reading + % of range)

Range	24-Hour 23° C ±1° C	90-Day 23° C ±5° C	1-Year 23° C ±5° C
100 mV	0.0030 + 0.0030	0.0040 + 0.0035	0.0050 + 0.0035
1 V	0.0020 + 0.0006	0.0030 + 0.0007	0.0040 + 0.0007
10 V	0.0015 + 0.0004	0.0020 + 0.0005	0.0035 + 0.0005
100 V	0.0020 + 0.0006	0.0035 + 0.0006	0.0045 + 0.0006
1000 V	0.0020 + 0.0006	0.0035 + 0.0010	0.0045 + 0.0010

Noise Rejection: (50 or 60 Hz, 1 kΩ unbalance in LO lead)
DC CMRR: 140 dB
AC CMRR: 70 dB
Normal mode rejection (60 Hz/50 Hz) ±0.1%:
100 PLC (1.67 s/2.00 s): 70 dB
10 PLC (167 ms/200 ms): 70 dB
1 PLC (16.7 ms/20.0 ms): 60 dB
<1 PLC (3 ms or 800 ms): 0 dB

Maximum Reading Rate: (readings/s)

Power line frequency	Resolution in digits		
	6½	5½	4½
60 Hz	6	300	1000
50 Hz	5	300	1000

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

ac Voltage (true rms)
Input Characteristics

Range	Maximum reading (6½ digits)	Resolution in digits		
		6½	5½	4½
100 mV	120.0000	100 nV	1 μV	10 μV
1 V	1.200000	1 μV	10 μV	100 μV
10 V	12.00000	10 μV	100 μV	1 mV
100 V	120.0000	100 μV	1 mV	10 mV
750 V	750.000	1 mV	10 mV	100 mV

Input Resistance: 1 MΩ ±2%, in parallel with 100 pF
Input Protection: >750 V rms on all ranges
Measurement Accuracy: ±(% of reading + % of range); 1 year, 23° C ± 5° C

Frequency	Ranges	
	100 mV	1, 10, 100, 1000 V
3 to 5 Hz	1.00 + 0.04	1.00 + 0.03
5 to 10 Hz	0.35 + 0.04	0.35 + 0.03
10 Hz to 20 kHz	0.06 + 0.04	0.06 + 0.03
20 to 50 kHz	0.12 + 0.04	0.12 + 0.05
50 to 100 kHz	0.60 + 0.08	0.60 + 0.08
100 to 300 kHz	4.00 + 0.50	4.00 + 0.50

Note: −3 dB frequency typically >1 MHz

Maximum Volt - Hz Product: 8×10^7
Crest Factor: Maximum of 5:1 at full scale
Maximum Reading Rate: 10 readings/s (50 readings/s with default delays defeated)

Resistance: (2-wire Ω, 4-wire Ω)
Input Characteristics

Range	Maximum reading (6½ digits)	Resolution in digits		
		6½	5½	4½
100 Ω	120.0000	100 μΩ	1 mΩ	10 mΩ
1 kΩ	1.200000	1 mΩ	10 mΩ	100 mΩ
10 kΩ	12.00000	10 mΩ	100 mΩ	1 Ω
100 kΩ	120.0000	100 mΩ	1 Ω	10 Ω
1 MΩ	1.200000	1 Ω	10 Ω	100 Ω
10 MΩ	12.00000	10 Ω	100 Ω	1 kΩ
100 MΩ	120.0000	100 Ω	1 kΩ	10 kΩ

Input Protection: >1000 V on all ranges
Measurement Accuracy: ±(% of reading + % of range)
Specs are for 4-wire Ω or 2-wire Ω using Math Null

Range	24-Hour 23° C ±1° C	90-Day 23° C ±5° C	1-Year 23° C ±5° C	Current source
100 Ω	0.0030+0.0030	0.008+0.004	0.010+0.004	1 mA
1 kΩ	0.0020+0.0005	0.008+0.001	0.010+0.001	1 mA
10 kΩ	0.0020+0.0005	0.008+0.001	0.010+0.001	100 μA
100 kΩ	0.0020+0.0005	0.008+0.001	0.010+0.001	10 μA
1 MΩ	0.002+0.001	0.008+0.001	0.010+0.001	5.0 μA
10 MΩ	0.015+0.001	0.020+0.001	0.040+0.001	500 nA
100 MΩ	0.300+0.010	0.800+0.010	0.800+0.010	500 nA*

* Measurement is computed from 10 MΩ in parallel with input.

Maximum Reading Rate: Same as dcV

dc Current
Input Characteristics

Range	Maximum reading (6½ digits)	Resolution in digits		
		6½	5½	4½
10 mA	12.00000	10 nA	100 nA	1 μA
100 mA	120.0000	100 nA	1 μA	10 μA
1 A	1.200000	1 μA	10 μA	100 μA
3 A	3.00000	10 μA	100 μA	1 mA

Burden Voltage: <2 V for 3 A input; <0.1 V for 10 mA input
Input Protection: Externally accessible 3 A 250 V fuse; Internal 7 A 500 V fuse
Measurement Accuracy: ±(% of reading + % of range)

Range	24-Hour 23° C ±1° C	90-Day 23° C ±5° C	1-Year 23° C ±5° C	Shunt resistance
10 mA	0.005+0.010	0.030+0.020	0.050+0.020	5.0 Ω
100 mA	0.010+0.004	0.030+0.005	0.050+0.005	5.0 Ω
1 A	0.050+0.006	0.080+0.010	0.100+0.010	0.1 Ω
3 A	0.100+0.020	0.120+0.020	0.120+0.020	0.1 Ω

Maximum Reading Rate: Same as DCV

ac Current (true rms)
Measurement Accuracy: ±(% of reading + % of range); 1 year, 23° C ± 5° C

Frequency	Ranges	
	1 A	3 A
3 to 5 Hz	1.00 + 0.04	1.10 + 0.06
5 to 10 Hz	0.30 + 0.04	0.35 + 0.06
10 Hz to 5 kHz	0.10 + 0.04	0.15 + 0.06

Burden Voltage: <1.5 V rms for 3 A input
Input Protection: Externally accessible 3 A 250 V fuse; Internal 7 A 500 V fuse
Maximum Reading Rate: Same as acV

Frequency or Period:
Range: 3 Hz to 300 kHz (333 ms to 3.33 μs)
1-Year Accuracy: 0.01% (40 Hz to 300 kHz); 0.05% (3 to 40 Hz)
Resolution: 10 μHz to 1 Hz

Other Measurement Functions: Continuity, Diode Test, Ratio dc:dc, Limit Test

Math Functions: NULL, Min/Max/Avg, dB, dBm, Limit Test
Memory: 512-reading internal storage
Standard Programming Languages: SCPI, HP 3478A and Fluke 8840A/42A
Accessories Included: Test lead kit, Operators Manual, Service Manual, Test Report, and power cord.

General Specifications
Power: 100/120/220/240V, ±10%
Power Line Frequency: 45 to 66 Hz, 360 to 440 Hz
Power Consumption: 25 VA peak (10 W average)
Operating Environment: 0° to 55° C, full accuracy to 80% RH, 30° C
Storage Environment: −40° C to 75° C
Size: 88.5 mm H × 212.6 mm W × 348.3 mm D (4 in × 8.5 in × 14 in)
Weight: Net, 3.6 kg (8.0 lb); shipping, 5.9 kg (13 lb)
Safety: Designed to UL-1244, IEC-348, CSA
Warranty: 3 years standard
Computer Interface: HP-IB and RS-232C standard

Ordering Information

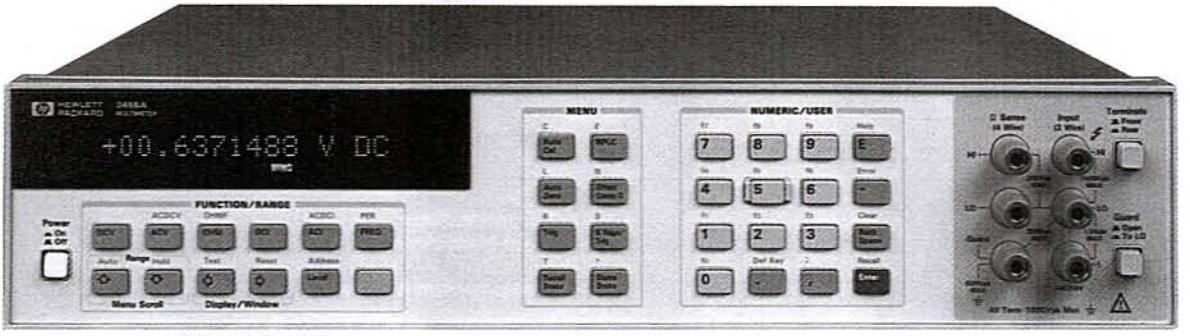
	Price
HP 34401A Multimeter	$995
Opt 908 Rack Mount Kit	$51
HP 34130A Deluxe Test Lead Kit (unique to HP 34401A)	$35
HP 34161A Accessory Pouch	$38

☎ For off-the-shelf shipment, call 800-452-4844.

DIGITAL MULTIMETERS

A System Multimeter with Both High Speed and High Accuracy

HP 3458A



HP 3458A

DESIGNED FOR MATE SYSTEMS

DESIGNED FOR HP-IB SYSTEMS

The HP 3458A multimeter shatters longstanding performance barriers of speed and accuracy on the production test floor, in research and development, and in the calibration lab. The HP 3458A is the fastest, most flexible, and most accurate multimeter offered by Hewlett-Packard. In your system or on the bench, the HP 3458A saves you time and money with unprecedented test system throughput and accuracy, seven-function measurement flexibility, and low cost of ownership.

Select a rate of 100,000 readings per second for maximal test throughput. Or achieve highest levels of precision with up to 8½ digits of measurement resolution and 0.1 part per million transfer accuracy. Add to this the HP 3458A's simplicity of operation, and you have the ideal multimeter for your most demanding applications.

High-Test System Throughput

Faster Testing
- Up to 100,000 readings/s
- Internal test setups >340/s
- Programmable integration times from 500 ns to 1 s

Greater Test Yield
- More accuracy for tighter test margins
- Up to 8½ digits resolution

Longer Uptime
- Two-source (10 V, 100 kΩ) calibration, including ac
- Self-adjusting, self-verifying autocalibration for all functions and ranges, including ac

High-Resolution Digitizing

Greater Waveform Resolution and Accuracy
- 16 to 24 bits resolution
- 100,000 to 0.2 samples/sec
- 12 MHz bandwidth
- Timing resolution to 10 ns
- Less than 100 ps time jitter
- Over 75,000 reading internal memory

Flexible Digitizing Software
- Powerful, easy-to-use analysis software for HP 9000 Series 200/300 computers or HP Vectra with measurement coprocessor
- Subprograms for waveform acquisition, data transfer, FFT, IFT, and data presentation

Calibration Lab Precision

Superb Transfer Measurements
- 8½ digits resolution
- 0.1 ppm dc volts linearity
- 0.1 ppm dc volts transfer capability
- 0.01 ppm rms internal noise

Extraordinary Accuracy
- 0.6 ppm for 24 hours in dc volts
- 2.2 ppm for 24 hours in ohms
- 100 ppm mid-band ac volts
- 8 ppm (4 ppm optional) per year voltage reference stability

HP 3458A Multimeter Performance Features

dc Volts
- 5 ranges: 0.1 V to 1000 V
- 8½ to 4½ digits resolution
- Up to 100,000 readings/s (4½ digits)
- Maximum sensitivity: 10 nV
- 0.6 ppm 24-hour accuracy
- 8 ppm (4 ppm optional)/year voltage reference stability

Ohms
- 9 ranges: 10 Ω to 1 GΩ
- 2-wire and 4-wire Ω with offset compensation
- Up to 50,000 readings/s (5½ digits)
- Maximum sensitivity: 10 μΩ
- 2.2 ppm 24-hour accuracy

ac Volts
- 6 ranges: 10 mV to 1000 V
- 1 Hz to 10 MHz bandwidth
- Up to 50 readings/s with all readings to specified accuracy
- Choice of sampling or analog true rms techniques
- 100 ppm best accuracy

dc Current
- 8 ranges: 100 nA to 1 A
- Up to 1,350 readings/s (5½ digits)
- Maximum sensitivity: 1 pA
- 14 ppm 24-hour accuracy

ac Current
- 5 ranges: 100 μA to 1 A
- 10 Hz to 100 kHz bandwidth
- Up to 50 readings/s
- 500 ppm 24-hour accuracy

Frequency and Period
- Voltage or current ranges
- Frequency: 1 Hz to 10 MHz
- Period: 100 ns to 1 s
- 0.01 % accuracy
- ac or dc coupled

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

Throughput

Maximum Reading Rates

- 100,000 readings/s at 4½ digits (16 bits)
- 50,000 readings/s at 5½ digits
- 6,000 readings/s at 6½ digits
- 60 readings/s at 7½ digits
- 6 readings/s at 8½ digits

Measurement System Speed

- 100,000 readings/s over HP-IB or with internal memory
- 110 autoranges/s
- 340 function or range changes/s
- Postprocessed math from internal memory

Abbreviated Technical Specifications

dc Voltage

Range	Full Scale	Maximum Resolution	1-Year* Accuracy	Transfer Accuracy 10 min, Tref ±0.5° C	Input Impedance
			ppm of reading + ppm of range		
100 mV	120.00000	10 nV	9(5) + 3	0.5 + 0.5	>10 GΩ
1 V	1.20000000	10 nV	8(4) + 0.3	0.3 + 0.1	>10 GΩ
10 V	12.0000000	100 nV	8(4) + 0.05	0.05 + 0.05	>10 GΩ
100 V	120.000000	1 μV	10(6) + 0.3	0.5 + 0.1	10 MΩ ±1%
1000 V	1050.00000	10 μV	10(6) + 0.1	1.5 + 0.05	10 MΩ ±1%

One-year specifications for NPLC 100 within 24 hours and ± 1° C of last ACAL, Tcal ± 5° C, MATH NULL, fixed range. Add 2 ppm of reading additional error for HP factory traceability of 10 V dc to US NIST. Traceability error is the absolute error relative to National Standards associated with the source of last external calibration. Transfer specifications for NPLC 100, following 4-hour warm-up. Full scale to 10% of full scale. Measurements on the 1000 V range are within 5% of the initial measurement value and following measurement settling. Tref is the starting ambient temperature. Measurements are made on a fixed range using accepted metrology practices.
*High stability (Option 002) ppm of reading in parentheses.

Noise Rejection (dB)[1]

	ac NMR[2]	ac ECMR	dc ECMR
NPLC < 1	0	90	140
NPLC ≥ 1	60	150	140
NPLC ≥ 10	60	150	140
NPLC ≥ 100	70	160	140
NPLC = 1000	80	170	140

[1] Applies for 1 kΩ unbalance in the LO lead and ±0.1% of the line frequency currently set for LFREQ.
[2] For line frequency ±1%, ACNMR is 40 dB for NPLC ≥ 1, or 80 dB for NPLC ≥ 100. For line frequency ±5%, ACNMR is 65 dB for NPLC ≥ 100.

Maximum Input

	Rated Input	Nondestructive
HI to LO	± 1000 V pk	± 1200 V pk
LO to guard	± 200 V pk	± 350 V pk
Guard to earth	± 500 V pk	± 1000 V pk

True rms ac Voltage
(Synchronous Subsampled Mode)

Range	Full Scale	Maximum Resolution	Accuracy* 24 hour–2 year 40 Hz to 1 kHz % of reading + % of range	Input Impedance
10 mV	12.00000	10 nV	0.02 + 0.011	1MΩ ±15% with <140 pf
100 mV	120.00000	10 nV	0.007 + 0.002	1MΩ ±15% with <140 pf
1 V	1.2000000	100 nV	0.007 + 0.002	1MΩ ±15% with <140 pf
10 V	12.000000	1 μV	0.007 + 0.002	1MΩ ±2% with <140 pf
100 V	120.00000	10 μV	0.02 + 0.002	1MΩ ±2% with <140 pf
1000 V	700.0000	100 μV	0.04 + 0.002	1MΩ ±2% with <140 pf

*Specifications apply for full scale to 10% of full scale, dc<10% of ac, sine wave input, crest factor of 1.4. Within 24 hours and ± 1° C of last ACAL. Peak (ac+dc) input limited to 5× full scale for all ranges. Add 2 ppm of reading additional error for HP factory traceability of 10 V dc to US NIST.

Maximum Input

	Rated Input	Nondestructive
HI to LO	±1000 V pk	±1200 V pk
LO to guard	±200 V pk	±350 V pk
Guard to earth	±500 V pk	±1000 V pk
Volt-Hz product	1×10^8	

Resistance

Range	Full Scale	Maximum Resolution	Current through Unknown	1-Year Accuracy* (4-wire Ω) ppm of rdg + ppm of range
10 Ω	12.00000	10 μΩ	10 mA	15 + 5
100 Ω	120.00000	10 μΩ	1 mA	12 + 5
1 kΩ	1.2000000	100 μΩ	1 mA	10 + 0.5
10 kΩ	12.000000	1 mΩ	100 μA	10 + 0.5
100 kΩ	120.00000	10 mΩ	50 μA	10 + 0.5
1 MΩ	1.2000000	100 mΩ	5 μA	15 + 2
10 MΩ	12.000000	1 Ω	500 nA	50 + 10
100 MΩ	120.00000	10 Ω	500 nA	500 + 10
1 GΩ	1.2000000	100 Ω	500 nA	0.5% + 10

*Specifications for 100 NPLC, offset compensation on, within 24 hours and ± 1° C of last ACAL, Tcal ±5° C. Add 3 ppm of reading additional error for HP factory traceability of 10 kΩ to US NIST.

Memory

	Standard		Option 001	
	Readings	Bytes	Readings	Bytes
Reading storage (16 bit)	10,240	20 k	+65,536	+128 k
Non-volatile, for subprograms and/or state storage		14 k		

Math Functions: The HP 3458A performs the following math functions on measurements: NULL, SCALE, OFFSET, RMS FILTER, SINGLE POLE FILTER, THERMISTOR LINEARIZATION, DB, DBM, % ERROR, PASS/FAIL LIMIT TESTING, and STATISTICS. Two math functions may be used at one time.

General Specifications

Operating Temperature: 0° to 55° C
Warmup Time: Four hours to all specifications except where noted
Humidity Range: 95% RH, 0° to 40° C
Storage Temperature: −40° to +75° C
Power: 100/120 V, 220/240 V ± 10%, 48 to 66 Hz, 360 to 420 Hz automatically sensed. Fused at 1.5 A @ 115 V or 0.5 A @ 230 V. <30 W, < 80 VA (peak).
Size: 425.5 mm W × 88.9 mm H × 502.9 mm D (16.75 in × 3.5 in × 19.8 in)
Weight: Net, 12 kg (26.5 lb); shipping, 14.8 kg (32.5 lb)

Ordering Information

	Price
HP 3458A Multimeter (with HP-IB, 20 KB reading memory, and 8 ppm stability)	$6,595
Opt 001 Extended Reading Memory (expands total to 148 KB)	$570
Opt 002 High Stability (4 ppm/year) Reference	$1,080
Opt 005 Waveform Analysis Library for HP Series 300 computers with BASIC 4.0 or greater and HP Vectra with Measurement Coprocessor	$430
Opt 1BN MIL-STD-45662A Certificate of Calibration	$200
Opt 1BP MIL-STD-45662A Certificate of Calibration with data	$300
Opt W30 Two additional years return-to-HP hardware support (see page 636)	$160
Opt W32 Three-year customer return calibration coverage	
Opt 700 CIIL Language	$1,080
Opt 907 Front Handle Kit	$60
Opt 908 Rack Flange Kit	$40
Opt 909 Rack Flange Kit (with handles)	$90

DIGITAL MULTIMETERS

3½- to 6½- Digit DMM with Extended Resolution to 7½ Digits

HP 3457A

- Over 1,350 readings/sec at 3½ digits
- Seven functions: dcV, acV, dcI, acI, Ω, frequency, and period
- Three plug-in multiplexer options
- dc sensitivity to 10 nanovolts
- Outstanding combination of performance and price

DESIGNED FOR HP-IB SYSTEMS

DESIGNED FOR MATE SYSTEMS

HP 3457A

HP 3457A Digital Multimeter

The HP 3457A has seven functions with 3½ to 6½ digits of resolution, extendable to 7½ digits. Reading rates vary from 1 reading every 2 seconds to 1350 rds/s. Basic dc volts accuracy is 5 ppm. The input of the HP 3457A can be expanded to ten channels with either of the optional plug-in multiplexer assemblies. In bench operation, the front panel is extremely flexible and comprehensive. In systems, the Hewlett-Packard Interface Bus (HP-IB) is standard.

Powerful Measurement Management

The HP 3457A combines superb analog measuring capability with powerful measurement management. More than 3,000 readings or entire measurement sequences can be stored in the HP 3457A. The present digital multimeter (DMM) setup can also be stored in the non-volatile memory for convenient reconfiguration.

Math functions include PASS/FAIL limit testing, NULL, SCALE, THERMISTOR linearization, and others. Total electronic calibration makes it easy to maintain performance.

System Features

The HP 3457A has all the features you've come to expect, plus more to make interfacing to your computer easy—features like flexible formatting of ASCII, 16-bit binary, or 32-bit binary data and buffer memory. In addition, you'll find the VOLTMETER COMPLETE output and EXTERNAL TRIGGER input signals ideal for synchronizing other instruments with the HP 3457A. Finally, programmable front-rear terminal switching lets you measure two separate inputs without a scanner.

Control Interface Intermediate Language (CIIL)

With Option 700, the HP 3457A responds to standardized DMM CIIL commands via HP-IB. Physically and functionally identical to the standard HP 3457A, Option 700 adds the CIIL command set with a built-in test module adapter (TMA) to the DMM's standard HPML.

Three Rear-Panel Plug-In Options

One of three optional assemblies may be used with the HP 3457A. Using the multiplexer assemblies, you can scan up to ten signal channels either sequentially or randomly. All of the capability of the normal front and rear input terminals is available for multiple inputs. Using the high-voltage assembly allows single-channel measurement of either ac or dc voltages at the rear panel.

The HP 44491A Armature Relay Multiplexer Assembly offers eight 2-wire channels and two current/actuator channels. Under software control, the eight 2-wire channels can be reconfigured to four 4-wire ohm channels. The two current channels offer automatic make-before-break switching so that the path for current up to 1.5 A is never broken. In addition, these two channels can be used as external device actuator channels. Each channel can switch up to 150 V.

For higher speed scanning, the HP 44492A Reed Relay Multiplexer Assembly offers ten 2-wire channels. The HP 44492A is useful for switching Vdc, Vac, 2-wire Ω, frequency, and period measurement signals with a maximum amplitude of 125 V.

For measurement of voltages up to 1414 V peak, the HP 44497A High Voltage Assembly offers a 1000:1 attenuator input (channel 1) for the high-voltage measurements. In addition, the other rear terminal input (channel 0) can be used to take conventional Vdc, Vac, 2-wire and 4-wire Ω, period, frequency, dcI, and acI measurements. Using the HP 44497A with the HP 3457A in the 6½-digit mode will yield a resolution of 1 mV for a 1000 V input. Implementing the MATH Scale function will cause the HP 3457A LCD to display the measurement results in kilovolts.

Abbreviated Technical Specifications

90-day, Tcal ±5° C

dc Voltage

		Best 6½-Digit Accuracy ± (% Rdg + Cnts)*		
Range	**Maximum Reading**	**% of Reading**	**Count Error**	**Input Resistance**
30 mV	30.30000 mV	0.0040	365	>10 GΩ
300 mV	303.0000 mV	0.0025	39	>10 GΩ
3 V	3.030000 V	0.0017	6	>10 GΩ
30 V	30.30000 V	0.0035	19	10 MΩ ± 1%
300 V	303.0000 V	0.0050	6	10 MΩ ± 1%

*After 1-hr warmup, with integration time of 100 power line cycles (PLC). Tcal is the temperature of the calibration environment between 18° and 28° C.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

True rms ac V and (ac + dc)V

Bandwidth: 20 Hz to 1 MHz
Crest Factor: 3.5:1 at full scale
Common Mode Rejection: (1 kΩ unbalance in LO): > 76 dB, dc-60 Hz
Accuracy: (90 day)

Accuracy specified for sine wave inputs, >10% of range. dc component <10% of ac component after 2-hour warmup and within one week of autocal. Integration time is 10 PLC. ac Band set to <400 Hz.

Range	Maximum Reading	(100 Hz to 20 kHz) Best 5½-Digit Accuracy ± (% Rdg + Cnts)				
		ac Coupled		dc Coupled		
		% of Reading	Count Error	% of Reading	Count Error	Input Impedance
30 mV	32.50000 mV	0.13	116	0.17	364	1 MΩ ± 1% shunted by <90 pf
300 mV	325.0000 mV	0.13	116	0.17	364	
3 V	3.250000 V	0.13	116	0.17	364	
30 V	32.50000 V	0.13	116	0.17	364	
300 V	303.0000 V	0.19	116	0.23	364	

Resistance (2- and 4-wire Ω) (90 day accuracy)

Range	Maximum Reading	Best 6½-Digit Accuracy ± (% Rdg + Cnts)		
		% of Reading	Count Error	Current Output
30 Ω	30.30000 Ω	0.0065	315	1 mA
300 Ω	303.0000 Ω	0.0045	34	1 mA
3 kΩ	3.030000 kΩ	0.0035	6	1 mA
30 kΩ	30.30000 kΩ	0.0035	6	100 μA
300 kΩ	303.0000 kΩ	0.0040	7	10 μA
3 MΩ	3.030000 MΩ	0.0055	12	1 μA
30 MΩ	30.30000 MΩ	0.025	80	100 nA
300 MΩ	303.0000 MΩ	1.6	1000	100 nA
3 GΩ	3.030000 GΩ	16.0	1000	100 nA

For 2-wire Ω, add 200 mΩ to count error specifications. After 1-hr warmup with integration time of 100 power line cycles (PLC). Tcal is the temperature of the calibration environment between 18° and 28° C. For 2-wire Ω only, accuracy is specified following autocal (ACAL), under stable conditions (±1°C).

Maximum Reading Rates (dc V, dc I, and resistance up to 30 kΩ)

Power Line Cycles	Maximum No. of Digits	Readings per Second 60 Hz (50 Hz)		NMR
		Auto Zero On	Auto Zero Off	
.0005	3½	300	1350	0
.005	4½	280	1250	0
.1	5½	140 (128)	360 (312)	0
1.0	6½	26 (22)	53 (45)	60 dB
10	7½	2.5 (2.0)	4.8 (4.0)	80 dB
100	7½	.25 (0.2)	0.5 (0.4)	90 dB

Reading rates are specified with zero delay, fixed range, display off, and front panel off. The output is to internal reading memory using single integer format and internal timer. Integration time in PLC. Using Math HIRES mode for 7½ digits.

dc Current (90 day accuracy)

Range	Maximum Reading	Best 6½-Digit Accuracy ± (% Rdg + Cnts)		Shunt Resistance
		% of Reading	Count Error	
300 μA	303.0000 μA	0.02	104	1000 Ω
3 mA	3.030000 mA	0.02	104	100 Ω
30 mA	30.30000 mA	0.02	104	10 Ω
300 mA	303.0000 mA	0.07	204	1 Ω
1 A	1.000000 A	0.07	604	0.1 Ω

*After 1-hr warmup, with integration time of 100 PLC. Tcal is the temperature of the calibration environment between 18° and 28° C.

Common Mode Rejection (dB): 1 kΩ unbalance in low lead; dc ECMR 140 dB; ac ECMR: <1 PLC, 76 dB; ac ECMR >1 PLC, 156 dB for 50, 60 Hz ±.08%

Memory: 6235 available bytes that can be partitioned into 3 segments, one devoted to storing measurements, one devoted to storing measurement subprograms, and one devoted to storing instrument states.

Math Functions: The HP 3547A performs the following math functions on measurements: NULL, SCALE, OFFSET, RMS FILTER, SINGLE POLE FILTER, THERMISTOR LINEARIZATION, DB, DBM, % ERROR, PASS/FAIL, LIMIT TESTING, and STATISTICS. Two math functions may be used at one time.

General Specifications

Operating Temperature: 0° to 55° C
Warmup Time: One hour to all specifications except where noted
Humidity Range: 95% RH, 0° to 40° C
Storage Temperature: −40° to +75° C
Power: 100/120/220/240 V ± 10%, 48 Hz to 66 Hz, 220 V, ± 10%, 48 Hz to 66 Hz. Fused at .2 A (115 V) or 0.08 A (230 V). <30 V A.
Size: 89 mm H (without removable feet) × 425 mm W × 292 mm D (3.5 in × 16.75 in × 11.5 in). Height (with removable feet): 100 mm (4 in). Allow 76 mm (3 in) additional depth for wiring.
Weight: Net, 5.05 kg (11.1 lb); shipping, 9.3 kg (20.5 lb)

Plug-in Options

HP 44491A Armature Relay Multiplexer Assembly Input Characteristics: Eight 2-wire armature relay channels and two current/actuator channels. Maximum voltage (terminal-to-terminal or terminal-to-chassis) 250 Vrms. Maximum current (per channel) 1.0 A dc or ac rms. Thermal offset <3 μV. Closed channel resistance (end of relay life) <2 Ω. Maximum switching and measurement speed 33 channels/second.

HP 44492A Reed Relay Multiplexer Assembly Input Characteristics: Ten 2-wire reed relay channels. Maximum voltage (terminal-to-terminal or terminal-to-chassis) 125 V peak. Thermal offset <3 μV. Closed channel resistance (end of relay life) <4 Ω. Specified for <100 kHz ac volts and frequency operation. Maximum switching and measurement speed 300 channels/second.

HP 44497A High-Voltage Attenuator Assembly Input Characteristics: Two relay channels, channel 1 devoted to high-voltage measurements. Maximum high-to-low voltage of 1000 volts dc or ac rms. Maximum low-to-earth voltage of 350 V peak. Nondestructive overload voltage of 1700 V peak, 1200 volts dc. Attenuator accuracy to be added to HP 3457A range and function accuracy for total accuracy.

dc	0.030% of reading
20 Hz to 1 kHz	2.8% of reading
1 kHz to 10 kHz	12% of reading

Note: One-year accuracy applies to Tcal ±5%, NPLC = 1 or greater. Specifications are for low-to-earth voltage less than 0.1 times high-to-earth voltage.

Ordering Information

	Price
HP 3457A Multimeter	$3,260
***HP 44491A** Armature Relay Multiplexer Assembly	$560
***HP 44492A** Reed Relay Multiplexer Assembly	$560
***HP 44497A** High Voltage Attenuator Assembly	$560
Opt 401 Side Handle Kit (5061-1171)	+$45
Opt 700 CIIL Language	+$1,000
Opt 907 Front Handle Kit (5061-1170)	+$70
Opt 908 Rack Flange Kit (5061-1168)	+$35
Opt 909 Rack Flange and Front Handle Kit (5061-1169)	+$85
Opt 910 Extra Operating and Service Manual	+$110
Opt W30 Extended Repair Service (see page 636)	+$80
Opt W32 Three-year customer return repair coverage	

Accessories

HP 44493A Screw Terminal Connector for HP 44491A (includes strain relief and housing)	$70
HP 44494A Screw Terminal Connector for HP 44492A (includes strain relief and housing)	$70
HP 44414A Four Thermistor Pack	$63 ☎

*Plug-in options may be ordered and shipped separately without a HP 3457A mainframe. Unless otherwise specified, optional plug-in assemblies will be shipped with the HP 3457A mainframe.

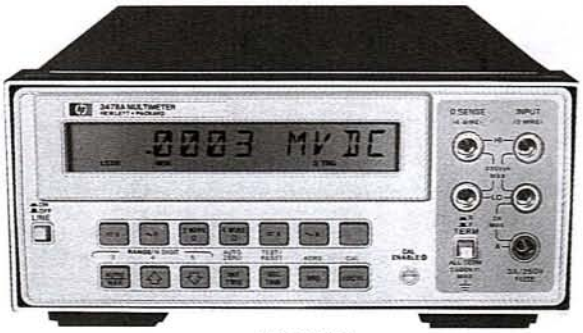
☎ For off-the-shelf shipment, call 800-452-4844.

DIGITAL MULTIMETERS

High-Performance 5½- to 3½- Digit Multimeters

HP 3478A, 3468A/B

- Five functions
- Up to 100 nanovolt resolution
- Electronic calibration



HP 3478A

- Higher accuracy
- Extended ranges
- HP-IB interface
- Front/rear terminals

HP 3468A

HP 3468B

- Portable
- Battery option
- Low cost
- HP-IL interface

HP 3468A/B and HP 3478A 5½- to 3½-Digit Multimeters

The HP 3468A/B and the HP 3478A are autoranging 5½- to 3½-digit DMMs, with five functions: dc volts, true rms ac volts, 2- and 4-wire ohms, dc current, and true rms ac current. All three DMMs feature closed-box electronic calibration, which eliminates internal adjustments, resulting in a lower cost of ownership.

High Performance

All three DMMs offer high performance. The HP 3468A/B are designed with the bench in mind, while the HP 3478A is optimal for system use. The HP 3478A can perform production tests or acquire experimental data at 90 readings per second with 3½ digit resolution, or take 35 readings per second with 130 dB of noise rejection at 4½ digits. The HP 3478A also offers 100 nV and 100 μΩ resolution in the 5½-digit mode.

All three DMMs measure true rms ac voltage to 300 kHz, with crest factors up to 4:1. They measure true rms ac current to 20 kHz.

For even greater performance consider the new HP 34401A digital multimeter.

Battery Operation

Both the HP 3468A and HP 3468B are available with an optional rechargeable battery for portable measurements (Option 001). This allows for up to five hours of continuous battery operation.

The HP 3468A comes in a streamlined portable package with a handle for convenient carrying; the HP 3468B comes in a plastic system case for easy rack mounting.

System Operation

The HP 3478A features selectable front/rear inputs for flexible system connections. The Voltmeter Complete output and External Trigger input allow synchronization of the HP 3478A with a scanner for fast multiplexed measurements without the slower software commands. The test program can write prompt messages or results on the alphanumeric display. The operator can respond by pressing the HP 3478A's SRQ key to interrupt the controller and start the next test.

Reliablilty/Cost of Ownership

The HP 3468A/B and the HP 3478A all have demonstrated reliability. Mean time between failure (MTBF) rates exceed 100,000 hours of operation. As a result, we offer a three-year extended warranty (Option W30) for less than 4 percent of the purchase price.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

Abbreviated Technical Specifications

dc Voltage

Input Characteristics

Range*	Maximum Reading (5½ digit)	Resolution		
		5½ digit	4½ digit	3½ digit
30 mV	±30.3099 mV	100nV	1 μV	10 μV
300 mV	±303.099 mV	1 μV	10 μV	100 μV
3 V	±3.03099 V	10 μV	100 μV	1 mV
30 V	±30.3099 V	100 μV	1 mV	10 mV
300 V	±303.099 V	1 mV	10 mV	100 mV

*30 mV range available on HP 3478A only.

Input Resistance: 30 mV, 300 mV, 3 V ranges: $>10^{10}\Omega$
30 V, 300 V ranges: 10 MΩ ±1%

Maximum Input Voltage (nondestructive): Hi to Lo: 303 Vrms or 450 V peak; Hi or Lo to Earth Ground: 500 V peak

Measurement Accuracy: ±(% of reading + number of counts). Auto zero ON. 5½ digits.

HP 3478A

Range	T_{Cal}* ±1° C	T_{Cal}* ±5° C	
	24 hours	90 days	1 year
30 mV	0.025 + 40	0.0275 + 40	0.035 + 40
300 mV	0.004 + 4	0.005 + 5	0.007 + 5
3 V	0.003 + 2	0.004 + 2	0.006 + 2
30 V	0.004 + 3	0.005 + 4	0.007 + 4
300 V	0.004 + 2	0.005 + 2	0.007 + 2

HP 3468 A/B

Range	T_{Cal}* ±1° C	T_{Cal}* ±5° C	
	24 hours	90 days	1 year
300 mV	0.005 + 4	0.009 + 5	0.02 + 5
3 V	0.0035 + 2	0.0072 + 2	0.0181 + 2
30 V	0.005 + 3	0.009 + 3	0.02 + 3
300 V	0.0055 + 2	0.009 + 2	0.02 + 2

*T_{Cal} is the temperature of the environment where the HP 3478A and the HP 3468A/B were calibrated. Calibration should be done with the temperature of the environment between 20° C and 30° C. Twenty-four-hour accuracy is relative to calibration standards.

Temperature coefficient: 0° C to 55° C, 5½ digits, auto zero ON. ±(% of reading + number of counts)/° C.

Range	HP 3478A	HP 3468A/B
30 mV	0.0028 + 5.0	-------
300 mV	0.0005 + 0.5	0.0008 + 0.5
3 V	0.0004 + 0.05	0.0007 + 0.05
30 V	0.0006 + 0.5	0.0008 + 0.5
300 V	0.0004 + 0.05	0.0007 + 0.05

Noise rejection: in dB with 1 kΩ imbalance in Lo lead; ac rejection for 50, 60 Hz ± 0.1%. Auto zero ON.

Display	ac NMR	ac ECMR	dc CMR
5½ digits	80	150	140
4½ digits	59	130	140
3½ digits	0	70	140

Maximum Reading Rates (readings/sec.) **HP 3478A**

Line Frequency	Auto Zero and Display	Resolution		
		3½ digits	4½ digits	5½ digits
60 Hz	Off	90	35	4.4
	On	60	20	2.3
50 Hz	Off	85	30	3.7
	On	50	17	1.9

ac Voltage (true rms responding)

Input Characteristics

Range	Maximum Reading (5½ digit)	Resolution		
		5½ digit	4½ digit	3½ digit
300 mV	303.099 mV	1 μV	10 μV	100 μV
3 V	3.03099 V	10 μV	100 μV	1 mV
30 V	30.3099 V	100 μV	1 mV	10 mV
300 V	303.009 V	1 mV	10 mV	100 mV

Input Impedance: 1 MΩ ± 1% shunted by <60 pF
Maximum Input Voltage (nondestructive): Hi to Lo: 303 V rms or 450 V peak; Hi or Lo to Earth Ground: ±500 V peak.
Measurement Accuracy: ±(% of reading + number of counts). Auto zero ON. 5½ digit display. Accuracy is specified for sinewave inputs only, >10% of full scale.

1 Year, T_{cal} ±5° C **HP 3478A**

Frequency	Ranges		
	300 mV	3 V, 30 V	300 V
20 to 50 Hz	1.14 + 163	1.14 + 102	1.18 + 102
50 to 100 Hz	0.46 + 163	0.46 + 103	0.50 + 102
100 Hz to 20 kHz	0.20 + 120	0.20 + 70	0.24 + 70
20 to 50 kHz	0.38 + 205	0.26 + 140	0.42 + 140
50 to 100 kHz	1.20 + 840	0.87 + 780	0.98 + 780
100 to 300 kHz	10.1 + 3720 (30 V range only)		

1 Year, T_{cal} ±5° C **HP 3468A/B**

Frequency	Ranges		
	300 mV	3 V, 30 V	300 V
20 to 50 Hz	1.14 + 163	1.14 + 102	1.18 + 102
50 to 100 Hz	0.46 + 163	0.46 + 103	0.5 + 102
100 Hz to 20 kHz	0.29 + 163	0.26 + 102	0.33 + 102
20 to 50 kHz	0.56 + 247	0.41 + 180	0.55 + 180
50 to 100 kHz	1.74 + 882	1.05 + 825	1.26 + 825
100 k to 300 kHz	10.1 + 3720 (30 V range only)		

Crest Factor: >4:1 at full scale

Resistance (2-wire Ω, 4-wire Ω)

Input Characteristics

Range*	Maximum Reading (5½ Digit)	Resolution		
		5½ digit	4½ digit	3½ digit
30 Ω	30.3099 Ω	100 μΩ	1 mΩ	10 mΩ
300 Ω	303.099 Ω	1 mΩ	10 mΩ	100 mΩ
3 kΩ	3.03099 kΩ	10 mΩ	100 mΩ	1 Ω
30 kΩ	30.3099 kΩ	100 mΩ	1 Ω	10 Ω
300 kΩ	303.099 kΩ	1 Ω	10 Ω	100 Ω
3 MΩ	3.03099 MΩ	10 Ω	100 Ω	1 kΩ
30 MΩ	30.3099 MΩ	100 Ω	1 kΩ	10 kΩ

Input Protection (nondestructive): Hi to Lo: ±350 V peak; Hi or Lo to Earth Ground: ±500 V peak

Measurement Accuracy: ±(% of reading + number of counts). Auto zero ON. 5½ digit display. 4-wire Ω.

	T_{cal} ± 1° C	T_{cal} ± 5° C	
Range*	24 Hours	90 Days	1 Year
30 Ω	0.023 + 35	0.027 + 41	0.034 + 41
300 Ω	0.0045 + 4	0.012 + 5	0.017 + 5
3 k to 300 kΩ	0.0035 + 2	0.011 + 2	0.016 + 2
3 MΩ	0.0052 + 2	0.011 + 2	0.016 + 2
30 MΩ	0.036 + 7	0.066 + 7	0.078 + 7

*30 Ω range available on HP 3478A only.

Current Through Unknown

Range*	30 Ω	300 Ω	3 kΩ	30 kΩ	300 kΩ	3 MΩ	30 MΩ
Current	1 mA	1 mA	1 mA	100 μA	10 μA	1 μA	100 nA

*30 Ω range available on HP 3478A only.

dc Current

Input Characteristics

Range*	Maximum Reading (5½ digit)	Resolution		
		5½ digit	4½ digit	3½ digit
300 mA	303.099 mA	1 μA	10 μA	100 μA
3 A	3.03099 A	10 μA	100 μA	1 mA

Maximum Input (nondestructive): 3 A from <250 V source: fuse protected
Measurement Accuracy: ±(% of reading + number of counts). Auto zero ON. 5½ digit display.

Range*	T_{Cal}* ± 5° C	
	90 Days	1 Year
300 mA	0.11 + 40	0.15 + 40
3 A (<1 A)	0.14 + 6	0.17 + 6
3 A (>1 A)	1.0 + 30	1.0 + 30

*300 mA range available on HP 3478A only.

Maximum Burden at Full Scale: 1 V (3 A range), 0.1 V (0.3 A range)

ac Current (true rms responding)

Input Characteristics

Range	Maximum Reading (5½ digit)	Resolution		
		5½ digit	4½ digit	3½ digit
300 mA	303.099 mA	1 μA	10 μA	100 μA
3 A	3.03099 A	10 μA	100 μA	1 mA

Maximum Input (nondestructive): 3 A from <250 V source; fuse protected
Measurement Accuracy: ±(% of reading + number of counts). Auto zero ON. 5½ digit display. Accuracy specified for sinewave inputs only, >10% of full scale.
1 Year, T_{cal} ±5° C

Frequency	HP 3478A		HP 3468A/B	
	Ranges		Ranges	
	300 mA	3 A	300 mA	3 A
20 to 50 Hz	1.54 + 163	2.24 + 163	1.77 + 163	2.5 + 163
50 to 1 kHz	0.81 + 163	1.50 + 163	1.1 + 163	1.8 + 163
1 k to 10 kHz	0.72 + 163	1.42 + 163	1.0 + 163	1.7 + 163
10 k to 20 kHz	0.86 + 163	1.56 + 163	1.14 + 163	1.84 + 163

General

Operating Temperature: 0 to 55° C
Humidity Range: 95% R.H., 0 to 40° C
Power: ac line 48 to 440 Hz; 86 to 250 V, 25 VA max
Size: HP 3468A: 238.1 mm W × 98.4 mm H × 276.2 mm D (9.37 in × 3.87 in × 10.88 in); HP 3468B: 213 mm W × 89 mm H × 275 mm D (without feet) (8.39 in × 3.5 in × 10.83 in); HP 3478A: 215 mm W × 102 mm H × 356 mm D (8.46 in × 4 in × 14 in)
Weight: HP 3468A/B: 2.1 kg; HP 3468A/B w/Opt 001: 3.1 kg (6.8 lb); HP 3478A: 3 kg (6.6 lb).

Ordering Information

	Price
HP 3478A DMM with test probes & HP-IB	$1,295 ☎
HP 3468A DMM in Streamlined Portable Case with HP-IL and test probes	$1,095 ☎
HP 3468B DMM in Rack and Stack Case with HP-IL and test probes	$1,095 ☎
Choose one power option (no charge):	
Opt 315 100 V, 50 Hz; **Opt 335** 220 V, 50 Hz	$0
Opt 316 100 V, 60 Hz; **Opt 336** 220 V, 60 Hz	$0
Opt 325 120 V, 50 Hz; **Opt 345** 240 V, 50 Hz	$0
Opt 326 120 V, 60 Hz; **Opt 346** 240 V, 60 Hz	$0
HP 3478A Opt W30 extended repair service	$35
HP 3478A Opt 907 Front Handle Kit (5061-0088)	$80
HP 3478A Opt 908 Rack Mount Kit (5061-0072)	$80
HP 3478A Opt 910 Extra Manuals (03478-90008/03478-90009)	$30
HP 3468A/B Option W30 add 3 year Extended Hardware Support	$25
HP 3468A/B Option 001, add Rechargeable Battery Pack	$240
HP 3468B Option 401, add Side Handle Kit (5061-1171)	$60
HP 3468B Option 907 Front Handle Kit	$80
HP 3468B Option 908 Rack Mount Kit	$80
HP p/n 5060-0174 Rack Mount Kit for rackmounting two instruments side-by-side	$91

☎ For off-the-shelf shipment, call 800-452-4844.

DIGITAL MULTIMETERS

6½- to 3½-Digit HP-IB DMM with High Stability

HP 3456A

- Up to 330 readings per second
- 100 nanovolt resolution
- 100 micro-Ω to 1.0 gigaohm

DESIGNED FOR HP-IB SYSTEMS

HP 3456A

HP 3456A Digital Multimeter

This fully guarded, integrating Digital Multimeter (DMM) is designed for bench or system use. The HP 3456A measures dc voltage, true rms ac voltage, and resistance.

Measurement speed and accuracy can be enhanced for a specific application by using the HP 3456A's selectable integration time (up to 100 power line cycles). An operator can select up to 330 readings per second for high-speed bursts or one reading every 15 minutes for periodic measurements. Resolution of 100 nanovolts at 48 readings per second (6½ digits) to 10-microvolt resolution at 330 readings per second (3½ or 4½ digits) can be selected.

With good repeatability and 100 nanovolt sensitivity, accuracy on the 10-volt range is ±0.0008% +2 counts, over a 24-hour period at 23° C ±1° C.

Four full-scale, true rms ac voltage ranges are provided, with reading speeds up to 12 readings per second over a 10-Hz to 250-kHz range. Best accuracy is 0.05%. Crest factor is greater than seven at full scale.

With the HP 3456A's program memory and reading storage capability, the HP 3456A can take measurements and store them while the computer performs another task.

Another feature of the HP 3456A is its hardware scanner advance for scanned or multiplexed system applications. As soon as the HP 3456A's measurement cycle is complete, a TTL signal can trigger a variety of switching instruments.

Abbreviated Technical Specifications

dc Voltage

Range	Maximum Reading (5½ digit)	Resolution			Input Resistance	Maximum Input Voltage
		6½ digit	5½ digit	4½ digit		
0.1 V	.119999 V	100 nV	1 μV	10 μV	>10¹⁰ Ω	±1000 V peak
1.0 V	1.19999 V	1 μV	10 μV	100 μV	>10¹⁰ Ω	
10.0 V	11.9999 V	10 μV	100 μV	1 mV	>10¹⁰ Ω	
100.0 V	119.999 V	100 μV	1 mV	10 mV	10 MΩ ±.5%	
1000.0 V	1000.00 V	1 mV	10 mV	100 mV	10 MΩ ±.5%	

Measurement Accuracy: ± (% of reading + number of counts)

Range	24 hours: 23° C ±1° C		90 days: 23° C ±5° C		1 year: 23° C ±5° C	
	6½ digit (≥10 PLC)	6½ digit (1 PLC)	6½ digit (≥10 PLC)	6½ digit (1 PLC)	6½ digit (>=10 PLC)	6½ digit (1 PLC)
0.1 V	.0022 + 24	0.0024 + 32	0.0026 + 24	0.0027 + 32	0.0034 + 24	0.0035 + 32
1.0 V	0.0009 + 4	0.0012 + 5	0.0016 + 4	0.0017 + 5	0.0024 + 4	0.0025 + 5
10.0 V	0.0008 + 2	0.0011 + 3	0.0015 + 2	0.0016 + 3	0.0023 + 2	0.0024 + 3
100.0 V	0.0011 + 3	0.0014 + 4	0.0018 + 3	0.0019 + 4	0.0026 + 3	0.0027 + 4
1000.0 V[1]	0.0011 + 2	0.0013 + 3	0.0016 + 2	0.0017 + 3	0.0024 + 2	0.0025 + 3

[1]Add .02 $\left(\frac{\text{Input Voltage}^2}{1000}\right)$ % to % of reading.

ac True rms Voltage (ac, ac + dc)

Range	Maximum Reading (5½ digit)	Resolution			Input Impedance	Maximum Input Voltage
		6½ digit	5½ digit	4½ digit		
1.0 V	1.19999 V	1 μV	10 μV	100 μV	1 MΩ ±.5% shunted by <90 pF	±1000 V peak (700 V rms) 10⁸ VHz
10.0 V	11.9999 V	10 μV	100 μV	1 mV		
100.00 V	119.999 V	100 μV	1 mV	10 mV		
1000.0 V	700.00 V	1 mV	10 mV	100 mV		

Measurement Accuracy: ± (% of reading + number of counts)
90 days: 23° C ± 5° C

Integration Time In Power Line Cycles	Frequency In Hz					
	10 to 20[1]	Filter Off— 20 to 30	400-20 k 30-20 k	20 k to 50 k 20 k to 50 k	50 k to 100 k 50 k to 100 k	100 k to 250 k[1] 100 k to 250 k
>1 ~ (6 digit)[2]	.47 + 450	.35 + 500	.07 + 730	.17 + 1700	.55 ± 2900	5.0 + 6500
.1 ~ (5 digit)	.48 + 90	.36 + 53	.08 + 73	.18 + 173	.56 + 293	5.0 + 653
.01 ~ (4 digit)	.56 + 10	.41 + 7	.13 + 9	.23 + 19	.61 + 31	5.1 + 67

[1]Frequencies >100 kHz are specified for 1.0 V and 10 V ranges only.
[2]Integration time in power line cycles (PLC). For 5½ digits, multiply counts by 0.1. For 4½ digits, multiply counts by 0.01.

Resistance (2 W Ω, 4 W Ω, 2 W OC Ω, 4 W OC Ω)

Range	Maximum Reading (5½ digit)	Resolution			Current Through Unknown
		6½ digit	5½ digit	4½ digit	
100 Ω	119.999 Ω	100 μΩ	1 mΩ	10 mΩ	1 mA
1 kΩ	1199.99 Ω	1 mΩ	10 mΩ	100 mΩ	1 mA
10 kΩ	11.9999 kΩ	10 mΩ	100 mΩ	1 Ω	100 μA
100 kΩ	119.999 kΩ	100 mΩ	1 Ω	10 Ω	50 μA
1 MΩ	1199.99 kΩ	1 Ω	10 Ω	100 Ω	5 μA
10 MΩ	11.9999 MΩ	10 Ω	100 Ω	1 kΩ	500 nA
100 MΩ	119.999 MΩ	100 Ω	1 kΩ	10 kΩ	≤500 nA[1]
1 GΩ	1000.00 MΩ	1 kΩ	10 kΩ	100 kΩ	≤500 nA[1]

[1]Ω source is a 500 nA current source in parallel with a 10 MΩ resistance.

Measurement Accuracy: ± (% of reading + number of counts)

Range	24 hours: 23° C ±1° C		90 days: 23° C ±5° C	
	6½ digit (≥10 PLC)	6½ digit (1 PLC)	6½ digit (≥10 PLC)	6½ digit (1 PLC)
100 Ω	0.003 + 24	0.003 + 32	0.004 + 24	0.004 + 32
1 kΩ	0.002 + 4	0.003 + 5	0.003 + 4	0.004 + 5
10 kΩ	0.002 + 4	0.003 + 5	0.003 + 4	0.004 + 5
100 kΩ	0.002 + 2	0.003 + 3	0.003 + 2	0.004 + 3
1 MΩ	0.006 + 2	0.006 + 3	0.007 + 2	0.007 + 3
10 MΩ	0.041 + 2	0.041 + 3	0.042 + 2	0.042 + 3
100 MΩ	1.3 + 1	1.3 + 1	1.8 + 1	1.8 + 1
1 GΩ	11 + 1	11 + 1	16 + 1	16 + 1

Ratio

Type: dc/dc, ac/dc, or (ac + dc)/dc
Method: 4-wire with Volts Lo input common

$$\text{Ratio} = \frac{\text{Signal Voltage}}{\text{Ref. Hi Voltage} - \text{Ref. Lo Voltage}}$$

Reading Rate

Integration Time in Power Line Cycles (PLC)	Rates(rdgs/second)			
	Auto Zero Off		Auto Zero On	
	60 Hz	50 Hz	60 Hz	50 Hz
0.01 (4½ digit)	330	290	210	180
0.10 (5½ digit)	210	180	120	100
1.00 (6½ digit)	48	40	25	20
10.00 (6½ digit)	5.8	4.8	2.9	2.4
100.00 (6½ digit)	.57	.47	.29	.24

Memory

Reading Store: Store up to 350 readings
Program Memory: Can execute an internal program that controls instrument configuration and measurement sequence

General

Operating Temperature: 0 to 50° C
Humidity Range: 95% R.H., 0 to 40° C
Power: 100, 120, 220, 240 V +5%, −10%, 48 Hz to 400 Hz line operation, 45 VA max
Size: 425.5 mm W × 88.9 mm H × 527.1 mm D (16¾ in × 3½ in × 20¾ in)
Weight: Net, 10.49 kg (23.13 lb); shipping, 13.35 kg (29.43 lb)

Ordering Information

	Price
HP 3456A Digital Voltmeter	$6,395
Opt 050 Noise Rejection for 50 Hz	$0
Opt 060 Noise Rejection for 60 Hz	$0
Opt W30 Three-Year Hardware Support	+$120

(see page 636)

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- 5½/6½-digit DVM with auto cal
- High-speed 3½-digit system voltmeter

DESIGNED FOR HP-IB SYSTEMS

HP 3455A

HP 3455A Multimeter

The HP 3455A Digital Voltmeter is a 5½- to 6½-digit integrating voltmeter for bench or systems applications. The HP 3455A measures dc volts, ac volts, and resistance. HP-IB and auto or manual ranging are included.

You can make dc measurements with up to 1μV sensitivity. Resistance can be measured in either a 2-wire or 4-wire mode. The high-resolution (6½-digit) mode gives dc and Ω measurements with more than 1-part-per-million resolution. The standard true rms ac-to-dc converter measures sinusoid and complex signals with crest factors of up to 7:1 at full scale from 30 Hz to 1 MHz.

Abbreviated Specifications

dc Voltage

Accuracy ± (% of reading + counts), 6½-digit mode

24 hours: 23° C ± 1° C		
Range	**24 Hours**	**90 Days**
1 V	0.003 + 4	0.006 + 4
10 V	0.002 + 3	0.005 + 3
100 & 1000 V	0.004 + 3	0.007 + 3

Input Resistance: 0.1 V through 10 V range: $>10^{10}$ Ω; 100 V and 1000 V range: 10 MΩ ±0.1% with Auto Cal. "off"
Maximum Input Voltage: High to low input terminals: ±1414 V peak; guard to chassis: ±500 V peak; guard to low terminal: ±200 V peak
NMR at 50 or 60 Hz ±0.1%: >60 dB
ECMR with 1 kΩ Unbalance in Low Lead at dc: >160dB

ac Voltage (rms converter)
Input Impedance
Front terminals: 2 MΩ ±1% shunted by less than 100 pf
Rear terminals: 2 MΩ ±1% shunted by less than 75 pf
Maximum Input Voltage
High to low terminals: ±1000 volts RMS; 10^7 VHz max
Guard to chassis: ±500 V peak; guard to low terminal: ±200 V peak
Crest Factor: 7:1 at full scale
Accuracy: ±[% of reading + counts] (ac coupled)

Fast acV	**300 Hz to 20 kHz**				
acV	**30 Hz to 20 kHz**	**20 kHz to 100 kHz**	**100 kHz to 250 kHz**	**250 kHz to 500 kHz**	**500 kHz to 1 MHz**
90 days 23° C ±5° C	0.05 + 50	0.50 + 100	2.00 + 250	5.00 + 500	6.00 + 3100

Resistance
Accuracy ± (% of reading + counts) 4-wire, 6½-digit mode

24 hours: 23° C ± 1° C		
Range	**24 Hours**	**90 Days**
1 kΩ	0.0025 + 4	0.0035 + 5
10 kΩ	0.0045 + 4	0.0060 + 5
100 kΩ	0.0020 + 5	0.0035 + 6
1000 kΩ	0.0120 + 4	0.0135 + 5
10,000 kΩ	0.1000 + 4	0.1000 + 5

General

Power: 100, 120, 240 V +5% −10%, 48 to 400 Hz; <60 VA
Size: 88.9 mm H × 425.5 mm W × 527.1 mm D (3.5 in × 16.75 in × 20.75 in)
Weight: Net, 9.38 kg (20.7 lb); shipping, 11.8 kg (26 lb)

HP 3400B

Maximum Readings per Second for Remote Operations

Function	**50 Hz**	**60 Hz**
dcV	22	24
Ω	11	12
acV (rms)	1.1	1.3
Fast acV (rms)	12	13

Ordering Information

	Price
HP 3455A Digital Voltmeter	$7,295
Opt 001 Average Converter	−$97

HP 3400B Multimeter

The HP 3400B is a true rms analog voltmeter that replaces in form, fit and function the HP 3400A. Specifications of the HP 3400A and HP 3400B are identical except the HP 3400B measures to 20 MHz. Six-decade frequency coverage makes the HP 3400A extremely flexible for audio and RF measurements up to 20 MHz and permits the measurement of broadband noise and fast rise-time pulses.

Pulses or other nonsinusoids with crest factors up to 10:1 can be measured full scale. Plots of measured data and higher resolution measurements can be produced by connecting a DMM to the convenient rear-panel dc output that produces a linear 0 to 1 volt output proportional to the meter deflection.

Abbreviated Specifications

Voltage Range: 1 mV to 300 V full scale, 12 ranges
dB Range: −72 to + 52 dBm (0 dBm = 1 mW into 600 Ω)
Frequency Range: 10 Hz to 20 MHz
Response: Responds to the RMS value (heating value) of the input signal for all waveforms
Meter Accuracy: % of full scale (20 to 30° C)*

10 Hz	**50 Hz**	**1 MHz**	**2 MHz**	**3 MHz**	**20 MHz**
5%	1%	2%	3%	5%	

ac to dc Converter Accuracy: % of full scale (20 to 30° C)

10 Hz	**50 Hz**	**1 MHz**	**2 MHz**	**3 MHz**	**20 MHz**
5%	0.75%	2%	3%	5%	

* Temperature Coefficient: 0.1% from 0 to 20 and 30 to 55° C

Crest Factor: (ratio of peak to rms amplitude of input signal): 10:1 at full scale
Input Impedance: 0.001 V to 0.3 V range: 10 M Ω shunted by <50 pF; 1.0 V to 300 V range: 10 M Ω shunted by < 20 pF, ac coupled input
Input Floor Noise: <10 μV
Output: Negative 1 V dc into open circuit at full-scale deflection, proportional to meter deflection from 10 to 100% of full scale. 1 mA max.; nominal source impedance is 1 kΩ. Output noise is <1mV rms.
Accessories Furnished: 10110B adapter, BNC-to-dual banana jack

Ordering Information

	Price
HP 3400B RMS Voltmeter	$2,395
Opt 001 Expanded dB scale, placed on top	+$60

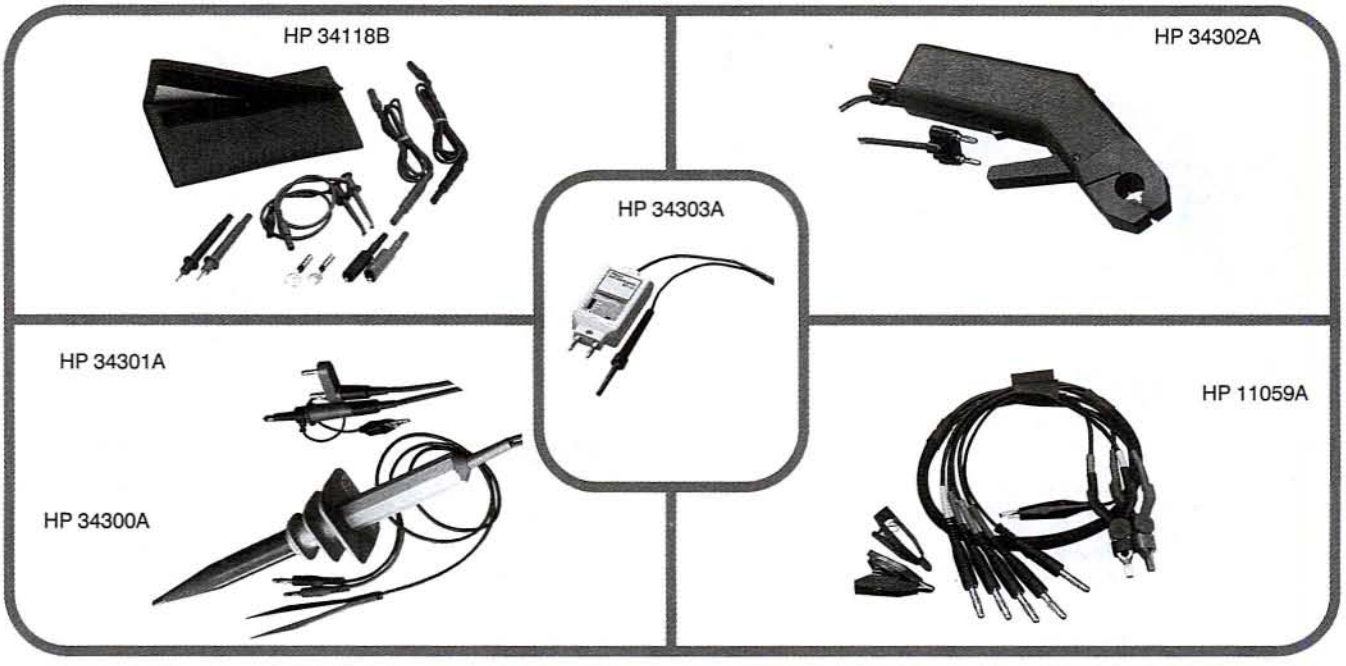
Rear terminals in parallel with front terminals and linear log scale uppermost on the meter face are available on special order.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

DIGITAL MULTIMETERS

Accessories

Probes, Test Leads



HP 11049A, 11050A and 11051A Thermal Converters

Used for ac/dc transfer measurements. Special order from factory.

HP 11059A Kelvin Probe Set

Works with any DMM with 4-wire Ω. Circuit connection is performed with two gold-plated flat tweezers with special gripping surfaces to ensure precise contact to the components being measured. An alligator clip and lead are provided for either grounding or guarding. Instrument connection is through banana plugs. Not to be used over 42 volts peak.

HP 11060A Surface Mount Device Test Probe

Designed for SMD testing, the tweezer design of this probe provides an easy method to access and measure SMD-resistive networks. Not to be used over 42 volts peak.

HP 34118B Deluxe Test Lead Kit

Right-angle test leads with four sets of attachable probes: alligator clips, spade lugs, spring-loaded hook tips, and probes. Includes Velcro™-sealed nylon pouch.

HP 34300A 40 kV ac/dc High-Voltage Probe

A probe for use with any DMM having an input resistance of 10 MΩ. Maximum input (at sea level): 40 kV (dc + peak ac), derated 1 percent of voltage rating per 100 meters in rise from sea level.
Voltage Division Ratio: 1000:1
Bandwidth: dc to 300 Hz
Input Resistance: 1 GΩ
Division Ratio Accuracy: ±2% (dc, 1000:1, 10 MΩ termination)

HP 34301A RF Detector Probe

This probe detects high-frequency signals for voltage measurements. The probe can be used with any DMM having a 10 MΩ input.
Bandwidth: 100 kHz to 700 MHz
Voltage Range: 0.25 V to 50 V rms
Accuracy: 100 kHz to 500 MHz, ±1 dB
500 MHz to 700 MHz, ±3 dB
Input Capacitance: Approx. 5 pF
Maximum ac Input: 50 V rms
Transfer Ratio: 1 Vdc output for 1 V rms input

HP 34330A 30-AMP Current Shunt (not pictured)

Output: 1 mV/A; 15 A Continuous; 30 A for 15 minutes max

HP 34302A Clamp-on ac/dc Current Probe

A clamp-on probe used for measuring ground currents, power supply ripple, or current distribution in systems. This probe measures ac, dc and ac + dc currents without breaking the circuit.
Ranges: ± 10 A dc or 10 A ac; ± 100 A dc or 100 A ac
Frequency Response: dc to 1 kHz
Recommended Load: > 3.0 k Ω
Rated Output: ± 1.0 V dc at 10 A
± 1.0 V dc at 100 A
Aperture Size: 19 mm
Accuracy: ±2% of rated output

HP 34303A Temperature Probe

Temperature measurements are read directly in °C or °F on DMMs having a minimum input impedance of 10 kΩ. The probe is a temperature-to-voltage transducer with a forward-biased diode providing calibrated linear output. A standard dual banana plug output connector provides universal connection to DMMs. A 9-volt battery is required for operation (not included).
Temperature Range: −58° to 302 ° F; −50° to 150 ° C
Output: 10 mV/ ° C or ° F
Resolution: 0.01 ° C or ° F
Accuracy: ±3.0° F; ±1.7° C

Ordering Information	Price	
HP 11002A Test Leads (banana, alligator)	$22	◻
HP 11003A Test Leads (banana, alligator, and probe)	$22	◻
HP 11049A 3 V, 5 Ω Thermal Converter	Contact Factory	
HP 11050A 1 V, 50 Ω Thermal Converter	Contact Factory	
HP 11051A 0.5 V, 50 Ω Thermal Converter	Contact Factory	
HP 11053A Low Thermal Lug-Lug Jumper Set	$29	◻
HP 11058A Low Thermal Banana-Banana Jumper Set	$29	◻
HP 11059A Kelvin Probe Set	$135	◻
HP 11060A Surface Mount Device Test Probe	$24	◻
HP 11062A Kelvin Clip Set	$26	◻
HP 11096B High-Frequency Probe	$250	◻
HP 11174A Low-Thermal Lug-Banana Jumper Set	$29	◻
HP 34110A Carrying Case for ½ Rack Size Instruments	$90	◻
HP 34111A dc High-Voltage Probe	$280	
HP 34118B Deluxe Test Lead Kit	$30	◻
HP 34119A High-Voltage Probe	$130	◻
HP 34300A 40 kV ac/dc High-Voltage Probe	$90	◻
HP 34301A RF Detector Probe	$80	◻
HP 34302A Clamp-on ac/dc Current Probe	$250	◻
HP 34303A Temperature Probe	$120	◻
HP 34330A Current Shunt	$55	◻

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Excellent standard feature set
- Choice of general-purpose or rugged model
- 0.3% or 0.7% basic DCV accuracy
- 3-year standard warranty on all models
- 3200-count analog/digital display
- All models in stock

HP 2373A, E2377A, and E2378A

HP E2300 Series Handheld Multimeters

The HP E2300 Series of handheld multimeters is ideal for portable basic measurements. Standard features on all three models include:

- dc and ac volts, dc and ac current, resistance, audible continuity, and diode test
- Maximum 1 kV dc, 750 V rms, 10 A
- Choice of auto-ranging or manual range hold
- Large 3200-count digitial display (samples approx. 2 times/s) with 32-segment analog bar (samples approx 12 times/s)
- Display annunciators for all functions (except temperature on E2377A and E2378A), also for low-battery indication, overload, range hold, and data hold (E2377A and E2378A)
- Built-in tilt stand and three terminal input jacks
- One-year calibration cycle
- Three-year warranty

Three Models to Choose From

The basic HP E2373A multimeter is ideal for troubleshooting. It offers all the standard features above, along with a basic Vdc accuracy of 0.7 percent. Audible continuity and a choice of auto or manual ranging make this low-cost meter an excellent choice.

For more exacting tasks, the HP E2377A has a basic Vdc accuracy of 0.3 percent and a 1-kHz bandwidth. It also adds data hold and temperature functions to the solid feature set of the HP E2373A. The temperature function is built in and can be used with any K-type thermocouple probe.

For outside use and rougher applications, the HP E2378A has the same functions and accuracy as the HP E2377A, and is encased in a yellow splash-proof case.

Refer to the following chart to determine which of the three models best suits your needs.

	E2373A	E2377A	E2378A
Basic dc accuracy	0.7%	0.3%	0.3%
Basic ac accuracy	1.2%	1%	1%
Maximum ac bandwidth	500 Hz	1 kHz	1 kHz
Audible continuity and diode test	Yes	Yes	Yes
Data hold function	No	Yes	Yes
Temperature function	No	Yes	Yes
Input protection up to 300 mA range	0.5 A/250 V	0.5 A/250 V	0.5 A/250 V
10 A range	unfused	15 A/250 V	15 A/250 V
Power supply (low mercury, alkaline batteries)	AA (1.5 V) × 2	AAA (1.5 V) × 2	AAA (1.5 V) × 2
Battery life (minimum)	2500 h	1000 h	1000 h

Standard Accessories Included

All three meters come with low mercury, alkaline batteries, spare fuse(s), operating manual, and test leads.

Always in Stock

All models and accessories are always in stock.

Additional Accessories (see photo on next page)

To extend the capability of your handheld multimeter, a variety of accessories are available:

HP E2301A Surface Thermocouple Probe, K-type (−130° C to 260° C*; accuracy is the greater of ±2.2° C or 0.75 percent of reading.) Note: Must also order E2303A, Thermocouple Probe Adapter.

HP E2302A Airflow Thermocouple Probe, K-type (same range and accuracy as E2301A.) Note: Must also order E2303A, Thermocouple Probe Adapter.

HP E2303A Thermocouple Probe Adapter (uncompensated, banana to K-type connector). For use with E2377A or E2378A multimeters and any K-type thermocouple probe.

HP E2304A Handheld Multimeter Carrying Case (padded, water-resistant nylon case with 2-zipper closing and inside pocket).

HP E2305A Replacement Test Leads (right angle), 2-pair.

HP E2306A Deluxe Test Lead Kit. Right-angle test leads with four sets of attachable probes: alligator clips, spade lugs, spring-loaded hook tips, and probes. Includes Velcro™-sealed nylon pouch.

For additional multimeter accessories, refer to page 168.

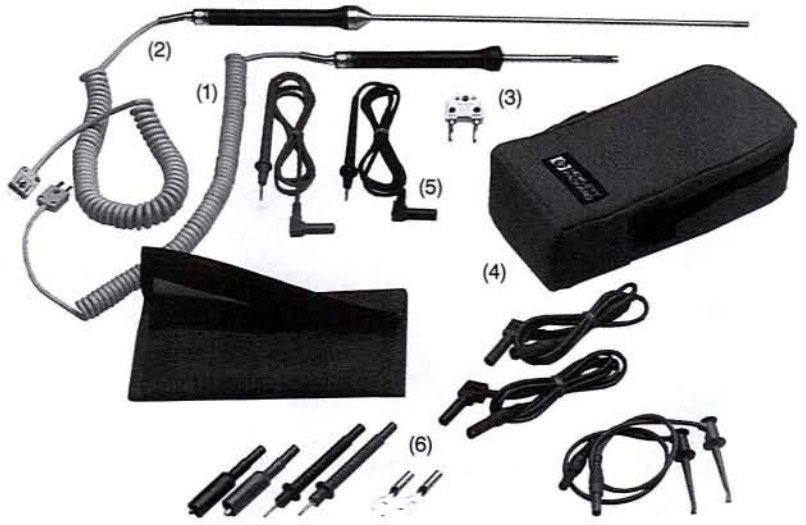
Velcro is a registered trademark of Velcro USA, Intl.

*When E2301A or E2302A is used with the E2377A or E2378A range is −20° C to 260° C.

DIGITAL MULTIMETERS

3½-Digit Handheld Multimeters (cont'd)

HP E2373A, E2377A, E2378A



Accessories for handheld multimeters

Specifications

23° C ± 5° C, <80% RH

Function	Range	Resolution	Accuracy[1] ± (% rdg + number of digits)	
			E2373A	E2377A E2378A
dc voltage	300 mV	100 µV	0.5% + 2	0.3% + 2
	3 V	1 mV	0.5% + 1	0.3% + 2
	30 V	10 mV	0.5% + 1	0.4% + 1
	300 V	100 mV	0.7% + 1	0.4% + 1
	1000 V	1 V	0.7% + 1	0.4% + 1
ac voltage	3 V	1 mV	1.2% + 4	1.0% + 3[2]
	30 V	10 mV	1.2% + 4	1.0% + 3[2]
	300 V	100 mV	1.2% + 4	1.0% + 3[2]
	750 V	1 V	1.2% + 4	1.0% + 3[2]
dc current	300 µA	100 nA	—	1.0% + 2
	3 mA	1 µA	—	1.0% + 2
	30 mA	10 µA	1.0% + 2	1.0% + 2
	300 mA	100 µA	1.5% + 2	1.5% + 2
	10 A	10 mA	1.5% + 2	1.5% + 2
ac current	300 µA	100 nA	—	2.0% + 5
	3 mA	1 µA	—	2.0% + 5
	30 mA	10 µA	2.0% + 5	2.0% + 5
	300 mA	100 µA	2.0% + 5	2.0% + 5
	10 A	10 mA	2.0% + 5	2.0% + 5
Resistance	300 Ω	100 mΩ	0.7% + 2	0.7% + 2
	3 kΩ	1 Ω	0.7% + 1	0.7% + 1
	30 kΩ	10 Ω	0.7% + 1	0.7% + 1
	300 kΩ	100 Ω	0.7% + 1	0.7% + 1
	3 MΩ	1 kΩ	1.5% + 1	0.7% + 1
	300 MΩ	10 kΩ	3.0% + 1	2.0% + 1

Input Resistance (dc voltage): 300 mV range > 1000 MΩ
3 V range 11 MΩ
30 to 1 kV ranges 10 MΩ

Maximum Input: ±1000 Vdc or 750 Vac rms

Continuity Check: 300 Ω range; approx 20 Ω threshold

Temperature Test: −20° C to 700° C with 1° resolution (not E2373A)

Diode Test: 0.6 mA test current, ±(3% + 2 mV) accuracy

[1] One digit corresponds to the range's resolution.
[2] 40 to 500 Hz range.

	E2373A	E2377A	E2378A
Size			
Height	164 mm (6.5 in)	176 mm (6.9 in)	186 mm (7.3 in)
Width	76 mm (3.0 in)	80 mm (3.15 in)	89 mm (3.5 in)
Depth	33 mm (1.3 in)	37 mm (1.4 in)	37 mm (1.4 in)
Net weight	0.27 kg (0.58 lb)	0.34 kg (0.75 lb)	0.45 kg (0.99 lb)

Ordering Information

		Price
HP E2373A Multimeter	(1 ea)	$99
	(2 to 5)	$96
	(6 to 9)	$94
	(10+)	$93
HP E2377A Multimeter	(1 ea)	$169
	(2 to 5)	$164
	(6 to 9)	$161
	(10+)	$159
HP E2378A Multimeter	(1 ea)	$189
	(2 to 5)	$183
	(6 to 9)	$180
	(10+)	$178
HP E2301A Surface Thermocouple Probe (1)		$120
HP E2302A Airflow Thermocouple Probe (2)		$75
HP E2303A Thermocouple probe Adapter (3)	(1 ea)	$12
	(2+)	$10
HP E2304A Handheld Multimeter Carrying Case (4)		$19
HP E2305A Replacement Test Leads, 2 pair (5)		$15
HP E2306A Deluxe Test Lead Kit (6)		$35

For off-the-shelf shipment, call 800-452-4844.

HP 8990A

DESIGNED FOR HP-IB SYSTEMS

HP 8990A Peak Power Analyzer

Complete Pulse Power Characterization

The HP 8990A Peak Power Analyzer provides complete and accurate characterization of today's complex pulsed signals. This new peak power analyzer is capable of performing 8 automatic timing measurements (rise time, fall time, pulse width, PRI, PRF, duty cycle, and delay) and 5 automatic power measurements (peak power, average power, pulse top/base amplitude, and overshoot) with push-button ease. Front panel operation is intuitive and straightforward. Data entries can be typed in or made with the front panel knob; automatic measurements are made with simple keystrokes.

The HP 8990A offers two sensor channels plus two external triggering/oscilloscope channels, which permits the simultaneous measurement of modulating signals and detected power envelopes. Powerful measurement and display routines put you in control of your most demanding pulse applications. Measurement statistics, high speed/high sensitivity triggering, amplitude and time markers, dual-time-base windowing, measurement limit test, waveform storage, and waveform math are some of the new capabilities featured in the HP 8990A.

The peak power analyzer is compatible with the HP 84812/3/4/5A peak power sensors. These sensors and the HP 8990A combine to give you outstanding measurement accuracy in demanding situations and include automatic temperature sensing and correction.

New Lower-Cost Peak Power Analyzer
<10 ns rise/fall time
>40 dB dynamic range
Contact HP for information.

HP 8990A Specifications

Sensor inputs (Channels 1 & 4)

Frequency Range: 50 MHz to 40 GHz, sensor dependent
Power Range: −32 to +20 dBm (usable to −40 dBm)
Rise/Fall Time:

Input signal range (dBm)	Rise time/fall time
0 to +20	< 5 ns (<45 ns with HP 84815A)
−16 to 0	<6 ns (<45 ns with HP 84815A)
−26 to −16	<1 μs
−32 to −26	<80 μs

Instrumentation Uncertainty, Including Noise and Offset:

$$\pm\left(3.5\% + \frac{0.07\,\mu\text{W}}{\text{signal power}} \times 100\%\right)$$

Max Pulse Repetition Rate: 100 MHz externally triggered, 1 MHz internally triggered
Linear Vertical Scale: 50 nW/div to 20 mW/div in 1-2-5 sequence
Log Vertical Scale: 0.1 to 5 dB/div in 1-2-5 sequence
Video Inputs (Channels 2 & 3)
Bandwidth: dc coupled: dc to 100 MHz (repetitive); dc to 1 MHz (single shot). ac coupled: 10 Hz to 100 MHz (repetitive); 10 Hz to 1 MHz (single shot).
Rise time: <5 ns
Vertical sensitivity: 100 mV/div to 500 mV/div
Vertical gain accuracy: ±1.5%
Available offset range: ±20V

Time Base
Range: 2 ns/div to 5 s/div in 1-2-5 sequence
Resolution: 100 ps
Accuracy: 0.005%
General Characteristics:
Power requirements: Voltage: 90-132 or 198-264 Vac; 48-66 Hz. Power: 250 VA max
HP-IB codes: SH1, AH1, T5, L4, SR1, RL1, PP1, DC1, DT1, C0, E2
Size: 422 mm W × 194 mm H × 366 mm D (16.62 in × 7.65 in × 14.4 in)
Weight: Net, 12.8 kg (28 lb); shipping, 20.1 kg (44 lb)

HP 84812A/13A/14A/15A Specifications:

Frequency Range: HP 84812A: 500 MHz to 18 GHz
HP 84813A: 500 MHz to 26.5 GHz
HP 84814A: 500 MHz to 40 GHz
HP 84815A: 50 MHz to 18 GHz
Power Range: −32 to +20 dBm (usable to −40 dBm)
Sensor Input SWR (reflection coefficient):
50 MHz to 18 GHz: 1.25 (0.11)
6 to 18 GHz: 1.30 (0.13) (HP 84815A only)
18 GHz to 26.5 GHz: 1.35 (0.15)
26.5 GHz to 40 GHz: 1.60 (0.23)
Sensor Calibration Uncertainty:

Frequency	RSS uncertainty
< 4 GHz	± 3.6%
< 12 GHz	± 3.8%
< 18 GHz	± 4.3%
< 26.5 GHz	± 5.5%
< 40 GHz	± 6.5%

Connector Type: HP 84812A, HP 84815A: Type-N (m)
HP 84813A: APC-3.5 mm (m)
HP 84814A: 2.4 mm (m)
General Characteristics
Size: HP 84812A, HP 84815A: 37 mm W × 27 mm H × 137 mm D (1.45 in × 1.05 in × 5.4 in)
HP 84813A, HP 84814A: 37 mm W × 27 mm H × 127 mm D (1.45 in × 1.05 in × 5.0 in)
Weight: Net, 0.29 kg (0.64 lb); shipping, 0.64 kg (1.4 lb)

Ordering Information

	Price
HP 8990A Peak Power Analyzer	$15,500
Opt 001 Deletes Channel 4	−$3,000
Opt W30 Extended Repair Service (see page 636)	$375
HP 84812A Peak Power Sensor	$1,650
Opt W30 Extended Repair Service (see page 636)	$45
HP 84813A Peak Power Sensor	$1,900
Opt W30 Extended Repair Service (see page 636)	$45
HP 84814A Peak Power Sensor	$2,550
Opt W30 Extended Repair Service (see page 636)	$45
HP 84815A Peak Power Sensor	$1,750
Opt 30 Extended Repair service (see page 636)	$45

For the most current prices and product information, contact your local Hewlett-Packard sales office.

POWER METERS

Power Meter

HP 437B, 70100A, E1416A

HP 437B

HP 70100A

HP E1416A

HP 437B Power Meter

The HP 437B is a low-cost, high-performance, single-channel, programmable, average power meter compatible with the HP 8480 family of thermocouple and diode power sensors. Depending on which power sensor is used, the HP 437B can measure from −70 dBm (100 pW) to +44 dBm (25 W) at frequencies from 100 KHz to 110 GHz.

Designed for ATE systems and demanding benchtop measurements, the HP 437B Power Meter makes fast, accurate, and reliable average power measurements. Only 3 inches high and half rack wide, the HP 437B minimizes the use of critical rack space in ATE systems. The advanced plastics technology used in the HP 437B cabinet combines the light weight of plastic with the shielding effectiveness of metal, making the HP 437B the only power meter to meet MIL-STD-461C EMI specifications.

A modern and flexible feature set makes this meter easy to use in any application:

- Automatic calibration and zeroing
- Frequency entry instead of Cal Factor
- Ten pre-loaded sensor Cal Factor versus frequency tables
- Selectable resolution to 0.001 dB
- Offset entry in dB
- Duty cycle entry for a convenient peak power representation of the measured average power
- Ten store/recall registers
- HP-IB is standard
- Analog meter is a standard feature

With a measurement speed twice as fast as that of the industry-standard HP 436A, powerful programming capability, state-of-the-art accuracy, and exceptional reliability, the HP 437B lets you measure your test signal with speed, precision, and confidence.

HP 70100A and E1416A MMS and VXI Power Meters

The HP 70100A is a full-feature single-channel power meter module for the Modular Measurement System (see page 88). It has all the capability of the HP 437B Power Meter in an 1/8th rack-width module. The HP 70100A features the same modern and flexible feature set as the HP 437B, the same state-of-the-art accuracy, and is also fully compatible with the HP 8480 series of power sensors. The HP E1416A power meter is a VXI version of the HP 70100A. For information on the HP E1416A, refer to page 172.

HP 437B, 70100A, and E1416A Specifications

Frequency Range: 100 kHz to 110 GHz, sensor dependent
Power Range: −70 to +44 dBm (100 pW to 25 W), sensor dependent
Power Sensors: Compatible with all HP 8480 series power sensors
Dynamic Range: 50 dB in 10 dB steps
Display Units: Absolute: Watts, dBm; relative: percent, dB
Resolution: Selectable resolution of 0.1, 0.01, and 0.001 dB in logarithmic mode; or 1%, 0.1%, and 0.01% of full scale in linear mode

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

Accuracy

Instrumentation: ±0.02 dB or ±0.5%
In REL Mode: ±0.02 dB or ±0.5% within measurement range; ±0.04 dB or 1% outside measurement range
Zero Set: ±0.5% of full scale on most sensitive range

Power Reference

Power Output: 1.00 mW, Factory set to ±0.7% traceable to US National Institute of Standards and Technology
Accuracy: ±1.2% worst case (±0.9% RSS) for 1 year

General (HP 437B only)

EMI: Radiated and Conducted Emissions and Radiated and Conducted Susceptibility are within the requirements of RE02, CE03, RS01/03 and CS01/03 called out in MIL-STD-461C, and within the requirements of VDE 0871 and CISPR Publication 11
Rear-Panel Output: Analog 0-1 volt without digital filtering or Cal Factor correction, 1 kΩ output impedence, BNC connector
Line Voltage: 100 and 120 Vac, +5%-10%, 48-66 Hz, 360-440 Hz; 220 and 240 Vac, +5% to 10%, 48 to 66 Hz
Power Requirement: 8 watts maximum (10 VA max)
HP-IB Codes: SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP1, DC1, DT1, C0
Weight: Net 2.6 kg (5.9 lb); shipping 4.5 kg (10 lb)
Size: 88 mm H × 212 mm W × 273 mm D (3.46 in × 8.35 in × 10.75 in)

Accessories

Furnished: HP 11730A, 1.5 m (5 ft) cable for power sensors; 2.4m (7.5 ft) power cable. Mains plug shipped to match destination requirements.
Available: To select or substitute nonstandard lengths for power sensor cable, see page 173. To rackmount one HP 437B, order part number 5060-0173. To rackmount two HP 437B power meters, order part number 5060-0174.

Ordering Information	Price
HP 437B Power Meter	$2,725
Opt 002 Supplies a parallel rear-panel sensor input	+$100
Opt 003 Supplies a parallel rear-panel sensor input and moves reference oscillator to rear-panel	+$100
Opt 004 Delete the HP 11730A sensor cable	−$50
Opt 401 Provides side-carrying handle and standoff feet	+$50
Opt 915 Service manual	+$25
Opt 916 Extra operating manual (00437-90015)	+$25
Opt W30 Two additional years of return-to-HP warranty	+$65
HP 70100A Power Meter Module	$3,250
Opt 003 Moves reference oscillator from front to rear panel	$0
Opt 004 Delete the HP 11730A Power Sensor Cable	−$75
Opt 005 Delete Reference Oscillator	−$255
Opt W30 Extended Repair Service (see page 636)	+$70

For off-the-shelf shipment, call 800-452-4844.

HP 436A

DESIGNED FOR HP-IB SYSTEMS

- Ideal for ATE applications
- Dual power sensors
- Innovative ratio & difference measurements

HP 438A

DESIGNED FOR HP-IB SYSTEMS

HP 436A Power Meter

The HP 436A Power Meter is a general-purpose digital power meter intended for manual and automatic radio-frequency (RF) and microwave-power measurements. It is compatible with the entire series of HP 8480 thermocouple and diode power sensors.

The HP 436A measures either absolute or relative power. It displays absolute power in either watts or dBm, and relative power in dB. The HP 436A offers intuitive and straightforward manual operation as well as optional HP-IB programmability (Option 022).

Specifications

Frequency Range: 100 kHz to 110 GHz, sensor dependent
Power Range: −70 to +44 dBm (100 pW to 25 W), sensor dependent
Accuracy
Instrumentation
Watt mode: ±0.5%
dBm mode: ±0.02 dB ±0.001 dB/° C
dB (REL) mode[1]: ±0.02 dB ±0.001 dB/° C
Zero: Automatic, operated via front panel switch
Zero set: ±0.5% of full scale on most sensitive range, typical
Zero carry over: ±0.2% of full scale when zeroed on the most sensitive range
Power reference: Internal 50 MHz oscillator with Type-N female connector on front panel (or rear panel, Opt 003)
Power output: 1.0 mW. Factory set to ±0.7% traceable to the U.S. National Institute of Standards and Technology
Accuracy: ±1.2% worst case (±0.9% rss) for one year

Supplemental Characteristics

Recorder Output: Linearly proportional to indicated power with 1 volt corresponding to full scale and 0.316 volts to −5 dB; 1 kΩ output impedance, BNC connector
Power Consumption: 100, 120, 220, 240V (+5%, −10%), 48 to 66 Hz, and 360 to 440 Hz; <20 VA (<23 VA with Opt 022)
HP-IB Function Codes: AH1, C0, DC2, DT0, LE0, P0, RL2, SH1, SR0, T3, TE0
Weight: Net, 4.5 kg (10 lb); shipping, 5.5 kg (12 lb)
Size: 134 mm H × 213 mm W × 279 mm D (5.2 in × 8.4 in × 11.0 in)

Accessories

Furnished: HP 11730A, 1.5-m (5-ft) power sensor cable; 2.3-m (7.5-ft) power cable
Available: To select and substitute nonstandard lengths for power sensor cables, see page 176. HP 5061-9657 rackmount adapter kit (one HP 436A by itself).

Ordering Information

	Price
HP 436A Power Meter	$4,750
Opt 003 Reference oscillator output on rear panel only	$50
Opt 004 Delete Power Sensor Cable	−$50
Opt 022 Digital Input/Output, fully HP-IB compatible	$0
Opt 908 Kit for rackmounting one HP 436A	+$55
Opt 910 Extra Operating and Service Manual (00436-90034)	+$25
Opt W30 Extended Repair Service (see page 636)	+$80
Opt W32 Calibration Service (see page 636)	$685

[1]Specifications for within range measurements. For range-to-range accuracy add ±0.02 dB.

HP 438A Power Meter

The HP 438A power meter is a dual-channel power meter designed specifically for ATE systems. The compact front panel saves critical rack space, while the dual channel design allows simple and accurate measurements of the ratio and difference of power levels from two separate sensors. This meter is compatible with the HP 8480 series of thermocouple and diode power sensors.

HP-IB capability is standard on the HP 438A. For U.S. Air Force Modular Automatic Test Equipment (MATE) system application, Option 700 provides the HP 438A with the internal capability to be controlled by the MATE Control Interface Intermediate Language (CIIL).

Specifications

Frequency Range: 100 kHz to 110 GHz, sensor dependent
Power Range: −70 to +44 dBm (100 pW to 25W), sensor dependent. Uses HP 8480 series power sensors
Instrumentation Accuracy
Single channel: ±0.5% (watt mode) or ±0.02 dB (dBm mode)
Dual channel: ±1% (watt mode) or ±0.04 dB (dBm mode)
Zeroing: Automatic, ±0.5% of full scale on most sensitive range
Power Reference
Power output: 1.00 mW. Factory set to ±0.7%, traceable to the U.S. National Institute Standards and Technology
Accuracy: ±1.2% worst case (±0.9% rss) for 1 year
Connector: front panel Type-N female (also rear panel Opt 002)

Supplemental Characteristics

Recorder Output: Linearly proportional to indicated power in watts. One volt corresponds to full scale; 1 KΩ output impedance. BNC rear panel female connector
Line Voltage: 100, 120, 220, or 240 Vac +5% −10%. 100 and 120 volts, 48 to 66 Hz and 300 to 440Hz. 220 and 240 volts, 48 to 66 Hz only
Power Requirements: 65 VA, 35 watts, maximum
HP-IB Interface Codes: SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP1, DC1, DT1, C0
Weight: Net, 5.9 kg (13 lb); shipping, 9.1 kg (20 lb)
Size: 89 mm H × 213 mm W × 418 mm D (3.5 in × 8.4 in × 16.8 in)

Accessories

Furnished: HP 11730A, 2 each, 1.5-meter (5-ft) power sensor cables. Power cable, 1 each, 2.4 meters (7.5 ft). Mains plug matches destination requirements.
Available: To select and substitute nonstandard lengths for power sensor cables, see page 176.

Ordering Information

	Price
HP 438A Dual Channel Power Meter	$5,350
Opt 002 Rear Panel Sensor Connector (in parallel with front panel) and additional reference oscillator with rear panel output	+450
Opt 700 Internal MATE Programming	+$2,000
Opt 004 Delete Power Sensor Cables	−$100
Opt 910 Additional Manual (00438-90015)	+$25
Opt W30 Extended Repair Service (see page 636)	+$130
Opt W32 Calibration Service (see page 636)	$305

For fast off-the-shelf shipment, call 800-452-4844.

POWER METERS

Peak Power Sensor and Peak Power Meters

HP 435B, 8900C/D, 84811A

HP 435B

HP 8900C

HP 8900D

HP 435B Power Meter

The HP 435B Power Meter is an analog power meter, compatible with the entire series of HP 8480 Power Sensors. Depending on which sensor is used, the HP 435B can measure power from −65 dBm to +44 dBm, full scale, at frequencies from 100 kHz to 110 GHz. This versatile instrument also features <1 percent instrumentation uncertainty, low noise and drift, auto-zero, recorder output, optional battery operation, and long cable options up to 61 m (200 ft).

HP 435B Specifications

Frequency Range: 100 kHz to 110 GHz (sensor dependent)
Temperature Range: 0° to 55° C
Power Range (calibrated in watts and dB in 5 dB steps)
With HP 848xB: +5 dBm (3 mW) to +44 dBm (25 W) full scale
With HP 848xH: −5 dBm (0.3 mW) to +35 dBm (3 W) full scale
With HP 848xA: −25 dBm (3 μW) to +20 dBm (100 mW) full scale
With HP 848xD: −65 dBm (300 pW) to −20 dBm (10 μW) full scale

Accuracy

Instrumentation: ±1% of full scale on all ranges
Zero: Automatic, operated by front-panel switch
Zero Set: ±0.5% of full scale on most sensitive range, typical
Zero Carryover: ±0.5% of full scale
Power Reference: Internal 50 MHz oscillator with Type N female connector on front panel (or rear panel, Opt 003 only)
Power output: 1.00 mW. Factory set to ±0.7% traceable to the U.S. National Institute of Standards and Technology
Accuracy: ±1.2% worst case (±0.9% rss) for one year

Supplemental Characteristics

Recorder Output: Linearly proportional to indicated power with 1 volt corresponding to full scale: 1 kΩ output impedance, BNC connector
RF Blanking Output: Provides a contact closure to ground. Used for turning off RF input to sensor during auto-zeroing. BNC connector
Power Consumption: 110 or 120 V (+5%, −10%), 48 to 66 Hz and 360 to 440 Hz; also 220 or 240 V (+5%, −10%), 48 to 66 Hz only: <20V · A
Weight: Net, 2.7 kg (5.9 lb); shipping, 4.2 kg (9.2 lb)
Size: 155 mm H × 130 mm W × 279 mm D (6.3 in × 5.1 in × 11 in)

Accessories

Furnished: HP 11730A, 1.52-m (5-ft) cable for the power sensor; 2.3m (7.5 ft) power cable (mains plug shipped to match destination requirements)
Available
To select or substitute nonstandard lengths for power sensor cables, see HP 11730A-F Power sensor cables section.
HP 5060-8762: Rack adapter frame (holds three instruments the size of the HP 435B)

Ordering Information

	Price
HP 435B Power Meter	$2,050 ☎
Opt 001 Rechargeable battery installed provides up to 16 hours of continuous operation	+$300
Opt 002 Input connector placed on rear panel in parallel with front	+$50
Opt 003 Parallel sensor inputs front and rear panels, reference oscillator output on rear panel	+$50
Opt 004 Delete power sensor cable	−$50
Opt 910 Extra operating and service manual (00435-90040)	+$7.50 ☎
Opt W30 Extended Repair Service (see page 636)	+$50
Opt W32 Calibration Service (see page 636)	$505

HP 8900C/D Peak Power Meters

The HP 8900C and 8900D Peak Power Meters directly display the peak power of RF pulses over a 100-MHz to 18-GHz frequency range. Measurements can be made on pulses with widths from 1 μs (100 ns in Compare mode) to CW, and repetition rates from 100 Hz (0 Hz in Compare mode) to 100 kHz.

The HP 8900C is an economical analog meter calibrated in watts and dBm. The analog display with its large, easy-to-read scale makes it simple to peak or null pulsed power systems. The HP 8900D has a high resolution 3½-digit digital display calibrated in watts. The direct reading display and range annunciators make the digital version a good choice for production and field applications where unambiguous or frequent readings are required.

HP 84811A Peak Power Sensor

The HP 84811A Peak Power Sensor works with the HP 8900C/D Peak Power Meters to measure the peak power of RF pulses. It is supplied with a 4-foot flexible cable to easily reach the pulse source being measured. The HP 84811A also conveniently detaches from the meter for storage, recalibration, or replacement.

HP 8900C/D Peak Power Meters Specifications

Frequency Range: 100 MHz to 18 GHz
Dynamic Range: 20 dB (0 to +20 dBm)
HP 8900C: 4 ranges of 3, 10, 30, and 100 mW full scale
HP 8900D: 2 ranges of 10 and 100 mW full scale
Pulse Response:
Direct mode
Pulse width: 1μs to CW
Repetition rate: 100 Hz to 100 kHz
Compare mode
Pulse width: 100 ns (typical) limited by rise time specification
Repetition rate: 0 to 100 kHz
Rise time: 75 ns
Fall time: 125 ns (as measured on video output)
Power Consumption: 100 and 120 Vac +5, −10%, 48 to 66 Hz and 360 to 440 Hz; 220 and 240 Vac +5, −10%, 48 to 66 Hz

Meter Accuracy	CW	Pulse	Transfer Accuracy CW to Pulse
Direct	±0.2 dB	±0.35 dB	±0.2 dB
Compare	±0.2 dB	±0.25 dB	±0.1 dB

HP 84811A Peak Power Sensor Specifications

Power Range: 0 to +20 dBm (1 mW to 100 mW)
Frequency Range: 100 MHz to 18 GHz
SWR: 100 MHz to 12 GHz < 1.5. 12 GHz to 18 GHz < 2.0
Maximum Peak Power: +24 dBm (250 mW) for 5 minutes
Connector Type: N (male)
Calibration Accuracy: (+10° to +40° C), ±0.7 dB 0.1 to 12 GHz ±1.0 dB to 18 GHz. 0° to 10° C and 40° to 55° C: add ±0.2 dB

Ordering Information

	Price
HP 8900C Analog Peak Power Meter	$3,300
HP 8900D Digital Peak Power Meter	$4,000
Opt W30 Extended Repair Service (for HP 8900C/D) (see page 636)	+$75
Opt W32 Calibration Service (see page 636)	$285
HP 84811A Peak Power Sensor	$1,300 ☎
Opt W30 Extended Repair Service (see page 636)	$50
Opt W32 Calibration Service (see page 636)	$285

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.


HP 432A


HP 5477A


HP Thermistor Mounts

HP 432A Power Meter

High accuracy—no thermoelectric error: High accuracy over a wide temperature range is featured on the HP 432 Power Meter. By measuring the output voltage of the thermistor bridges and computing the corresponding power, even higher accuracy of ±0.2 percent ±0.5 μW can be obtained.

Accuracy can be maintained on even the most sensitive range because the error due to thermoelectric effect is reduced to a negligible level.

Calibrated mounts: Each thermistor mount is furnished with data stating the calibration factor and effective efficiency at various frequencies across the operating range. For easy and accurate power measurements, the front panel of the HP 432 contains a calibration factor control, calibrated in 1 percent steps from 88 percent to 100 percent, that compensates for losses in the mount and eliminates the need for calculation.

Instrument type: Automatic, self-balancing power meter for use with temperature-compensated thermistor sensor.

Specifications (Partial)

Power Range: 7 ranges with full-scale readings of 10, 30, 100, and 300 μW, 1, 3, and 10 mW; also calibrated in dBm from −20 dBm to +10 dBm full scale in 5 dB steps

Noise: Less than 0.25% of full scale peak (typical)

Response Time: At recorder output, 35 ms time constant (typical)

Fine Zero: Automatic, operated by front panel switch

Zero Carryover: Less than 0.50% of full scale when zeroed on most sensitive range

Meter: Taut-band suspension, individually calibrated, mirror-backed scales. Milliwatt scale more than 108 mm (4.25 in) long

Calibration Factor Control: 13-position switch normalizes meter reading to account for thermistor sensor calibration factor. Range 100% to 88% in 1% steps

Thermistor Sensor: Thermistor sensors are required for operation of the HP 432A/B. For microwave sensors HP 478B, 8478B, and 486 series, see next column.

Recorder Output: Proportional to indicated power with 1 volt corresponding to full scale. 1-kΩ output impedance

BCD Output: 8, 4, 2, 1 code: "1" positive. TTL compatible logic. Operates with HP 5150A, Opt 002 (BCD) Digital Recorder.

Power Consumption: 115 or 230 Vac ±10%, 50 to 400 Hz, 1.5 watts

Weight: Net, 2.3 kg (5.5 lb); shipping, 4.6 kg (10 lb)

Size: 130 mm W × 155 mm H × 279 mm D (5.2 in × 6.1 in × 11.0 in)

HP 8477A Power Meter Calibrator

The HP 8477A Calibrator is specifically designed for use with the HP 432 Power Meter. It allows you to verify full-scale meter readings on all ranges, and meter tracking. Simply connect three cables between the power meter and calibrator; no charts or additional instruments are required.

Power: 115 or 230 Vac ±10%, 50 to 400 Hz, 3 watts

Temperature-Compensated Thermistor Mounts

High efficiency and good radio frequency (RF) match are characteristic of the HP 478A and 8478B coaxial and 486A series waveguide thermistor mounts. Used in conjunction with the HP 432 Power Meter they provide high accuracy even in routine power measurements. These thermistor mounts are temperature compensated for low drift, even in the presence of thermal shocks, permitting measurement of microwave power as low as 1 microwatt. Each mount contains data showing calibration factor and effective efficiency at six frequencies, directly traceable to the U.S. National Institute Standards and Technology at those frequencies where NIST provides calibration service.

HP 486, 478, 8478B Specifications

HP Model	Frequency Range, GHz	Maximum SWR	Price	
478A	10 MHz to 10 GHz	1.75, 10 to 25 MHz 1.3, 25 MHz to 7 GHz 1.5, 7 to 10 GHz	$775	☎
8478B[1]	10 MHz to 18 GHz	1.75, 10 to 30 MHz 1.35, 30 to 100 MHz 1.1, 0.1 to 1 GHz 1.35, 1 to 12.4 GHz 1.6, 12.4 to 18 GHz	$975	☎
X486A	8.20 to 12.4	1.5	$1,600	
P486A	12.4 to 18.0	1.5	$1,600	
K486A[2]	18.0 to 26.5	2.0	$1,600	
R486A[2]	26.5 to 40.0	2.0	$1,600	
[1]Opt 011: Furnished with APC-7 RF connector			+ $25	
[2]Circular flange adapters:				
K-band (UG-425/U) HP 11515A			$450	
R-band (UG-381/U) HP 11516A			$450	

Ordering Information

	Price	
HP 432A Power Meter	$3,000	
Opt 001 Rechargeable battery installed, provides up to 20 hours' continuous operation (HP 432A only).	+ $300	
Opt 002 Input connector placed on rear panel in parallel with front	+ $25	
Opt 003 Input connector on rear panel only	+ $25	
Opt 009 3.1-m (10-ft) Cable for 110-Ω or 200-Ω Sensor	+ $65	
Opt 010 6.1-m (20-ft) Cable for 100-Ω or 200-Ω Sensor	+ $100	
Opt 011 15.2-m (50-ft) Cable for 100-Ω or 200-Ω Sensor	+ $140	
Opt 012 30.5-m (100-ft) Cable for 100-Ω or 200-Ω Sensor	+ $210	
Opt 013 61-m (200-ft) Cable for 100-Ω or 200-Ω Sensor	+ $350	
Opt 100 100 Vac Operation, 48 to 66 Hz	$100	
Opt 910 Extra Operating and Service Manual (HP432A: P/N 00432-90009; HP432B: P/N 00432-90053)	+ $5	☎
Opt W30 Extended Repair Service (see page 636)	+ $50	
Opt W32 Calibration Service (see page 636)	$595	
HP 8477A Power Meter Calibrator	$3,000	
Opt W30 Extended Repair Service (see page 636)	+ $50	
Opt W32 Calibration Service (see page 636)	$405	

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

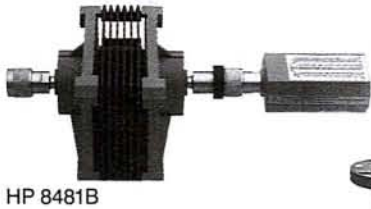
POWER METERS

Power Sensors, Range Calibrator, and Power Sensor Cables

HP 8481A/B/D/H, 8482A/B/H, 8483A, 8485A/D, R/Q 8486A/D, W8486A, 8487A/D, 11708A, 11683A, 11730A-F

HP 8481A

HP 8485A



HP 8481B

HP Q8486A

HP 11760S

HP 8480 Power Sensor Family

The HP 8480 power sensors are designed for use with the HP 435B, 436A, 437B, 438A, 70100A, and E1416A Power Meters. These thermocouple and diode power sensors provide extraordinary accuracy, stability, and SWR over a wide range of frequencies (100 kHz to 110 GHz) and power levels (−70 to +44 dBm).

Best SWR in the Industry

Mismatch uncertainty is usually the largest single source of error in power measurements. The HP 8480 power sensor family gives you extremely low SWR even at mm-wave frequencies. For example, the new HP W8486A power sensor has a specified SWR of less than 1.08:1 over its entire 75 to 110 GHz frequency range. This low SWR translates into minimum mismatch uncertainty and optimum measurement accuracy.

Accurate Calibration and Traceability

Each power sensor in the HP 8480 family is individually calibrated and traceable to the U.S. National Institute of Standards and Technology (NIST, formerly NBS). The uncertainty in this calibration factor is your link to NIST. The Cal Factor measurement system used by HP Standards Lab provides you with minimum Cal Factor uncertainty.

True-RMS Reading Sensors

HP high-sensitivity diode power sensors (HP 8481D/5D/6D/7D) are always operated inside the square-law region. This means that the sensor will act as a true-RMS reading device over its entire −70 to −20 dBm dynamic range. The benefit to you: HP sensors provide you with accurate readings even if your test signal is subjected to multitone environments, modulated carriers, or carriers with high harmonics.

mm-Wave Sensor Calibration

A 50 MHz calibration port is included in HP waveguide power sensors for calibration with the power meter. This calibration provides traceability to NIST at millimeter-wave frequencies, and it eliminates the uncertainties due to temperature changes and the variance in making measurements with different meter/sensor combinations.

Accurate Accessories Included

With HP power sensors, you can start making measurements right away. No more hunting around for attenuators or adapters. HP sensors include all the accessories you need to optimize accuracy and save time.

In-House Power Sensor Calibration

Power sensor calibration is now easier than ever with the new HP 11760S calibration system, designed specifically for Metrology and Cal Lab engineers. In less than four minutes, this complete sensor calibration system can measure your sensor's Cal Factor, calculate all measurement uncertainties, generate a permanent record for your files, and plot a new replacement Cal Factor label.

For more information on the HP 11760S Power Sensor Calibration System, please contact your HP Field Engineer.

HP 11683A Range Calibrator

The HP 11683A Calibrator is specifically designed for use with the HP 435B, 436A, 437B, 438A, 70100A, and E1416A Power Meters. It allows verification of full-scale meter readings on all ranges, as well as meter tracking. Simply connect the cable between the power meter and calibrator. The CAL ADJ control on the power meter is used to set the meter to full scale on the 1 mW range. The calibrator and meter are then stepped through the other ranges verifying accuracy within ±1 percent plus noise and drift. The HP 11683A also has a polarity switch that tests the auto-zero circuit. The HP 11683A is not HP-IB compatible.

HP 11683A Range Calibrator Specifications

Calibration Functions: Outputs corresponding to meter readings of 3, 10, 30, 100, and 300 μW; 1, 3, 10, 30, and 100 mW
Calibration Uncertainty: ±0.25% in all ranges
Power: 100, 120, 220, or 240 Vac +5%, −10%, 48 −440 Hz, less than 10 V · A
Weight: Net, 1.13 kg (2.5 lb); shipping, 1.9 kg (4.2 lb)
Size: 133 mm W × 89 mm H × 216 mm D (5.25 in × 3.5 in × 8.5 in)

HP 11730A-F Power Sensor Cables

The HP 11730 series power sensor cables are for use with the HP 435B, 436A, 437B, 438A, 70100A, and E1416A power meters and the HP 8480 series of thermocouple and diode power sensors. These cables are designed to reduce RFI effects on low power readings with an improved shielding design in the cable itself. Cables may be ordered individually or in pairs in any combination desired for single and dual-channel measurements.

The HP 11730A cable is the standard cable for the HP 435B, 436A, 437B, 438A (2 cables shipped), 70100A, and E1416A meters. To order a nonstandard cable, select Option 004 for the meter in question, and order the desired cable from below.

Ordering Information	Price
HP 11683A Range Calibrator	$1,750
HP 11730A 1.5 Meter (5 ft) Sensor Cable	$100
HP 11730B 5.0 Meter (10 ft) Sensor Cable	$120
HP 11730C 6.1 Meter (20 ft) Sensor Cable	$175
HP 11730D 15.2 Meter (50 ft) Sensor Cable	$250
HP 11730E 30.5 Meter (100 ft) Sensor Cable	$350
HP 11730F 61.0 Meter (200 ft) Sensor Cable	$550

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 8480 Series Specifications

25 Watt Sensors 1 mW to 25W (0 to +44 dBm)

HP Model	Frequency Range	Maximum SWR	Power Linearity	Maximum Power[1]	Connector Type	Weight	Price
8481B	10 MHz – 18 GHz	10 MHz – 2 GHz: 1.10 2 – 12.4 GHz: 1.18 12.4 – 18 GHz: 1.28	+35 to +44 dBm ±4%	0-35° C: 30W avg 35-55° C: 25W avg 0.01-5.8 GHz: 500W pk 5.8-18 GHz: 125W pk 500W-μs per pulse	N(m)	Net 0.8 kg (1.75 lb) Shipping 1.5 kg (3.25 lb)	$1,850
8482B	100 kHz – 4.2 GHz	100 kHz – 2 GHz: 1.10 2 – 4.2 GHz: 1.18			N(m)		$1,750

3 Watt Sensors 100 μW to 3W (−10 to +35 dBm)

8481H	10 MHz – 18 GHz	10 MHz – 8 GHz: 1.20 8 – 12.4 GHz: 1.25 12.4 – 18 GHz: 1.30	+25 to +35 dBm ±5%	3.5W avg, 100W pk 100W · μs per pulse	N(m)	Net 0.2 kg (0.38 lb) Shipping 0.5 kg (1 lb)	$975
8482H	100 kHz – 4.2 GHz	100 kHz – 4.2 GHz: 1.20			N(m)		$950

100 mW Sensors 1 μW to 100 mW (−30 to +20 dBm)

8485A	50 MHz – 26.5 GHz	50 – 100 MHz: 1.15 100 MHz – 2 GHz: 1.10 2 – 2.4 GHz: 1.15 12.4 – 18 GHz: 1.20 18 – 26.5 GHz: 1.25	+10 to +20 dBm +2, −4%	300 mW avg, 15W pk 30W · μs per pulse	APC-3.5mm (m)	Net 0.2 kg (0.38 lb) Shipping 0.5 kg (1 lb)	$1,200
Opt. 033	50 MHz – 33 GHz	26.5-33 GHz: 1.40					+$400
8481A	10 MHz – 18 GHz	10 – 30 MHz: 1.40 30 – 50 MHz: 1.18 50 MHz – 2 GHz: 1.10 2 – 12.4 GHz: 1.18 12.4 – 18 GHz: 1.28			N(m)		$775
8482A	100 kHz – 4.2 GHz	100 – 300 kHz: 1.60 0.3 – 1 MHz: 1.20 1 MHz – 2 GHz: 1.10 2 – 4.2 GHz: 1.30			N(m)		$775
8483A (75 Ω)	100 kHz – 2 GHz	100 – 600 kHz: 1.80 600kHz – 2 GHz: 1.18		300 mW avg, 10W pk	N(m) 75 Ω		$775
R8486A	26.5 – 40 GHz	1.4	+10 to +20 dBm +2, −4%	300 mW avg, 15W pk 30W · μs per pulse	Waveguide Flange UG-599/U	Net 0.26 kg (0.53 lb) Shipping 0.66 kg (1.3lb)	$2,300
Q8486A	33 – 50 GHz	1.5			Waveguide Flange UG-383/U		$3,000
W8486A	75-110 GHz	1.08	+1, −3%	200 mW avg 40 W peak	Waveguide Flange UG-387/U	Net 0.4 kg (0.9 lb) Shipping 1.0 kg (2.1 lb)	$5,925
8487A	50 MHz – 50 GHz	50 – 100 MHz: 1.15 100 MHz – 2 GHz: 1.10 2 – 12.4 GHz: 1.15 12.4 – 18 GHz: 1.20 18 – 26.5 GHz: 1.25 26.5 – 40 GHz: 1.30 40 – 50 GHz: 1.50	+10 to +20 dBm +2, −4%	300mW avg, 15W pk 30W · μs per pulse	2.4 mm (m)	Net 0.14 kg (0.28 lb) Shipping 0.5 kg (1 lb)	$2,500

High Sensitivity Sensors 100 pW to 10 μW (−70 to −20 dBm)

8481D[3,4]	10 MHz – 18 GHz	10 – 30 MHz: 1.40 30 MHz – 4 GHz: 1.15 4 – 10 GHz: 1.20 10 – 15 GHz: 1.30 15 – 18 GHz: 1.35	−30 to −20 dBm ±1%	100 mW avg 100 mW pk	N(m)	Net 0.18 kg (0.41 lb.) Shipping 0.9 kg (2 lb)	$1,100
8485D[3]	50 MHz – 26.5 GHz	0.05 – 0.1 GHz: 1.19 0.1 – 4 GHz: 1.15 4 – 12 GHz: 1.19 12 – 18 GHz: 1.25 18 – 26.5 GHz: 1.29	−30 to −20 dBM ±2%	100 mW avg 100 mW pk	APC-3.5 mm (m)	Net 0.2 kg (0.38 lb) Shipping 0.5 kg (1 lb)	$1,550
Opt. 033	50 MHz – 33 GHz	26.5 – 33 GHz: 1.35					+$400
8487D[3]	50 MHz – 50 GHz	0.05 – 0.1 GHz: 1.19 0.1 – 2 GHz: 1.15 2 – 12.4 GHz: 1.20 12.4 – 18 GHz: 1.29 18 – 34 GHz: 1.37 34 – 40 GHz: 1.61 40 – 50 GHz: 1.89	−30 to − 20 dBm ±2%	100 mW avg 100 mW pk	2.4 mm (m)	Net 0.2 kg (0.38 lb) Shipping 0.5 kg (1 lb)	$3,100
R8486D[3]	26.5 – 40 GHz	1.4	−30 dB to −25 dBm ±3% −25 dB to −dBm ±5%	100 mW avg or pk 40 Vdc max	Waveguide Flange UG-599/U	Net 0.26 kg (0.53 lb) Shipping 0.66 kg (1.3 lb)	$3,000
Q8486D[3]	33 – 50 GHz	1.4			Waveguide Flange UG-383/U		$3,850

[1] Negligible deviation except for those power ranges noted.
[2] For pulses greater than 30W the maximum average power (P_a) is limited by the energy per pulse (E) in W · μs according to P_a = 30-0.02E.
[3] Includes HP 11708A 30 dB attenuator for calibrating against a 0 dBm, 50 MHz power reference. HP 11708A is factory set to 30 dB ±0.05 dB at 50MHz, traceable to NIST.SWR <1.05 at 50 MHz.
[4] This sensor directly replaces the popular HP 8484A Power Sensor.

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

ELECTRONIC COUNTERS
General Information

The Hewlett-Packard counter family includes a broad selection of frequency and time-interval measurement options and a selection of modulation domain analyzers for advanced measurement and analysis requirements.

Electronic Counters

Hewlett-Packard offers the industry's broadest line of electronic counters and counter/timers: 31 models. Starting with the first frequency-measurement projects in the 1940s, Hewlett-Packard has pioneered the major technologies enabling today's electronic counters and modulation domain analyzers.

Electronic counter/timers are used throughout most technical industries for measuring and analyzing frequency, phase, and time-interval signal characteristics. The breadth of the HP offering allows the best product to be selected for each application. An ideal functional and performance fit delivers the greatest value: the best and most cost-effective solution.

HP counter/timers offer:

- High measurement accuracy
- Fast system throughput/HP-IB capability
- Low cost of ownership
- Ease of use
- Data reduction on many models
- Triggering simplicity

New Measurement Technology

Modulation domain products feature "continuous count" technology. Unlike traditional counters, these products do not stop between measurements to process data. Rather, they measure continuously and process results on-the-fly. As a result, new kinds of measurements are made possible.

Modulation domain products include those listed below.

- **HP 53310A:** Combines affordability and ease of use.
- **HP 5372A:** Provides increased functionality and higher performance.
- **HP 5373A:** Is tuned for complex signal modulations on pulsed and non-repetitive signals.

Options provide increased performance.

- **Option 040** for the HP 5372A: Offers jitter spectrum analysis for oscillators, communications, and other serial data streams.
- **Option 031** for the HP 53310A: Optimizes RF designs for DECT, CT2, and CT3 radios.

For more information on modulation domain products, see the section starting on page 180.

Counter Products

Basic and High-Performance Universal Counters

Universal counters, also called counter/timers, offer the ability to measure frequency and time intervals. Many models measure period, ratio, statistics, voltage, and totalize. Higher-performance products provide complete, automatic characterization of rise time, pulse width, and other signal parameters. Many options, such as frequency extension, voltage measurement, portable battery operation, higher performance timebases, and systems capability (HP-IB), are also available to customize the product to your specific needs.

Two new high-performance universal counters have been added to the counter product line: the HP 53131A and the HP 53132A.

The HP 53131A is designed for manufacturing test, troubleshooting, and service. This counter allows you to easily make highly reliable frequency and timing measurements. Featured are extensive in-box analysis, automatic limit testing, analog display mode, single button recall, and more. The HP 53131A's half-rack size and light weight make it well suited for both benchtop and rackmounting.

The HP 53132A is designed for high-performance ATE systems. It combines the functionality of the HP 53131A with up to 12 digit/s measurement resolution and data transfer rates up to 1000 fully-formatted measurements per second over the HP-IB.

- **HP 53131A:** New addition to product line, increased functionality.
- **HP 53132A:** New addition to product line, high resolution and data rates.
- **HP 5314A:** An affordable portable.
- **HP 5315A:** The high-performance portable.
- **HP 5316B:** The low-cost systems counter.
- **HP 5334B:** High performance at a moderate price.
- **HP 5335A:** Top performance in universal counters.

Precision Time Interval Counter

The HP 5370B universal time interval counter is optimized for precision time-interval measurements and offers time-interval resolution of 100 ps rms. It measures frequency and period (with increased accuracy per unit time compared to other counters) from dc to 100 MHz. Statistics, external trigger, systems interface (HP-IB), and other features are all standard.

- **HP 5370B:** The standard for precision time-interval measurements.

Basic RF Frequency Counters

These low-cost products provide frequency measurements dc to 3 GHz for bench and systems. HP-IB is standard. The reciprocal (high-accuracy) measurement technique is used; battery and extended-accuracy timebase are available.

- **HP 5384A:** The economical counter for systems and field service.
- **HP 5385A:** The medium-frequency, affordable, systems and field service counter.
- **HP 5386A:** The high-end (3 GHz) compact RF counter.

Microwave and Millimeter-Wave Frequency Counters

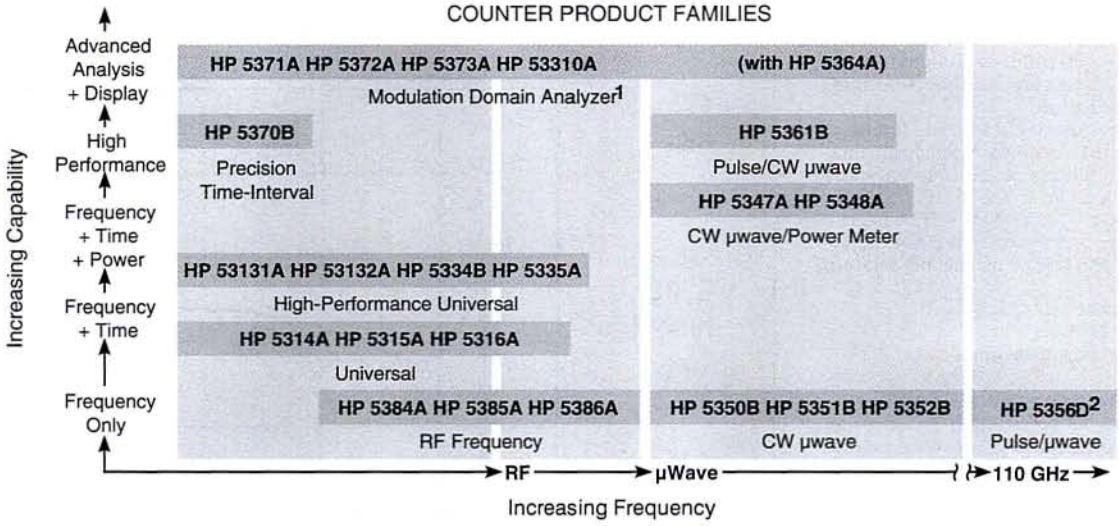
These products provide fundamental high-performance frequency measurements, dc to 110 GHz. Many enhancements—power measurement, battery operation, systems interface (HP-IB), and high-accuracy time bases—are available standard or as options.

Pulse counters add the capability to automatically measure and profile burst or pulsed microwave or millimeter-wave signals.

- **HP 5361B:** Profiles pulsed/CW microwave frequencies.
- **HP 5347A/5348A:** Portable CW microwave counter plus power meter for telecommunications service.
- **HP 5350B/5351B/5352B:** CW microwave, 10 Hz to 46 GHz.

Mature Products

For information on the mature HP counter products see pages 206 and 207.



Counter Selection Guide[3]

Model	Frequency range (extension)	Freq. resolution (1 s gate time)	Sensitivity	Time-interval res. (single-shot/ averaging)	Additional features	Page	Price	
Universal Counters								
HP 5314A	100 MHz	1 Hz	25 mV	100 ns	Battery optional	187	$795	☎
HP 5315A	100 MHz (1 GHz)	7 digits	10 mV	100 ns/10 ps	Battery optional	190	$1,495	☎
HP 5316B	100 MHz (1 GHz)	7 digits	10 mV	100 ns/10 ps	HP-IB standard	190	$1,845	☎
High-Performance Universal Counters								
HP 53131A	225 MHz (3 GHz)	10 digits	35 mV	500 ps	Optional 3-GHz channel 3	189	$1,500	
HP 53132A	225 MHz (3 GHz)	12 digits	35 mV	125 ps	HP-IB standard, optional 3-GHz channel 3	189	$2,400	
HP 5334B	100 MHz (1.3 GHz)	9 digits	15 mV	2 ns/200 ps	HP-IB standard, auto pulse characterization	192	$2,305	☎
HP 5335A	200 MHz (1.3 GHz)	9 digits	25 mV	2 ns/100 ps	HP-IB standard, dc DVM optional, auto pulse characterization	194	$5,250	
Precision Time-Interval Counter								
HP 5370B	100 MHz	11 digits	35 mV	100 ps/0.3 ps	HP-IB standard, statistics	196	$16,900	
RF Frequency Counters								
HP 5384A	225 MHz	9 digits	15 mV		HP-IB standard, battery optional	198	$1,750	☎
HP 5385A	1 GHz	9 digits	15 mV		HP-IB standard, battery optional	198	$2,175	☎
HP 5386A	3 GHz	9 digits	−33 dBm		HP-IB standard	198	$3,950	☎
CW Microwave Counters								
HP 5350B	20 GHz	1 Hz	−40 dBm		HP-IB standard, MATE optional	200	$5,950	☎
HP 5351B	26.5 GHz	1 Hz	−40 dBm		HP-IB standard, MATE optional	200	$7,150	
HP 5352B	40 GHz (46 GHz)	1 Hz	−30 dBm		HP-IB standard, MATE optional	200	$11,000	
CW Microwave Counter/Power Meters								
HP 5347A	20 GHz	1 Hz	−32 dBm		HP-IB optional, battery optional, −70dBm to +20 dBm power range	202	$8,750	
HP 5348A	26.5 GHz	1 Hz	−32 dBm		HP-IB optional, battery optional, −70 dBm to +20 dBm power range	202	$9,850	
Pulsed/CW Microwave Counter								
HP 5361B	20 GHz	1 Hz	−32 dBm		HP-IB standard, MATE optional, full microwave pulse measurements, automatic pulse profiling	204	$12,495	

1. Information on the modulation domain analyzers starts on the next page.
2. For frequencies above 46 GHz, see the HP 5356D on page 207.
3. See pages 206–207 for information about mature products. For modular counters, see the VXI products on page 75.

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

Modulation Domain Analysis: A New View of Complex Signals

As a pioneer of counter/timer technology, Hewlett-Packard recognized a need to expand traditional frequency and time measurement techniques. With modulation domain analyzers, HP offers a unique method for viewing complex signals that is both intuitive and insightful.

Oscilloscopes display amplitude (voltage) versus time: the time domain. Spectrum analyzers show amplitude versus frequency: the frequency domain. The HP 53310A, HP 5371A, HP 5372A, and HP 5373A bring a new dimension to frequency and time-interval analysis with views of the modulation domain:

- Frequency versus time
- Phase versus time
- Time interval versus time

Improved Measurement Analysis

A wide range of applications benefit from modulation domain analysis. Jitter measurements in digital communication systems, disk and tape drives, and mechanical systems are dramatically improved. Identify the sources of jitter—the first step in improving system performance.

Modulation domain analyzers simplify the study of step response for voltage-controlled oscillators (see Figure 1). They easily characterize the frequency-hopping performance of an agile transmitter. Chirp linearity and phase switching in radar systems are easily understood from displays of frequency or phase versus time.

For more examples of applications that benefit from modulation domain analysis, see the next section which covers the specific HP modulation domain analysis products.

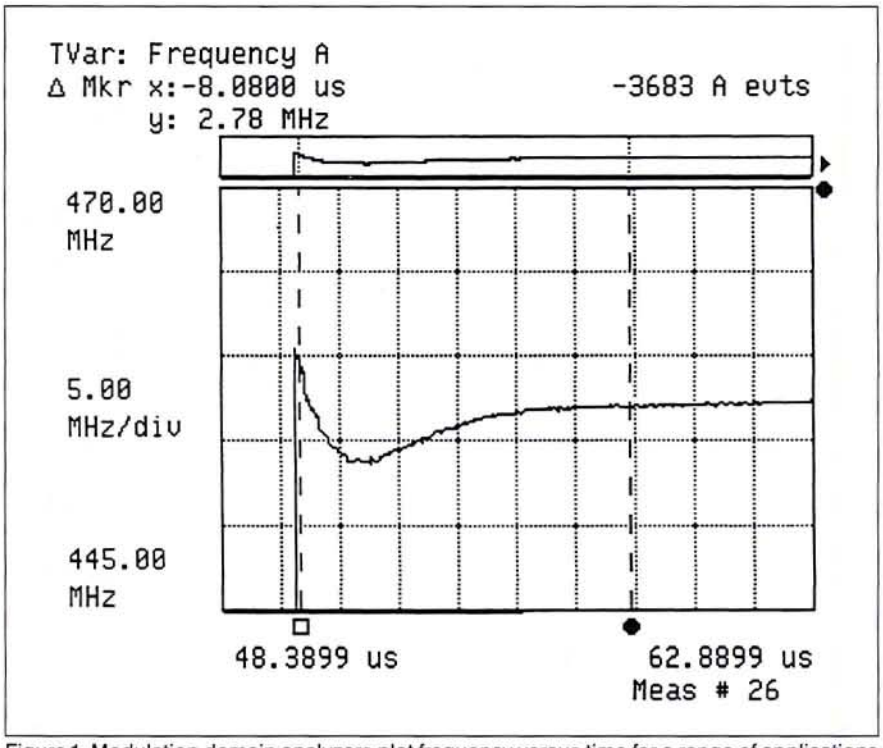


Figure 1. Modulation domain analyzers plot frequency versus time for a range of applications including the simplified, direct characterization of voltage-controlled oscillators. View the step response and analyze ringing and overshoot, settling time, and post-tuning drift.

Application Details

Discover new ways to view signals—new perspectives for solving elusive problems or fine-tuning product performance. Contact your local sales office for a demonstration of an HP modulation domain analyzer, or request the application notes that describe this breakthrough measurement technique.

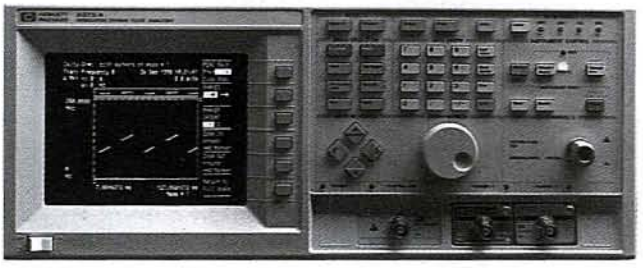
Modulation Domain Analyzer Selection Guide

Model	Frequency range (extension)	Single-shot freq. res. (1s gate)	Time-interval resolution (single-shot/ averaging)	Maximum continuous meas. rate (meas/s)	Memory size	Output meas/s	Analysis and display	Page	Price
HP 5371A	500 MHz (18 GHz)[1]	10 digits	150 ps/1 ps	10 M	1000	HP-IB: to 20,000	Frequency and time vs. time Software histogram Event timing graph Numeric display	185	$24,500
HP 5372A	500 MHz (2 GHz) (18 GHz)[1]	10 digits	150 ps/1 ps	13 M	8000	HP-IB: to 20,000 Fast Port: to 13×10^6	As HP 5371A plus: Hardware histogram Frequency and time vs. time average Pre-triggering Time deviation (jitter) Phase deviation Window margin analysis Jitter spectrum analysis (Option 040)	185	$30,000*
HP 5373A	500 MHz (2 GHz) (18 GHz)[1]	10 digits	150 ps/1 ps	13 M	8000	HP-IB: to 20,000 FastPort: to 13×10^6	As HP 5372A plus: Frequency, phase, and time vs. time Pulse carrier frequency Chirp deviation Pulse width, PRI, PRF Peak power, % AM	185	$32,000*
HP 53310A	200 MHz (2.5 GHz) (18 GHz)[1]	10 digits	200 ps/1 ps	25 M	8000 (32,000 w/Opt 001)	HP-IB: to 20,000	Frequency and time vs. time Autoscale (setup) Large display Jitter analysis Simple triggering Digital RF communications (Option 031)	186	$9,500

[1] Requires HP 5364A
* Includes half day on-site productivity assistance.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Characterize frequency, phase, and time-interval versus time
- Fast time-interval histogram analysis
- Jitter spectrum analysis
- 150 ps rms single-shot resolution, 2 ps resolution with averaging
- Choice of products to fit project requirements and budgets
- DECT, CT2, CT3 mobile communications measurements



HP 5372A

HP 53310A

NEW

The Modulation Domain: Viewing Complex Signals

Hewlett-Packard frequency and time-interval analyzers offer a view of information that traditional measurement techniques miss. The modulation domain—mapping frequency, phase, or time-interval vs. time—can more effectively characterize:

- Data storage products
- Radar systems
- Communication systems
- Electromechanical systems
- Frequency stability
- VCOs
- Frequency agile systems

This new view of data is intuitive and offers a direct view of jitter or modulation. The HP modulation domain analyzers provide insight into changes of frequency or time intervals.

A Choice of Solutions

Choose from four HP modulation domain analyzers based on your project requirements.

Affordability and Ease of Use

The most affordable modulation domain analyzer, the HP 53310A, includes many innovations for ease of use. Characterization of modulation and jitter is easier with built-in analysis. Parameters such as peak-to-peak deviation, carrier frequency, and modulation rate are all quickly and automatically displayed. Jitter analysis is simplified with automated mean, standard deviation, and probability functions.

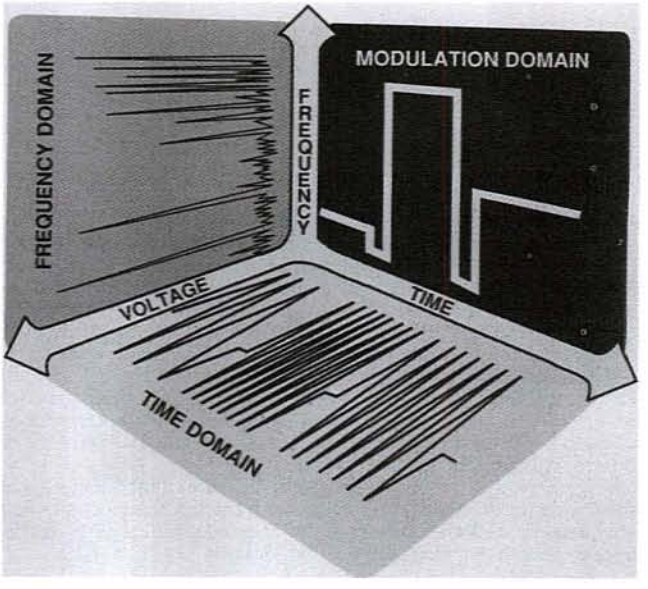
Measurement Versatility

In addition to offering expanded functionality, the HP 5371A and HP 5372A can analyze signals ranging up to 500 MHz, or (with an optional configuration of the HP 5372A) up to 2 GHz. Up to eighteen measurement functions and increased display modes offer the versatility to handle a broad range of situations. With a new hardware option, the HP 5372A can compute and display a spectral presentation of jitter data without the need for an external computer or special processor.

Based on the same technology, the HP 5372A is a superset of the HP 5371A. Choose the lower-priced HP 5371A or more powerful HP 5372A based upon your project constraints.

Pulsed Systems Design and Analysis

The HP 5373A Modulation Domain Pulse Analyzer minimizes the design and testing effort for radar systems, and enhances design efforts for EW, ELINT, IFF, and related equipment and components. The analyzer measures modulation and carrier frequency on pulsed RF signals to 500 MHz. A detector channel can precisely measure envelope parameters such as pulse width and PRT, peak envelope power, percent AM, jitter, and more. The HP 5373A is easy to use and attractively priced compared to specialized or home-grown test sets used for radar and related advanced systems design.



ELECTRONIC COUNTERS

Modulation Domain Analyzers (cont'd)

HP 5371A, 5372A, 5373A, 53310A

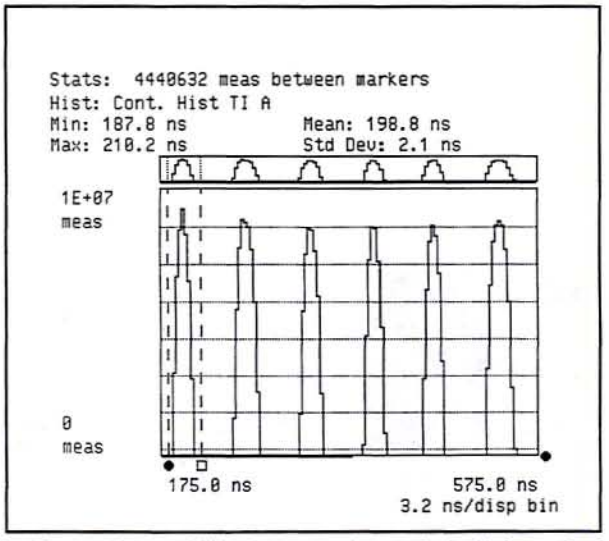
Measurement Solutions

Window Margin Analysis for Disk and Tape Drive Characterization

The HP 5372A features hardware data reduction to sort time-interval measurements into histograms as fast as 13.3 million measurements per second. Analyze data from a histogram, or have the HP 5372A display window margin information directly. These are fast and accurate methods of viewing a drive's overall timing performance in research and development or in production.

Use the time-interval detect capability of the HP 5372A to monitor for timing errors. An inhibit input can gate out sector header, ECC, and servo fields to measure only in data fields.

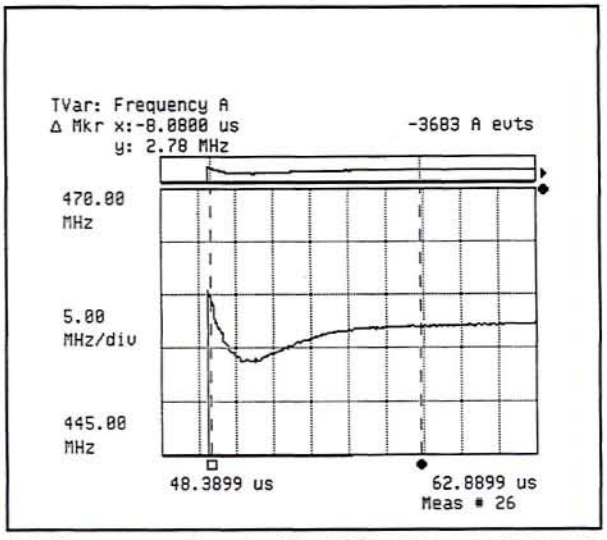
The HP 5372A can measure data-to-data as fast as every 75 ns. For faster systems, a random event sampling mode ensures that histogram information is equally sampled across all code spacings.



Flexible graphic capabilities let you retrieve statistical information for any single distribution of this RLL (2,7) histogram.

Direct VCO Characterization with Frequency Versus Time Displays

Voltage-controlled oscillators are a key component in many electronic systems. VCO switching and settling characteristics directly affect total system performance. Switching and settling measurements have traditionally been made using discriminators and a storage oscilloscope, but the modulation domain simplifies this characterization by directly showing frequency or phase settling versus time. View the step response and easily characterize ringing and overshoot, settling time, and post-tuning drift. The optional 2-GHz Channel C on the HP 5372A or HP 53310A extends VCO analysis to cover 100-MHz to 2-GHz frequency steps. The HP 5364A Microwave Mixer/Detector lets you analyze VCO's operating between 2 GHz and 18 GHz.



A plot of frequency vs time simplifies VCO switching and post-tuning drift analysis.

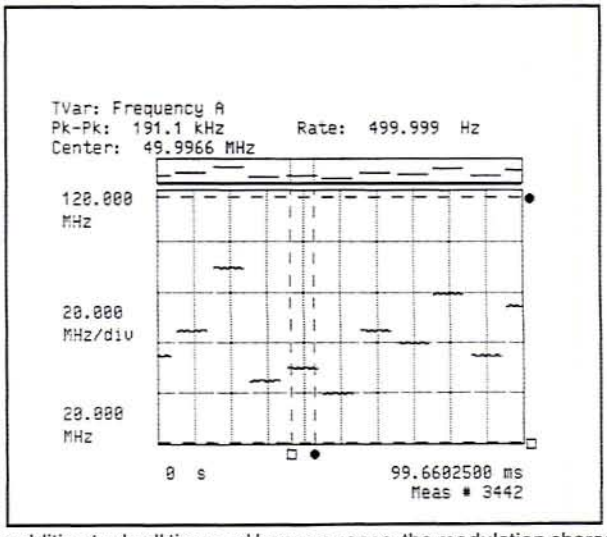
A Clear Picture of Agile Signals

Characterization of agile transmitters is difficult in the time or frequency domains. Pseudo-random selection of the carrier means repetitive techniques are inadequate to properly characterize an agile radio's performance. "Golden receiver" or back-to-back testing, where transmitters and receivers are tested in pairs, yield little quantitative information about the radio's performance.

The modulation domain provides a clear view of these agile signals. Parameters such as dwell time, hop rate, and carrier settling time can be obtained from the graphic display. Modulation parameters such as peak-to-peak deviation, center frequency, and modulation rate can be easily displayed.

A histogram of frequencies is a clear measure of random usage of the frequency spectrum. Flat histogram characteristics indicate when channels are used with equal probability, providing the highest resistance to jamming and communication security.

- Direct frequency vs. time profiles of agile signals
- Characterize switching time, settling time, and hopping rate
- Examine modulation on agile carriers

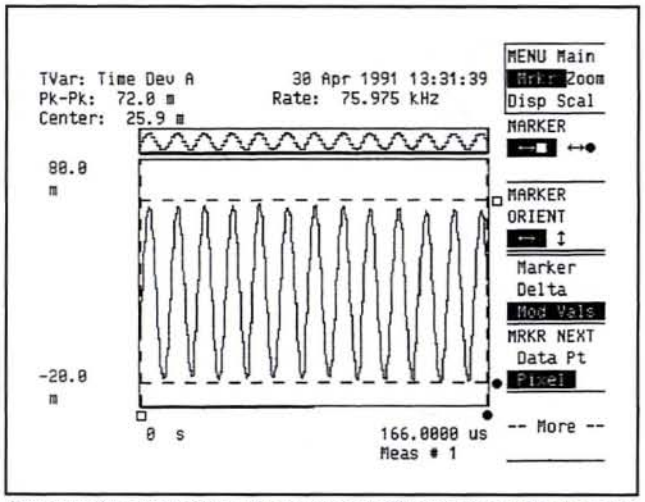


In addition to dwell time and hop sequence, the modulation characteristics on the agile carrier can easily be examined using the HP 5373A time variation graph.

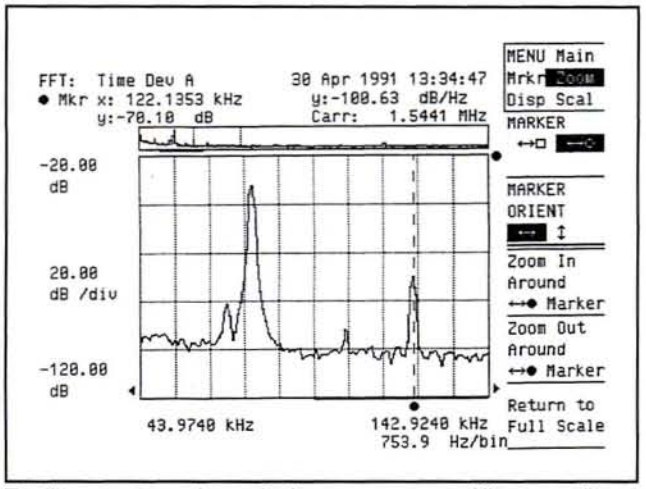
Flexible Jitter Spectrum Analysis for Digital Communications

The HP 5371A and HP 5372A frequency and time-interval analyzers can be used to characterize jitter or phase noise in digital communications, oscillators, and other serial data systems. The HP 5371A measures and displays the variations of period jitter with time or in a histogram. The HP 5372A adds the capability to display jitter as the variation of the significant instants from the ideal timing position (the time deviation function).

With the new Jitter Spectrum Analysis feature (Option 040) of the HP 5372A, jitter spectrum measurements are possible with higher resolution than current jitter test sets. Any clock rate, including nonstandard rates, can be accommodated or measurements made without the presence of a clock. The jitter bandwidth can exceed 2 MHz. The Jitter Spectrum Analysis option is ideal for characterizing the phase noise performance of low-cost oscillators and synthesizers. This new option of the HP 5372A eliminates the need for an external computer for analysis.



Jitter as a function of time. A strong periodic component is shown in this jitter vs. time graph. The rate of the jitter and the peak-to-peak jitter are displayed in Unit Intervals.

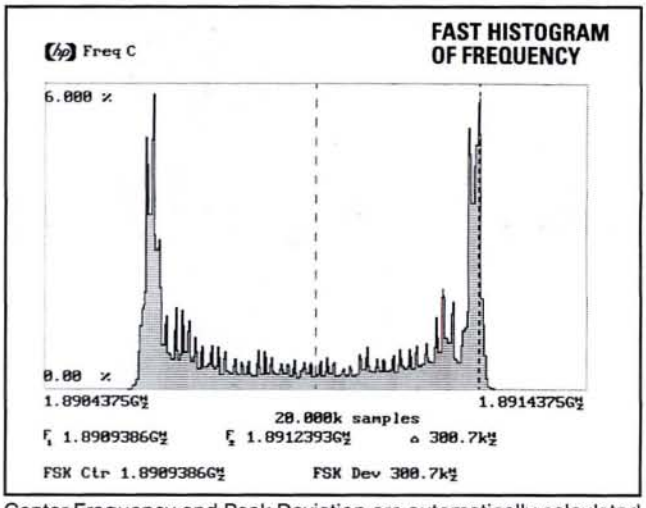


The jitter spectrum shows the large component of jitter as well as a smaller spur. The HP 5372A Jitter Spectrum Analysis (Option 040) enables the viewing of all components of jitter.

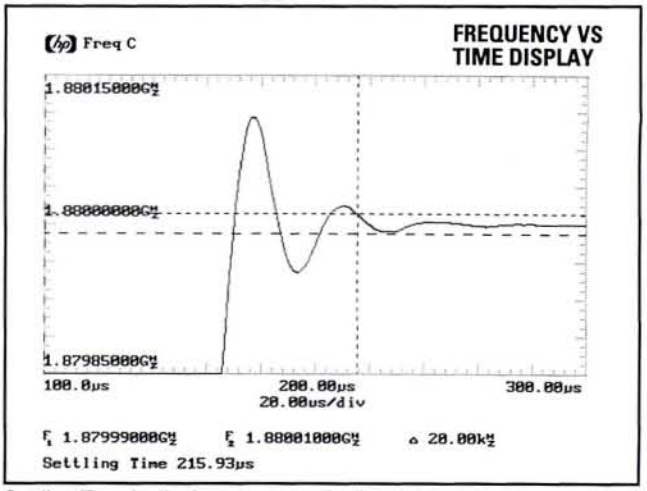
Modulation Analysis for Mobile Communications

The HP 53310A's new Option 031 "Digital RF Communications Analysis/High Resolution 2.5 GHz Input" provides automatic measurements of synthesizer settling time, Frequency Shift Keyed (FSK) center frequency, and FSK peak deviation on DECT, CT2, and CT3 radios. Features for optimizing RF designs include:

- **High resolution measurements**—built-in downconversion provides superior frequency resolution for RF signals.
- **Time referenced trigger**—measurements can be referenced in time to an external trigger. Accurately reference your synthesizer settling time to the step command edge.
- **Increased modulation bandwidth**—sample rates up to 7.5 MHz can be achieved for repetitive signals, extending the modulation bandwidth to cover fast data rate systems (DECT).
- **RF envelope trigger**—simplifies measurement setup by automatically triggering on a detected TDMA burst.



Center Frequency and Peak Deviation are automatically calculated from frequency histograms.



Settling Time is displayed automatically on this direct measurement of the synthesizer step.

ELECTRONIC COUNTERS

Modulation Domain Analyzers (cont'd)

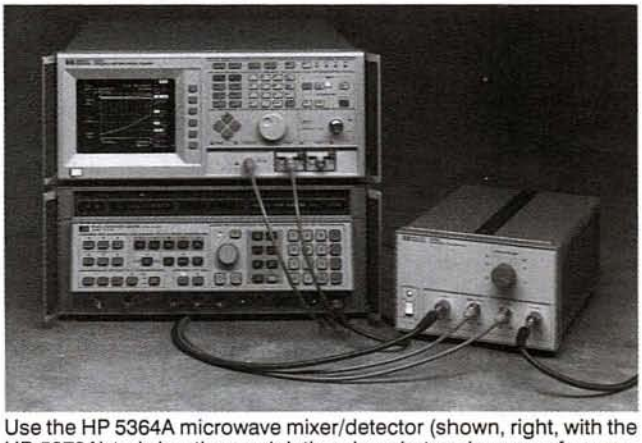
HP 5371A, 5372A, 5373A, 53310A

Powerful Radar Signal Characterization

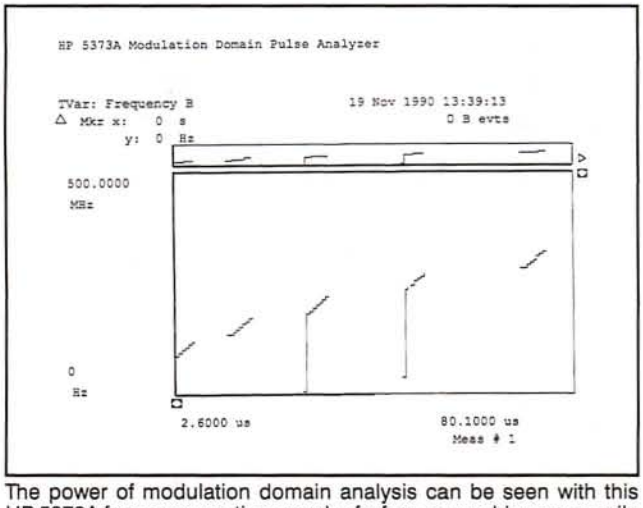
Combining the HP 5364A microwave mixer/detector with an HP modulation domain analyzer and a local oscillator extends the modulation domain to 18 GHz.

The HP 5364A microwave mixer/detector is designed to ensure downconversion with minimal distortion and group delay over its 500-MHz IF bandwidth. Configure the HP 5364A with your own local oscillator or an HP source such as the HP 8671A synthesized CW generator, the HP 8673C synthesized signal generator, or the HP 8673E synthesized signal generator. In addition to the IF channel, the HP 5364A provides a video detector output to trigger the HP 5373A. The video output can also be used to directly measure pulse width, rise and fall time, and PRF/PRI.

Radar chirp-linearity is easily characterized in the modulation domain. The HP 5364A microwave mixer/detector can be used to downconvert the chirp to baseband, maximizing measurement resolution. A frequency vs. time display clearly shows deviation from linearity. The HP 5373A features display-averaging which dramatically improves the resolution of measurements on repetitive signals.



Use the HP 5364A microwave mixer/detector (shown, right, with the HP 5373A) to bring the modulation domain to microwave frequencies between 2 and 18 GHz. The HP 5364A can be used with any modulation domain analyzer.



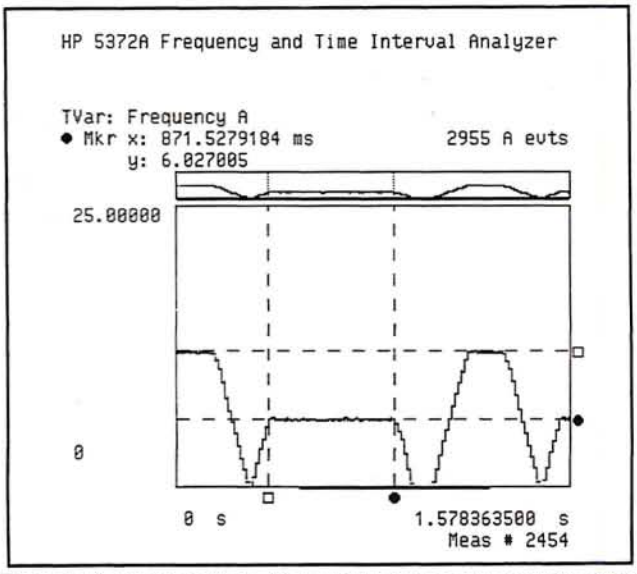
The power of modulation domain analysis can be seen with this HP 5373A frequency vs. time graph of a frequency chirp on an agile carrier with a varying PRI.

Characterize Motion Control Systems

Pulse encoders for motion control systems deliver pulse streams that correspond to linear or rotary position. Position and velocity can be analyzed by characterizing the timing of pulses delivered by the encoder.

Continuous time-interval and frequency measurements with the HP 53310A give insight about positioning system performance. Variations in velocity or rotational non-linearities can be easily analyzed by viewing the time variation display: a plot of velocity versus time. For closed-loop systems, factors such as system damping, overshoot, and response time can be quickly verified—independently of the system's control.

- Rotational or linear velocity vs. time profiles
- Position control analysis
- Analyze damping, overshoot, and response time



The velocity (frequency) vs. time graph allows easy analysis of the print sweep and double-speed return of a motion-control servo used in a graphics printer.

HP 5371A, HP 5372A, and HP 5373A Summary

Basic Performance

- Continuous measurements to a 10 MHz rate (13.3 MHz rate using the HP 5372A or HP 5373A fast-measurement mode)
- 125 mHz to 500 MHz frequency range. 100 MHz to 2 GHz in optional Channel C (HP 5372A or HP 5373A)
- −4.0 to +4.0 s or 10 ns to 8 s time-interval range
- 150 ps rms single-shot time-interval resolution, 10 digits per second frequency resolution
- 1 ns minimum input pulsewidth
- 2 mV trigger level resolution; auto-trigger capabilities
- Selection of input pods: 50 Ω, 1 MΩ, or 10 kΩ, 2 pf active

Arming and Triggering Capabilities

- Measurement holdoff by time, events, or signal edge
- Measurement sample by time, events, signal edge, or parity
- Arm on any of 3 input channels: external arm, input A, or input B

Measurements

Function	Range
Frequency A[1], B[1]	125 mHz to 500 MHz 8 kHz to 500 MHz[2]
Frequency C[1] (HP 5372A/73A)	100 MHz to 2 GHz
Frequency A&B, A&C, B&C, A+B, A+C, B−A, C−A, B+C, C−B, A/B, B/A, A/C, C/A, B/C, C/B	250 mHz to 500 MHz (A and B) 16 kHz to 500 MHz (A and B)[2] 100 MHz to 2 GHz (C)
Period A[1], B[1]	2 ns to 8 seconds 2 ns to 131 μs[2]
Period C[1] (HP 5372A/73A)	500 ps to 10 ns
Period A&B, A&C, B&C, A+B, A+C, B−A, C−A, B+C, C−B, A/B, B/A, A/C, C/A, B/C, C/B	2 ns to 4.0 s (A and B) 2 ns to 65 μs (A and B)[3] 500 ps to 10 ns (C)
Totalize A, B, A&B, A+B, A−B, B−A, A/B, B/A	0 to (2^{32} − 1) events, each channel
Time interval A, B, A−>, B−>A	10 ns to 8.0 seconds 10 ns to 131 μs[3]
Continuous time interval A[1], B[1]	100 ns to 8.0 seconds 75 ns to 131 μs[3]
± Time interval A, B, A−>B, B−>A	−4.0 s to +4.0 s including 0 s −65 μs to +65 μs including 0 s[3]
Rise and fall time A[2]	1 ns to 100 μs (auto-trigger)
Positive and negative pulsewidth A[2]	1 ns to 1 ms (auto-trigger)
Duty cycle A[2]	0% to 100% for pulsewidths >1 ns and periods <1 ms (auto-trigger)
Phase A rel B, B rel A	0° to > ±360°
Peak amplitudes A, B	1 kHz to 200 MHz, 200 mV peak-to-peak to 2 V peak-to-peak

[1] Maximum sample rate for these measurements is 10 MHz (100 ns), and up to 13.3 MHz (75 ns) using the HP 5372A or HP 5373A fast-measurement mode. For all other measurements, maximum sample rate is 5 MHz (200 ns) in the normal measurement mode and 7.7 MHz (135 ns) in the fast-measurement mode.
[2] Requires 8 ns setup time between measurements.
[3] Fast measurement mode values (HP 5372A or HP 5373A).

HP-IB Performance and Features

- Up to 20,000 measurements/second throughput (HP 5371A), 25,000 for HP 5372A and HP 5373A (binary format)
- Three output formats: ASCII, floating-point, or binary
- Full programmability
- Direct graphics output to printer or plotter

Analysis Features

- Time variation of measurements: frequency versus time, time interval versus time, and phase versus time. Averaged plots to improve vertical resolution are obtainable using the HP 5372A or HP 5373A.
- Histogram
- Fast time-interval histogram (HP 5372A or HP 5373A; histograms computed at measurement rate)
- Event timing plots
- Limit test
- Statistics: mean, minimum, maximum, standard deviation, variance, rms
- Allan variance, root Allan variance
- Window margin analysis (HP 5372A only)
- Modulation parameters: center frequency, peak-peak deviation, modulation rate
- Frequency deviations from a linear chirp (HP 5373A only)
- Function keys for pulsed signal analysis: PRF, PRI, % AM envelope measurements (HP 5373A only)
- Jitter spectrum analysis (HP 5372A only)

HP 5364A Microwave Mixer/Downconverter

- 2 to 18 GHz input frequency range
- 10 to 500 MHz IF output range
- 2.2 GHz to 18 GHz local oscillator input range
- Built-in manual attenuator
- 73 dB RF input dynamic range for pulse signals, 53 dB for CW signals
- APC 3.5 (m) connectors for RF and LO inputs
- <7.5 ns video output risetime
- Less than 1 ns group delay over 500 MHz IF output range

HP 53700A Continuous Measurement Software

These compiled subroutines simplify and speed binary programming for the HP 5371A and HP Series 300 computers. Sample programs are included. Software is supported with the HP 5371A only.

Ordering Information

	Price
HP 5371A Frequency and Time Interval Analyzer	$24,500
HP 5372A Frequency and Time Interval Analyzer The HP 5371A and HP 5372A both include two HP 54002A 50 Ω input pods.	$30,000*
HP 5373A Modulation Domain Pulse Analyzer Includes one HP 53702A 500-MHz envelope detector, one HP 54002A 50 Ω input pod.	$32,000*
Options (HP 5371A, HP 5372A, HP 5373A)	
Opt W30 Extended Repair Service (see page 636)	
Opt W32 Calibration Service (see page 636)	
Options (HP 5372A, HP 5373A only)	
Opt 020 FastPort Data Output	+$1,600
Opt 030 2-GHz Channel C (front-panel input)	+$2,150
Opt 060 Rear-Panel Inputs (50 Ω BNC) for channels A and B. 1 MΩ BNC for external arm. Deletes front panel inputs.	$0
Options (HP 5372A only)	
Opt 040 Jitter Spectrum Analysis	+$2,000
Opt 090 Rear Panel Inputs for Channels A, B, and C. 1 MΩ BNC for External Arm, 50 Ω BNC for channels A and B, type N connector for C. Deletes front panel inputs.	+$2,150
HP 5364A Microwave Mixer/Detector	$13,650
HP 53700A Continuous Measurement Software (supported with HP 5371A only)	$1,250
Accessories	
HP 54001A 1-GHz Active Pod (10:1, 10K)	$830
HP 54002A 50 Ω Pod	$160
HP 54003A 1 MΩ Pod (with 10:1 scope probe)	$720
HP J06-59992A Time Interval Calibrator	$3,000

*Includes half day on-site productivity assistance.

For the most current prices and product information, contact your local Hewlett-Packard sales office, see page 665.

ELECTRONIC COUNTERS
Frequency and Time Interval Analyzers
HP 53310A

HP 53310A Modulation Domain Analyzer

With the HP 53310A, HP advances modulation domain technology in two directions: affordability and ease of use. Key features of this newest frequency and time-interval analysis product include:

- **Automated setup:** A single button can set up the HP 53310A for measurement. Settings are selected by automatic signal evaluation.
- **Single-touch measurements:** Peak-to-peak deviation, carrier frequency, and modulation rate are easily and quickly measured for quantifying jitter and modulation. The Save/Recall function stores up to 10 measurement steps for fast repeat operations.
- **One-button statistics:** Mean, standard deviation, and probability functions are simplified for easy jitter analysis.
- **Softkey-driven menus:** Measurement parameters and analysis functions are easily selected while measurement data is displayed.
- **Large display:** The expanded screen displays measurement results clearly and aids analysis.
- **Low cost:** The HP 53310A is priced to fit budget-constrained projects and departments.

Product Description

The HP 53310A offers powerful analyzer features:

- **Dual timebases:** A main timebase and a window timebase allow data capture while viewing measurement details in the window.
- **Auto or triggered operation:** Select auto, edge-triggering (rising or falling), or a new, unique feature: measurement value triggering (frequency or time-interval). Value triggering can eliminate the need for and expense of external sync signal generation. This can shorten project time and lower costs.
- **Display vs. time or histogram:** Select the appropriate view.
- **Fast histograms:** Up to 16 million measurements/acquisition.
- **Automated measurements:** Autoscale selects appropriate setup parameters; built-in analysis functions eliminate calculations.

Specifications*

Frequency Measurements

Range: 10 Hz to 200 MHz (Channel A)
10 Hz to 100 MHz (Channel B)
50 MHz to 2.5 GHz (Channel C)
Maximum Measurement Rate: 1 MHz (1.5 MHz for fast histograms)

Time Interval Measurements

+ Time interval:
Range: +20 ns to +1 s
Maximum measurement rate: 1.25 MHz (2.5 MHz for fast histograms)
± Time interval:
Range: −0.5 s to +0.5 s
Maximum measurement rate: 1.25 MHz (2.0 MHz for fast histograms)

Time Axis in Versus Time

Resolution:
Main timebase setting/45 (with panorama off)
Window timebase setting/45 (with panorama on)

Inputs

Channels A and B
Sensitivity (minimum hysteresis): 20 mV rms sinewave to 100 MHz (25 mV rms sinewave for Freq A from 100 to 200 MHz)
Minimum pulse width: 5 ns at 60 mV peak-to-peak (2.5 ns at 75 mV peak-to-peak for Freq A ≥ 50 MHz)
Input amplifier noise: 600 μV rms
Threshold drift: ±3 mV after warmup at 25° C
Voltage threshold accuracy: ±(25 mV + 1% of threshold value)
Maximum hysteresis: Increases the minimum input signal amplitude required by factor of 3 (increased noise immunity)
Impedance: 50 Ω or 1 MΩ (500 kΩ in common)
AC coupling: 100 Hz cutoff frequency
Capacitance (1 MΩ): <20 pF (<30 pF in common)
Dynamic range (ac): 60 mV peak-to-peak to 5 V peak-to-peak
Signal operating range (dc): ±10 V (1 MΩ), ±5 V (50 Ω)
Damage level: 5 V rms (50 Ω); 40 V rms for <5 kHz, 5 V rms for >5 kHz (1 MΩ)

Channel C (Opt 030)
Sensitivity: −25 dBm to 1.5 GHz, −20 dBm from >1.5 to 2.0 GHz, −15 dBm from >2.0 to 2.5 GHz
Maximum input level: +7 dBm
Damage level: +15 dBm
External Arm
Impedance: 1 MΩ
Delay: <10 ns
Note: Sensitivity, minimum pulse width, signal operating range and damage level of external input are the same as for Channel B.

Frequency Reference

Standard Crystal (See page 196)
Temperature stability: $<8 \times 10^{-6}$, referenced to 25° C
Short-term stability: $<4 \times 10^{-9}$ for 1 second average
Aging rate: $<3 \times 10^{-7}$ per month
Opt 010: High-stability oven reference (see page 196)
Temperature stability: $<7 \times 10^{-9}$ referenced to 25° C
Short-term stability: $<4 \times 10^{-11}$ for 1 second average
Aging rate: $<5 \times 10^{-10}$ per day, $<1 \times 10^{-7}$ per year
Warm-up: Within 5×10^{-9} of final value (frequency 24 hours after turn-on) 10 minutes after turn-on.

Rear-Panel Connectors

HP-IB
Full programmability: All instrument settings and operating modes except specific self-test routines
Data acquisition and transfer rate: For 450-point data record, approximately 17 times/sec with an HP 9000 Series 300 (when measuring, for example, a 1-MHz carrier with a timebase setting of 40 μs/division)
Data transfer rate: Approximately 175 kB/s
Interface capabilities: SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E2
Test Limit Output
Operation: Goes high when measurements fall outside the display range of the fast histogram
Operating range: Low < 0.6 V and high > 1.5 V into 50 Ω
Frequency Standard Input
Frequency: 5 MHz or 10 MHz
Operating range: 1 V peak-to-peak to 5 V peak-to-peak into 1 kΩ
Damage level: 10 V rms
Frequency Standard Output
Frequency: 10 MHz, or External Reference if frequency standard input selected
Operating range (ac-coupled): >1 V peak-to-peak square wave (50 Ω), >2 V peak-to-peak square wave (1 MΩ)
Power Requirements
Voltage: 115/230 V ac (−25% to +15%)
Frequency: 48 to 66 Hz
Maximum power: 300 VA

General

Operating Temperature: 0° to 55° C
Size: 194 mm W × 425 mm H × 363 mm D (440 mm D, handle extended)
Weight: Net, 10 kg; shipping, 18 kg

Ordering Information

	Price
HP 53310A Modulation Domain Analyzer	$9,500
Opt 001 Extended Measurement Memory (4 X)	$500
Opt 010 High-Stability Oven Timebase	$1,600
Opt 030 2.5-GHz Channel C	$1,450
Opt 031 Digital RF Communications	$5,000
Opt W30 Extended Repair Service (see page 636)	$235
Opt W32 Calibration Service (see page 636)	$380
HP 5364A 2 to 18 GHz Mixer/Detector	$13,650
HP J06-59992A Time Interval Calibrator	$3,000

*For complete specifications on the HP 53310A see data sheet #5091-2596. For specifications on Option 031 see data sheet #5091-2597.

- 100 MHz
- 100 ns time interval
- Portable

HP 5314A

HP 5314A Universal Counter

The HP 5314A Universal Counter combines excellent performance and traditional HP quality at a very attractive price. This counter is designed to deliver reliable, high-quality operation in such areas as production test, frequency monitoring, education, training, service, and calibration. A battery (Option 002) makes the HP 5314A especially attractive for field and portable applications.

Specifications

Input Channel Characteristics (A and B)

Range: Channel A: 10 Hz to 10 MHz direct
1 MHz to 100 MHz prescaled
Channel B: 10 Hz to 2.5 MHz
Sensitivity: Channel A: 25 mV rms to 100 MHz
75 mV peak-to-peak at minimum pulse width of 5 ns (100 MHz range)
Channel B: 25 mV rms to 2.5 MHz
75 mV peak-to-peak at minimum pulse width of 200 ns
Coupling: ac
Impedance: 1 M Ω nominal shunted by less than 30 pF
Attenuator: ×1 or ×20 nominal (channel A only)
Trigger Level: Continuously variable ± 350 mV times attenuator setting around average value of signal
Slope: Independent selection of + or − slope
Channel Input: Selectable SEPARATE or COMMON A
Dynamic Range: 75 mV peak-to-peak to 4 V peak-to-peak

Frequency

Range: 10 Hz to 10 MHz direct count
1 to 100 MHz prescaled by 10
Least Significant Digit (LSD) Displayed: Direct count 0.1 Hz, 1 Hz, 10 Hz switch-selectable. Prescaled 10 Hz, 100 Hz, 1 kHz switch-selectable
Resolution: ± LSD
Accuracy: ± LSD ± (time base error) x freq

Period

Range: 10 Hz to 2.5 MHz
LSD Displayed: $\frac{100\text{ ns}}{N}$ for N=1 to 1000 in decade steps of N
Resolution: ± LSD ± $\frac{(1.4 \times \text{Trigger Error})}{N}$
Accuracy: ± LSD ± $\frac{(1.4 \times \text{Trigger Error})}{N}$
± (timebase error) × period

Time Interval

Range: 250 ns to 1 s
LSD Displayed: 100 ns
Resolution: ± LSD ± START trigger error ± STOP trigger error
Accuracy: ± LSD ± START trigger error
± STOP trigger error ± (timebase error) × TI
External arming required for START/STOP channels

Ratio (A to B)

Range: 10 Hz to 10 MHz Channel A
10 Hz to 2.5 MHz Channel B
LSD Displayed: 1/N in decade steps of N for N = 1 to 1000
Resolution: ± LSD ± (B trigger error × frequency A)/N
Accuracy: ± LSD ± (B trigger error × frequency A)/N

Totalize

Range: 10 Hz to 10 MHz
Resolution: ± 1 count of input
Totalize controlled by front panel switch

General

Check: Counts internal 10 MHz oscillator
Display: 7-digit amber LED display with gate and overflow indication
Max Sample Rate: 5 readings per second
Operating Temperature: 0° to 50° C
Power Requirement: 115V, +10%, −25%; 230 V, +9%, −17%; 48 to 66 Hz; 10 VA max
Weight: 2.0 kg (4.4 lb)
Size: 238 mm W × 98 mm H × 276 mm D (9⅜ in × 3⅞ in × 10⅞ in)
Timebase (see page 196)
Frequency: 10 MHz
Aging rate: < 3 parts in 10^7 per month
Temperature: < ± 1 part in 10^6, 0° to 50° C
Line voltage: < ± 1 part in 10^7 for ± 10% variation

Options

Option 001: High-stability timebase (TCXO); see page 196
Frequency: 10 MHz
Aging rate: < 1 part in 10^7 per month
Temperature: < ± 1 part in 10^6, 0° to 40° C
Line voltage: < ± 1 part in 10^8 for ± 10% variation
Option 002: Battery
Type: Rechargeable lead-acid (sealed)
Capacity: Typically 8 hours of continuous operation at 25° C
Recharging time: Typically 16 hours to 98% of full charge, instrument non-operating. Charging circuitry included with option. Batteries not charged during instrument operation.
Battery voltage sensor: Automatically shuts instrument off when low-battery condition exists.
Line-failure protection: Instrument automatically switches to batteries in case of line failure.
Weight: Option 002 typically adds 1.5 kg (3.3 lb) to weight of instrument.

Accessories

Carrying case for half-rack-size instruments

Definition

Trigger error:

$$\frac{\sqrt{(80\mu V)^2 + e_n^2}}{\text{input slew rate at trigger point } (\mu V/s)} \text{ (rms)}$$

where e_n is the rms noise of the input for a 100 MHz bandwidth in Channel A and 10 MHz bandwidth in Channel B.

Ordering Information

	Price
HP 5314A 100 MHz/100 ns Universal Counter	$795
Opt 001 High-Stability Timebase	+ $180
Opt 002 Battery	+ $200
Opt W30 Extended Repair Service (see page 636)	+ $45
Opt W32 Calibration Service (see page 636)	+ $565
HP 34110A Carrying Case	$90
All orders must include one of these line power options:	
Opt 115 86 to 127 V	$0
Opt 230 190 to 250 V	$0

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

ELECTRONIC COUNTERS

HP's Newest Universal Counters

HP 53131A/53132A

- Two-channel frequency and time measurement to 225 MHz (3 GHz optional)
- Time interval resolutions of 125 and 500 ps
- Frequency resolution of 10 and 12 digits per second
- Single-key setup recall
- Very high measurement throughput

HP 53131A / 53132A: Bench and ATE tools for the professional

NEW

DESIGNED FOR HP-IB SYSTEMS

HP 53131A and HP 53132A Universal Counters

A Range of Solutions

The new HP 53131A and HP 53132A universal counters offer exceptional price and performance in a rugged, lightweight, half-rack package. Between them, they address needs that range from general bench top applications in manufacturing test and service to very high-speed automatic test systems.

Both counters use a sophisticated technique that provides frequency resolution of 10 or 12 digits per second (depending on the model). This performance exceeds that found in more expensive products and ensures highly accurate results in a minimum amount of time. Both counters are very easy to use and feature fast, single-key recall of user-set states. These instrument states include all measurement, analysis, limit testing, statistics, and printing information necessary to provide answers. Single-key recall maximizes throughput for the bench user, and ensures the job is done right.

Pick the right combination of counter and available options to do the job at the lowest price with the least complication. Combine this with a three-year warranty to get the very best performance and value available in a universal counter today.

Choosing the Right Counter

Throughput for the Bench User

Consider the HP 53131A for bench applications in manufacturing, in service, and in the lab. Its single-key recall operation allows you to execute setups instantly for all the tasks you regularly perform. Manufacturing engineers and technicians will find the HP 53131A an ideal tool for quick and accurate characterization of manufacturing problems. Ease of use and a full suite of measurement, analysis, and statistical functions, combined with single-key setup recall, help users achieve maximum throughput.

Optimized for System Performance

For high-speed automatic test applications, consider the HP 53132A. This counter is capable of sustained data-transfer rates of 1000 fully formatted measurements per second to an ATE controller. It can be up to 100 times faster than the HP 53131A, which pays off in high-speed ATE applications. A fully programmable HP-IB interface is standard, and Standard Commands for Programmable Instruments (SCPI) programming is fully supported. The HP 53132A is also capable of frequency resolution to 12 digits per second and features time interval resolution of 125 ps (LSD). Consider it for applications where you might otherwise use an expensive precision time interval counter.

HP 53131A Features

Specify Resolution in Digits

The HP 53131A universal counter provides for entering the desired number of display digits. This allows direct specification of the required precision, and avoids the need to calculate gate time.

Digital and Analog Display Modes

The HP 53131A provides both digital and analog display modes. Precise numeric results usually are viewed on the digital display. Limit tests or visual examination of changes benefit from the real-time analog display mode. Need to tune an IF frequency to a given tolerance? Use the analog display and limits. The display can be blanked, if needed, when the instrument is used in secure areas.

Analog display mode showing user-entered limit indicators (:). The position of the asterisk indicates each measurement relative to the limit indicators.

Limit Testing

Limit testing allows the user to set upper and lower limits for any measurement. When a measurement fails the limit condition, the HP 53131A can flag that measurement automatically and continue, or it can stop when a limit test fails. Built-in limit testing minimizes the time and expense of process control and ensures that out-of-limit conditions are reported. The HP 53131A provides an output signal, which can be used to trigger external devices to take action when a limit is exceeded.

Statistical Analysis

The HP 53131A measures and tracks the mean, minimum, maximum, and standard deviation of measured data in real time. Statistics can be computed for all measurements or only for measurements that fall within limits. That is, the combination of limit testing and statistics can be used to filter data.

Scale and Offset

The HP 53131A provides for scaling and offsetting of results. For example, offset gives calibrated answers when measuring an IF or downconverted frequency. Scale might be used to perform units' conversions.

Print and Output to a Computer

The HP 53131A outputs results to either an RS-232 or an HP-IB printer. Hardcopy results are easily available; no computer is needed. The HP 53131A also outputs data over either RS-232 or HP-IB to an external computer programmed to accept it.

Store and Recall Setups

Create and store the setups that determine how the HP 53131A will measure, analyze, and report answers. A setup can include the measurement to be made, the precision desired, limits to be met, statistics to compute, and offset and scaling factors to apply. Setups can also control hardcopy printing. Up to 20 setups can be stored. Any stored setup can be recalled quickly using a single key. Benefits include maximum throughput and productivity through speed and ease of operation, fewer operator errors, and minimal training.

Timebase Calibration

Either of the optional (medium or high-stability) timebases can be calibrated quickly by connecting a house standard or other reference to Channel 1 and executing a calibration keystroke sequence. This ensures product specifications are measured correctly and that contractual obligations to customers are met.

Extended Frequency Range

The HP 53131A is available with an optional Channel 3 to provide frequency measurements up to 3 GHz. Choose this option if you are working on mobile communication and advanced networking products, for example.

HP-IB and SCPI

A fully programmable HP-IB interface is an option for the HP 53131A. When installed, the instrument is programmable using SCPI (the instrument has an output-only HP-IB interface as standard). The HP-IB option is well suited to low-volume manufacturing or in a development environment. Programs developed using the HP 53131A can run without modification using the higher performance HP 53132A in a high-volume manufacturing environment.

Programs written in SCPI tend to be self-documenting and easy to maintain. SCPI also makes it much easier to substitute one manufacturer's product for another's, or to interchange one type of instrument for another.

HP 53132A Features

The HP 53132A universal counter provides a superset of the features and performance found in the HP 53131A. The instrument includes a fully programmable HP-IB interface and SCPI. Consider this counter for most automatic test applications.

The HP 53132A is optimized for applications that demand high speed and high precision. It is capable of transferring data to a computer at rates up to 1000 fully formatted measurements a second. It also can achieve 12 digits of frequency resolution a second. While measurement resolution and data transfer rates do interact, the HP 53132A is often faster than the HP 53131A by a factor of approximately 100. The speed inherent in this counter substantially boosts throughput of tested products and significantly reduces costs.

The HP 53132A, with a single-shot time interval resolution of 125 ps, is the best counter in its class. It can replace expensive, precision time interval counters in many applications.

HP 53131A Specifications and Characteristics

Measurements: Frequency, frequency ratio, time interval, period, rise/fall time, positive/negative pulse width, duty cycle, phase (Ch. 1 to Ch. 2), totalize, peak voltage, time interval average, time interval delay
Analysis: Automatic limit testing, math (scale and offset), statistics (minimum, maximum, mean, standard deviation); statistics available on all measurements or only measurements that fall within limits
Measurement Characteristics:
Frequency: Range (Ch. 1 and 2): 225 MHz; (Ch. 3): 3 GHz
Time interval resolution: 500 ps (LSD), can be improved by averaging
Input conditioning (independently selectable on both Ch. 1 and 2)
Impedance, coupling: 1 MΩ or 50 Ω; ac or dc
Low pass filter: 100 kHz, switchable
Attenuation: X 1 or X 10
Ext. Timebase Reference Input: 1, 5, 10 MHz
Trigger: Trigger on rising/falling edge; set level by percent of signal level or absolute voltage; set sensitivity to LOW, MED, or HIGH
Gating and Arming: Auto; manual (set gate time or number of digits of resolution); external; delay
General: RS-232 (talk-only) and HP-IB (talk-only), full diagnostics, electronic calibration of all optional timebases, analog display mode, medium- and high-stability oven oscillator options, HP-IB option with SCPI programming language, rugged, half-rack package

HP 53132A Specifications and Characteristics (same as HP 53131A, plus)

Fully Programmable: HP-IB & SCPI standard
Data Transfer: 1000 measurements per second
Resolution: 12 digits per second
Time Interval Resolution: 125 ps (LSD)

Ordering Information	Price
HP 53131A Universal Counter	$1,500
HP 53132A Universal Counter	$2,400
(Both counters come with standard crystal timebase, power cord, operating manual)	
Opt 001 Medium Stability Timebase	$450
Opt 010 High Stability Oven Timebase	$900
Opt 030 3.0 GHz RF Input Channel	$800
Opt 040 HP-IB Interface with SCPI programming (HP 53131A only)	$300
Opt 060 Rear Input Terminals	$100
Opt 908 Rack Mount Kit	$51
HP 34161A Accessory Pouch	$38

For the most current prices and product information, contact your local Hewlett-Packard sales office – see page 665.

ELECTRONIC COUNTERS

Universal

HP 5315A, 5316B

- Frequency, period, ratio, and totalize to 100 MHz
- Portable and HP-IB models
- 1-GHz capability available
- 100-ns time interval, 10-ps T.I. averaging

HP 5315A

HP 5316B

Hewlett-Packard Instrument Drivers

DESIGNED FOR HP-IB SYSTEMS

HP 5315A and HP 5316B Universal Counters

HP's economical HP 5315A and HP 5316B counters offer outstanding performance at affordable prices. A unique custom circuit called the MRC (Multiple Register Counter) packs counting and computing power into this popular counter series. Reciprocal counting techniques provide outstanding frequency resolution of 7 digits per second even at low frequencies. The continuously adjustable gate time allows automatic selection of sample size for easy trade-offs between measurement time and resolution.

Versatile Measurement Capabilities

The MRC counters measure frequency to 100 MHz—up to 1.0 GHz with the optional Channel C—for CW and pulsed RF signals as narrow as 60 ms. Three time-interval measurements are possible: single-shot (100 ns to 100,000 s), averaging (down to 10 ps resolution), and time-interval delay. The MRC counters also measure/perform: Period A, Ratio A/B, A By B (totalizes A input between 2 events on B), and Totalize (manually gated mode).

Both channels offer input signal conditioning controls: ±slope, ±2.5 Vdc trigger level, and ac/dc coupling. A Separate/Common switch and 100-kHz low-pass filter for Channel A are included.

A Choice of Portable or System Models

The HP 5315A, a portable, lightweight unit, includes a carrying handle and optional battery power for up to 4 hours continuous operation. The HP 5316A offers the measurement capabilities of the HP 5315A in a rack-and-stack metal case, built-in HP-IB capabilities, and front-panel access to Channel A and B trigger levels for easy measurement with a DVM.

HP 5315A, 5316B Specifications

Input Characteristics (Channel A and Channel B)

Range: dc-coupled, 0 to 100 MHz; ac-coupled, 30 Hz to 100 MHz
Sensitivity: 10 mV rms sine wave to 10 MHz; 25 mV rms sine wave to 100 MHz. 75 mV peak-to-peak pulse at minimum pulse width of 5 ns. Sensitivity can be varied continuously up to 500 mV rms nominal by adjusting sensitivity control. In sensitivity mode, trigger level is automatically set to 0 V nominal.
Dynamic Range: 30 mV to 5 V peak-to-peak, 0 to 10 MHz; 75 mV to 5 V peak-to-peak, 10 to 100 MHz
Coupling: ac or dc, switchable
Filter: Low-pass, switchable in or out of Channel A. 3 dB point at 100 kHz nominally.
Impedance: 1 M Ω nominal shunted by less than 40 pF
Signal Operating Range: +2.5 Vdc to −2.5 Vdc
Attenuator: ×1 or ×20 nominal
Trigger Level: Variable between +2.5 Vdc and −2.5 Vdc
Slope: Independent selection of + or − slope
Common Input: All specifications are the same as A and B except:
Sensitivity: 20 mV rms sine wave to 10 MHz; 50 mV rms to 100 MHz; 150 mV peak-to-peak at a minimum pulse width of 5 ns.
Dynamic range: 60 mV to 5 V peak-to-peak to 10 MHz; 150 mV to 5 V peak-to-peak, 10 to 100 MHz.
Impedance: 500 k Ω nominal shunted by less than 70 pF

Frequency and Period (Channel A)

Range: 0.1 Hz to 100 MHz; 10 ns to 10^5 s (period)
Resolution: See Graph 1
Accuracy: ± resolution ± timebase error (Graph 2)

Time Interval

Range: 100 ns to 10^5 s **LSD displayed:** 100 ns
Resolution: ± LSD ± noise trigger error (Graph 3)
Accuracy: ± resolution ± timebase error (Graph 2)

Time Interval Average

Range: 0 ns to 10^5 s
LSD Displayed: 100 ns/$\sqrt{N}$, 10 ps max
Number of Intervals Averaged (N): N = Gate Time × FREQ
Minimum Dead Time (stop to start): 200 ns
Resolution: ± LSD ± [noise trigger error (Graph 3)]/$\sqrt{N}$
Accuracy: ± resolution ± timebase error (Graph 2) ± 4 ns

Time Interval Delay (Holdoff)

Front-panel knob inserts a variable delay of nominally 500 μs to 20 ms between START (Channel A) and enabling of STOP (Channel B). Electrical inputs during delay time are ignored. Delay time may be digitally measured by simultaneously pressing T.I. Averaging, T.I. Delay, and blue key. Other specifications are identical to Time Interval.

Ratio

Range: 0.1 MHz to 100 MHz, both channels
LSD: [(2.5 × Period A)/gate time] × ratio

Totalize

Manual: 0 to 100 MHz
A Gated by B: Totalizes input A between two events of B. Instrument must be reset between measurements. Gate opens on A slope, closes on B slope.

General

Standard Timebase
Frequency: 10 MHz
Aging rate: $<3 \times 10^{-7}$/mo
Temperature: $\pm 5 \times 10^{-6}$, 0° to 50° C
Line voltage: $<1 \times 10^{-7}$ for a ± 10% variation
Check: Counts internal 10-MHz reference frequency
Error Light: LED activated if logic error found during self-check.
Display: 8-digit LED display, with engineering units annunciator
Overflow: Frequency and totalize measurements only; 8 least significant digits displayed and front panel LED actuated.
Gate Time: Continuously variable, nominally from 60 ms to 10 s or 1 period of the input, whichever is longer.
Sample Rate: Up to 7 readings per second nominal except in time-interval mode, where it is continuously variable nominally from 250 ms to 10 s via gate time control.
Operating Temperature: 0° to 50° C
Power: 100, 120, 220, 240 V (+5%, −10%) 48 to 66 Hz; 15 VA maximum (30 VA maximum, HP 5316B)
Weight: Net, 2.2 kg (4 lb 12 oz); shipping, 4.1 kg (9 lb)
Size: 98 mm H × 238 mm W × 276 mm D (3⅞ in × 9⅜ in × 10⅞ in)

Unique HP 5316B Specifications

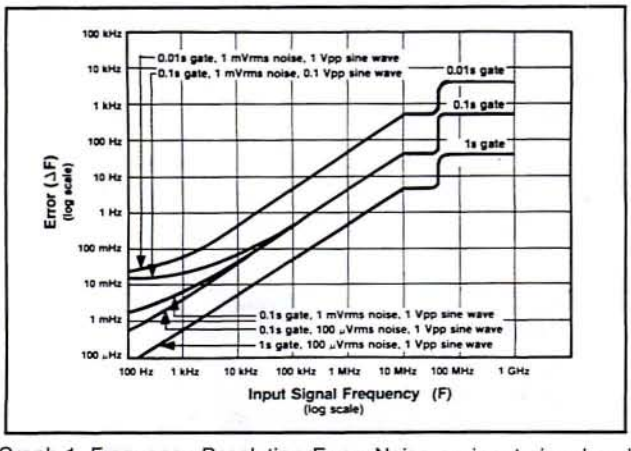
Rack-and-stack metal case; rear-panel, switchable ac power-line module
Rackmount Kit: HP 5062-3972 recommended
Oscillator Output: 10 MHz, 50 mV peak-to-peak into 50 Ω load on rear panel
External Frequency Standard Input: 1, 5, 10 MHz, 1 V rms into 500 Ω, or rear panel
Trigger-Level Output: ±5%, ±15 mV over ±2.0 Vdc range at front panel connectors
Size: 88 mm H × 212 mm W × 415 mm D (3½ in × 8⅜ in × 16½ in)
Weight: Net, 3.7 kg (8 lb 2 oz); shipping, 6.3 kg (14 lb)

Hewlett-Packard Interface Bus Programming

Measurements: Frequency A and C, Frequency A Armed by B, Period A, Totalize A Gated by B, Ratio A/B, Time Int. A→B, Time Int. Average A→B, Time Int. Delay, Read Gate Time
Controls: Gate Time Command, which sets long (60 ms to 10 s) or short (500 μs to 30 ms) range; Trigger Level Commands, which set Channel A and/or B slope (±) and Channel A and/or B trigger from −2.50 Vdc to +2.50 Vdc in steps of .01V
HP-IB Interface Functions: SH1, AH1, TI, L2, SR1, RL1, PP0, DC1, DT1, C0, E1 (see page 101)

Options

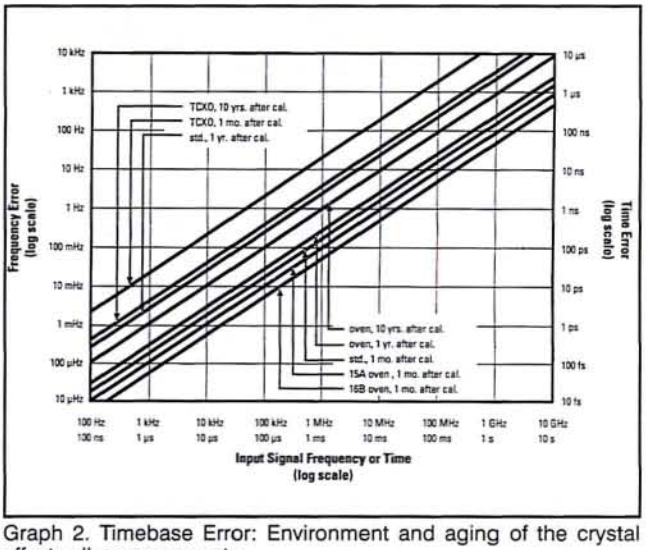
Opt 001: High-stability timebase (TCXO); see page 196
Frequency: 10 MHz
Aging rate: $<1 \times 10^{-7}$/mo
Temperature: $\pm 1 \times 10^{-6}$, 0° to 40° C
Line voltage: $<1 \times 10^{-8}$ for a ± 10% variation
Opt 002: Battery (HP 5315A only)
Type: Rechargeable lead-acid (sealed)
Capacity: Typically 4 hours of continuous operation at 25° C
Recharging time: Typically 16 hours to 98% of full charge, instrument non-operating. Charging circuitry included.
Low-voltage indicator: Instrument turns off automatically when battery low. Discharge LED flashes slowly.
Line-failure action: Instrument automatically switches to battery.
Weight: Opt 002 adds 1.4 kg (3 lb) to weight of instrument.
Opt 003: C Channel
Input range: 50 to 1000 MHz, prescaled by 10
Sensitivity: 15 mV rms sinewave (−23.5 dBm) to 650 MHz. 75 mV rms sinewave (−9.5 dBm) to 1000 MHz. Sensitivity can be decreased continuously by up to 20 dB nominal (50 to 500 MHz) and 10 dB nominal (500 to 1000 MHz) by adjusting sensitivity control. Trigger level is fixed at 0 V nominal.
Dynamic range: 15 mV to 1 V rms (36 dB), 50 to 650 MHz, 75 mV to 1 V rms (20 dB), 650 to 1000 MHz
Signal operating range: +5 Vdc to −5 Vdc
Coupling: ac
Impedance: 50 Ω nominal (VSWR, <2.5:1 typical)
Damage level: ±8 V (dc + ac peak), fuse protected
Resolution and accuracy: Same as Frequency A (gate time × 10)



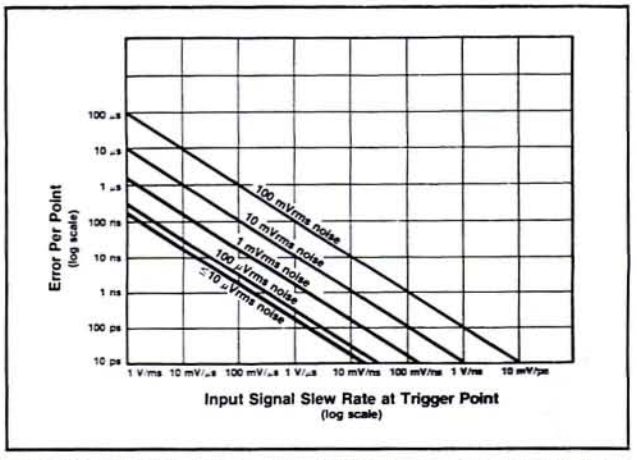
Graph 1. Frequency Resolution Error: Noise on input signal and internal uncertainties affect frequency and period measurements.

Opt 004: High-stability oven timebase (HP 5315A); see page 196.
Frequency: 10 MHz
Aging rate: $<3 \times 10^{-8}$/mo*
Temperature: $\pm 1 \times 10^{-7}$, 0° to 50° C
Line voltage: $<1 \times 10^{-8}$, for a 10% variation
Oven will operate from fully charged battery for > 24 hours in standby mode.
Opt 004: High-stability oven timebase (HP 5316B); see page 196.
Frequency: 10 MHz
Aging rate: $<3 \times 10^{-8}$/mo**
Temperature: $\pm 2 \times 10^{-8}$, 0° to 50° C
Line voltage: $<1 \times 10^{-9}$, for a 10% variation

* After 30 days continuous operation (ac power applied, in OFF or ON position).
** After 30 days continuous operation. $<5 \times 10^{-8}$/mo., after 7 days continuous operation.



Graph 2. Timebase Error: Environment and aging of the crystal affects all measurements.



Graph 3. Input Noise Trigger Error: Noise on the input signal affects start/stop points for time-interval measurements.

Ordering Information

	Price
HP 5315A Universal Counter	$1,495
HP 5316B Universal Counter	$1,845
Options (for HP 5315A and HP 5316B)	
Opt 001 TCXO Timebase	+$180
Opt 002 Battery Pack (HP 5315A only)	+$350
Opt 003 C Channel (1.0 GHz)	+$400
Opt 004 High-Stability Timebase	+$600
Opt W30 Extended Repair Service (see page 636)	+$45
Opt W32 Calibration Service (see page 636)	+$565

HP 5315A Power Options (one option must be selected)

Opt 100 90 to 105 Vac	**Opt 220** 198 to 231 Vac
Opt 120 108 to 126 Vac	**Opt 240** 216 to 252 Vac

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

ELECTRONIC COUNTERS

100-MHz Universal Counter

HP 5334B

- Two matched 100-MHz input channels; optional C Channel to 1.3 GHz
- 9 digits per second resolution from 1 Hz to 1.3 GHz
- 2 ns time interval resolution, 200 ps with averaging
- Automatic rise/fall time, pulse width, and ac/dc voltage measurements
- Complete HP-IB programmability standard

HP 5334B

DESIGNED FOR HP-IB SYSTEMS

HP 5334B Universal Counter

Expanded Capabilities for Bench or System

- Rise/fall time, pulse-width measurements at the push of a button
- ac/dc voltage measurements of the input signal
- Offset, normalize, and average measurements for greater usability of results
- Auto triggering and auto attenuation for user convenience
- 100-MHz frequency and period measurements with resolution of 9 digits per second of gate time
- Time interval and time-interval delay to 2 ns resolution, 200 ps with averaging
- Full HP-IB programmability standard with optional rear inputs for system applications. Make up to 140 readings per second.
- 1.3 GHz C Channel and high-stability oven time base options
- External arming/gating for synchronizing measurements to external events

HP 5334B Specifications

Input Characteristics (Channels A and B)

Range
dc-coupled: 0 to 100 MHz
ac-coupled: 1 MΩ, 30 Hz to 100 MHz; 50 Ω, 1 to 100 MHz
Sensitivity:
15 mV rms sine wave to 20 MHz, 35 mV rms sine wave to 100 MHz
100 mV peak-to-peak at a minimum pulse width of 5 ns
Dynamic Range (X1): 45 mV to 5 V peak-to-peak, to 20 MHz. 100 mV to 2.5 V peak-to-peak, to 100 MHz
Trigger Level Range
Manual (auto trigger off): Continuously adjustable over ±5.1 V (× attn), displayed in 20 mV steps (× attn)
Preset: 0V nominal in Sensitivity Mode
Auto trigger
dc-coupled: 100 Hz to 100 MHz
ac-coupled: 1 MΩ, 100 Hz to 100 MHz; 50 Ω, 1 to 100 MHz
Trigger Slope: Independent selection of + or − slope
Impedance: 1 MΩ or 50 Ω, nominal, switch-selectable.
Attenuator
Manual: × 1 or × 10 nominal, switch-selectable
Auto: Attenuator automatically switched when in auto trigger.
Low-Pass Filter: 100 kHz nominal, Channel A, switchable
External Arm
Sensitivity: 500 mV peak-to-peak at min. pulse width of 50 ns
Signal operating range: −5 Vdc to +5 Vdc
Slope: Independent selection of START and STOP ARM slopes: +, −, or OFF

Frequency A and Frequency B

Range: 0.001 Hz to 100 MHz
Resolution: See Graph 1
Accuracy: ± resolution ± time base error (Graph 2)

Period A

Range: 10 ns to 10^3 s (single gate), 10 s (100 gate average)
Resolution, Accuracy: Δfreq [per]/freq (Graphs 1 and 2)

Time Interval A to B

Range: −1 ns to 10^3 (single shot), 10 s (100 gate average)
LSD: 1 ns (100 ps using 100 gate average)
Resolution: ± LSD noise trigger error (Graph 3) ± 1 ns rms
Accuracy: ± resolution time base error (Graph 2) ± trig level timing error (Graph 4) ± trig level setting error (Graph 5) ± 2 ns

Time Interval Delay

Selectable delay can be inserted between START and STOP of time interval A to B. Inputs during delay are ignored. Delay range is 1 ms to 99.999 s.

Ratio A/B

Range: 0.001 Hz to 100 MHz both channels
LSD: 4 × RATIO/[FREQ A x GATE TIME]
Resolution and Accuracy: ± LSD ± [B trig error (Graph 3)/GATE TIME]

Totalize A

Range: 0 to 10^{12} −1
Resolution and Accuracy: 1 count of input signal

Pulse Width A

Range: 5 ns to 10 ms
LSD, Resolution, Accuracy: Same as time interval A to B except ± 2 ns in Accuracy deleted

Rise/Fall Time A

Range: 30 ns to 10 ms
Minimum Amplitude: 500 mV peak-to-peak
Dynamic Range: 500 mV to 40 V peak-to-peak
LSD, Resolution, Accuracy: Same as time interval A to B

ac/dc Voltage:

Measurements: Max. and min. peaks or dc level of Channel A or Channel B input are displayed.
Frequency Range: dc, 100 Hz to 20 MHz
Dynamic Range: 0 to 40 V peak−to−peak; ±51 Vdc
Resolution: × 1: 20 mV × 10: 200 mV

Timebase

Frequency: 10 MHz
Aging Rate: $<3 \times 10^{-7}$ per month
Temperature: 5×10^{-6}, 0 to 50° C

Math

Display = (measurement/normalize) + offset
Entry Range: $\pm 1 \times 10^{-10}$ to $\pm 9.99999999999 \times 10^{9}$
Single Cycle: 1 measurement per push of RESET

Average

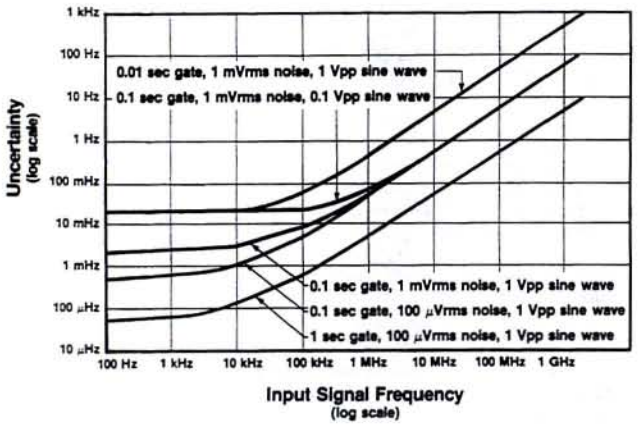
100 Gate Average: 100 measurements accumulated and average value displayed. Adds 1 digit of resolution to measurements and reduces resolution error by 10.

Hewlett-Packard Interface Bus (HP-IB)

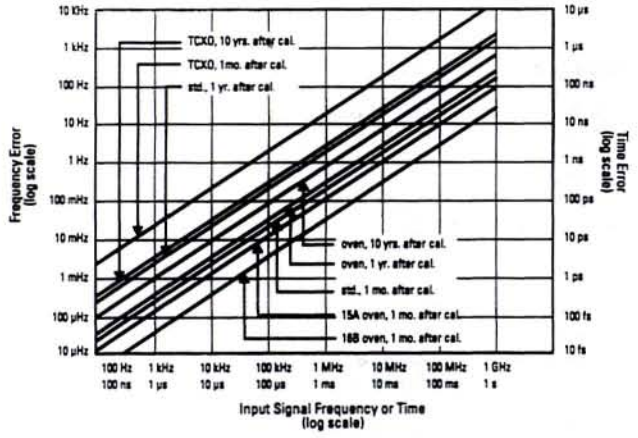
Programmable Controls: All front-panel controls and functions, except power-on/stby switch.
Trigger Level: Set Channel A or B in 20 mV steps (× attn)

Data Output

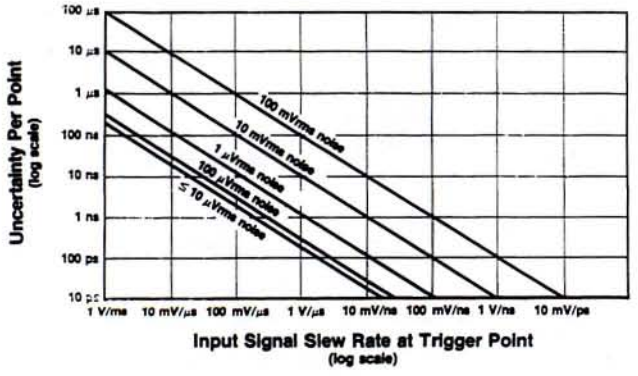
Normal operation: 10 readings/s, formatted.
High-speed mode: Up to 140 readings/s (55 readings/s with Option 700), unformatted
HP-IB interface functions: SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, C0, E2 (see page 101)



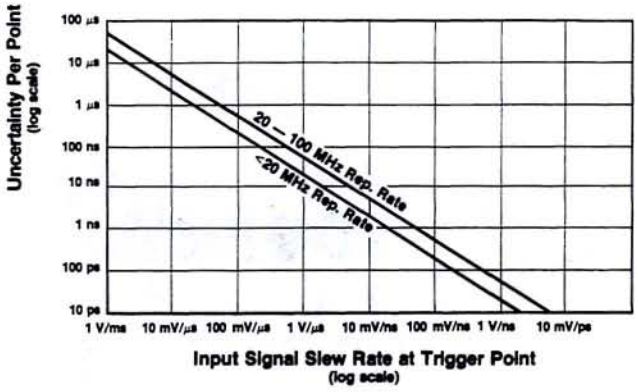
Graph 1. Frequency Resolution Error: Noise on the input signal and internal uncertainties affect frequency and period measurements.



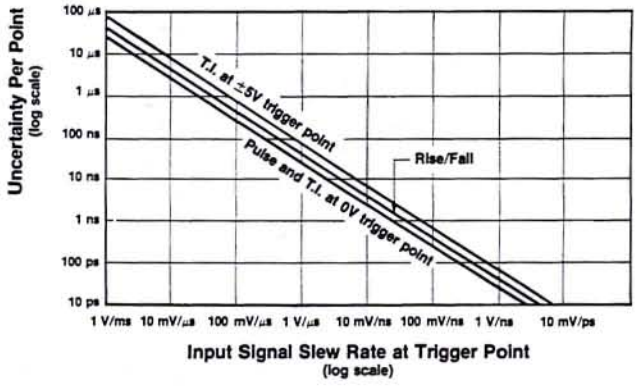
Graph 2. Time Base Error: Crystal environment and aging affects all measurements.



Graph 3. Input Noise Trigger Error: Noise on the input signal affects both the start and stop points of all time – interval measurements.



Graph 4. Trigger Level Timing Error: Affects the start and stop points of all time-interval measurements. Total error is the larger of the 2 trigger-point errors.



Graph 5. Trigger Level Setting Error: Affects both the start and stop points of all time-interval measurements.

HP 5334A

See Mature Products (page 206) for information regarding the HP 5334A Universal Counter.

Options

Opt 010: High-Stability Time Base (Oven)
Frequency: 10 MHz
Aging rate: 5×10^{-10}/day after 24-hour warmup
Opt 030: 1300 MHz C Channel
Range: 90 to 1300 MHz
Sensitivity: 15 mV rms (−23.5 dBm) sine wave, 90 to 1000 MHz; 75 mV rms (−9.5 dBm) sine wave, 1000 to 1300 MHz
Resolution and accuracy: Same as Frequency A and B

Ordering Information

	Price
HP 5334B Universal Counter	$2,305
Opt 010 Oven Oscillator	+$880
Opt 030 Channel C	+$595
Opt 060 Rear Terminals	+$150
Channel A, B and ARM in parallel with front inputs. Option 030 at rear panel only.	
Opt W30 Extended Repair Service (see page 636)	+$50
Opt W32 Calibration Service (see page 636)	+$525

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 661.

ELECTRONIC COUNTERS

Universal Systems Counter and Preamplifier

HP 5335A, 10855A

- A high-performance 200 MHz/2-ns universal counter
- Built-in automatic rise time, duty cycle, pulse width, slew rate and phase measurements
- Advanced automatic triggering capabilities
- HP-IB plus math and statistics functions standard

HP 5335A

DESIGNED FOR HP-IB SYSTEMS

HP 5335A Universal Counter

Designed for bench or systems applications, the HP 5335A has 20 measurement functions, all automatically selected by push-button or by HP-IB. These functions, plus greatly expanded arming and triggering capability, make the HP 5335A a powerful universal counter. Math and statistics features, matched Channel A and B input amplifiers, and HP-IB are all included in the standard unit.

The HP 5335A can automatically measure waveform characteristics. With a signal source, rise and fall times, output slew rate, and propagation times can be measured with one test setup. Duty cycle can be measured to see the distortion on a square wave through the amplifier due to different rising and falling slew rates. Phase measurements are push-button selectable and performed automatically.

Advanced Triggering and Full Measurement Capabilities

The HP 5335A offers several powerful features:

Manual and Automatic Triggering: In manual, the ±5 Vdc range reduces the need for input attenuators. Two auto trigger modes (front-panel or HP-IB control) select 10 to 90% rise/fall-time trigger points, 50% phase trigger points, or a preset value, then track dc offset to remain on the trigger point.

Trigger Level DVM: View both input channel trigger levels.

Frequency: Measure to 200 MHz on Channel A, 100 MHz on Channel B, and 1.3 GHz on optional Channel C. Resolution is 9 digits per second over the entire frequency range.

Time Intervals: Matched custom input amplifiers reduce trigger errors between Channels A and B. Analog interpolation converts the clock to a 1-GHz-equivalent time base, yielding single-shot time-interval measurements better than 2 ns (100 ps with averaging).

Math and Statistics: Averaging can extend resolution for all measurements except phase. Sample sizes are selectable: 100 or 1000. The HP 5335A calculates standard deviation. Built-in math functions (scale, offset, and normalize) simplify conversions for viewing flow, speed, pressure, and temperature parameters, and can be set individually for each measurement function.

HP 10855A 2-1300 MHz Preamplifier

The HP 10855A Preamplifier enhances measurements of very low-level signals. The ±1.5 dB flat response reduces distortion in non-sinusoidal waveforms. The HP 10855A operates with instruments having probe power outlets, or with the HP 1122A Probe Power Supply. The HP 5334A/5335A Option 030 and HP 5328B Option 031 counters support the HP 10855A.

HP 10855A Specifications

Frequency Range: 2 MHz to 1300 MHz
Gain (minimum): 22 dB; 24 dB typical
Gain Flatness Across Full Frequency Range: ±1.5 dB
Noise Figure: <8.5 dB typical
Output power for 1 dB gain compression 0 dBm
Harmonic Distortion: −30 dB for −15 dBm output, typical; −25 dBm for < −66dB output, typical
VSWR: <2.9, typical
Impedance: 50 Ω nominal
Reverse Isolation: >45 dB
Maximum Input: 3.5 V rms (+24 dBm), fuse protected

HP 5335A Specifications

Input Characteristics (Channels A and B)

Range: dc-coupled, 0 to 100 MHz;
ac, 1 MΩ, 30 Hz to 100 MHz; 50 Ω, 200 kHz to 100 MHz
Note: Channel A range 200 MHz in Frequency A and Ratio modes.
Sensitivity (X1): 25 mV rms sinewave.
75 mV peak-to-peak pulse, minimum pulse width of 5 ns
Dynamic Range (X1): 75 mV to 5 V peak-to-peak, to 100 MHz; 75 mV to 2.5 V peak-to-peak, >100 MHz
Signal Operating Range (X1, dc): −5 to 5 Vdc
Trigger Level Range (X1)
Auto Trigger OFF
Preset: Set to 0 Vdc nominal; adjustable: −5 to +5 Vdc
Auto Trigger ON
Preset: Set to nominal 50% point of input signal.
Adjustable: Nominally between + and − peaks of input signal.
Auto Trigger (X1), (Requires Repetitive Signal)
Range (50% duty cycle): dc-coupled, 30 Hz to 200 MHz
ac: 1 MΩ, 30 Hz to 200 MHz; 50 Ω, 200 kHz to 200 MHz
Minimum signal: 100 mV rms
Duty cycle range: 10% to 90%
Response time: 3 s, typical
Coupling: ac or dc, switchable
Impedance: 1 MΩ, nominal, shunted by <35 pF or 50 Ω nominal, switchable. In Common A, 1 MΩ is shunted by <50 pF.
Attenuator: ×1 or ×10 nominal, switchable
Slope: Independent selection of + or − slope
Channel Input: Separate or Common A, switchable

Frequency A

Range: 0 to 200 MHz, prescaled by 2
LSD Displayed: $\frac{1\text{ ns}}{\text{gate time}} \times$ freq. (e.g. 9 digits in a second)
Resolution: $\pm (2 \times \text{LSD}) \pm 1.4 \times \frac{\text{trigger error}}{\text{gate time}} \times \text{freq}$
Accuracy: ± (resolution) ± (timebase error) × freq

Period A

Range: 10 ns to 10^7 s
LSD Displayed: $\frac{1\text{ ns}}{\text{gate time}} \times$ PER. (e.g. 9 digits in a second)
Period Average: Select MEAN function, and n = 100 or 1000

Time Interval A→B

Range: 0 ns to 10^7 s
LSD Displayed: 1 ns (100 ps using MEAN)
Resolution: ± (2 × LSD) ± (START trigger error) ± (STOP trigger error)
Accuracy: ± (resolution) ± (timebase error) × TI ± (trigger level timing error) ± (2 ns)
Gate Mode: MIN only
Time Interval Average: Select MEAN function, and n = 100 or 1000

Time Interval Delay (Holdoff)

Front panel Gate Adjust control inserts a variable delay between START and enabling of STOP. Electrical inputs during delay are ignored. Delay ranges are same as gate time ranges (100 μs to 4 s, nominal) for gate modes of Fast, Norm, and Manual.

Inverse Time Interval A→B

Range: 10^{-7} to 10^9 units/second
LSD Displayed, Resolution, and Accuracy are inverse of Time Interval A→B specifications.

Rise and Fall Time A

Range: 20 ns to 10 ms transition with 50 Hz to 25 MHz repetition rates (50% duty cycle)
Minimum Pulse Height: 500 mV peak-to-peak
Minimum Pulse Width: 20 ns
Duty Cycle Range: 20% to 80%
LSD Displayed, Resolution: See Time Interval A→B specifications.

Pulse Width A

Range: 5 ns to 10^7 s
Trigger Point Range: 40% to 60% of pulse height
LSD Displayed, Resolution: See Time Interval A→B specifications.

Duty Cycle A (Constant Duty Cycle Required)
Range: 1% to 99%, 0 to 100 MHz
Trigger Point Range: 40% to 60% of pulse height
LSD Displayed: $\frac{1\text{ ns}}{\text{period}} \times 100\%$

Slew Rate A
Range: 50 V/s to 10^8 V/s slew rate with 50 Hz to 25 MHz repetition rates (50% duty cycle). Minimum pulse height, width, and duty cycle range are same as Rise and Fall Time A
Input Mode: Automatically set to COMMON A with 10% and 90% trigger levels

Ratio A/B
Range: Channel A: 0 to 200 MHz (prescaled by 2);
Channel B: 0 to 100 MHz.
LSD Displayed: $\frac{\text{Ratio}}{\text{Freq} \times \text{Gate Time}}$ where Freq is higher frequency after prescaling

Totalize A
Range: 0 to 100 MHz
LSD Displayed: 1 count of input
HP-IB Output: At end of gate
Manual
Count reset: Via RESET key
HP-IB output: Totalize data on-the-fly sent if Cycle mode set to Single. Input frequency range in this mode is 0 to 50 Hz nominal.
Gated
Count reset: Automatic after measurement

Phase A Rel B
Range: −180° to 360° (Range Hold OFF) or 0° to 360° (Range Hold ON) with signal repetition rates of 30 Hz to 1 MHz.
Minimum Signal: 100 mV rms
LSD Displayed: 0.1°

Gate Time
Range: 100 μs to 10^7 s
LSD Displayed: Up to 3 digits with Ext. Arm Enable OFF, 100 ns when ON. MIN Gate Mode display zero.

Trigger Level
Range: ×1, +5 to −5 V; ×10, +50 to −50 V
Resolution: ×1, 10 mV; ×10, 100 mV
Accuracy (×1): ±20 mV, ±0.5% of reading

Timebase
Standard Crystal (see page 196)
Frequency: 10 MHz
Aging rate: $<3 \times 10^{-7}$/month
Temperature: $< 5 \times 10^{-6}$, 0 to 50° C
Line voltage: $<1 \times 10^{-7}$ for 10% change
High-Stability Crystal: See Option 010
External Timebase Input: Rear-panel BNC accepts 5 or 10 MHz, 200 mV rms into 1 kΩ; 5 V rms maximum
Timebase Out: 10 MHz, >1 V peak-to-peak into 50 Ω via rear panel

Statistics
Sample Size: Selectable, n = 100 to 1000 samples
Functions: Std. dev., mean, and smooth (weighted running average)

Math
All measurement functions, except GATE TIME, Totalize in Scale Mode, and TRIG LVL, may be operated upon by Math functions. Offset, Normalize, and Scale may be used independently or together:

$$\text{Display} = \frac{\text{measurement} + \text{offset}}{\text{normalize}} \times \text{scale}.$$

Number Value Range: $\pm 1 \times 10^{-9}$ to $\pm 9 \times 10^{9}$
Last Display: Causes value of previous display to Offset (negative value), Normalize, or Scale all subsequent measurements
Measurement t-1: Causes each new measurement to be Offset, Normalized, or Scaled by immediately preceding measurement

Hewlett-Packard Interface Bus (See Option 040)
Programmable Controls: All measurement functions, Math, Statistics, Reset, Range Hold, Ext. Arm Enable/Slope, Check, Gate Adj. (~1 ms to 1 s), Gate Open/Close (gate times to ∞), Gate Mode, Cycle, Preset, Slope, Common A, Auto Trigger
Special Functions: FREQ B, PULSE B, TIME B→A, TOT A-B, LEARN, MIN, MAX, all internal diagnostic routines
Interface Functions: SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0 (see page 101)
Data Output: Fixed format consisting of 19 characters plus CR and LF output typically in 8 ms

General
Gate: Minimum, manual, or continuously variable (NORM/FAST) via Gate Adj. control
NORM: 20 ms to 4 s nominal
FAST: 100 μs to 20 ms nominal
MIN: Minimum gate time. Actual time depends on function.
MANUAL: Each press opens or closes gate.
Cycle: Determines delay between measurements
NORM: No more than a 4 readings per second, nominal
MIN: Updates display as rapidly as possible (~15 readings per second, depending on function)
SINGLE: One measurement taken with each press of button.
Arming: Ext. Arm Enable key allows rear-panel input to determine Start and/or Stop point of a measurement. External gate defined by both Start and Stop armed. All measurements are armable except Manual Totalize, Phase, and Trigger Level.
Start arm: + or − slope of arm input signal starts measurement.
Stop arm: + or − slope of arm input signal stops measurement. When used, Start Arm must occur before Stop Arm.
Ext. arm input: Rear-panel BNC accepts TTL into 20 kΩ. Minimum Start to Stop Time: 200 ns.
Trigger Level Out: dc output into 1 MΩ via rear panel BNCs for Channel A and B; not adjusted for attenuators.
Accuracy at dc (×1): ±15 mV ±0.5% of TRIG LVL reading
Gate Out: TTL level into 50 Ω; goes low when gate open; rear panel BNC
Range Hold: Freezes decimal point and exponent of display.
Display: 12-digit LED; exponent range of +18 to −18
Operating Temperature: 0° to 50° C
Power Requirements: 100, 120, 220, 240 Vac (+5%, −10%), 48 to 66 Hz; 130 VA max
Weight: Net, 8.8 kg (19 lb 8 oz); shipping, 13.6 kg (30 lb)
Size: 425.5 mm W × 132.6 mm H × 345.4 mm D (16¾ in × 5¼ in × 13½ in), not including removable handles

Options
Opt 010: High Stability Timebase Oven (see page 196)
Frequency: 10 MHz.
Aging rate: $< 5 \times 10^{-10}$/day after 24-hour warmup
Short term: $<1 \times 10^{-10}$ rms for 1s average
Temperature: $< 7 \times 10^{-9}$, 0° to 50° C
Line voltage: $< 1 \times 10^{-10}$ for 10% change
Warmup: within 5×10^{-9} of final value in 20 minutes
Opt 020: dc Digital Voltmeter
Range: 4 digits, autoranging, autopolarity, in ±10, ±100, ±1000 V ranges
Sensitivity: 100 μV, 1 mV, 10 mV, 100 mV for ±1 V, ±10 V, ±100 V, ±1000 V readings
LSD displayed: Same as sensitivity
Input type: Floating pair
Input frequency impedance: 10 MΩ ± 1%
Opt 030: 1.3 GHz C Channel
Input range: 150 MHz to 1.3 GHz prescaled by 20
Input sensitivity: 10 mV rms sinewave (−27 dBm) to 1 GHz; 100 mV rms sine wave (−7 dBm) to 1.3 GHz
LSD displayed, resolution, accuracy: Same as Frequency A
Ratio C/A Range: Channel A, 0 to 200 MHz
Channel C, 150 to 1300 MHz
Opt 040: Complete Systems Programmability
Adds remote selection of low-pass filter, ac/dc coupling, attenuator, dc trigger level, and input impedance for Channels A and B

Ordering Information	Price
HP 5335A Universal Counter (with front handles)	$5,250
Opt 010 Oven Oscillator	+$990
Opt 020 DVM	+$730
Opt 030 C Channel	+$1,015
Opt 040 Expanded HP-IB Control	+$950
Opt 908 Rack Flange Kit for Use Without Handles	+$50
Opt 913 Rack Flange Kit for Use With Supplied Front Handles	+$70
Opt W30 Extended Repair Service (see page 636)	$110
Opt W32 Calibration Service (see page 636)	$525
HP 10855A 2 MHz to 1300 MHz Preamplifier	$1,150

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

ELECTRONIC COUNTERS

Universal Time-Interval Counter and Low-Pass Filter Kit

HP 5370B, 10856A

- 20 ps single-shot LSD; ±100 ps accuracy
- 11 digits/s frequency resolution
- Up to 8000 measurements/sec
- Built-in statistics functions
- Frequency and period to 100 MHz

HP 5370B

DESIGNED FOR HP-IB SYSTEMS

HP 5370B's Precision and Measurement Speed

- IC tester performance verification
- Fast IC characterization
- Disk drive manufacture
- Digital communications—jitter analysis
- Radar/laser ranging calibration
- Nuclear systems
- Calibration labs

Use the Full Range of Functions

Time Interval: Achieve 20 ps single-shot LSD on time intervals from 0 to 10 s, including negative time (in which the STOP channel event occurs before the START channel event)

Frequency: Measure up to 100 MHz with 11 digits of resolution in 1 s. Choose gate times down to 1 period: use 1 period with average mode and access the powerful Statistics capabilities

Period: Measure period average from 1 to 100k samples and use Statistics

Statistics: Reduce external computations, reduce random errors, and improve measurement throughput

Sample size: Select 1, 10, 1k, 10k or 100k samples from the front panel, or 1 to 65,536 samples over HP-IB. For the selected sample size, you can compute:

- Mean
- Standard Deviation
- Minimum
- Maximum

Flexible Arming and Gating: +TI or ±TI with internal or external arming, with or without external hold-off

Full HP-IB Programming and Fast Data Output:

- Up to 8000 readings/s in fast binary mode—125 μs dead time
- 10 to 20 readings/s fully formatted—330 μs dead time

Time Interval Measurement Characteristics

Range

±TI: −10 to +10 s, including zero

+TI: 10 ns to 10 s

Resolution

Measurement resolution depends on input signal noise and slew rate. See Graph 3 for characteristic curves.

Accuracy

Time-interval measurement accuracy is influenced by internal systematic uncertainties, trigger-level timing error for each trigger edge, and timebase aging in addition to resolution or random uncertainties. Graphs 1 and 2 show characteristic systematic uncertainties for the HP 5370B. These uncertainties may be reduced to less than 10 ps by calibration with the HP J06-59992A time interval calibrator. Careful calibration and averaging will result in accuracies to ± 100 ps.

Frequency and Period Measurement Characteristics

Range

Frequency: 0.1 Hz to 100 MHz

Period: 10 ns to 10 s

Resolution

Measurement resolution depends on input signal noise as well as measurement gate time. Refer to Graph 6 for characteristic curves.

Accuracy

Accuracy is influenced by internal uncertainties, timebase aging, and noise on the input signal. Graphs 4 and 5 show the contributions of timebase aging and internal uncertainties to measurement accuracy. Periodic timebase calibration minimizes uncertainty due to timebase aging. Internal uncertainties and noise effects may be reduced by selecting longer gate times, or by averaging results.

High-Precision Oscillators

The accuracy of frequency and time-interval measurements is vitally dependent on the timebase or reference element selected. HP has pioneered the field of high-precision crystal oscillators. The current counter product line benefits from HP's leadership in quality and precision oscillator technology.

Three oscillator varieties are standard or optional with the HP counters and counter/timers:

- **RTXO:** Room-temperature crystal oscillators are designed for minimum frequency change over a change in temperature.
- **TCXO:** Temperature-compensated crystal oscillators use external components to offset temperature effects. TCXO temperature characteristics are typically 5 times better than an RTXO, or $<5 \times 10^{-7}$ for a 0° to 50° C change.
- **Oven Timebases:** This alternative places the crystal and temperature-sensitive elements within a temperature-controlled environment. A heating element maintains a consistent temperature. The best stability is achieved when the operating point is 15° to 20° C above the highest temperature to which the unit will be exposed. After warmup, the frequency remains very stable, typically $<7 \times 10^{-9}$ over a 0° to 50° C variation.

For more information, please request Application Note 200-2, "Fundamentals of Quartz Oscillators," from your local HP office.

For More Information

Ask your local HP sales representative for the following literature for more details on the HP 5370B time interval counter and the HP J06-59992A time interval calibrator. (See page 665 for your local HP sales office.)

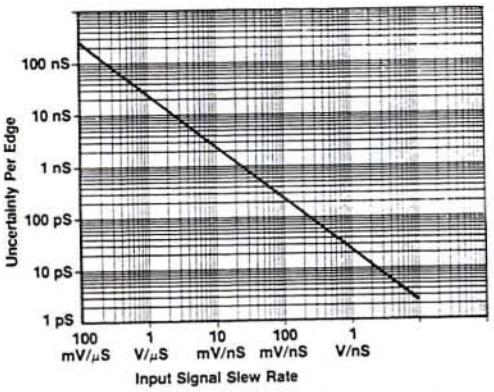
HP 5370B Technical Data Sheet, Literature Number 5952-7915

HP J06-59992A Technical Data Sheet, Literature Number 5952-7837

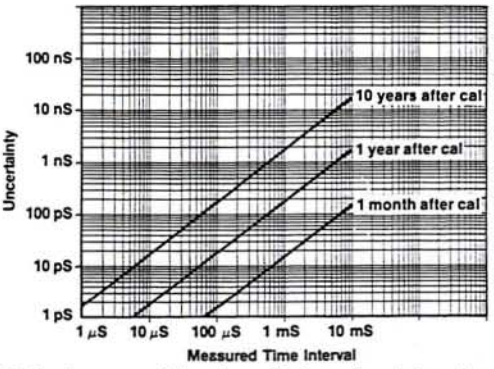
Product Note 5370B-2: "Better than 100 ps Accuracy in HP 5370B Time Interval Measurements Through Bias Error Reduction," Literature Number 5952-7834.

Product Note 5370B-3: "High Throughput Picosecond Characterization of Pulse Parameters," Literature Number 5952-7769.

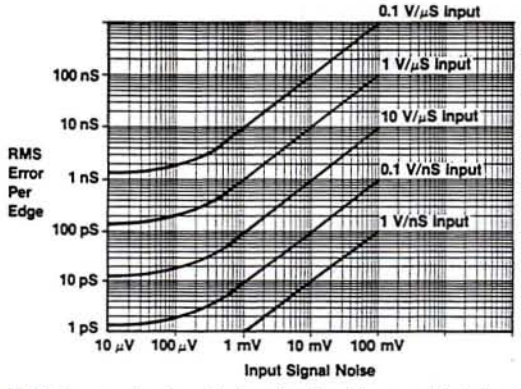
Application Note 191-7: "High-Speed Timing Acquisition and Statistical Jitter Analysis," Literature Number 5952-7908.



Graph 1. Trigger-level timing error varies with input signal slew rate. Uncertainty is associated with both start and stop edges.



Graph 2. Timebase crystal aging affects a time-interval or pulse-width measurement.



Graph 3. Noise on the input signal will add uncertainty to a time-interval measurement. Averaging will reduce the effects of random noise.

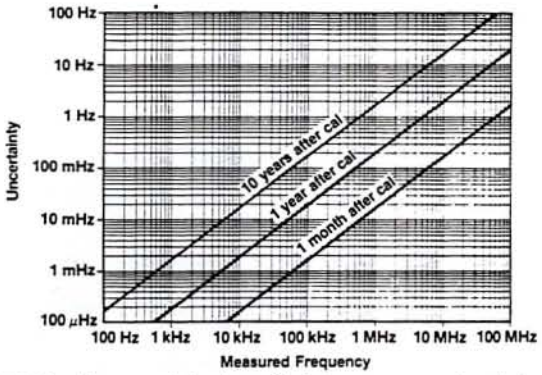
HP 10856A Low-Pass Filter Kit

The four low-pass filters of the HP 10856A filter kit are recommended for use with any HP frequency counter to reduce high-frequency noise or unwanted signals that cause frequency or period measurement errors. Further applications for the kit include reducing noise (trace fuzz) in oscilloscope and spectrum analyzer displays.

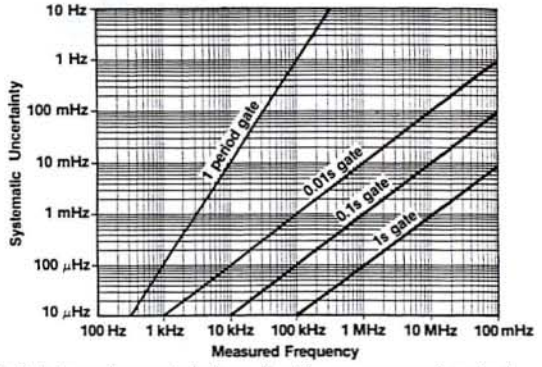
HP 10856A Specifications

Cutoff Frequency (nominal)	5 KHz	50 KHz	500 KHz	15 MHz
Input Impedance (nominal)	1 MΩ	100 kΩ	10 kΩ	50 Ω
Signal Rejection, 100 MHz to 500 MHz	>40 dB	>40 dB	>40 dB	>20 dB

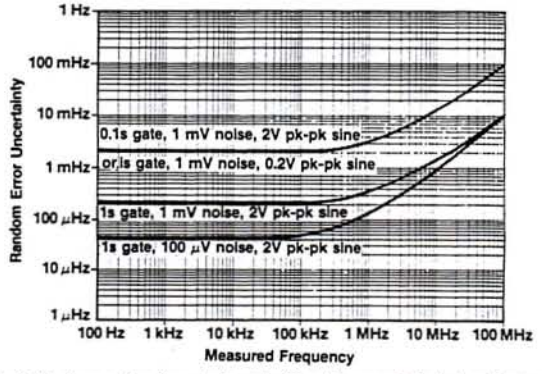
Roll-Off: 20 dB per decade
Attenuation: × 2, reduces signal voltage by a factor of 2
Output Impedance: For use with 1 MΩ input instruments



Graph 4. Timebase crystal aging affects frequency and period measurements. You can further reduce the uncertainty by using an atomic frequency standard.



Graph 5. Internal uncertainties affect frequency and period measurements.



Graph 6. Noise on the input signal will add uncertainty to a frequency or period measurement. Longer gate times and averaging will reduce the effects of random noise.

Ordering Information

	Price
HP 5370B Time Interval Counter	$16,900
Opt 913 Rack Flange Kit for Use with Supplied Front Handles	+$45
Opt 908 Rack Flange Kit, No Front Handles	+$32.50
Opt W30 Extended Repair Service (see page 636)	$305
Opt W32 Calibration Service (see page 636)	$1,345
HP 10856A Low-Pass Filter Kit	+$595
HP J06-59992A Time Interval Calibrator	Call HP

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

ELECTRONIC COUNTERS

RF Frequency Counters

HP 5384A, 5385A, 5386A

- Frequency measurements to 3 GHz (HP 5386A)
- Up to 11 digits of resolution, 9 digits per second
- −23.5 dBm sensitivity
- HP-IB standard
- Systems performance and portability

HP 5386A

DESIGNED FOR HP-IB SYSTEMS

Hewlett-Packard Instrument Drivers

HP 5384A/5385A/5386A Frequency Counters

The HP 5384A/5385A/5386A are HP's lowest-priced system frequency counters. They provide outstanding measurement performance for bench, field, and systems applications. Combining wide frequency range, high resolution, high sensitivity, and HP-IB compatibility, these counters are comparable with instruments that cost much more.

Portable

The half-rack-width package makes the HP 5384A/5385A/5386A portable and saves rack or bench space.

Versatile Display

The 12-digit liquid-crystal display has larger characters than other LED displays and is easier to read in sunlight. The added feature of remote display extends the usefulness of these counters beyond that of simply making and displaying frequency measurements. User-friendly messages, prompts, and measurement units are easily displayed.

Low Cost of Ownership

Integrated design and extensive self-tests result in greater reliability, easier serviceability, and ultimately lower cost of ownership.

Performance

If your frequency measurement needs are below 3 GHz, HP RF counters provide the basic performance of traditional microwave counters at about half the price. The HP 5386A measures frequencies from 10 Hz to 3 GHz with only two input ports, instead of the three ports found with other counters. The high-frequency input measures frequencies from 100 MHz to 3 GHz with -23.5 dBm sensitivity (15 mV rms). In addition, prescaling techniques offer peak-to-peak FM tolerance of at least 100 MHz for your communications applications. You can select the number of digits displayed from 3-to-11 to blank meaningless digits from an unstable digital source. The HP RF counters also solve systems problems with full remote programmability (via HP-IB standard feature) and remote display capabilities. The high-stability timebase option will lengthen the required calibration period (for kHz accuracy at 3 GHz) from six months to a full year.

Applications

The HP RF counters fit well in the following application areas for local oscillator, IF, and radio transmitter frequency measurements:

- Military and private communications
- TACAN, DME, and Identify Friend or Foe
- Global Positioning System
- MDS Television

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

Specifications

Input Channel A (HP 5384A/85A/86A): 1 MΩ // 25 pF
Range: 10 Hz to 100 MHz

Sensitivity	HP 5384A/5385A	HP 5386A
10 to 50 Hz, sinewave	25 mV rms	15 mV rms
50 Hz to 100 MHz, sinewave	15 mV rms	15 mV rms
5 ns minimum pulse width	45 mV peak-to-peak	45 mV peak-to-peak

Dynamic range: 45 mV to 4 V peak-to-peak × attenuator setting
Attenuator: ×1 or ×20 nominal above 50 Hz input
Low-pass filter: 100 kHz nominal 3 dB point
Manual trigger level: Variable, −0.1 V to +0.1 V × attenuator
Damage level ×1: 10 to 200 Hz: 350 V (dc + ac peak)
0.2 to 420 KHz: 170V (dc + ac peak)
0.42 to 10 MHz: (5 x 10^7 V rms Hz)/freq
>10 MHz: 5V rms
×20: <1 MHz: same as ×1; >1 MHz: 50 V rms

Input Channel B (HP 5384A): 50 Ω
Range: 50 to 225 MHz
Sensitivity: 10 mV rms, 50 to 200 MHz; 15 mV rms, 200 to 225 MHz
Dynamic range: 10 mV to 1 V rms
Manual attenuator: Variable, ×1 to ×5 (0 to 14 dB) nominal
Damage level: 350 Vdc + 5 V rms ac

Input Channel B (HP 5385A): 50 Ω, fused
Range: 90 to 1000 MHz
Sensitivity: 10 mV rms (−27 dBm), 100 to 1000 MHz, 15 mV rms (−23.5 dBm), 90 to 100 MHz
Dynamic range: 10 mV to 7 V rms (−27 to +30 dBm)
Manual attenuator: variable, ×1 to ×18 (0 to 25 dB) nominal
Damage level: ac >1 MHz: + 30 dBm (7 V rms)
ac <1 MHz: 2 V rms, dc ± 5 V

Input Channel B (HP 5386A): 50 Ω nominal, VSWR 2.5, typical
Range: 100 MHz to 3 GHz, prescaled (90 MHz to 3.5 GHz, typical)
Sensitivity: 15 mV rms (−23.5 dBm); 5 mV rms (-33.0 dBm) typical
Dynamic range: 15 mV rms to .5 V rms (-23.5 dBm to +7 dBm); 5 mV rms to .5 V rms (-33.0 dBm to +7 dBm), typical
Note: Manual attenuator not active for channel B.

Frequency A and B

Range Channel A: 10 Hz to 100 MHz
Range Channel B: 50 to 225 MHz (HP 5384A); 90 MHz to 1 GHz (HP 5385A); 100 MHz to 3 GHz (HP 5386A)
LSD Displayed: 10 Hz to 1 nHz
Accuracy: ± resolution ± time base to error × frequency (see Graphs 1 and 3).

Period A

Range: 10 ns to 0.1 s
LSD Displayed: .0001 fs to 10 ns
Accuracy: ± resolution ± time base to error × period (see Graphs 2 and 3 on the next page)

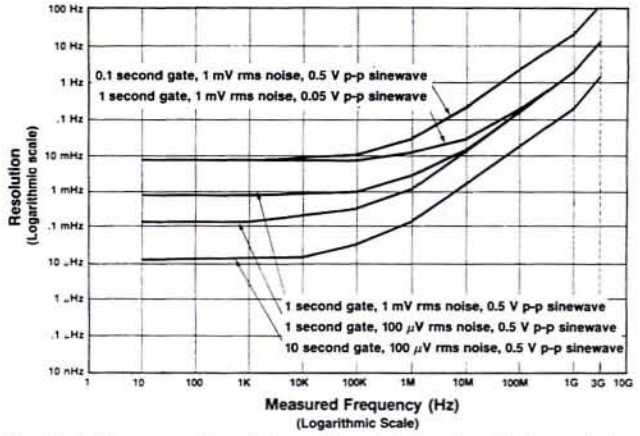
Timebases (see page 172)

Standard HP 5384A: RTXO, 10 MHz
Aging rate: $<3 \times 10^{-7}$/mo
Temperature: $<5 \times 10^{-6}$, 0° to 50° C, ref. 25° C
Line voltage: $<1 \times 10^{-7}$ for ± 10% variation

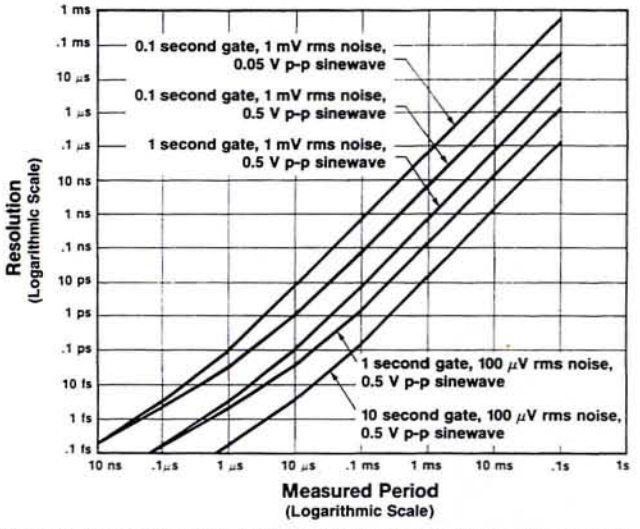
HP 5384A Opt 001, Standard HP 5385A/5386A: TCXO, 10 MHz
Aging rate: $<1 \times 10^{-7}$/mo
Temperature: $<2 \times 10^{-6}$, 0° to 40° C, ref. 25° C
Line voltage: $<5 \times 10^{-8}$ for ± 10% variation

Oven timebase (Option 004): 10 MHz
Aging Rate: $<3 \times 10^{-8}$/mo. after 30 days continuous operation
Temperature: $<1 \times 10^{-7}$, 0° to 50° C, ref. 25° C
Line Voltage: $<2 \times 10^{-9}$ for ± 10% variation

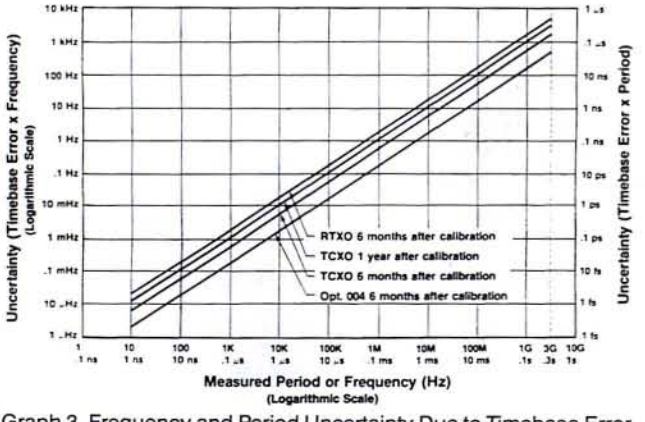
Battery Operation with Option 004 (HP 5384A/5385A only)
Typical: 3 hours
Standby: 24-hour continuous operation



Graph 1. Frequency Resolution. Uncertainties that limit resolution can be reduced by increasing the gate time, reducing the noise on the input signal, or increasing the input signal amplitude.



Graph 2. Period Resolution. Uncertainties that limit resolution can be reduced by increasing the gate time, reducing the noise on the input signal, or increasing the input signal amplitude.



Graph 3. Frequency and Period Uncertainty Due to Timebase Error. Timebase error can be reduced by calibrating the timebase more frequently, or by using a timebase with a better aging rate.

I/O Interface

HP-IB Standard

Programmable functions: Frequency A, Frequency B, Period A
Programmable controls: ATTN A, FILTER A, MAN LEVEL A, MAN LEVEL A/B (HP 5384A/85A only), Gate Time
Display: Normal, Increment, Decrement (digits displayed); Remote, Local; any 12-character message can be displayed on the LCD via a system controller.
Data output: Output will be maximum resolution/gate time.
Format: 17 characters plus CR and LF
Rate: 4 readings/s maximum at 0.1 s gate
HP-IB interface functions: SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E1 (see page 101)
Talk only: Set with address switch = 31

Battery Pack (Option 005, HP 5384A/5385A Only)

Type: Sealed lead-acid
Capacity: 4 hours (typ.) at 25° C without Opt 004
Recharge Time: 16 hours (typ.) in standby mode
Battery-Low Annunciator: Enabled 20 min prior to instrument shutdown nominally
Battery Save Switch (rear panel): Prevents discharge of interval battery by the oven time base, Opt 004, during instrument standby
Line Failure Protection: Instrument automatically switches to battery in the event of a line failure
Weight: Adds 1.4 kg (3 lb) to instrument weight

General

Check: 10 MHz self-test
Gate Times: 0.1, 1, or 10 seconds (nominal)
Display: 12-digit alphanumeric liquid crystal
Display Digits (variable): Frequency 3 to 11; period 3 to 8
Timebase Output: 10 MHz, 25 mV peak-to-peak (nominal) into 50 Ω
External Timebase Input: 10 MHz, 0.5 V rms into 500 Ω; 15 V (dc + ac peak) maximum
Operating Temperature: 0° to 50° C
Power Requirements
ac: Selectable, 18 VA max (30 VA max., HP 5386A). 115 V + 10%, −25%; 230 V + 10%, −15% (48 to 66 Hz); 115 V ± 10% (380 to 420 Hz)
dc (HP 5384A/5385A only): 9 to 15 Vdc, 1.0 A maximum
Weight
HP 5384A/5385A: Net, 2.2 kg (4.8 lb); shipping, 4.1 kg (9 lb)
HP 5386A: Net, 3.4 kg (7.8 lb); shipping, 5.3 kg (11.9 lb)
Size
HP 5384A/5385A: 212 mm W × 98 mm H × 276 mm D (8⅜ in × 3⅞ in × 10⅞ in)
HP 5386A: 212.3 mm W × 88.1 mm H × 421.6 mm D (8⅜ in × 3½ in × 16½ in)

Ordering Information

	Price
HP 5384A Frequency Counter 225 MHz	$1,750
HP 5385A Frequency Counter 1.0 GHz	$2,175
HP 5386A Frequency Counter 3.0 GHz	$3,950
Options for HP 5384A, 5385A, 5386A:	
Opt 004 High-Stability Oven Timebase	+$575
Opt W30 Extended Repair Service (see page 636)	
HP 5384-5385A	+$50
HP 5386A	+$85
Opt W32 Calibration Service (see page 636)	+$715
HP 5384A/5385A only:	
Opt 001 High-Stability TCXO (HP 5384A only; standard with HP 5385A/5386A).	+$160
Opt 005 Battery Pack	+$315
Side Handle Kit: HP 5061-1171	$50
Rack Mount Kit (single): HP 5060-0173	$95
Rack Mount Kit (dual): HP 5060-0174	$80
Vinyl Carrying/Operating Case: HP 34110A	$90
HP 5386A only:	
Front Handle Kit: HP 5062-3988	$55
Rack Mount Kit (single): HP 5062-3972	$60
Rack Mount Kit (dual): HP 5062-3974 and 5061-9694	$45

For off-the-shelf shipment, call 800-452-4844.

ELECTRONIC COUNTERS

CW Microwave Frequency Counters

HP 5350B, 5351B, 5352B

- 10 Hz to 46 GHz without an external mixer
- Exceptional sensitivity to −40 dBm
- 1 GHz/s tracking speed
- 60-ms acquisition time
- 100 measurements/s (HP-IB) in automatic mode
- Three years of hardware support with Option W30

5352B

DESIGNED FOR HP-IB SYSTEMS

HP 5350B/5351B/5352B Microwave Counters

The HP 5350B/5351B/5352B are automatic CW microwave frequency counters that measure to 20, 26.5, and 40 GHz (46 GHz with Option 005), respectively. With resolution as fine as 1 Hz, these counters provide fast and precise frequency measurements.

By integrating all microwave components onto a single hybrid GaAs circuit, these counters offer high performance at low prices. Wide frequency coverage, exceptional sensitivity, fast tracking speed, high measurement throughput, and wide FM tolerance are a few of the high-performance features of these counters.

With a built-in microprocessor, the HP 5350B/5351B/5352B have math capabilities such as measurement scaling and offset. These functions are useful for indirect measurements. Automatic amplitude discrimination automatically measures the frequency of the highest-amplitude signal in a multi-signal environment. Other convenience features include diagnostic routines that perform tests on the counter for general information and troubleshooting.

With high measurement throughput, the HP 5350B/5351B/5352B are ideal components for test systems. Their English-like commands simplify systems integration by reducing programming time and effort. In automatic test systems, the programmable alphanumeric liquid-crystal display (LCD) can serve as a message center; if operational security is a concern, keyboard and display lockout can be activated. In noise-sensitive environments, you can put these counters in SLEEP mode to reduce kickback noise to as low as −70 dBm.

Direct Inputs to 46 GHz: Low-Cost, Versatile Solutions

The HP 5350B/5351B/5352B can meet expanding measurement needs. The HP 5350B/5351B measure frequency from 10 Hz to 20 GHz and 26.5 GHz, respectively. The HP 5352B, which extends input capability to 40 GHz (46 GHz with Option 005), measures in the millimeter-wave range directly—without expensive mixers.

Exceptional Sensitivity: Direct Measurement of Low-Level Signals

Because these counters have input sensitivity to −40 dBm (−30 dBm for HP 5352B), accurately measuring your low-energy signals becomes a simple task. For example, you no longer need expensive microwave amplifiers to make low-level measurements. Also, you no longer have to worry about signal attenuation by the probe when you make frequency measurements at different nodes within your circuit. These conveniences simplify measurements in applications such as receiver front-end testing.

Low Acquisition Time: High Throughput

With acquisition time reduced to 60 ms in automatic, fast-acquisition tracking mode (20 ms in manual mode), these high-speed counters can significantly improve your measurement throughput.

In bench-top applications, this high-speed throughput gives you fast measurement response. The LCD will update measurements rapidly to shorten evaluation time. For applications that require fast response to source tuning, these counters are ideal solutions.

In systems environments, fast measurement throughput contributes to overall system efficiency. Delivering more than 100 measurements/s over HP-IB in automatic mode, these counters save money by reducing test time.

1 GHz/s Tracking: Measuring Fast-Moving Signals

Fast acquisition offers fast tracking speed. With acquisition time below 60 ms, these counters can track source drift to 1 GHz/s effortlessly. For example, when measuring the response of a voltage-controlled oscillator (VCO) to voltage-source tuning, these counters track the changing frequency rapidly to measure transfer characteristics.

HP 5350B/5351B/5352B Specifications

Input 1

Frequency Range: HP 5350B: 500 MHz to 20 GHz
HP 5351B: 500 MHz to 26.5 GHz
HP 5352B: 500 MHz to 40 GHz
Option 005: 500 MHz to 46 GHz

Sensitivity: See Graph 1

Maximum Input: +7 dBm

Damage Level: +25 dBm; HP 5350B/5351B Opt 006: +39 dBm (500 MHz to 6 GHz), +36 dBm (6 GHz to 18 GHz), +34.8 dBm (18 GHz to 26.5 GHz)

SWR (typical): 500 MHz to 10 GHz: 2:1; Option 002/006, 2.5:1
10 GHz to 26.5 GHz: 3:1; Option 002/006, 3.5:1
26.5 GHz to 46 GHz: 3.5:1

Coupling: dc to 50 Ω termination, ac to instrument

Connector: Precision Type N (female) (HP 5350B)
APC-3.5 (male) with collar (HP 5351B/HP 5352B)
APC-2.4 (male) with collar (Option 005)

Accuracy: ±1 LSD ± Timebase Error × Frequency. See Graph 2, page 191, for timebase error. High-stability timebase (Option 010) has timebase uncertainties that are 1/10 of the values for the oven timebase (Option 001). LSD = least significant digit.

Residual Stability: Counter and source using common 10-MHz timebase or counter using external higher-stability timebase: .3 LSD rms typical for resolution 1 Hz to 1 kHz at 25°C; HP 5352B: .7 LSD typical 26.5 to 40 GHz.

Resolution: Selectable, 1 Hz to 1 MHz

FM Tolerance: See Graph 2: FM Rate Tolerance

Maximum deviation: Auto: 20 MHz p-to-p (HP 5350B/51B),
12 MHz p-to-p (HP 5352B),
9 MHz p-to-p (Option 005)
Manual: 60 MHz p-to-p (HP 5350/51B),
55 MHz p-to-p (HP 5352B),
55 MHz p-to-p (Option 005)

Maximum FM rate: 10 MHz

Tracking Speed

Fast-acquisition track: 1 GHz/s

Normal FM rate: 1 MHz/s

Low FM rate: 80 kHz/s

AM Tolerance: Any modulation index, provided the minimum signal level is not less than the sensitivity specification.

Modes of Operation

Automatic: Counter automatically acquires and displays highest-level signal within sensitivity range

Manual: Center frequency must be entered to within ± 20 MHz or input frequency; ± 3 MHz worst case below 1 GHz

Automatic Amplitude Discrimination: Measures largest signal present, providing that signal is >6 dB (typical) above any signal within 500 MHz; >20 dB (typical) above any signal within 500 MHz to 20 (46) GHz

Acquisition Time

Automatic mode: Fast-acquisition track: <60 ms
Normal FM rate: <125 ms
Low FM rate: <1.25 s

Manual mode: <20 ms

	TCX0	Option 001	Option 010
Aging Rate	1×10^{-7}/month	5×10^{-10}/day	2×10^{-8}/year
Short Term	1×10^{-9}/s	1×10^{-10}/s	1×10^{-10}/s
Temperature 0° to 50° C	1×10^{-6}	1×10^{-9}	1×10^{-9}
Line 10% change	1×10^{-7}	1×10^{-10}	1×10^{-10}
Warmup to $<5 \times 10^{-9}$ @ 25° C		10 min	10 min

Table 1. Time Base (10 MHz)

Input 2

Frequency Range: 10 Hz to 525 MHz
50 Ω: 10 MHz to 525 MHz
1 MΩ: 10 Hz to 80 MHz
Sensitivity: Full operating environment:
50 Ω: 10 MHz to 525 MHz, 25 mV rms: 15 mV typical @ 25° C
1 MΩ: 10 Hz to 80 MHz, 25 mV rms: 15 mV typical @ 25° C
Gate Time = 1/resolution: 1 ms min
Maximum Input: 50 Ω: +10 dBm; 1 MΩ: 1V rms
Damage Level: 50 Ω or 1 MΩ dc to 5 kHz: 250 V (dc + ac peak); >5 kHz: 5.5 V rms (+ 28 dBm) + 1.25×10^6 V rms/freq
Coupling: ac
Connector: Replaceable fuse, type BNC (female)
Accuracy:

$$\pm 1 \text{ LSD} \pm \left(\frac{1.4 \times \text{Trigger Error}^1}{\text{Gate Time}} \pm \text{Timebase Error} \right) \times \text{Freq}$$

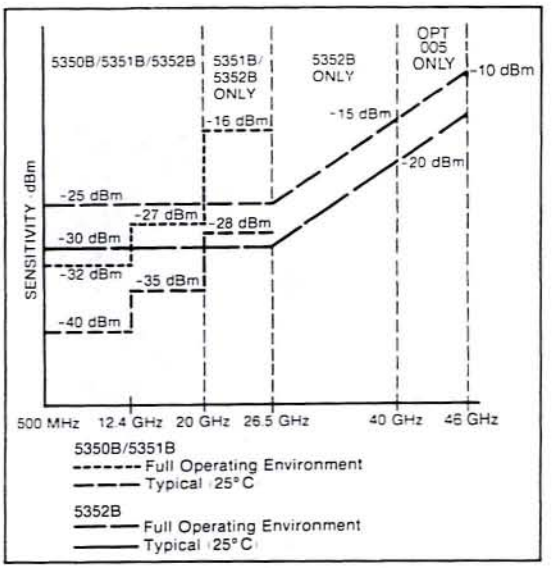
See Graph 2, page 191, for timebase error;
Gate time = 1/resolution = 1 ms minimum
Impedance: 1 MΩ nominal shunted by <70 pF or 50 Ω nominal
Resolution: Selectable, 1 Hz to 1 MHz
High Resolution: 1 MΩ mode: 0.001 Hz for <100 kHz input; 0.01 Hz for <1 MHz input; 0.1 Hz for <10 MHz input; 1 Hz for >10 MHz input: 1-second gate
Timebase Output: 10 MHz and 1 MHz, 2.4 V square wave ac coupled into 1 kΩ: 1.5V peak-to-peak into 50 Ω; rear panel BNC connectors
External Timebase: 1, 2, 5, or 10 MHz, 0.7 V min. to 8 V max. peak-to-peak sine wave or square wave into > 1 kΩ shunted by <30 pF, via rear-panel BNC connector

General

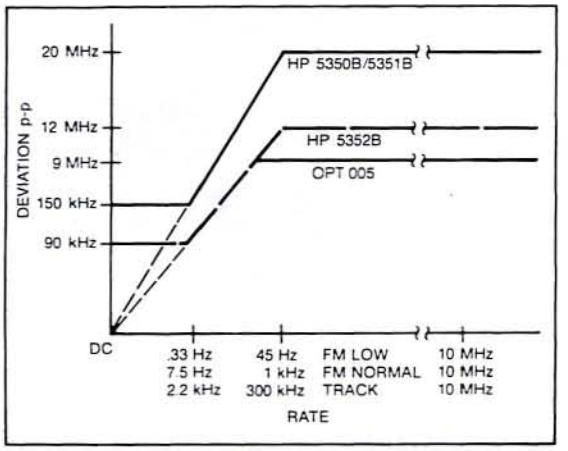
Display: Segmented 24-character alphanumeric LCD (backlighted)
Built-in Features: Self-check, diagnostics, display and keyboard lockout, overload indicator, HP-IB teach-learn mode
Data Output: Over HP-IB bus; varies with frequency and resolution
Auto mode: >100 readings/s, 10 kHz resolution, no math functions, "DUMP" mode
Manual mode: >120 readings/s, 10 kHz resolution, no math functions, "DUMP" mode
Math Functions: Scale, offset, smooth (exponential averaging)
Sample Rate: Variable from less than 50 ms between measurements to HOLD, which holds the display indefinitely or until trigger occurs.
Display Rate: 5/s, variable over HP-IB
Sleep Mode: Input 1 emissions reduced to < −70 dBm typical when sleep mode or Input 2 is selected.
IF Output: Rear-panel BNC provides 30-110 MHz down-converted microwave signal at > −20 dBm into 50 Ω, ac-coupled.
HP-IB Interface Functions: SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0, E1 (see page 101)
Operation Temperature: 0° C to 50° C
Power Requirements: 100 VA max
Line Select: 100 V (90 to 105 Vac rms; 47.5 to 440 Hz)
115/120 V (104/126 Vac rms; 47.5 to 440 Hz)
220 V (198 to 231 Vac rms; 47.5 to 66 Hz)
230/240 V (207 to 252 Vac rms; 47.5 to 66 Hz)
Accessories Furnished: Power cord, manual
Size: 133 mm H × 425 mm W × 358 mm D (5¼ in × 16¾ in x 14 in)
Weight: 11 kg (24 lb)

[1] Trigger error = $\frac{\sqrt{(e_n^2 + e_s^2)}}{\text{Input slew rate in V/S at trigger point}}$ s rms

Where e_n = effective rms noise of counter's input channel (100 μV typical)
e_s = rms noise of the input signal for a 500 MHz bandwidth.



Graph 1. Sensitivity



Graph 2. FM rate tolerance

Ordering Information

	Price
HP 5350B 20 GHz Microwave Frequency Counter	$5,950
HP 5351B 26.5 GHz Microwave Frequency Counter	$7,150
HP 5352B 40 GHz Microwave Frequency Counter	$11,000
Options for HP 5350B/5351B/5352B:	
Opt 001 Oven Timebase	+$780
Opt 002 Rear-Panel Inputs (HP 5350B/51B only)	+$315
Opt 005 Frequency Extension to 46 GHz (HP 5352B only)	+$4,050
Opt 006 Microwave Level Limiter (HP 5350B/51B only)	+$730
Opt 010 High-Stability Oven Timebase	+$1,560
Opt 910 Additional Operating and Service Manual	+$78
Opt 908 Rack Mount Kit for Use with Front Handles removed	+$45
Opt 913 Rack Mount Kit for Use with Supplied Front Handles	+$45
Opt 1A3 Bellcore CLEI Barcode Sticker	+$30
Opt W30 Extended Repair Service (see page 636)	Call HP
Opt W32 Calibration Service (see page 636)	+$865
Additional Equipment Available:	
Transit Case (HP 9211-2643)	$430
Waveguide (3 inch straight) Adapter WR28-APC3.5 (HP 05356-20217)	$1,850
Waveguide (3 inch straight) to Coaxial Adapter WR42-APC3.5 (HP 05356-20216)	$1,900
Adapter: In series APC 3.5 male-to-male (HP 1250-1748)	$170
Adapter: In series APC 3.5 female-to-female (HP 1250-1749)	$185

For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

ELECTRONIC COUNTERS

Microwave Counter/Power Meter

HP 5347A, 5348A

- Quick, easy power and frequency measurements
- Portable; battery operation
- Built-in sensor calibration tables
- Supports many HP power sensors

DESIGNED FOR HP-IB SYSTEMS

HP 5347A with optional soft carrying case and HP 8485A power sensor

HP 5347A and HP 5348A Microwave Counter/Power Meters

The HP 5347A and HP 5348A Microwave Counter/Power Meters offer the convenience of a single instrument that meets both your frequency and power measurement needs. The HP 5347A counter/power meter makes these measurements to 20 GHz; the HP 5348A, to 26.5 GHz. Both counter/power meters offer the accuracy and resolution that previously required a standalone counter and a separate power meter. Measurements are easy. The HP 5347A and 5348A are designed for ease of use; they have only 5 function keys. They are rugged, lightweight, and battery powered.

True Power Meter Performance

As power meters, the HP 5347A and 5348A offer excellent dynamic range, linearity, and accuracy. They use the same proven power sensors used with Hewlett-Packard's standalone power meters. Power sensors and accurate, wide-range measurements go hand in hand.

Power measurements can be made from −70 dBm to +20 dBm over a 10 MHz to 26.5 GHz frequency range, depending on the sensors used. Exceptional power-meter linearity and low sensor SWR combine to give you outstanding measurement accuracy. The instrumentation accuracy is ±0.5% in linear mode or ±0.02 dB in logarithmic mode, making power-meter uncertainty a negligible part of your total measurement error.

Outstanding Frequency Measurements

The frequency counter performance rivals that of HP's highest-performance standalone CW microwave counters. The HP 5347A measures frequency from 10 Hz to 20 GHz; the HP 5348A, from 10 Hz to 26.5 GHz. You can select either 1 Hz or 10 kHz resolution while measuring signals down to −35 dBm.

Portable, Easy to Use

The HP 5347A and 5348A come in a rugged, lightweight, and portable package. Several features have been designed in for quick and easy, portable measurements. An internal-battery option, for example, provides up to 2 hours of cordless measurements.

Designed for Measurement Ease

How many times have you purchased test equipment only to find that you never use most of the available functionality? The excess functionality only clutters the front panel and makes measurements difficult. Hewlett-Packard recognizes the importance of quick and easy measurements to field service personnel. The HP 5347A and HP 5348A are designed for ease of use.

Five Function Keys Simplify Operation

Unnecessary functions were designed out of the HP 5347A and HP 5348A counter/power meters. Only 5 function keys are required to make accurate frequency and power measurements. The chance of getting an incorrect reading due to instrument setup is almost eliminated. Little or no time is required to learn how to use these instruments. A 1-page starter guide is shipped with every instrument.

No Need for Calibration Tables

An average calibration table is permanently stored in memory. You no longer need to spend time entering power sensor calibration factors. Using average calibration tables results in only a slight reduction in overall measurement accuracy. With the HP 5347A and 5348A, the press of a single key stores a frequency measurement for use in a power measurement. The stored frequency is then used to access the power sensor calibration factor in the permanently stored calibration-factor-versus frequency tables.

Internal Battery for Cordless Measurements

An optional internal battery allows you to make cordless measurements for up to 2 hours. In the field, you do not need a power cord. Just walk right up to the output port and make your measurement.

Because at times it might be more convenient to operate the instrument from a dc supply, an external dc input is available for even greater flexibility in choosing a power source.

A Rugged Package for Tough Environments

These instruments are designed to survive the harsh transportation and operation environments common to portable applications. Their membrane front panels keep dirt and moisture from entering the instruments. An optional soft carrying case stores accessories, protects the unit during transit, and frees your hands to make measurements.

For Benchtop and ATE Systems Too

Having frequency and true power measurements in a single portable package saves valuable bench space in a manufacturing environment. The ease-of-use features will also be greatly appreciated.

A rackmount kit and HP-IB option are available for using the HP 5347A or HP 5348A in an ATE system.

Counter Specifications

Input 1

Frequency Range:
HP 5347A: 500 MHz to 20.0 GHz
HP 5348A: 500 MHz to 26.5 GHz
Sensitivity:
HP 5347A/48A: 500 MHz to 12.4 GHz: −32 dBm (−35 dBm typical)
12.4 GHz to 20.0 GHz: −27 dBm (−32 dBm typical)
HP 5348A: 20.0 GHz to 26.5 GHz: −20 dBm (−27 dBm typical)
Maximum Input: +7 dBm
Damage Level: +25 dBm, peak
Connector: HP 5347A: N(f); HP 5348A: APC 3.5(m)
Coupling: ac
Accuracy: ± LSD ± timebase error × frequency
Accuracy specification applies from 0° to 50° C when using internal timebase, 0° to 55° C with external timebase.
Resolution: 1 Hz or 10 kHz, selectable
Tracking Speed: Resolution = 1 Hz, speed = 1 MHz/s
Resolution = 10 kHz, speed = 1 GHz/s
Acquisition Time: Resolution = 1 Hz, time = < 125 ms
Resolution = 10 kHz, time < 60 ms
Maximum Deviation: 20 MHz peak-to-peak, automatic mode
Maximum FM Rate: 10 MHz
AM Tolerance: Any modulation index, provided the minimum signal level is not less than the sensitivity specification.
TCXO Timebase: See page 191 for specifications. See page 196 for a general description of timebases.
External Timebase: 10 MHz, 0.7 V min. to 8 V max peak-to-peak sine wave or square wave into > 1 KΩ shunted by < 30 pF, via front-panel BNC connector.

Input 2

Frequency Range: 10 Hz to 525 MHz
Sensitivity: 25 mV rms (15 mV rms typical)
Impedance: 1 MΩ nominal shunted by < 70 pF (10 Hz to 80 MHz) or 50 Ω nominal (10 MHz to 525 MHz)
Maximum Input: +10 dBm (50 Ω input), 1 V rms (1 MΩ input)
Connector: BNC (f)
Coupling: ac
Resolution: 1 Hz or 10 kHz, selectable

Options

Battery (Option 002): 1 to 2 hours of operation (typical); 12 hours to charge (typical)
Microwave Level Limiter (Option 006)
Damage level: 500 MHz to 6 GHz: 39 dBm; 6 GHz to 18 GHz: 36 dBm; 18 GHz to 26 GHz: 34.8 dBm
Sensitivity, reduced by: 500 MHz to 12.4 GHz: 3 dBm; 12.4 GHz to 20 GHz: 4 dBm; 20 GHz to 26 GHz: 5 dBm
Oven Timebase: Special option

Power Meter Specifications

Frequency Range: 10 to 26.5 GHz, sensor-dependent
Power Range: −70 dBm to +20 dBm (100 pW to 100 mW), sensor-dependent
Power Sensors: HP 8481A, HP 8481D, HP 8484A, HP 8485A (The HP 8481D is a direct replacement for the HP 8484A.)
Dynamic Range: 50 dB in 10 dB steps
Display Units: Watts, dBm
Resolution: 0.01 dB in log mode, 0.1% of full scale in linear mode
Accuracy
Instrumentation: ±0.02 dB or ±0.5%
Zero set (digital settability of zero): ±0.5% of full scale on most sensitive range
Power Reference
Power output: 1.00 mW. Factory set to ±0.7% traceable to U.S. National Institute of Standards and Technology.
Accuracy: ±1.2% worst case (±0.9% RSS) for one year.

General

Diagnostics: Rear panel or HP-IB selectable, service diagnostics and user information
Data Output: Counter: varies with frequency (90 measurements/sec with 10 kHz resol, DUMP mode); Power Meter: 18 measurements/sec
HP-IB Interface Functions: SH1, AH1, T5, L4, SR1, RL1, DC1, DT1, E1 (see page 101)
Operating Temperature: 0° to 55° C
Power Requirements: 50 VA maximum
Line Select: 100V (90 to 105 Vac rms; 47.5 440 Hz)
115/120V (104 to 126 Vac rms; 47.5 to 440 Hz)
220V (198 to 231 Vac rms; 47.5 to 66 Hz)
230/240V (207 to 252 Vac rms; 47.5 to 66 Hz)
External dc: 14 to 26 Vdc, 40 W, binding post
Accessories Supplied: Power cord, operating/programming manual, power sensor cable (HP 11730M)
Size: 144 mm H × 325 mm W × 456 mm D (5.66 in × 12.8 in × 18.0 in)
Weight: 9.1 kg (20 lb); with battery, 10.4 kg (23 lb)

Ordering Information	Price
HP 5347A 20 GHz Counter/Power Meter	$8,750 ☎
HP 5348A 26.5 GHz Counter/Power Meter	$9,850
Options for HP 5347A and HP 5348A	
Opt 002 Battery Pack	+$450 ☎
Opt 006 Microwave Level Limiter	+$950
Opt 011 HP-IB Interface	+$350
Oven Timebase Special Option	Call HP
Opt 070 Soft Carrying Case	+$295 ☎
Opt 913 Rack Mount Kit	+$410
Opt 915 Service Manual	+$150
Opt 916 Additional Operating/Programming Manual	+$75
Opt W30 (HP 5347A) Extended Repair Service (see page 636)	+$190
Opt W30 (HP 5348A) Extended Repair Service (see page 636)	+$215
Opt W32 (HP 5347A/48A) Calibration Service (see page 636)	+$835
Power sensors	
HP 8481A Power Sensor	$775
HP 8481D Power Sensor	$1,000
HP 8485A Power Sensor	1,200
HP Power sensor cables	
HP 11730A 1.5-m (5-ft) Sensor Cable	$100
HP 11730B 3.0-m (10-ft) Sensor Cable	$120
HP 11730C 6.1-m (20-ft) Sensor Cable	$175
HP 11730D 15.2-m (50-ft) Sensor Cable	$250
HP 11730E 30.5-m (100-ft) Sensor Cable	$350
HP 11730F 61.0-m (200-ft) Sensor Cable	$550
Additional equipment available:	
Transit Case 9211-2649 (see page 622)	$480

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales

ELECTRONIC COUNTERS

Pulse/CW Microwave Counter

HP 5361B

- Built-in frequency profiling
- Frequency extensions to 26.5 GHz, 40 GHz
- Measure frequency (pulsed or CW), PRI, PRF, pulse width, offtime, and frequency profiles directly
- 1 Hz resolution on pulsed and CW signals
- Up to +50 dBm pulse level protection (optional)
- 60 ns minimum pulse width
- Measurements down to 1 Hz PRF

HP 5361B

HP 5361B Pulse/CW Microwave Counter

Make All Your Frequency Measurements with One Microwave Counter

The HP 5361B was designed for both high precision pulse and CW performance. It is the only pulse/CW microwave counter with frequency modulation profiling built in. Characterize radar, EW, and communications systems or components. Lower your equipment costs by eliminating the need for a separate CW counter, pulse generator, and computer.

Precision Pulse Measurement Provides Accuracy to Spare

The HP 5361B measures 40 GHz pulsed microwave signals with up to 1 Hz resolution. Six separate pulse microwave measurements are available to characterize your signals: frequency, PRF, PRI, pulse width, off-time, and frequency profiling.

True CW Performance at No Extra Cost

Count CW signals from 10 Hz to 40 GHz with 1 Hz resolution. Resolution improves to 0.001 Hz at 100 kHz. Other CW counter features include Fast Track and Low FM Rate. Fast Track enables the counter to measure a signal that is sweeping at up to 800 MHz/s. Low FM Rate allows measurements on a signal that is varying slowly in frequency.

Frequency Profiling Made Easy and Inexpensive

Intentional or unintentional FM on your carrier, such as a chirp, is easy to measure and plot with the HP 5361B and a printer. The function PROFILE, with a printer, makes it possible to accurately determine the frequency vs. time characteristics of your pulsed or CW signal, replacing a computer, pulse generator, and much software.

Frequency profiling is becoming more important as demands are increased on radar, EW, transponder, and communication equipment. Unwanted frequency perturbations on a switching voltage controlled/digitally tuned oscillator (VCO/DTO) degrade performance. If the linearity of a chirp deviates too much from the desired characteristics, the range side lobes will be out of spec. Characterizing frequency transients, modulation, and linearity is essential to lowering costs and increasing performance in future systems.

Previously, frequency profiling required a microwave counter, a pulse generator, a computer, software, and much interconnection. The PROFILE function allows you to make frequency measurements inside a pulse with no extra equipment, other than a printer. The printer is used to output a plot of frequency versus time.

Easy to Use Because It Is Automatic

An external gate is not needed for pulsed signals. Pushing the PROFILE key starts the profiling function. The signal is acquired, the pulse width measured, and frequency profiling started. When the profile is finished, it is sent to the printer for a permanent hard copy.

The Most Accurate Method of Frequency Profiling

Gating error is an inherent part of most counter architectures. It can be a small but consistent error of less than 100 ps. The algorithms and hardware associated with PROFILE reduce this gating error to a negligible amount, providing more accurate measurements.

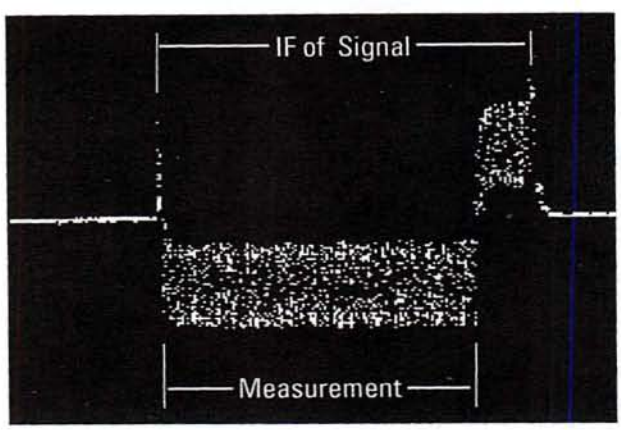
Automatic Measurements Simplify Testing

The HP 5361B's suite of automatic features is designed to make your testing easier. The counter performs many automatic operations that must be done manually with other counters. All you need to do is connect your signal and choose the function, and the counter does the rest. Automatic features include:

Auto-Calibration: Performs a major calibration internally at power-up, or on command. No external connections are needed.
Auto-Assess: Determines whether the signal is pulsed or CW and shifts to the correct measurement routines
Auto-Acquire: Acquires a signal from 500 MHz to 40 GHz
Auto-Gate: Sets the gate width for CW signals (dependent on the selected resolution). Pulsed signals are assigned a gate width calculated to minimize measurement errors.
Auto-PRF: Allows you to measure the carrier frequency of signals with stable or changing PRIs, from 2 MHz to 50 Hz. A low-PRF mode allows measurements to 1 Hz PRF
Auto-Position: Positions the gate inside the microwave pulse. Turn-on and turn-off transients do not corrupt the measurement.
Auto-Track: Tracks a signal sweeping up to 800 MHz per second in Fast Track (after a CW signal has been acquired)
Auto-Resolution: Calculates the number of pulses to average for the true requested resolution. Smoothing improves resolution.
Auto-Indicate: Displays the measurement and indicates whether the signal is pulsed or CW

Scope-View Gives You Confidence in Externally Gated Measurements

View the exact position of the measurement on any 100 MHz oscilloscope. For externally gated measurements, there is always a possibility that the gating signal may not coincide with the microwave pulse. Scope-View enables you to easily set up an externally gated measurement because you can see the downconverted pulse with a dc offset at the actual measurement interval.



Set up externally gated measurements with confidence using Scope-View.

A Cost-Effective Choice for Manufacturing and Service

Test software to control the HP 5361B can be written in 2 different ways. The counter can be controlled by English-like commands, or by Hewlett-Packard's Interactive Test Generator (ITG).

ITG: The Easiest Way to Generate Test Software – Use a Mouse

ITG can be used to generate test software for the HP 5361B. This allows the use of a mouse for easy code generation for a rack of instruments. The mouse is used to invoke different functions on graphical panels displayed on a computer. For more information, see page 111.

High-Speed Throughput Lowers Production Costs

The counter can also produce results at up to 100 measurements per second. The improved efficiency saves time and money.

Extended Calibration Cycles Keep the HP 5361B Working and Out of the Calibration Lab

The only periodic maintenance required for the HP 5361B is timebase calibration. Complete internal calibration is performed at power-up or upon command. To keep the counter out of the calibration lab even longer, Option 001 or 010 can be included. Option 010 extends the calibration cycle to 5 years, and still provides kHz measurement accuracy on a 40 GHz frequency measurement.

Power for Tomorrow's Radars, VCOs, and DTOs

The HP 5361B makes frequency, timing, and profiling measurements at the touch of a button. The counter also makes more complex measurements for the carrier frequency of agile signals, staggered PRIs, or the frequency transients in a pulsed or CW signal.

Frequency Modulation on the Pulse (FMOP) is Easy and Inexpensive to Quantify

Frequency-profiling a radar chirp to determine linearity or characterizing the droop when turning on a high-power stage is easy with the HP 5361B's PROFILE function and uses much less equipment.

One Counter Measures Radar Pulse Parameters and the STALO

The HP 5361B features state-of-the-art pulse microwave measurements without sacrificing its CW performance. This counter can characterize your radar pulse, and has the needed features for measurements that require high-CW precision, such as testing the Stable Local Oscillator (STALO). The counter measures with 1 Hz resolution up to 40 GHz.

Resist Input Burnout with a High Damage Level

Option 006 extends the damage level to +50 dBm for pulses of 1 μs and less, or approximately +40 dBm for CW signals. The standard damage level, and damage level above 26.5 GHz, is +25 dBm, more than enough for lower-power applications.

The Right Mix of Features Simplifies VCO and DTO Testing

The HP 5361B has features to accurately and easily test VCOs and DTOs. PROFILE lets you measure the step response with gate widths down to 11 ns. Post-tuning drift and settling time can also be measured in this way. Fast Track is useful for measuring tuning linearity because it tracks a signal that is moving at up to 800 MHz per second. The counter outputs results at up to 100 readings per second.

Summary Specifications

Functions

Frequency (pulse or CW), frequency profiling, PRF, PRI, pulse width, and offtime

Input characteristics

	Input 1 (50 Ω)	Input 2 (1 MΩ)	Input 2 (50 Ω)
Frequency Range	500 MHz to 20, 26.5, 40 GHz	10 Hz to 80 MHz	10 MHz to 525 MHz
Sensitivity		25 mV rms	25 mV rms
0.5 to 12.4 GHz	−28 dBm		
12.4 to 20 GHz	−23 dBm		
0.5 to 26.5 GHz (Opt 026, 040)	−20 dBm		
26.5 to 40 GHz (Opt 040)	0.37 × f(in GHz) to 29.8 dBm		

Frequency (Input 1)

Automatic and Manual Acquisition: 500 MHz to 20 GHz; 500 MHz to 26.5 GHz (Opt 026); 500 MHz to 40 GHz (Opt 040)
Least Significant Digit: 1 MHz to 1 Hz for frequency, 0.001 Hz for PRF
Pulse Frequency Measurements
Pulse width (minimum): Manual mode, 60 ns; auto mode, 100 ns
Pulse rep freq: Minimum 1 Hz; maximum 2 MHz
Measurement time, resolution, accuracy: See datasheet
CW Frequency Measurements
FM tolerance: 55 MHz peak-to-peak
Tracking speed (fast acquisition): 800 MHz/s
Acquisition time: Manual mode, <40 ms; automatic mode, fast acq., <100 ms
Gate times (1 Hz resolution): 200 to 1000 ms
Measurement time: ≥8.5 ms (in Dump Mode)
Accuracy: See datasheet

Pulse parameters (Input 1)

	Pulse Width	PRI	Offtime	PRF
Min/Max	60 ns/10 ms	500 ns/1 s	400 ns/1 s	1 Hz/2 MHz
LSD	(PW < 1 ms) 1 ns; (PW ≥ 1 ms) 100 ns			to 0.001 Hz
Accuracy (100 Avg.)	± (20 ns + timebase uncertainty × measurement ± LSD			± (20 ns) × (PRF)² ± LSD ± timebase uncertainty

Profile (Input 1)

Frequency Range (min/max for Y axis): 500 MHz/40 GHz
FM Chirp Tolerance (max span for Y axis): 50 MHz peak-to-peak
Time Range (min/max span for X axis): 100 ns/10 ms
Time Resolution: 1 ns
Internal Gate Width: Minimum: 11 to 23 ns; typical minimum: 14 ns
External Gate Width: Minimum: Manual acquisition 20 ns; auto-acquisition 60 ns
Number of Data Points: Up to 100
Profile Frequency Measurements
Printers supported: HP 2225A, HP 2227B, HP 3630A Opt 002
Profile phase measurements: See Application Note 377-4 for details. Computer required.

Frequency (Input 2)

Range: 10 Hz to 525 MHz
Accuracy: 0.001 to 1 Hz
Resolution/LSD: 0.001 to 1 Hz

Options

Opt 001 Oven Timebase: Aging rate $< 5 \times 10^{-10}$/day
Opt 006, Increased Damage Level: Pulsed, + 50 dBm (100 W) peak; CW, +39 dBm (8 W)
Opt 010 High-stability Oven Timebase: Aging rate $< 7 \times 10^{-10}$/week
(Standard timebase: Aging rate $< 1 \times 10^{-7}$/month)
Opt 026: Frequency extensions for input 1 to 26.5 GHz
Opt 040: Frequency extensions for input 1 to 40 GHz

Ordering Information

	Price
HP 5361B Pulsed/CW Microwave Counter	$12,495
Opt 001 Oven Timebase	+$950
Opt 006 Microwave Limiter	+$950
Opt 010 High-Stability Timebase	+$1,500
Opt 026 26.5 GHz Frequency Extension	+$2,600
Opt 040 40 GHz Frequency Extension	+$7,000
Opt 908 Rack Mount Kit for Use with Front Handles Removed	+$50
Opt 910 Additional Operating and Programming Manual	+$80
Opt 913 Rack Mount Kit for Use with Supplied Front Handles	+$83
Opt 915 Service Manual	+$215
Opt W30 Extended Repair Service (see page 636)	+$355
Opt W32 Calibration Service (see page 636)	+$525

For the most current prices and product information, contact your local Hewlett-Packard sales office (see page 665).

ELECTRONIC COUNTERS

Mature Products

HP 5328B, 5334A, 5340A, 5343A, 5345A, 5355A, 5356A/B/C/D

HP 5328B

DESIGNED FOR HP-IB SYSTEMS

HP 5334A with DVM and C-Channel (Option 050)

DESIGNED FOR HP-IB SYSTEMS

HP 5340A

DESIGNED FOR HP-IB SYSTEMS

Time-Proven Technology

Hewlett-Packard products pass the test of time. As new technology continues to enhance the counter product line, the established products remain viable and in demand. The products listed in this section are examples of HP's commitment to customers that depend on these mature products. If more details are required, please contact your local HP sales office for data sheets and complete product information.

HP 5328B Universal Counter

- Frequency measurements to 100 MHz, 1.3 GHz optional
- 10-ns time-interval resolution, 10 ps with averaging
- 10-ns period resolution, 1 fs with averaging
- ±1000 Vdc DVM and high-stability oven timebase options
- HP-IB programming and external arming standard

HP 5334A Universal Counter

The HP 5334B (see page 193) is a newer, more affordable version of the HP 5334A. Similar in function and specifications, the HP 5334A has two capabilities not offered with the HP 5334B:

- Front-panel setup memory: stores settings for easy recall
- Option 020 digital voltmeter: ±1000 V autoranging, autopolarity dc DVM with floating input

HP 5340A Automatic Microwave Counter

- Direct measurements from 10 Hz to 18 GHz, 23 GHz optional
- Single input connector
- Automatic amplitude discrimination
- High sensitivity: −35 dBm
- High AM and FM tolerance

Ordering Information	Price
HP 5328B Universal Counter	$8,315
Opt 010 High-Stability Timebase	+$990
Opt 021 High-Performance DVM	+$940
Opt 031 1300 MHz Channel C	+$1,250
Opt 050 DVM and Channel C	+$2,225
Opt 908 Rack Flange Kit, No Handles	+$35
Opt 913 Rack Flange Kit With Handles	+$45
Opt W30 Extended Repair Service (see page 636)	+$135
Opt W32 Calibration Service (see page 636)	+$620
HP 5334A Universal Counter	$6,000
Opt 010 Oven Timebase	+$990
Opt 020 DC Digital Voltmeter	+$700
Opt 030 1300 MHz C-Channel	+$950
Opt 050 DVM and C-Channel	+$1,650
Opt 060 Rear Panel Input	+$125
Opt 908 Rack Flange Kit, no handles	+$45
Opt 913 Rack Flange Kit, with handles	+$45
Opt W30 Extended Repair Service (see page 636)	+$85
Opt W32 Calibration Service (see page 636)	+$525
HP 5340A Frequency Counter	$22,900
Opt 001 High-Stability Timebase	+$1,050
Opt 002 Rear-Panel Connectors	+$250
Opt 005 Frequency Extension to 23 GHz	+$760
Opt 006 Limiter Input Protection (+39 dBm) Incompatible with Opt 002 and Opt 005. Consult factory special to combine these options.	+$1,050
Opt 011 Remote Programming – Digital Output (HP-IB)	+$950
Opt 908 Rack Flange Kit	+$110
Opt W30 Extended Repair Service (see page 636)	+$415
Opt W32 Calibration Service (see page 636)	+$1,405

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 5343A

DESIGNED FOR HP-IB SYSTEMS

HP 5345A

DESIGNED FOR HP-IB SYSTEMS

HP 5345A with the HP 5355A and HP 5356D

DESIGNED FOR HP-IB SYSTEMS

HP 5342A and HP 5343A CW Microwave Counters

The HP 5342A and HP 5343A Microwave Counters provide automatic frequency measurements to 18 and 26.5 GHz, respectively. The HP 5342A can be extended to measure up to 24 GHz with Option 005. Other features and capabilities include:

- Highly portable packaging
- Amplitude measurements, 0.1 dBm resolution (Option 002, HP 5342A)
- FM tolerance (peak-to-peak FM deviation to 50 MHz)
- Digital-to-analog conversion (Option 004)

HP 5345A Universal Systems Counter

The HP 5345A is a full-function universal counter that provides versatile, high-speed measuring capabilities. Measurements can be read out over HP-IB at speeds up to 9000 readings/second. Other features include:

- 500 MHz; extendable with the HP 5355A and HP 5356A/B/C/D
- 2-ns resolution time-interval measurements (jitter analysis)
- 25-mV sensitivity to 500 MHz
- High-throughput frequency, period, ratio, totalize, and scale

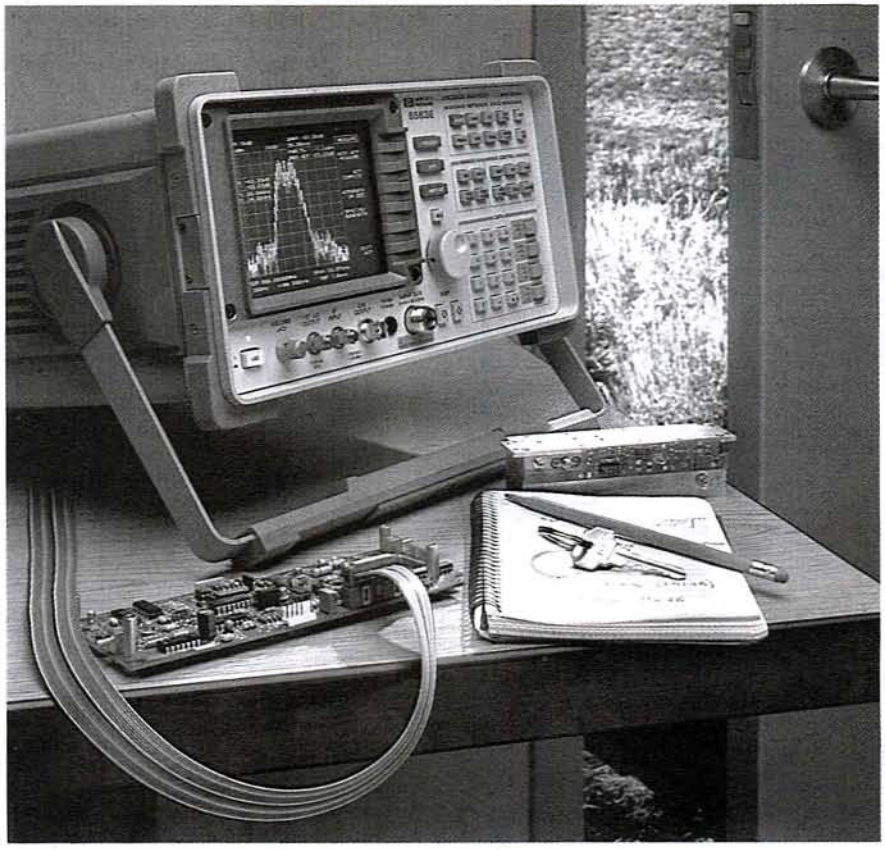
HP 5355A and HP 5356A/B/C/D CW Microwave Counters

The HP 5355A Automatic Frequency Converter, together with the HP 5356A/B/C/D Frequency Converter Heads, increase the pulse and CW frequency measurement capabilities of the HP 5345A to 18, 26.5, 40, and 110 GHz, respectively.

All of these counters characterize pulsed signals, with the 110-GHz version detecting incoming RF bursts as short as 75 ns. All are characterized by sensitivity to −25 dBm and 100-Hz measurement resolution.

Ordering Information	Price
HP 5342A Frequency Counter	$13,300
HP 5343A Frequency Counter	$15,250
Options and Accessories (HP 5342A, 5343A)	
Opt 001 High-Stability Timebase	+$990
Opt 002 Amplitude Measurement (HP 5342A Only)	+$2,750
Opt 003 Extended Dynamic Range (HP 5342A Only)	+$875
Opt 004 Digital-To-Analog Converter	+$440
Opt 005 Frequency to 24 GHz (HP 5342A Only)	+$550
Opt 006 Limiter Input Protection (+39 dBm)	
HP 5342A	+$935
HP 5343A	+$825
Opt 011 Digital I/O (HP-IB) (cable not included)	+$605
Opt 908 Rack Flange Kit	+$110
HP K70-59992A Rack Mounting Adapter Kit (with slot for access of front connectors from rear)	+$450
HP 10842A Extender Board Kit	$1,795
HP 5345A Plug-In Counter	$18,500
Opt 011 HP-IB Includes remote programming.	+$1,750
Opt 012 HP-IB Similar to Opt 011, but also includes slope and trigger-level controls.	+$1,850
Opt 908 Rack Flange Kit, HP 5060-8740	+$75
HP 10595A Board Extender Kit: For troubleshooting	$2,300
HP 5355A Automatic Frequency Converter	$15,225
HP 5356A 18 GHz Frequency Converter	$4,305
HP 5356B 26.5 GHz Frequency Converter	$4,305
HP 5356C 40 GHz Frequency Converter	$5,040
HP 5356D 36 to 110 GHz Harmonic Mixer Driver	$13,450
Options for HP 5356A	
Opt 001 High-Pass Filter	+$640
Opt 006 Limiter	+$950
Options for HP 5356B	
Opt 001 18 to 26.5 GHz Waveguide (WR-42)	+$1,700
Opt 006 Limiter	+$950
Options for HP 5356C	
Opt 001 26.5 to 40 GHz Waveguide (WR-28)	+$1,700
Options for HP 5356D (Requires an HP 5355A with S/N prefix greater than 2620-xxxx)	
Opt 005 (two HP 5061-5458 parts) 2 cables to connect HP 5356D to HP 1197Q/U/V or W	+$260
Opt 050 (HP 11970Q) 36 GHz to 50 GHz Harmonic Mixer	+$1,950
Opt 060 (HP 11970U) 40 GHz to 60 GHz Harmonic Mixer	+$2,100
Opt 075 (HP 11970V) 50 GHz to 75 GHz Harmonic Mixer	+$2,600
Opt 110 (HP 11970W) 75 GHz to 110 GHz Harmonic Mixer	+$2,900

SIGNAL ANALYZERS
General Information



Hewlett-Packard offers a complete line of signal analyzers to provide frequency, time, and modulation domain measurement capability. This section is devoted primarily to the frequency domain. It includes spectrum analyzers, distortion analyzers, audio analyzers, modulation analyzers, and measuring receivers. Each type of instrument has distinctive capabilities that make it the preferred instrument for a particular measurement application.

The spectrum analyzer is a swept-tuned, superheterodyne receiver that provides a CRT display of amplitude versus frequency. It is essentially a frequency-selective, peak-responding voltmeter calibrated to display the rms value of a sine wave. The spectrum analyzer can show the individual frequency components that make up a complex signal. (It does not provide phase information about a signal, however.) The swept receiver technique used in Hewlett-Packard spectrum analyzers enables frequency domain measurements to be made over a large dynamic range and a wide frequency range (5 Hz to 325 GHz).

The Fourier analyzer uses digital sampling and mathematical transformation techniques to form a Fourier spectrum of a signal. This method is useful for measuring signals from a few μHz to 100 kHz, and provides frequency, amplitude, and phase information. As with the spectrum analyzer, all information is presented on a CRT display. With its real-time signal analysis capability, the Fourier analyzer is able to capture periodic as well as random and transient events.

The wave analyzer uses a tunable filter, which can be visualized as a movable frequency window, to measure both the amplitude and the frequency of individual spectral components. This measurement technique essentially makes the instrument a frequency-selective voltmeter. The wave analyzer employs meters and digital displays to show the amplitude and frequency of the signal within the window. HP wave analyzers provide accurate results from 15 Hz to 32.5 MHz.

Distortion analyzers and audio analyzers employ broadband detectors and notch filters to measure signal properties such as total harmonic distortion. These tunable filters enable the analyzer to selectively display the level and frequency of harmonic and distortion products. Measurement results are shown on a meter or digital display. Audio analyzers include a signal source, making possible measurements such as SINAD, which include signal and distortion levels. The frequency range covered by HP distortion and audio analyzers extends from 5 Hz to 600 kHz.

Modulation analyzers and measuring receivers are designed to capture and analyze a fundamental signal and its entire modulation envelope. These analyzers use independent AM and FM detection circuits for simultaneous analysis of complex modulated signals. When these analyzers are combined with a downconverter and local oscillator, accurate measurements of frequency, power, and modulation characteristics can be made on signals from 150 kHz to 26.5 GHz. All measurement results are presented on a digital display.

Spectrum Analyzers

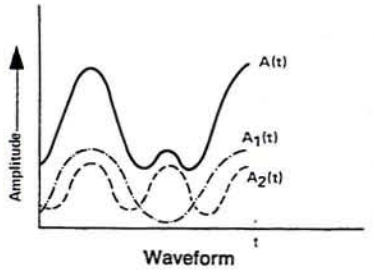
Spectrum analyzers take advantage of the frequency-conversion properties of the swept-tuned heterodyne receiver to make significant contributions to frequency-domain signal analysis. The following are some of the measurements that can be made with spectrum analyzers:

- Absolute and relative frequency
- Absolute and relative amplitude
- Noise
- Distortion products
- AM, FM, pulsed RF modulation
- Stimulus response
- Electromagnetic compatibility (EMC)

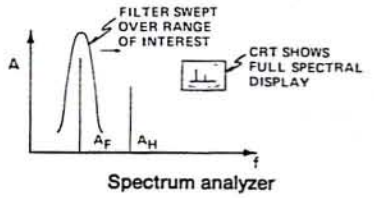
These measurements are possible because spectrum analyzers have the following characteristics:

- Broad frequency coverage from 5 Hz to 325 GHz
- Wide amplitude range from −148 dBm to +30 dBm
- Excellent sensitivity for low signal detection
- Excellent frequency stability
- High resolution of frequency and amplitude

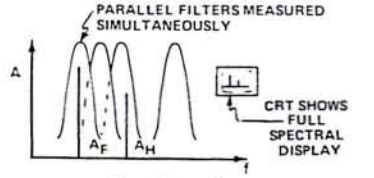
These capabilities allow spectrum analyzers to provide frequency-domain signal analysis for numerous applications, including the manufacture and maintenance of microwave communications links, radar, telecommunications equipment, CATV systems, and broadcast equipment; mobile communication systems; EMI diagnostic testing; and signal surveillance.



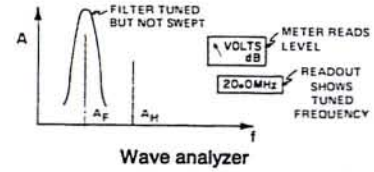
Waveform



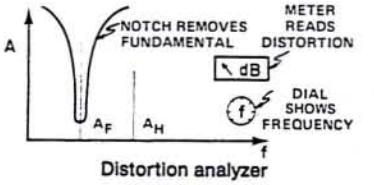
Spectrum analyzer



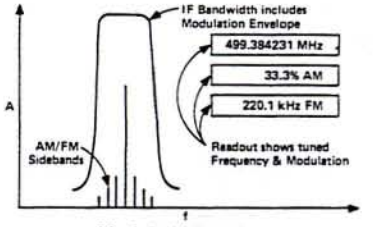
Fourier analyzer



Wave analyzer



Distortion analyzer



Modulation analyzer

In addition to the swept-tuned frequency mode, spectrum analyzers can also be used in the fixed-tuned mode (zero span) to provide time-domain measurement capability much like that of an oscilloscope.

With the addition of desktop technical computers, the capability of spectrum analyzers can be greatly enhanced. Computers can be used to directly control the operation of spectrum analyzers over HP-IB. Computers can also be used to develop downloadable programs (DLPs) for spectrum analyzers with the capability to store such programs in non-volatile memory. These custom measurement routines are then as easy to use as any of the standard instrument features. Custom measurement "personality" cards are available for many spectrum analyzers.

In addition, spectrum analyzers with HP-IB capability can directly control a plotter or printer, enabling a hard copy of the CRT display to be made without the use of a computer. Application areas that require accurate, high-speed, repetitive routines; physical separation of the operator and the analyzer; unattended operation or operation by personnel with limited technical skills—all are candidates for automation.

Areas that benefit significantly from automated spectrum analysis include:

- EMC testing
- frequency spectrum monitoring
- production testing of RF or microwave components, subsystems, or systems
- remote site testing

The basic measurement capabilities of the spectrum analyzer, combined with its ability to automate and to interface with other HP-IB instruments and peripherals, make this instrument ideal for many general-purpose and specialized applications.

Fourier Analyzers

Fourier analyzers offer fast, high-resolution spectrum and network analysis. Unlike conventional swept analyzers, Fourier-based analyzers can measure dynamic signals because they measure all frequencies simultaneously, not one at a time.

Fourier analyzers characterize signals using digital signal-processing techniques based on the Discrete Fourier Transform. For a complete description of these techniques, see Application Note 243, "The Fundamentals of Signal Analysis."

Fourier analyzers are especially useful on low-frequency signals (<100 kHz) or where very fast measurements are desired. They can improve measurement speed by a factor of between 10 and 100, and allow accurate measurements on frequencies as low as a few μHz. Signal components as closely spaced as 20 μHz can be clearly resolved and accurately measured.

Since both the magnitude and this phase of each frequency component are measured, the Fourier analyzer can measure the statistical properties of signals or the joint properties or relationships of two or more signals. Applications include acoustic, modal, vibration, or rotating machine analysis. In addition, various types of modulation can be detected and measured.

Simultaneous measurement of magnitude and phase on two or more channels provides high-quality network measurements. Transfer functions or frequency response can be easily measured, and the use of band-limited or band-translated random noise as the stimulus allows the entire frequency span of interest to be measured at once. Measurement of the coherence function can provide an indication of the validity of many network measurements.

Wave Analyzers/SLMs

Wave analyzers are known by several different names: frequency-selective voltmeters, carrier-frequency voltmeters, and selective-level meters. A wave analyzer can be thought of as a finite-bandwidth filter which can be tuned throughout a particular frequency range. Signals will be selectively measured as they are isolated within the bandwidth of the filter. For a particular signal, the wave analyzer will indicate both its frequency and its amplitude.

The uses of wave analyzers can be divided into three broad areas: (1) amplitude measurement of a single component of a complex frequency system, (2) amplitude measurement in the presence of noise and interfering signals, and (3) measurement of signal energy appearing in a specified, well-defined bandwidth.

Wave analyzers are most commonly used in communication systems, and have input configurations and measurement bandwidths optimized for these applications. Both balanced and unbalanced inputs are available, and impedances range from 50 to 600 ohms.

Distortion and Audio Analyzers

The Hewlett-Packard distortion and audio analyzers consist of a narrow-band rejection filter and broadband detector. Before the fundamental is rejected, the analyzer first measures the amplitude of the fundamental, all the harmonic components, and the noise. Then the rejection filter is employed to remove the fundamental. The ratio of the two measurements is total harmonic distortion plus noise.

Audio Analyzers

The audio analyzer performs several basic low-frequency measurements in addition to distortion, making it a general-purpose audio test set. The audio analyzer includes the SINAD function for testing mobile radio receiver sensitivity. It contains a low-distortion audio oscillator for stimulus-response testing in combination with its distortion analyzer. It has a true rms voltmeter and dc voltmeter for accurate measurement of complex waveform levels. Swept ac level and swept distortion measurements can be made using the internal source and rms voltmeter. A reciprocal frequency counter is included that continuously counts the frequency of the input signal.

True Harmonic Distortion Measurements

Computer-controlled spectrum analyzers provide a rapid means of measuring true harmonic distortion levels. The fundamental and its harmonic components are rapidly measured one at a time, and the distortion is computed and either stored or printed.

SIGNAL ANALYZERS
General Information

Modulation Analyzers/ Measuring Receivers

A modulation analyzer is a precision receiver designed to detect the entire modulation envelope of a signal under test. It can measure and display the carrier characteristics of RF frequency and power as well as AM, FM, and phase modulation characteristics such as AM depth, peak deviation, residual modulation, and various associated ratios. The modulation analyzer faithfully recovers the actual modulation signal for further analysis such as distortion testing.

In addition to having all the capabilities of the modulation analyzer, the measuring receiver can measure power down to −127 dBm. With very high accuracy, it can look at signals up to millimeter-wave frequencies. This makes it ideal for calibration of signal generators and attenuators.

Microwave Modulation Analyzers

Most modern microwave communication and radar/EW system designers are turning to the use of complex modulations, which involves the use of quadrature or "vector" modulation formats such as QPSK or 16QAM in the case of communication systems and complex, coded formats in the case of radar/EW systems.

In all these receivers, the signal processing is not handled in the traditional one-channel, amplitude-only mode, but instead is demodulated into in-phase and quadrature-phase signals that provide dynamic phase and amplitude information about the carrier's modulation.

The high bandwidth requirement has led to the introduction of the HP 8981B vector modulation analyzer, which contains a matched dual-channel, sampling oscilloscope with dc to 350 MHz baseband capability.

The HP 8981B contains an internal I/Q demodulator that takes an IF signal from 50 to 200 MHz and demodulates it into I and Q signals for display and analysis. Other demodulation frequency ranges are available up to 1400 MHz. Extensive application information is available in Application Notes 343-2, 343-3, and 343-4, as well as in related data sheets and product notes.

Peak Power Analysis

For comprehensive measurement and analysis of RF and microwave pulsed power, the HP 8990A peak power analyzer measures eight time parameters and five amplitude parameters. Its powerful waveform math routines can measure ratios and differences and can determine statistics of parameters measured with two RF channels or two video (100 MHz) channels.

Signal Analyzer Selection Guide

Dynamic Signal Analyzers

Frequency range	Frequency accuracy (±)[1]	Resolution bandwidth range	Average noise level (narrowest RBW)	Optimum dynamic range 2nd/3rd order	Amplitude accuracy (+)[2]	HP model number	Page
0.0625 Hz to 40 kHz	8 Hz	625 μHz to 1440 Hz	−100 dBV	60 dB/60 dB	0.5 dB	3560A	212
0.000125 Hz to 12.8 kHz	3 Hz	23 μHz to 900 Hz	−120 dBV	85 dB/85 dB	0.15 dB	3561A	214
0.000064 Hz to 100 kHz	4 Hz	12 μHz to 450 Hz	−116 dBV	85 dB/85 dB	0.15 dB	3562A, 3563A	220, 222
0.000244 Hz to 102.4 kHz	3 Hz	244 μHz to 920 Hz	−140 dBV	75 dB/75 dB	0.5 dB	35665A	218, 219
0.000122 Hz to 102.4 kHz	0.8 Hz	122 μHz to 4096 Hz	−133 dBV	80 dB/80 dB	0.15 dB	3567A	223, 224, 225
0.000122 Hz to 128 kHz	0.1 Hz	122 μHz to 512 Hz	−137 dBV	72 dB/72 dB	0.15 dB	3566A	223, 224, 225
0.0002 Hz to 10 MHz	32 Hz	350 μHz to 1 MHz	−170 dBm	70 to 75 dB typ.	0.5 dB	89410A	224, 225, 226

Spectrum Analyzers*

Frequency range	Frequency accuracy (±)	Resolution bandwidth range	Average noise level (narrowest RBW)	Optimum dynamic range 2nd/3rd order	Amplitude accuracy (±)[2,3]	HP model number	Page
20 Hz to 40.1 MHz	40 Hz	3 Hz to 30 kHz	−137 dBm	105 dB/86 dB	0.4 dB	3585B	226, 227
10 Hz to 150 MHz	150 Hz	0.004 Hz to 17 kHz	−132 dBm	80 dB/80 dB	0.3 dB	3588A, 3589A	232, 233, 234
10 kHz to 1500 MHz	5 kHz[3]	1 kHz to 3 MHz	−115 dBm[3]	72 dB/83 dB	2 dB	8567A	246
100 Hz to 1500 MHz	260 Hz[3]	10 Hz to 3 MHz	−135 dBm[3]	88 dB/97 dB	2 dB	8568B	246
0.0002 Hz to 1800 MHz	110 Hz[3]	350 μHz to 1 MHz	−170 dBm	70 to 75 dB typ.	2 dB	89440A	224, 225, 226
9 kHz to 1800 MHz	5 MHz[3]	1 kHz to 3 MHz	−115 dBm[3]	70 dB/80 dB	2 dB	8590D	235
9 kHz to 1800 MHz	240 Hz[3]	30 Hz to 3 MHz	−130 dBm[3]	77 dB/90 dB	2 dB	8591E	235
9 kHz to 2.9 GHz	240 Hz[3]	30 Hz to 3 MHz	−127 dBm[3]	78 dB/88 dB	2 dB	8594E	235
30 Hz to 2.9 GHz + mm	135 Hz[3]	1 Hz to 2 MHz	−145 dBm[3]	88 dB/103 dB	1.85 dB	8560E	241
100 Hz to 2.9 GHz + mm + lightwave	110 Hz[3]	10 Hz to 300 kHz (3 MHz option)	−134 dBm[3] (−156 dBm option)	82 dB/92 dB	1.5 dB (0.9 dB)[4]	71100C	249
9 kHz to 6.5 GHz	240 Hz[3]	30 Hz to 3 MHz	−125 dBm[3]	78 dB/88 dB	2 dB	8595E	235
30 Hz to 6.5 GHz + mm	135 Hz[3]	1 Hz to 2 MHz	−145 dBm[3]	98 dB/107 dB	1.85 dB	8561E	241
9 kHz to 12.8 GHz	240 Hz[3]	30 Hz to 3 MHz	−125 dBm	78 dB/88 dB	2 dB	8596E	235
9 kHz to 22 GHz (26.5 GHz)	5 MHz[3]	1 kHz to 3 MHz	−112 dBm[3]	92 dB/71 dB	2 dB	8592D	235
9 kHz to 22 GHz (26.5 GHz)	240 Hz[3]	30 Hz to 3 MHz	−127 dBm[3]	79 dB/89 dB	2 dB	8593E	235
9 kHz to 26.5 GHz + mm 30 Hz to 26.5 GHz (Opt 006)	135 Hz[3]	1 Hz to 2 MHz	−145 dBm[3]	114 dB/109 dB	1.85 dB	8563E	241
100 Hz to 22 GHz + mm	267 Hz[3]	10 Hz to 3 MHz	−134 dBm[3]	107 dB/86 dB	2 dB	8566B	246
50 kHz to 22 GHz + mm	117 Hz[3]	10 Hz to 300 kHz (3 MHz option)	−129 dBm[3] (−109 dBm)[5]	70 dB/88 dB (84 dB/91dB)[6]	1.5 dB (0.9 dB)[4]	71200C[7]	249
100 Hz to 26.5 GHz + mm 100 Hz to 40 GHz (Opt Z40)	117 Hz[3]	10 Hz to 3 MHz	−138 dBm[3] (−155 dBm option)	98 dB/93 dB	2.0 dB (0.9 dB)[4]	71209A	249
100 Hz to 22 GHz + mm + lightwave	117 Hz[3]	10 Hz to 3 MHz	−139 dBm[3] (−155 dBm option)	96 dB/98 dB	2.5 dB (0.9 dB)[4]	71210C	249

[1]One-year aging; settability and temperature drift included
[2]Relative accuracy = relative frequency response + lesser of either scale or fidelity or IF gain accuracy
[3]CF = 1 GHz
*Includes optional performance
[4] ±0.75 dB transfer accuracy using HP 70100A-H01 modular power meter
[5]CF = 10 GHz
[6]HP 71200C with HP 70600A preselector enabled
[7]Unpreselected system unless otherwise noted

Wave Analyzers/Selective Level Meters

Frequency range	Selective bandpass	Dynamic range		Freq. readouts	Type of inputs	Type of outputs	Modes of operation	HP model number	Page
		Absolute	Relative						
50 Hz to 32.5 MHz	20 Hz 400 Hz 3100 Hz	−130 to +20 dBm	>80 dB	LED, 0.1 Hz resolution	50/75 Ω, BNC 600 Ω banana jacks	Tracking generator Audio/loudspeaker 1 MHz ref.	Wideband Selective USB/LSB	3586C (3336C*)	258
50 Hz to 32.5 MHz	20 Hz 400 Hz 3100 Hz WTD	−130 to +20 dBm	>70 dB	LED 0.1 Hz resolution	75 Ω BNC/WECO 124 Ω WECO 135 Ω WECO 150 Ω Siemens 600 Ω WECO/ Siemens	Tracking generator Audio/loudspeaker 1 MHz ref.	Wideband Selective USB/LSB	3586A/B (3336A/B*) (3335A)	557

*Tracking synthesizers

Distortion/Audio Analyzers

Fundamental frequency range	Minimum distortion	Auto set level	Auto nulling	True RMS	AM detector	Filters	Internal source	HP-IB	HP model number	Page
20 Hz to 100 kHz	0.01% (−80 dB)	•	•	•	Note 1	•	•	•	8903B*	262
20 Hz to 100 kHz	0.01% (−80 dB)	•	•	•	Note 1	•		•	8903E**	262

*The HP 8903B also performs frequency count, signal/noise, SINAD, watts, and ac/dc voltage measurements.
**The HP 8903E also performs frequency count, SINAD, and ac/dc voltage measurements.
Note: The HP 8901A modulation analyzer provides complete demodulation of AM, FM, and θM signals.

Modulation Analyzers/Measuring Receivers

Frequency range	Modulation measurements	Amplitude measurement range	Audio frequency count + distortion measurement	HP model number	Page
dc to 350 MHz 50 to 1400 MHz*	Baseband, IF, I, Q, AM, mag/phase	5 mV to 5 V −5 to −20 dBm	No	8981B	261
150 kHz to 1300 MHz	AM, FM, θM	+30 to 0 dBm	No	8901A	264
150 kHz to 1300 MHz	AM, FM, θM	+30 to −20 dBm	Yes	8901B	264
150 kHz to 1300 MHz	AM, FM, θM	+30 to −127 dBm	Yes	8902A	266
150 kHz to 18 GHz or 26.5 GHz	AM, FM, θM	+30 to −100 dBm	Yes	8902S	267

*50 to 200 MHz standard. Operation above 200 MHz available as specials.

Carrier Phase Noise Analysis

Frequency range	Maximum sensitivity (depends on offset and method)	Functions available	HP model number	Page
5 MHz to 18 GHz	−170 dBc/Hz (Requires external reference source of equivalent performance)	Fully documented with specified phase detector, frequency discriminator, AM and two port measurements	3048A Phase Noise Measurement System	259

Peak Power Analysis

Frequency range	Time parameters	Amplitude parameters	Functions available	HP model number	Page
50 MHz to 40 GHz	Rise time, fall time, pulse width, off time, PRI, PRF, delay	Pulse-top amplitude, pulse-base amplitude, peak power, overshoot, average power	2 RF power, 2 video channels, ratios, differences, statistical averages, means, glitch-finding triggering	8990A	171

SIGNAL ANALYZERS

Portable Dual-Channel Dynamic Signal Analyzer, 31.25 mHz to 40 kHz

HP 3560A

- Frequency response, spectrum, transient analysis in the field
- 6 hr (typical) operation on rechargeable battery pack
- Lightweight (3.2 kg / 7 lbs) and portable
- Spectral map displays
- FFT synthesized 1/3 and 1/1 octave analysis
- On-line zoom for greater resolution

HP 3560A

HP 3560A Portable Dynamic Signal Analyzer

The HP 3560A portable dynamic signal analyzer is an FFT-based instrument capable of measuring time domain and frequency signals from both steady state and quickly changing signal sources. With two input channels, the HP 3560A provides a variety of frequency response measurements with a frequency range from 31.25 mHz to 40 kHz. Battery power and light weight allow you to make measurements anywhere they are needed with fully portable operation.

The HP 3560A provides more than raw measurements. The ICP input mode directly powers accelerometers, so external signal conditioning hardware is not required. Octave measurements, spectral map displays and marker functions make the HP 3560A a powerful, portable measurement and analysis tool.

Ultra-Portable Dual-Channel Measurements

The internal, rechargeable battery pack permits the HP 3560A to make spectrum and frequency response measurements in the field. The HP 3560A is built to withstand the harsh environmental conditions normally encountered in portable applications. With a 3.2 kg (7 lb) total weight, the HP 3560A can be taken virtually anywhere.

Troubleshoot Noise and Vibration Problems

Analysis features provide the power needed to isolate mechanical noise and vibration signal sources. Octave measurements allow standard acoustic techniques to be used in characterizing the desired signals. The octave measurements comply with ANSI S1.11 standard frequency bands and filter shapes.

Spectral map displays allow you to view your signal and how it changes as a function of time. Spectral map displays are essential for rotating machinery applications where vibration varies as a function of the machine's operating speed.

The spectral map display, combined with the external sampling capability of the HP 3560A, makes it easy to determine which vibration signals are related to the operating speed of the machine and which are fixed frequency signals due to other vibration modes such as structural resonances or oil whirl.

The dual-channel HP 3560A offers structural analysis in the field when used with HP 35207A and 35208A hammer kits. Variable block size, combined with Force/Exponential Windows and on-line zoom, provide the tools for data collection and viewing of FRFs when using impact test techniques. Coherence measurements and real/imaginary trace coordinates allow powerful structural analysis.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

Documentation and Analysis

The HP 3560A measurements can be printed on HP QuietJet or HP LaserJet printers, or HP-GL plotters via RS-232. Stored data can also be transferred to a computer via RS-232 and is compatible with Hewlett-Packard's SDF (Standard Data Format) which allows data transportability to other Hewlett-Packard dynamic signal analyzers such as the HP 3566A/3567A and HP 35665A, and third-party analysis packages for data analysis, comparisons and archiving.

Specification Summary

Frequency
Measurement range: 31.25 mHz to 40 kHz with alias protection
Spans: Baseband 50 Hz to 20 kHz in 1, 2, 5 sequence and 40 kHz.
Zoom: 20 Hz to 10 kHz in 1, 2, 5 sequence.
Resolution: Frequency span/lines selected
Number of Lines: Selectable 100, 200, 400, 800, and 1600 lines
Block size: 256, 512, 1024, 2048, 4096 points
Windows: Hann, Flat Top, Uniform, Force/Exponential

Amplitude (50 Hz to 20 kHz spans)
Accuracy: ± (0.5 dB + 0.025% of full scale)
Dynamic range: 60 dB to 10 kHz

Frequency Response Channel Match (50 Hz to 20 kHz spans)
0 to 80% of span: ±0.2 dB; ±5 deg
0 to 50% of span: ±0.1 dB, ±1 deg (typical)

Input
Range: 5 mV to 5 V full scale in 1,2,5 sequence
Characteristics: ac/dc coupling, ICP current source, engineering units, single/double integration, differentiation.
Impedance: 1 MΩ (typical)

Trigger
Source: Internal (Ch 1 or 2), external, free run
Level: Variable slope and level with 1% resolution
Pre-trigger delay: 0 to 4096 points
Post-trigger delay: 0 to 4096 points

External Sample Signal: 250 ns minimum low time, 9.75 ns minimum high time, TTL, 102.4 kHz maximum frequency

Averaging: Time, rms, exponential rms, peak hold, preview

Displays: Time record, power spectrum, power spectral density, frequency response, 1/3 octave, 1/1 octave, ch1 – ch2 time, map (2 to 99 traces on display), cross correlation, coherence, differentiated time

Display Coordinates: Linear magnitude, log magnitude, phase, real, imaginary. Linear x-axis, log x-axis, orders

Data Storage: Nonvolatile storage of 500 state/trace combinations with 200 line spectra

General
Power: Internal battery power
Recharger: 100/120 Vac +5%, −10%, 48-66 Hz 220/240 Vac +5%, −10%, 48-66 Hz
Weight: Approximately 3.2 kg (7 lbs)
Size: 300 mm H × 210 mm W × 95 mm D (11.75 in × 8.25 in × 3.75 in)
Interface: EIA-232D

Environmental	Operating	Non-operating
Temperature	0 to +40° C	−20 to +50° C
Relative humidity	15% to 95%	
Altitude	4600 m (15,000 ft)	15,000 m (50,000 ft)

Accessories
Microphones
HP 35220A Free field, standard sens., 5 Hz to 40 kHz, 35 to 160 dB
HP 35221A Free field, high sens., 5 Hz to 20 kHz, 20 to 145 dB
HP 35222A Pressure, standard sens., 5 Hz to 20 kHz, 35 to 160 dB
HP 35223A Pressure, high sens., 5 Hz to 10 kHz, 20 to 145 dB
HP 35224A Pre-amplifier, 2 Hz to 200 kHz, ± 0.5 dB
HP 35228A Microphone power supply (battery)
HP 35229A 94 dB/104 dB, 1 kHz calibrator
Accelerometers
HP 35200A General vibration; 10 mV/g, 1 Hz to 9 kHz
HP 35201A Machinery vibration; 50 mV/g, 1 Hz to 3 kHz
HP 35205A Handheld velocity probe, 100 mV/in/sec, 2 Hz to 2 kHz

Ordering Information

	Price
HP 3560A Portable Dynamic Signal Analyzer	$7,800

☎ For off-the-shelf shipment, call 800-452-4844.

Portable Dual-Channel Real-Time Frequency Analyzer, 1.4 Hz to 22.4 kHz

HP 3569A

- 22.4-kHz real-time 1/3 octave
- Two channels with microphone/ICP/voltage inputs
- Built-in white/pink noise source
- Sound pressure, sound intensity, statistics
- IEC 651 type-1 accuracy
- ANSI S1.11 1986 type 1-D octave filter shapes
- IEC 1043 199X class-1 processor accuracy
- Three-year warranty

HP 3569A

NEW

HP 3569A Real-Time Frequency Analyzer

The HP 3569A is a portable, battery-powered real-time frequency analyzer designed for onsite product-noise characterization, including sound-intensity analysis. Octave- and 1/3 octave resolution measurements are made in real time. For tonal measurements of single frequencies or narrowband signals, the optional FFT mode provides from 100 to 1600 lines of linear frequency resolution for high accuracy.

Lab-Quality Measurements in a Portable Package

This two-channel analyzer packs the performance of larger transportable analyzers into a small, neat package; the HP 3569A weighs less than 3.2 kg (7 lb), including the battery. The rugged case is water and shock resistant. A three-year warranty is standard.

State-of-the-art digital signal processing make these lab-quality measurements more affordable than ever before. The digital technology also provides inherent stability and does not exhibit the drifting normally associated with analog analyzers.

The sound-intensity mode in the HP 3569A can be used to identify noise sources or measure sound power. Individual surface areas are entered into a sound-power measurement table and sound power is automatically calculated at the end of the measurement. Sound-intensity probes are directly compatible. The HP 3569A provides internal power supplies for direct microphone connections for sound-pressure measurements. Reverberation time analysis can also be added as an option. An ICP input mode can directly power accelerometers, so external signal conditioning hardware is not required for vibration measurements.

Documentation and Analysis

An RS-232-C port provides direct printing of measurements to HP LaserJet printers or HP-GL plotters. Deep memory allows measurements to be saved and later transferred to a personal computer with Hewlett-Packard's SDF (Standard Data Format) utilities, which are included with the HP 3569A. An optional utilities package for the HP 95LX palmtop PC allows onsite data backup to the palmtop PC's RAM-disk cards, plus other conveniences.

Specification Summary

Octave Mode

Frequency: Maximum span of 36 bands plus two overall bands
1/3 octave bands, single channel: 1.6 Hz to 20 kHz (real time)
Octave bands, single channel: 2.0 Hz to 16 kHz (real time)
Maximum octave bands, dual channel: 10 kHz (1/3) and 8 kHz (1/1)
Amplitude accuracy: ±0.3 dB
Dynamic range: 72 dBfs
Input ranges: 70 to 130 dB SPL in 10-dB steps (5 mV to 5 V)
Weighting filters: A-weight, C-weight, linear, flat (all pass)
Measurement results: Leq, SPL (maximum), SPL (minimum), Ln, PSD
Averaging: Integration and exponential; from 3.9 μs to 100,000 s
Trigger source: SPL level, SPL event, external TTL

Intensity Mode (other specs same as octave mode)

Frequency: Maximum span of 33 bands plus two overall bands
1/3 octave: 1.6 Hz to 10 kHz; **Octave:** 2.0 Hz to 8 kHz
Indicator accuracy: ±0.2 dB
Measurement results: Active intensity, sound-pressure level (2 ch avg), P-I index, P-V index, particle velocity
Averaging: Integration; 0.032 s to 100,000 s
Trigger source: External TTL for start or gating

Narrowband Mode (Opt AY2)

Frequency: 100 to 1600 lines of resolution. Input range, weighting filters, ampl accuracy is the same as octave mode.
Baseband spans: 50 Hz to 25.6 kHz with 0-Hz start frequency
Digital zoom spans: 20 Hz to 10 kHz
Windows: Uniform, Hann, flat top
Measurement results: Spectrum/SPL, power spectral density, time, differentiated time, frequency response, coherence, cross-correlation, cross-spectrum
Averaging: RMS, RMS exponential, peak hold, time

Reverberation Time Mode (Opt AY3)

Computes reverberation time in octave or 1/3 octave bands by using Schroeder's reverse integration method to compute the decay times. Single channel; maximum bandwidth is 11.4 kHz; minimum integration time is 3.9 μs.
Data storage: Up to 3000 third-octave spectra can be saved in the nonvolatile RAM-disk memory. Up to 1000 third-octave spectra can be measured and stored at a rate of 256 spectra/s.

General

Power: Internal battery power; rechargeable during operation
Recharger: 100/120 or 220/240 Vac +5%, −10%, 48 to 66 Hz
Weight: Approximately 3.2 kg (7 lbs)
Size: 210 mm W × 300 mm H × 95 mm D (8.25 in × 11.75 in × 3.75 in)
Accessories included: The HP 3569A comes with a battery, ac adapter, carrying case, SDF utilities, and a three-year warranty.

Additional Accessories

Microphones: See p. 212; use HP 35224B preamplifiers.
Calibrators: See data sheet for complete list and specifications.
Accelerometers: See data sheet for complete list and specifications.
Cables: See data sheet for complete list and specifications.
Sound intensity probes:
HP 35230A sound-intensity probe without microphones
HP 35230A Opt 001—add ¼-in microphones and spacers
HP 35230A Opt 002—add ½-in microphones and spacers
HP 35239A B&K probe adapter kit

Ordering Information

	Price
HP 3569A Real-Time Frequency Analyzer	$13,000
Opt AY2 Narrowband FFT	$2,000
Opt AY3 Reverberation Time	$2,000
Opt 550 Data Transfer Utilities for HP Palmtop PC	$250

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

SIGNAL ANALYZERS

Single-Channel, Dynamic Signal Analyzer, 0.000125 Hz to 100 kHz

HP 3561A

- Spectrum analysis, FFT-synthesized ⅓ and 1/1 octave analysis
- Time capture (40 k sample)
- High-speed (7.5 kHz real-time rate)
- High accuracy, ±0.15 dB
- 80 dB dynamic range, to 640 μHz resolution bandwidth
- Nonvolatile memory option stores 127 measurements

HP 3561A

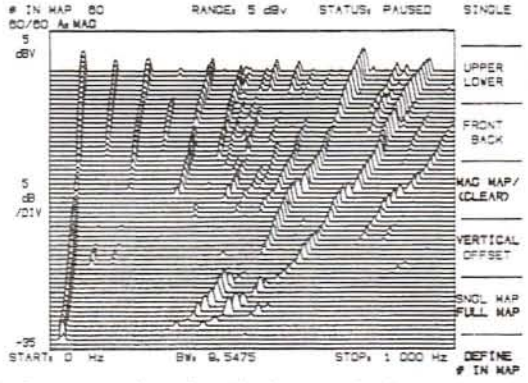
DESIGNED FOR HP-IB SYSTEMS

HP 3561A Signal Analyzer

If your test and measurement applications require the performance of a lab instrument with transportable convenience, the HP 3561A is ready to go to work for you. It provides 80 dB dynamic range with ±0.15 dB amplitude accuracy, giving you the precision needed to isolate small components in a signal.

The HP 3561A's set of measurement functions lets you approach problems from several different angles. Spectra can be displayed in a variety of formats and units, including a three-dimensional spectral map. This map displays up to 60 successive spectra and is extremely useful for analyzing transients and monitoring dynamic signals in both electronic and mechanical systems.

In addition to spectrum measurements, the HP 3561A displays time waveforms, so you can observe a signal in both the time and frequency domains simultaneously. A 40K sample time buffer captures transients for later measurements and analysis. Make acoustics measurements with its FFT-synthesized ⅓ and 1/1 octave measurements, together with the built-in analog A-weighted filter.



Spectral maps greatly reduce the time required to analyze changes in up to 60 successive measurements.

Solutions in Spectrum Analysis

The HP 3561A gives you the tools for fast, efficient spectrum analysis. In addition to standard marker features, such as marker-to-peak and peak tracking, it provides harmonic analysis with automatic computation of THD in either percent or dB. Band markers quickly compute rms band level or average band power. Sideband markers make it easy to identify the frequency spacing of modulation sidebands and automatically compute the power.

Solutions in Vibration and Acoustics

When used with an accelerometer or other motion transducer, the HP 3561A is an excellent diagnostic tool for vibration analysis. By using the display marker capabilities, you can quickly deduce the cause of many machine vibration problems. For acoustics measurements, the octave displays update quickly to indicate short-term changes in noise level. Calibrated sound pressure level measurements are also possible with the simple engineering units feature.

Specifications

Frequency

Range: 0.000125 Hz to 100 kHz
Accuracy: ± 0.003% of display center frequency
Resolution: 0.25% of frequency span
Window: Flat top, Hann, uniform, and exponential
Real-time bandwidth: (Typical) single display, 3 kHz. Fast average display, 7.5 kHz

Amplitude

Measurement range: +27 to −120 dBV noise floor (22.4 Vrms to 1μV noise floor)
Dynamic range: 80 dB
Accuracy at the passband center
±0.15 dB ±.015% of input range: +27 to −40 dBV input ranges
±0.25 dB ±.025% of input range: −41 to −51 dBV input ranges

Input

Impedance: $1X10^6$ Ω ± 5% shunted by 95 pF maximum
Isolation: Input low may be connected to chassis ground or floated up to 30 volts rms (42 volts peak) above ground
Coupling: Signal may be ac or dc coupled. Low frequency 3-dB point <1 Hz in ac mode.
ICP current: Nominal 4 mA current source provided

Output

Source: Pseudo-random, random, or impulse

Display

General: Magnitude, phase, time, and math traces can be selected.

Units available are:
Horizontal: Hz, seconds, RPM, orders; linear, or log spacing
Vertical: dBV, dBm (selectable Z), volts, volts squared, and user-defined units

Math: Arithmetic operations can be performed on new or recalled frequency spectra. Add, subtract, multiply, divide, integrate, differentiate and user-defined constants are provided. 1/BW is provided for Power Spectral Density (PSD) computations.

Internal Memory

	Nonvolatile	Volatile
Standard	2 traces, 6 states	40 time records
Optional	traces + states + (1 + 2x time records) = 127	40 time records

General

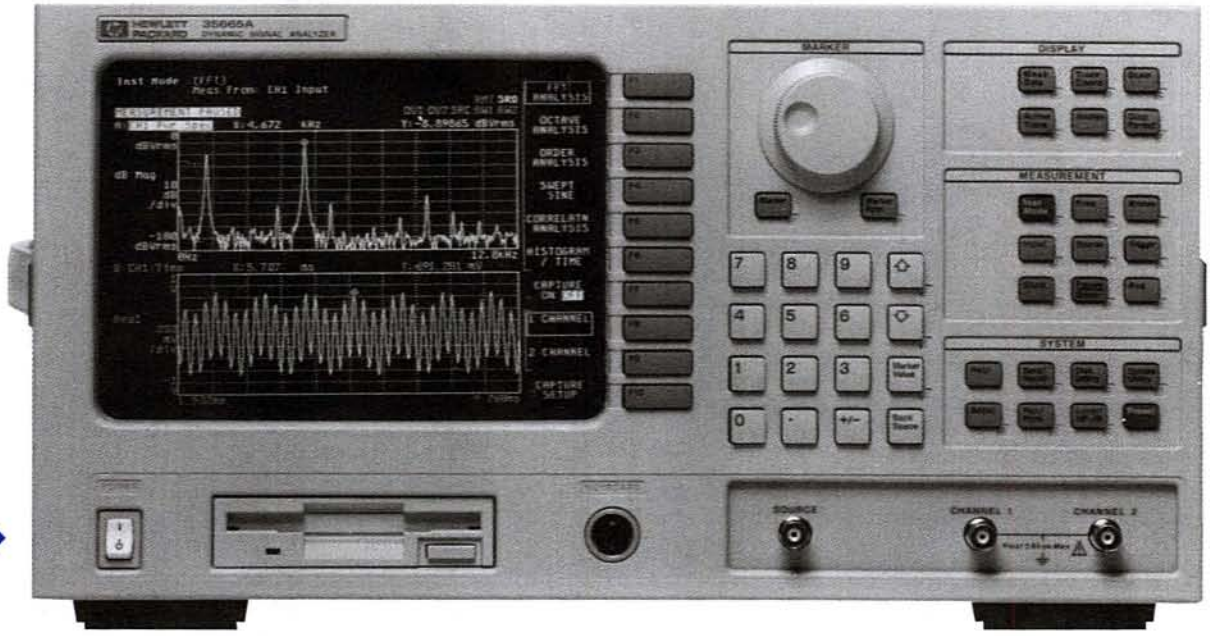
Weight: Net, 15 kg (33 lb); shipping, 21.6 kg (47.5 lb)
Size: 197 mm H × 335 mm W × 595 mm D (7.8 in × 13.2 in × 23.4 in)

Ordering Information

	Price
HP 3561A Dynamic Signal Analyzer	$14,000
Opt 001 Extended Non-Volatile Memory	+$1,675
Opt W30 Extended Repair Service (see page 636)	+$215

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Network, spectrum, waveform, transient analysis
- Flexible option structure—buy only what you need
- Up to 6.4 MB deep transient capture (optional)
- HP Instrument BASIC (optional)
- 1.44 MB internal LIF/MS-DOS® disk drive
- Fast update rate for interactive measurements
- High-speed processing: 8 traces/s, 12.8 kHz real-time fast average
- Computed order tracking for more stable measurements (optional)
- 31.5 kHz real-time octave measurements (optional)
- Fast swept-sine measurements (optional)



DESIGNED FOR HP-IB SYSTEMS

HP 35665A

HP 35665A Dynamic Signal Analyzer

The HP 35665A is a flexible FFT-based analyzer that provides time, spectrum, network and amplitude domain measurements with a broad range of measurement options applicable in electronics, servo-mechanical and electronic control systems, machinery vibration, and general noise and vibration troubleshooting applications. The measurement options include:

- Computed order tracking measurements
- Real-time octave measurements (complies with ANSI S1.11)
- Swept-sine measurements
- Curve fit/synthesis
- Arbitrary waveform source

Measurement options expand the electronics test capability of the standard HP 35665A into other application areas. With the addition of HP Instrument BASIC programs, even the most complex applications can be reduced to a single keystroke. The multi-faceted measurement modes of the HP 35665A have the measurement functionality of a spectrum analyzer, network analyzer, acoustic sound-level meter, acoustic intensity analyzer, vibration analyzer, audio oscilloscope and amplitude domain analyzer in a single package.

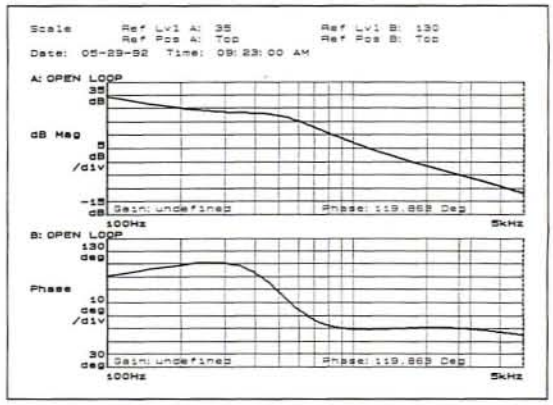
Add More Options as Your Needs Evolve

Your analysis requirements can change as test needs expand and change. The HP 35665A allows you to configure your own solution to meet both your test requirements and your budget. As your needs evolve, expanding the capability of your analyzer is as easy as ordering the firmware upgrade kit that you can install yourself. Any combination of measurement options is available, with no sacrifice in measurement speed.

Fast Swept-Sine and Broadband Control Systems Measurements

Swept-sine measurements typically offer higher signal-to-noise ratios, noise rejection and measurement accuracies than broadband techniques. The optional swept-sine measurements (Option 1D2) add this traditional measurement technique to the HP 35665A, but in an implementation that offers faster measurement results than before. Fast input auto-ranging during the measurement process increases dynamic range to greater than 130 dB.

Fast test time in production settings is even more critical with swept-sine tests since the instrument measurement time is usually the limiting factor in device throughput.



Advanced Modeling and Analysis Cut Design Time

The addition of curve fit and synthesis (Option 1D3) allows design engineers to measure real-life devices, compare the actual response to the design goals, model compensation circuits, and predict the end effect of the compensation circuits on the newly modified model. Curve fit and synthesis capability enhances design productivity by reducing the need to build prototypes and by simplifying the design optimization task.

Real-Time Octave for Compliance Testing

Real-time octave measurements (Option 1D1) provide continuous 1/1, 1/3 and 1/12 octave measurements per ANSI S1.11 (1986, order 3, type 1-D, extended and optional range), ANSI S1.4 and IEC 651-1979 type 0 impulse specifications. These high-performance measurements used to require separate real time analyzers. Now these same high-performance measurements are available at a fraction of the cost of previous solutions.

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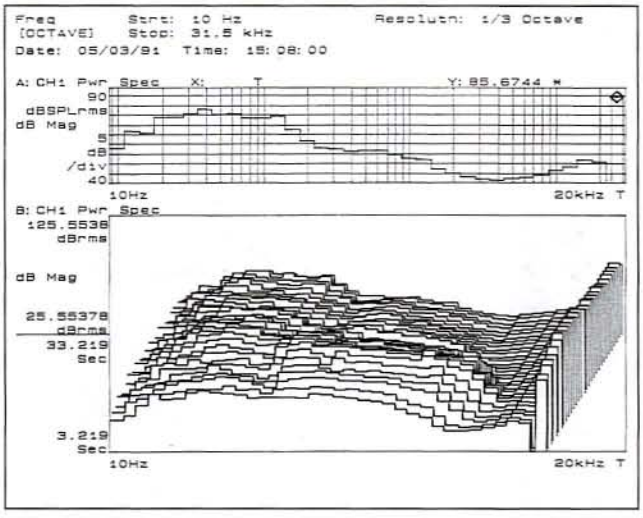
SIGNAL ANALYZERS

Dual-Channel Dynamic Signal Analyzer, 244 μHz to 102.4 kHz (cont'd)

HP 35665A



Computed Order Tracking Eases Machinery Analysis

The HP 35665A computed order tracking option (Option 1D0) adds Hewlett-Packard's order tracking capability to the HP 35665A. This algorithm digitally resamples the incoming signal resulting in extremely stable and repeatable order measurements that were not possible using analog ratio synthesis and filtering. In situations involving quickly varying and fast run up tests, this option provides unprecedented stability. It is only available on HP measurement hardware.

The internal tachometer input provides a powerful and flexible triggering facility that virtually eliminates the need for external signal-shaping circuitry.

HP Instrument BASIC for Powerful Automation

HP Instrument BASIC (Option 1C2), a subset of HP BASIC, provides the test automation power of an external computer inside the HP 35665A. In production applications, HP Instrument BASIC, along with other production oriented features, such as limit lines, enables the HP 35665A to control external HP-IB test equipment, like voltmeters and counters, address external peripherals, like disk drives, printers and plotters, and fully automate a production test procedure with custom graphics and interactive operator prompts.

HP Instrument BASIC is also useful in research and development and field applications. Complex test sequences can be recorded and simplified to a single key press. Tests can be repeated easily by operators not familiar with the measurement problem.

Measurements like electronic filter characterization (Q, 3 dB bandwidth, shape factor), acoustic intensity, Cepstrum displays, Hilbert Transforms and multi-plane balancing can also be derived using HP Instrument BASIC.

Specification Summary

Frequency

Measurement range: 244 μHz to 102.4 kHz (1-channel mode); 122 μHz to 51.2 kHz (2-channel mode)

Spans: 195.3 mHz to 102.4 kHz (1-channel mode) 97.6 mHz to 51.2 kHz (2-channel mode)

Measurement resolution: 100, 200, 400, and 800 lines

Frequency resolution: Frequency span/measurement resolution (minimum 244 μHz 1-channel mode 122 μHz 2-channel mode)

Windows: Hann, flat top, uniform, force, exponential

Amplitude

Range: 3.99 mVpk to 31.7 Vpk, manual or auto

Accuracy: ±2.92% (0.25 dB) of reading ±0.025% of full scale

Dynamic range: 72 dB (FFT mode);
120 dB (swept-sine measurement mode)
80 dB (octave mode per ANSI S1.11)

Noise: < −130 dBV/√Hz 160 Hz to 1.28 kHz
< −140 dBV/√Hz 1.28 kHz to 102.4 kHz

Single channel phase: ± 4.0 degrees relative to external trigger

Frequency Response Channel Match

Amplitude: ± 0.04 dB at full scale

Phase: ± 0.5 deg at full scale

Input Impedance: 1 MΩ ± 10% shunted by <100 pF

Coupling: ac, dc, ICP current source, engineering units, A-weight filter, integration and differentiation via math functions.

Source Types: Fixed sine, random, chirp, burst random, pink noise, burst chirp, swept-sine (Opt 1D2), arbitrary waveform (Opt 1D4)

Display Results: Frequency response, power spectrum, linear spectrum, coherence, cross spectrum, power spectral density, time, autocorrelation, cross-correlation, orbit (lissajous), histogram, PDF, CDF

Trace Types: Log magnitude, linear magnitude, dB magnitude, phase, real, imaginary, Nyquist, Bode, unwrapped phase

Trace Formats: Single, upper/lower, front/back, setup, waterfall, waterfall skew, grid on/off, display blanking

Update-Rate: >8 traces per second

Transient Capture: Continuous (real-time) data recording to RAM

Maximum rate: 262,144 samples/s for 1-channel mode

Maximum capture length: 200 ksamples (standard), 1.2 Msamples (Opt 1C1), 3.2 Msamples (opt ANA)

Saved Data and Measurement Memory: 400 KB (standard), 2.4 MB (Opt 1C1), 6.4 MB (Opt ANA)

Option 1D0 Computed Order Tracking

Computed ratio synthesis, computed tracking filters

Displays: Spectral map, order map, order track [mag + phase] or orbit

Trigger: Time or RPM, external or free run

Tachometer input: 0.5 to 2048 pulses per revolution

Trigger level: ± 20 V maximum, user-selectable level

Slope: Positive or negative
User-selectable trigger holdoff

Option 1D1 Real-Time Octave Measurements (All frequencies in nominal band center frequencies)

Measurements: 1/1 Octave (Full), 1/3 Octave, 1/12 Octave

Real-time frequency range:
1/1 octave measurements: 0.063 Hz to 16 kHz bands
1/3 octave measurements: 0.08 Hz to 31.5 kHz bands
1/12 octave measurements: 0.997 Hz to 12.34 kHz live measurements, 0.997 Hz to 49.35 kHz for post-processed time capture

Span: 1 to 12 octaves—all modes

Option 1D2 Swept-Sine Measurements

Sweep types: Up, down, linear, log, manual

Input ranging: Fixed range, or auto-range during measurement

Resolution: Selectable frequency resolution during measurement

Source level control: Auto-level feature adjusts source level to maintain constant signal level at selected input channel.

Option 1D3 Curve Fit/Synthesis

20 pole, 20 zero multiple degree of freedom curve fit, auto-order selection, user-selected pole/zero location with fit: table format: polynomial, pole/zero, partial fraction expansion

Ordering Information

	Price
HP 35665A Dynamic Signal Analyzer	$13,250
Opt 1D0 Computed Order Tracking Measurements	$2,500
Opt 1D1 Real-Time Octave Measurements	$2,000
Opt 1D2 Swept-Sine Measurement	$1,000
Opt 1D3 Curve Fit/Synthesis	$2,000
Opt 1D4 Arbitrary Waveform Source	$500
Opt 1C2 HP Instrument BASIC	$500
Opt 1C1 Add 2 MB Memory	$1,250
Opt ANA Add 6 MB Memory	$3,000
Opt 1F0 U.S. PC-Style Keyboard (other selected local keyboards are available)	$170

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Two or four channels (optional)
- Portable—fits under an airplane seat
- ac or 12–28 V dc power
- Microphone inputs (optional)
- HP Instrument BASIC (optional)
- Improved source offset resolution
- Real-time octave analysis (optional)
- Computed order tracking (optional)
- Triaxial measurements (optional)
- 122 μHz to 102.4 kHz frequency range
- 16-bit ADC/90 dB dynamic range (typical)
- 10 MB deep transient capture (optional)

NEW

HP 35670A Dynamic Signal Analyzer

The HP 35670A lets you make laboratory-quality measurements in the field—on an automobile test track, flying above a city, or in the narrow confines of a submarine. Small enough to fit under an airplane seat, the HP 35670A is a two- or four-channel (Option AY6), FFT-based spectrum/network analyzer. The standard instrument provides spectrum, network, time-domain, and amplitude-domain measurements from virtually dc to slightly over 100 kHz. Your ability to solve problems in the field is enhanced with the optional four-channel HP 35670A—measure noise at multiple locations inside vehicles, make triaxial vibration measurements, or gather data from several locations along a noise transmission path. Having an additional two channels often means finishing a job in the field and not having to bring the device back to the test bay for evaluation using multichannel systems.

Troubleshooters need a variety of instruments to meet unexpected needs. Yet, it isn't always practical to take several instruments into the field. The HP 35670A lets you carry all your tools in one package. Octave analysis (Option 1D1) adds *real-time* measurements of 1/1, 1/3, or 1/12 octave spectra at frequencies up to 40 kHz. Computed order tracking (Option 1D0) allows you to view spectra as a function of orders, or to view the amplitude of multiple orders as a function of RPM. Up to 8 MB of additional memory (Option AN2) provides deep transient time capture or extra space for up to four waterfalls of time- or frequency-domain data. An arbitrary source (Option 1D4) lets you test devices with real-life test signals. With HP Instrument BASIC (Option 1C2), you can automate measurements or customize your instrument interface. Everything you need to troubleshoot vibration and noise problems in the field is in one instrument. (You can retrofit all options—buy only the functionality you need today and add more as your needs change.)

An intuitive front panel makes the HP 35670A friendly to even occasional users. An online help function is one keystroke away if questions do arise. If desired, the entire instrument can be configured from a single *interactive* instrument-state display. This provides a single point of interaction with the instrument and a check list of measurement conditions. Once frequently used configurations are known, instrument state *save* and *recall* functions reduce instrument setup to a few keystrokes. An autostate function allows the instrument to turn on in a predefined configuration. HP Instrument BASIC (Option 1C2) can be used to provide a completely customized interface for simplified operation by nontechnical operators.

The instrument allows you to collect and display data in the manner most useful for your application. Select one of six instrument modes—FFT, octave , order, swept-sine (Option 1D2), correlation and histogram—as required. In all but the swept sine mode, data is collected using one of four trigger arming functions—automatic, time-step, RPM-step, or manual arm. (Order does not have manual arm.) For example, octave measurements can be made as a function of RPM and the results displayed in a waterfall format. Automatic up-only or up/down autoranging keep the instrument optimally configured during your measurement.

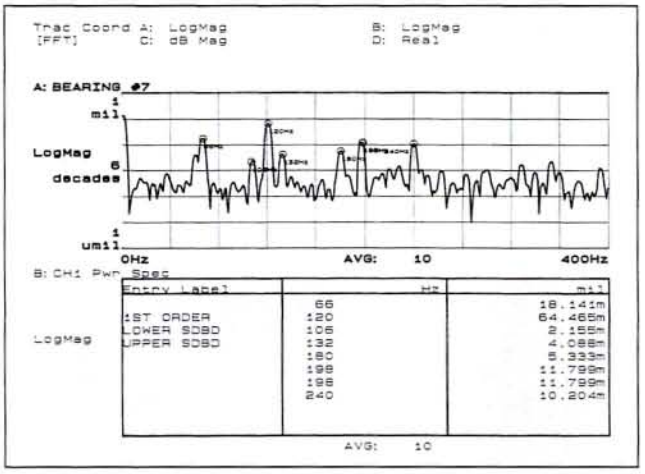
Measured data can be displayed directly or modified using waveform math operations or optional HP Instrument BASIC. Amplitude, phase, group delay, or real and imaginary components can be displayed as individual traces in a variety of formats—magnitude Vs frequency, polar, or Nyquist. Alternatively, data may be accumulated in waterfall displays as a function of time, RPM, or manual arming. Waterfall display markers can be used to extract information in the z-axis or to examine individual traces within the context of the entire measurement. Up to four waterfall displays can be viewed simultaneously. Data can be displayed with units of g's, m/s², m/s, in/s, m, mils, pascals, or user-defined units.

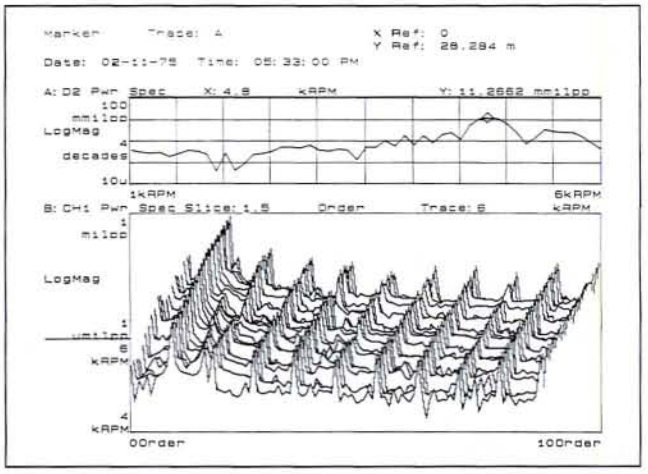
A deep transient time capture memory can record up to four channels of data plus a tachometer signal for playback in the narrowband FFT, octave, order, correlation, or histogram instrument modes. Pre- and post-trigger delay functions let you capture the leading edge of one-time events or eliminate transmission delay in signals.

SIGNAL ANALYZERS

2- or 4-Channel Dynamic Signal Analyzer (cont'd)

HP 35670A

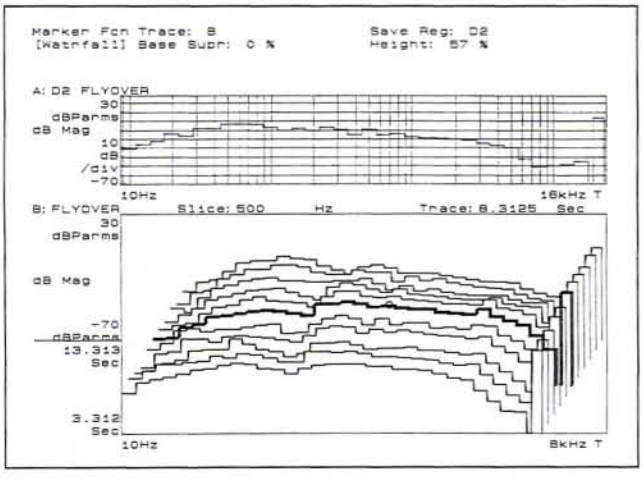




For the Electrical Engineer

The standard HP 35670A is very useful for evaluating signals and devices under 102.4 kHz. As a spectrum analyzer, the instrument provides a 90 dB dynamic range (typical) with a 25.6 kHz real-time rate at 800 lines of resolution. (Resolution can be set to 100, 200, 400, or 800 lines.) Special markers—harmonic, total harmonic distortion, and sideband—facilitate evaluation of spectra.

The device frequency response or group delay can be measured using either high-speed FFT analysis or the very exact swept-sine mode (Option 1D2). The measurement range is 80 dB when using FFT analysis and more than 130 dB with the swept-sine mode. Curve fit and synthesis functions (Option 1D3) allow users to quickly model their system and experiment with design modifications. Special marker functions and accessories facilitate the evaluation of control loops. Gain and phase margin markers quickly extract stability data from open loop response measurements. Time-domain markers facilitate extraction of information on closed loop performance. Available accessories include a summing junction, summing transformer, and clip-on transformers for signal injection into control loops.



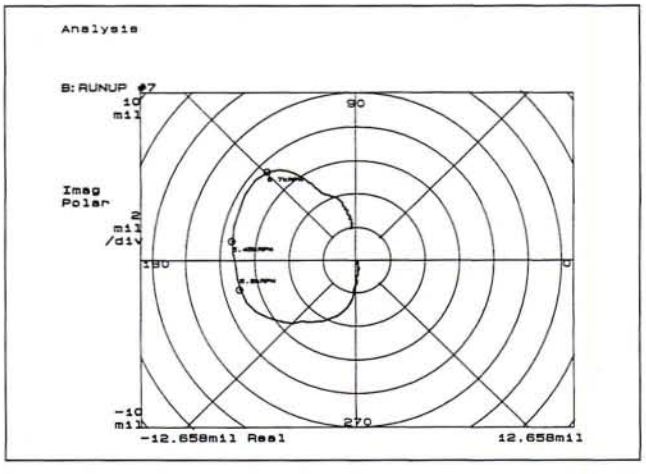
Real-Time Octave Analysis to 40 kHz (ANSI S1.11-1986)

Octave analysis (Option 1D1) adds a real-time octave analyzer to your HP 35670A. Signals can be analyzed in 1/1-, 1/3-, or 1/12-octave bands at frequencies up to 40 kHz (in the single-channel mode). Four LEMO connectors with power for microphones are provided by the HP 35225A microphone adapter and power supply. The 1/1- and 1/3-octave band filters in the HP 35670A comply fully with ANSI S1.11-1986 (Order 3 Type 1-D), DIN 45651, and IEC 225-1966. An overall total power band and an A-weighted overall power band can be activated as needed. All three octave band modes and the overall power band can be A-weighted with an analog filter in full compliance with IEC 651-1979 Type 0. The overall power band can be redefined as a broadband Impulse Detector that complies with IEC 651-1979 Type 0. A fan-off mode eliminates instrument noise from measurements. A pink noise source allows you to evaluate electroacoustic devices.

View Spectra in the Order Domain

View spectra as a function of orders or track up to five orders per channel on four channels simultaneously with computed order tracking (Option 1D0). Orders as high as 200 can be tracked. An order map can be displayed as a function of RPM or time, using the waterfall function. Waterfall markers let you view the track of any order or fraction of an order (depending on resolution selected).

Computed order tracking is ideal for troubleshooting rotating machinery. Run-up or run-down measurements can be displayed in bode or polar formats. Oscilloscope-quality orbit diagrams are another benefit. Because the data is resampled with changes in RPM, a single-loop orbit display is maintained as the shaft RPM is varied. With four channels (Option AY6), two orbits can be measured simultaneously—at both ends of a shaft for instance. An RPM measurement readout, available in any instrument mode, aids in the interpretation of measurement data from rotating machinery.



Computed order tracking provides alias-protected measurements without expensive and cumbersome external ratio synthesizers and tracking filters. This new technique uses a digital tracking algorithm that follows rapid changes in shaft RPM without time delay and eliminates the phase noise normally associated with ratio synthesizer techniques. Accuracy is enhanced over traditional methods.

Swept-Sine for Broad Measurement Range

The swept-sine (Option 1D2) instrument mode expands the network analysis range of the HP 35670A to 130 dB. Higher noise rejection and accuracy are obtained by autoranging (optimizing) the instrument during the sweep. Automatic sweep resolution reduces measurement time without sacrificing accuracy. The sweep resolution automatically increases when the magnitude or phase is changing significantly and automatically reduces (thereby speeding-up the sweep) during regions of little change. Alternatively, sweep resolution can be set by the user.

Advanced Modeling and Analysis Cut Design Time

Prototype revisions are reduced by modeling design modifications using curve fit and synthesis functions (Option 1D3). In a typical application, a model of the test device is created by curve fitting a frequency response measurement. Up to 20 poles and 20 zeros are used to describe the device; results can be output in pole/zero, pole/residue, or polynomial formats. The designer then transfers the circuit model to the synthesis function. Using synthesis, the model is modified by adding or deleting poles and zeros. The frequency response function of the modified model is then synthesized to test the design modification.

Curve fit and synthesis are especially powerful when combined with waveform math. For example, the compensation filter for a control loop can be modeled by subtracting the measured open loop response of the uncompensated control loop from a synthesized ideal open loop response and then curve fitting the results.

Automation Improves Productivity

HP Instrument BASIC (Option 1C2) replaces the external computer in small test systems. Like the computer, it can be used to automate measurements, create a custom user interface, synthesize new information from raw data, or control other instruments and peripherals. A special keystroke recording mode can be used to create autosequences or to quickly write the core of more sophisticated programs. Advanced analysis is made possible by the matrix math and graphics capabilities in HP Instrument BASIC. An optional external keyboard plugs into the rear panel. The HP 35670A provides direct control of external disks, plotters, and printers via HP-IB, RS-232, or parallel interfaces, and is fully programmable via the HP-IB.

Specification Summary

Contact your local HP sales office for complete specifications (sales offices are listed in the back of this catalog).

Frequency Range (800 lines):

Channel mode	One	Two	Four
Standard 2 Channels	244 μHz to 102.4 kHz	122 μHz to 51.2 kHz	
Option AY6 4 Channels	244 μHz to 51.2 kHz 102.4 kHz*	122 μHz to 51.2 kHz	61 μHz to 25.6 kHz

*without alias protection

Windows: Hann, flat top, uniform, force, and exponential

Amplitude
- **Range:** 3.99 mVpk to 31.7 Vpk, manual or auto
- **Accuracy:** ±2.92% (0.25 dB) of reading ±0.025% of full scale
- **Dynamic range:** 90 dB typical, 80 dB guaranteed (FFT mode) 130 dB (optional swept-sine mode), 80 dB from 10 Hz to 20 KHz on 1 V range (optional octave mode per ANSI S1.11)
- **Noise:** < -130 dBV/$\sqrt{\text{Hz}}$ 160 Hz to 1.28 kHz
  < -140 dBV/$\sqrt{\text{Hz}}$ 1.28 kHz to 102.4 kHz

Frequency Response Channel Match
- **Amplitude:** ±0.04 dB at full scale
- **Phase:** ±0.5 deg at full scale

Channels: 2 or 4 (Option AY6)
Channel Reference: 1 or 1&3 (Option AY6)
Input Impedance: 1 MΩ ±10% shunted by <100 pfd nominal
Coupling: dc, ac, and ac with ICP current source
Source Types: Fixed sine, random, chirp, burst random, pink noise, burst chirp, swept-sine (Option 1D2), and arbitrary source (Option 1D4)
Source dc Offset: ±10 V, 1 mV resolution from 0 to ±2 V, 5 mV resolution from ±2 V to ±10 V
Measurement Modes: Frequency response, power spectrum, linear spectrum, coherence, cross spectrum, power spectral density, time, windowed time, autocorrelation, cross-correlation, orbit (lissajous), histogram, PDF, CDF.
Trace Types: Log magnitude, linear magnitude, dB magnitude, phase, real, imaginary, polar, Nyquist, Bode, unwrapped phase and group delay
Trace Formats: Single, upper/lower, quad, front/back, setup, waterfall, waterfall skew, grid on/off, display blanking
Update Rate: > 8 traces/s
Transient Capture: Continuous (real-time) data recording to RAM
- **Maximum rate:** 262,144 samples/s for single channel mode
- **Maximum capture length:** 1.0 Msamples (standard), 3 Msamples (Option AN2, add 4 MB), 6 Msamples (Option UFC, add 8 MB)

Saved Data and Measurement Memory: 2.2 MB (standard), 6.2 MB (Option AN2) or 10.2 MB (Option UFC)
Trigger: Free run or external
- **External:** TTL or user-defined from −10 to 10 V
- **Internal:** From −31.66 to 31.66 V or as a % of range

Option 1D0 Computed Order Tracking (computed ratio synthesis, computed tracking filters)
- **Displays:** Spectral map, order map, order track (mag and phase), and orbit
- **Trigger arm:** Automatic, manual, RPM, time
- **Trigger:** Free run, source, HP-IB, channel, external
- **Tachometer input:** 0.5 to 2048 pulses per revolution
- **Tachometer level:** ±20 V maximum, user-selectable level
- **Tachometer slope:** Positive or negative, user-selectable holdoff

Option 1D1 Real-Time Octave Measurements (all frequencies in nominal band center frequencies):
- **Measurements:** 1/1 octave, 1/3 octave, 1/12 octave

Real-Time Frequency Range:

Channel mode	One	Two	Four
Standard (2 channel)			
1/1 Octave	63 mHz to 16 kHz	63 mHz to 8 kHz	
1/3 Octave	100 mHz to 40 kHz	100 mHz to 20 kHz	
1/12 Octave	100 mHz to 12.3 kHz	100 mHz to 6.2 kHz	
Option AY6 (4 channel)			
1/1 Octave	63 mHz to 6 kHz	63 mHz to 8 kHz	63 mHz to 4 kHz
1/3 Octave	100 mHz to 40 kHz	100 mHz to 20 kHz	100 mHz to 10 kHz
1/12 Octave	99 mHz to 12.3 kHz	99 mHz to 6.2 kHz	100 mHz to 3 kHz

Span: 1 to 12 octaves—all modes.
Option 1D2 Swept-Sine Measurements
- **Sweep types:** Up, down, linear, log, manual
- **Input ranging:** Fixed range, or autorange during measurement
- **Resolution:** Selectable frequency resolution or auto-resolution during measurement
- **Source level control:** Auto-level feature adjusts source level to maintain constant signal level at selected input channel.
- **Dynamic range:** 130 dB

Option 1D3 Curve Fit/Synthesis
20 pole, 20 zero multiple degree of freedom curve fit, auto-order selection, user-selected pole/zero location with fit
- **Table format:** Polynomial, pole/zero, pole/residue.

Ordering Information

	Price
HP 35670A Dynamic Signal Analyzer	$16,900
Opt AY6 Add 2 Input Channels	$5,000
Opt 1D0 Computed Order Tracking Measurements	$2,500
Opt 1D1 Real-Time Octave Measurements	$2,000
Opt UK4 Microphone Adaptor and Power Supply	$1,600
Opt 1D2 Swept-Sine Measurements	$1,000
Opt 1D3 Curve Fit/Synthesis	$2,000
Opt 1D4 Arbitrary Waveform Source	$500
Opt 1C2 HP Instrument BASIC	$500
Opt AN2 Add 4 MB Memory	$1,000
Opt UFC Add 8 MB RAM	$1,500
Opt UFF Add 1 MB Nonvolatile RAM	$1,500
Opt 1F0 PC-Style Keyboard—USA	$170
Opt 1F1 PC-Style Keyboard—German	$170
Opt 1F3 PC-Style Keyboard—French	$170
Opt 1F4 PC-Style Keyboard—U.K.	$170
HP 35670U	
Opt AY6 2 to 4 Channel Upgrade	$7,500
Accessories	
35250A dc Power Cable (3 m)	$250
35251A dc Power Cable w/Cigarette Lighter Adpt	$300

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665

SIGNAL ANALYZERS

Dual-Channel Dynamic Signal Analyzer with Digital Inputs and Source

HP 3563A, 3562A

HP 3563A

DESIGNED FOR HP-IB SYSTEMS

- Measurement of analog and digital signals
- Analog and digital stimulus application
- Network, spectrum, waveform, transient analysis
- Extraction of models with s- and z-domain curve fitting
- Modeling of systems using frequency response synthesis
- Linear, logarithmic, swept-sine modes
- 64 μHz to 100 kHz
- 80-dB dynamic range with full alias protection
- High accuracy ($\pm$0.15 dB)
- Acceptance of 16-bit digital input signals
- 13-bit digital input signal spectrum analysis
- 16-bit, swept-sine, digital network analysis

HP 3563A Control Systems Analyzer

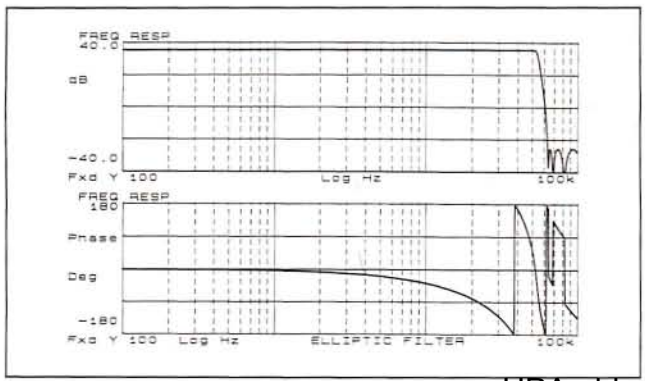
Although the HP 3563A is a general-purpose spectrum/network analyzer, it is called a control systems analyzer because it is the ideal instrument for characterizing control loops. Control systems are leading the transition from analog to digital implementation of electronic circuitry. In addition to measuring traditional analog signals and devices, the HP 3563A provides test and analysis of digital signals, digital devices (such as digital filters), and devices with mixed analog and digital inputs and outputs.

Whether your system is a control loop or other circuitry—electrical, mechanical, or electromechanical—Hewlett-Packard helps you analyze your next-generation systems with the HP 3563A control systems analyzer. A compatible superset of the popular HP 3562A dynamic signal analyzer, this FFT-based instrument offers the versatility required to make the most difficult spectrum, network, and waveform measurements. Measurements can be made over a 64-μHz to 100-kHz frequency range and an 80-dB dynamic range, at a real-time rate of 10 kHz. A swept-sine mode provides a measurement range of 130 dB for network analysis. For analog signals and devices, the analyzer has two differential input channels and an analog source with dc offset. Digital inputs accept TTL-level or CMOS parallel data up to 16 bits wide with data rates up to 256 kHz and clock rates up to 10 MHz. A 16-bit wide digital source provides the stimulus required for network analysis.

Direct Measurement of Dynamic Analog and Digital Signals

Once a signal is inside the analyzer, its original format does not affect the measurement. Signals can be evaluated using any of the measurement modes in the instrument. However, an appropriate interface is needed to get the signal in and out of the analyzer. For analog signals, BNC connectors provide the required interface. For digital signals, accessories supplied with the HP 3563A provide a convenient interface between the connection point (for example, a microprocessor bus) and the digital inputs or source output located on the rear panel of the instrument.

With both digital and analog signal inputs and sources, the HP 3563A has the flexibility to measure devices with analog inputs/digital outputs or devices with digital inputs/analog outputs in addition to purely analog or digital signals and devices.



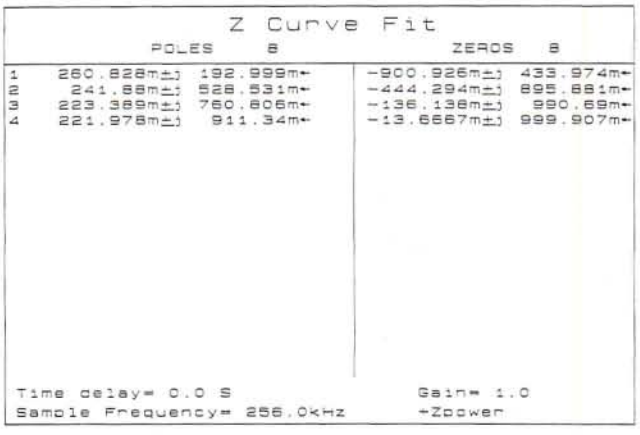
Network Analysis of Digital or Analog Devices

Accurate, high-resolution frequency response measurements of mechanical and analog, digital, or mixed analog/digital electronic systems can be performed with linear resolution FFT, logarithmic resolution FFT, or swept-sine analysis. A built-in signal source provides a variety of random noise, sine wave signals, or arbitrary waveforms in either analog or digital format.

Linear or logarithmic resolution network measurements are FFT modes. They provide high-speed measurements of frequency response magnitude and phase, as well as input and output power spectra. Logarithmic resolution provides a true, 80-points-per-decade, high-speed FFT measurement over one to five decades.

The swept-sine mode reconfigures the HP 3563A as a powerful swept-sine frequency response analyzer. The source can generate linear or logarithmic sweeps with a user-selectable sweep rate and resolution. Input channel functions include user-selectable (effective) filter bandwidth and automatic input ranging for over 130 dB of dynamic range.

Markers help turn data into information. In addition to x- and y-axis markers, the HP 3563A has special marker functions that provide specifically defined parameters for network measurements. Gain and phase margin markers facilitate control loop characterization. Frequency and dampening markers quickly model resonances. A slope marker provides convenient measurement of filter rolloff.

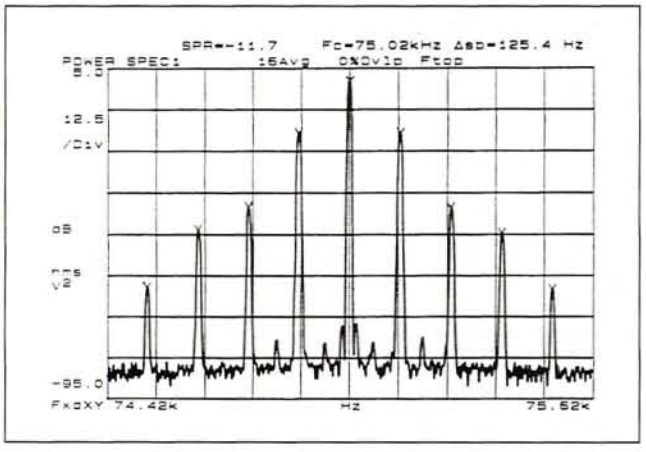


Turning Data into Information

Identify system poles and zeros by applying the HP 3563A curve fitter to a measured frequency response. Separate s- and z-domain curve fitters handle analog or digital systems. The multiple-degree-of-freedom algorithm used in the curve fitter accounts for interaction of adjacent poles more accurately than single-degree-of-freedom methods. Up to 40 poles and 40 zeros can be fit simultaneously. The pole/zero data format can be converted to polynomial or pole/residue format. A choice of impulse invariant, step invariant, and bilinear transformations converts the s-domain model to a z-domain model and vice versa. The ability to convert from one domain to the other greatly simplifies digital filter design.

Use frequency response synthesis to model s- or z-domain circuit models. In a typical application, a measured frequency response is curve-fit to create a model of an actual circuit. The designer then transfers the circuit model to the synthesis function. Here the model can be modified, with poles and zeros deleted and added as desired. Then, using synthesis, the frequency response of the new modified model can be displayed. The effects of circuit modifications can be tested without ever touching a soldering iron. A zero-order hold entry for the synthesis table models the effect of a digital-to-analog converter.

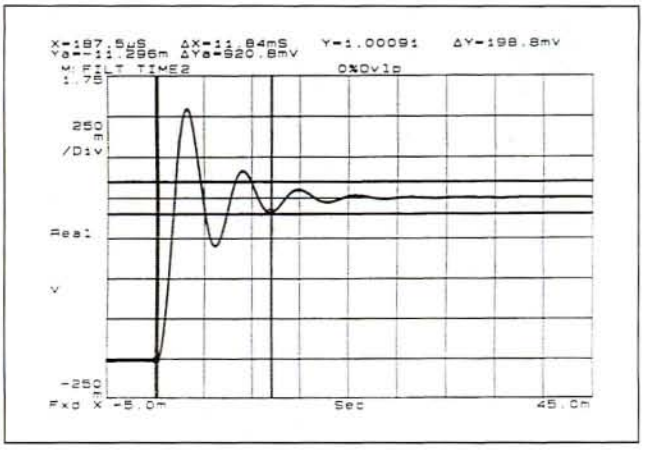
Seventeen math operations let you change measured data into needed information. Math operations can be executed in real-time from the front panel or automated for repeated use.



Spectrum Analysis

Online analysis of distortion, drift, modulation, and phase noise can benefit from the speed and accuracy of the HP 3562A. High-resolution measurements are typically 100 times faster than those of tuned spectrum analyzers; since the HP 3563A is an FFT-based analyzer, you can see transient events that a tuned analyzer would probably miss. Spectrum measurements are made with 801-line resolution over the specified frequency span. Using zoom, spectrum measurements can be made with 25.6 μHz resolution anywhere in the dc to 100 kHz frequency range.

Modulation analysis can be performed on either or both channels with harmonic and sideband markers or using the built-in demodulation capability. With the built-in capability, zoom measurements can be AM, FM, or PM demodulated with carrier frequencies up to 99.9 kHz.



Waveform and Transient Analysis

Sampled and digitized waveforms can be stored in internal memory (using single-channel time capture) or on an external disk drive (using single- or dual-channel time throughput). Stored data can then be recalled for analysis in the time domain or for baseband and zoom analysis in the frequency domain. Pre- and post-trigger delays enhance both waveform recording modes. They can be used to capture the rising edge of a single event or to compensate for delays in the system.

Troubleshooting Noise and Vibration Problems

The HP 3563A provides the measurements needed to identify structural resonances, analyze motor vibration, and locate noise sources. Data previewing and automatic overload rejection improve the quality of frequency response impact testing. Selecting rpm or orders for the frequency axis and using engineering units, such as g's and mil's, facilitate simple interpretation of vibration measurements. To order test accessories, such as impact hammers, accelerometers, and microphones, consult the *HP Test and Measurements Accessories* catalog.

Automation for Improved Productivity

Simplified documentation of test results and automation enhance productivity:

- Direct control of disk drives
- Direct plotter control
- Internal storage of up to five autosequence programs
- Completely HP-IB programmable

HP 3562A

DESIGNED FOR HP-IB SYSTEMS

The HP 3562A dynamic signal analyzer is an analog-only version of the HP 3563A. It is well suited for test and analysis of mechanical systems and predominantly analog electrical and electromechanical systems. Like the HP 3563A, the HP 3562A provides exceptional performance. The most significant difference between the two instruments is that the HP 3562A cannot be used to measure and analyze digital signals and devices. Call your local HP sales office and request a copy of the HP 3562A data sheet for an exact description of this instrument. Note that the HP 3562A can be converted to HP 3563A functionality.

SIGNAL ANALYZERS

Dual-Channel Dynamic Signal Analyzer with Digital Inputs and Source (cont'd)

HP 3563A, 3562A

Specifications (HP 3562A, 3563A)

Contact your local HP sales office for more information, including a data sheet with complete specifications.

Frequency

Measurement range: 64 μHz to 100 kHz, both channels, single- or dual-channel operation

Resolution: Span/800, both channels, single- or dual-channel operation, linear resolution mode

Spans	Baseband	Zoom
Number of spans	66	64
Min. span	10.24 mHz	20.48 mHz
Max. span	100 kHz	100 kHz
Time record (sec)	800/span	800/span

Window functions: Flat top, Hann, uniform, force, exponential, user-defined

Typical real-time bandwidths:

Single-channel, fast averaging 10 kHz

Throughput to CS/80 disk

Single channel	12.5 kHz
Dual channel	6.25 kHz

Amplitude

Accuracy: Defined as full-scale accuracy at any of the calculated frequency points. Overall accuracy for the linear or logarithmic resolution modes is the sum of the absolute accuracy, window flatness, and noise level. Overall accuracy for swept-sine mode is the sum of absolute accuracy and noise level.

Absolute accuracy: Single channel (channel 1 or 2)

±0.15 dB ±0.015% of input range (+27 to −40 dBV)

±0.25 dB ±0.025% of input range (−41 to −51 dBV)

Window flatness:

Flat top +0, −0.01 dB

Hann +0, −1.5 dB

Noise floor: With flat top window, 50Ω source impedance and input set to −51 dBV range

20 Hz to 1 kHz (1 kHz span) < −126 dBV (−134 dBV$\sqrt{\text{Hz}}$)

1 to 100 kHz (100 kHz span) < −115 dBV (−144 dBV$\sqrt{\text{Hz}}$)

Frequency response channel match:

Analog/analog: For input signals at full scale on any pair of ranges, accuracy is ±0.1 dB, ±0.5 degree (HP 3562A and 3563A).

Digital/digital: For simultaneous sampling on channels 1 and 2, accuracy is ±0.1 dB, ±0.5 degree (HP 3563A only).

Mixed analog/digital: With full-scale inputs on both channels, computational delay between channels corrected for; 1:1 sampling ratio, 16 averages, and 256 kHz sample clock; nominal accuracy is ±0.2 dB, ±1.0 degrees from 64 μHz to 20 kHz and ±0.2 dB, ±4.0 degrees from 20 to 100 kHz (HP 3563A only).

Dynamic range: All distortion (intermodulation and harmonic), spurious, and alias products are ≥ 80 dB below full-scale input range (16 averages).

Analog Input (HP 3563A and 3562A)

Input Impedance: 1 MΩ ±5% shunted by < 100 pF

Input Coupling: Inputs can be ac or dc coupled; ac rolloff is <3 dB at 1 Hz.

Crosstalk: −140 dB (50-Ω source, 50-Ω input termination, input connectors shielded)

Common Mode Rejection:

0 to 66 Hz	80 dB
66 to 500 Hz	65 dB

External Sampling Input: TTL-compatible input for signals ≤ 256 kHz (nominal maximum sampling rate)

Digital Input (HP 3563A)

Measurement data signals can be up to 16 bits wide and must be parallel data in two's complement or offset-binary format. (User selects truncation of unused upper bits or rounding of the three lowest bits for data more than 13 bits wide.) The data qualifier input accepts eight qualifier lines, a trigger, and one clock signal.

Trigger

Trigger Modes: Free run, input channel 1, input channel 2, source and external trigger. Free run applies to all measurement modes. Input channel 1, input channel 2, source and external trigger apply to the linear resolution, time capture, and time throughput measurement modes.

Trigger Delay: Pre- and post-trigger delay resolution is 1 sample (1/2048 of a time record).

Pre-Trigger: A measurement can be based on data that starts from 1 to 4096 samples (1/2048 to 2 time records) before trigger conditions are met.

Post-Trigger: A measurement is initiated from 1 to 65,536 samples (1/2048 to 32 time records) after the trigger conditions are met.

Analog Source (HP 3563A and 3562A)

Random noise, burst random, sine chirp, burst chirp, fixed sine, and swept sine are available from the front-panel source of the HP 3562A and 3563A. The HP 3563A also provides step, pulse, ramp, and arbitrary signals from the same front-panel source output. Users can select dc offset.

Output Impedance: 50 Ω (nominal)

Output Level: Between +10 and −10 V peak (ac + dc) into a ≥ 10-kΩ, < 1000-pF load. Maximum current is 20 mA.

ac Level: ±5 Vpeak (≥ 10-kΩ, < 1000-pF load)

dc Offset: ±10 Vpeak in 100-mV steps. Residual offset at 0V offset ≤ 10 mV

Distortion: Including subharmonics

25.6 μHz to 10 kHz −55 dB

10 to 100 kHz −40 dB

Pulse: Nominally 1 sample wide and bandlimited (HP 3563A)

Digital Source (HP 3563A)

All analog signal types can be output from the digital source connector. Data format is 16-bit parallel in either two's complement or offset binary. Output level is TTL compatible.

Maximum load: 8 LSTTL

Maximum output rate: 256 kHz

General

Specifications apply when AUTO CAL is enabled or within 5° C and 2 hours of last internal calibration.

Power: 86 to 127 Vac, 48 to 66 Hz
196 to 253 Vac, 48 to 66 Hz
450 VA maximum

Weight: Net, 27 kg (58 lb); shipping, 36 kg (79 lb)

Size: 426 mm W × 222 mm H × 578 mm D (16.75 in × 8.75 in × 22.75 in)

Accessories Included

HP 3563A: HP 01650-61607 16-bit Probe Cable: 3 each
HP 03563-61605 16-bit Probe Pod: 3 each
HP 03563-61604 8-bit Probe Cable: 3 each
HP 10347A Pattern Generator Probe Lead Set: 3 each
HP 5959-0288 Grabber (package of 20): 80 each (4 packages)
Pouch for Cables and Probes

HP 3563A/HP 3562A: Getting Started Guide, Operating Manual, Programming Reference

Accessories Available

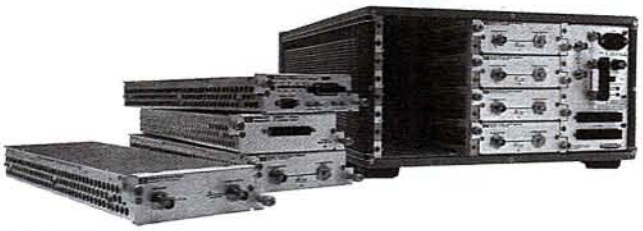
HP 3563A: HP 10346A 8-Channel TTL Tristate Buffer Pod
HP 10348A 8-Channel CMOS Tristate Buffer Pod
HP 01650-63203 Termination Adapter

HP 3563A/HP 3562A: Transit Case for One HP 3563A: HP p/n 9211-2663

Ordering Information

	Price
HP 3563A Control Systems Analyzer	$26,900
Opt 907 Front Handle Kit	+$77
Opt 908 Rack Mount Kit	+$41
Opt 909 Rack Mount and Front Handle kit	+$102
Opt 910 Extra Getting Started, Operating, Programming Manuals	+$179
Option 915 Add Service Manual and Kit	+$100
Opt 921 PC File Utilities	+$150
Opt 922 Delete Cables, Pods, and Pouch	−$1,450
Opt W30 Extended Repair Service (see page 636)	+$625
HP 3562A Dynamic Signal Analyzer	$21,600
Opt 907 Front Handle Kit	+$77
Opt 908 Rack Mount Kit	+$41
Opt 909 Rack Mount add Front Handle Kit	+$102
Opt 910 Extra Operating Manuals	+$225
Opt 914 Delete Service Manuals	−$100
Opt W30 Extended Repair Service (see page 636)	+$495

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.



HP 3565S

HP 3565S Multichannel Measurement System

Looking for a powerful, computer-based, modular measurement platform? The HP 3565S can be configured from 2 to 496 channels, and is optimized for fast signal acquisition and analysis. Using the HP 3565S, systems may be configured for modal analysis, closed-loop vibration control, rotating machinery analysis, noise and vibration analysis, signal monitoring, and more. As testing needs change, you can add new modules, new applications software, or enhance the system computer.

Measurement hardware is modular with five types of modules: Inputs, sources, signal processors, tachometer/trigger, and SCSI interface for high-speed data storage. You select the number of inputs, number of sources, and signal processing power desired. Whether you prefer UNIX workstations or DOS-based PCs, the HP 3565S acts as a measurement coprocessor, accelerating system performance.

Applications Software

System software for the HP 3565S is available from Hewlett-Packard (HP 3566A, HP 3567A, HP 35635R), and a variety of independent software vendors, such as: Leuven Measurement Systems (LMS), Mahrenholtz and Partner (M&P), Structural Measurement Systems (SMS), Creare Inc., and Structural Dynamics Research Corp. (SDRC). For further information, contact your HP sales representative.

HP 3565S Software Solution Providers

Vibration control	Data acquisition	Rotating machinery	Model analysis	Acoustic analysis	Signature analysis	Custom solutions
LMS M&P	Creare LMS SDRC	LMS SDRC	LMS SDRC SMS	LMS SMS	Creare LMS SDRC	Creare HP

The HP 35635R Programmer's Toolkit is a digital signal processing (DSP) development environment and training class for HP 3565S hardware. Custom, high-performance solutions can be created using C programming and the Toolkit library of commands and functions. A very high level of C programming and DSP expertise is required. Contact your HP sales representative about prices, class schedules, supported computers, and prerequisites for taking the class.

System Mainframes

Choose the HP 35650A mainframe for large, expandable systems. It provides power and cooling for up to 8 modules. Up to 8 of these mainframes may be interconnected for a total of 64 available slots.

Choose the HP 35650B mainframe for small, transportable systems. It provides power and cooling for 4 slots. This mainframe cannot be connected to additional mainframes.

Signal Processing Modules

The signal processing modules perform the following functions for the system:

- Control of all system operations, including commands to control the other modules and the flow of data between the modules
- Transfer of measurement data to the host computer via HP-IB
- Control of direct throughput to disk
- Generation of time records to be sent to the HP 35656A DAC
- Processing of time data from the input modules

HP 35651B Signal Processing Module

This signal processing module uses an MC 68020 main processor and a MC 56001 DSP processor for computing spectrums. The module includes 1 MB of RAM for data and program space. Additional RAM is available as an option. Most application software available for the HP 3565S uses this module.

HP 35654A Signal Processing Module

This module is a higher performance version of the HP 35651B, and is used for computation-intensive applications such as high-speed waterfall displays. In general, the added capability of this module is accessible only through custom programming, as taught in the HP 35635R Programmers Toolkit course.

HP 35659A SCSI Interface Module

The HP 35659A SCSI interface module provides high-speed digital recording of signals sampled by HP 3565S input modules. The samples can be recorded on an optional internal 420 MB hard disk, Option AMV, or on external HP SCSI-compatible drives. Actual throughput performance depends on the disk drive; however, several HP 35659A modules can be used in parallel to increase system performance. Approximate throughput rates for supported drives are:

Model number	Disk type	Size	Transfer rate
Series 6300	Removable optical	325 MB per side	600 kB/s
C2213A	Hard disk	660 MB	1.3 MB/s
C1520A DAT	DAT tape drive	1.3 GB	150 kB/s
7959S	Hard disk	325 MB	750 kB/s
Option AMV	Hard disk	420 MB	1.8 MB/s

Input Modules

All three input modules use analog-to-digital converters to digitize signals. In each channel, an A/D converter is preceded by an analog anti-alias filter and followed by a digital filter (with zoom capability) and an 8k FIFO buffer. Time data from the FIFO buffers is sent to the signal processing module for math-intensive computations.

HP 35652A/B Input Module

The HP 35652A single channel input module has 80-dB dynamic range and dc to 51.2 kHz bandwidth. Charge amplifiers for piezoelectric transducers and ICP transducer power supplies are built into each module.

The HP 35652B is similar to the HP 35652A, except with an increased measurement bandwidth to 102.4 kHz.

HP 35655A Input Module

This is an 8-channel input module, with dc to 12.8 kHz bandwidth for each of the 8 channels, and a dynamic range of 72 dB. All 8 channels sample simultaneously to maintain phase match across the channels and have their own filtering. Each channel includes an ICP power supply. When using ICP power, all transducers must be isolated from ground.

HP 35658A Tachometer/Trigger Module

The HP 35658A module provides a system trigger input and a tachometer input for rotating machinery analysis. The HP 35658A is not required for most system applications.

Source Modules

HP 35653C 102.4 kHz Source Module

This module provides the following excitation signals for frequency response measurements: continuous sine wave, burst sine wave, band-limited random noise, or burst random noise of variable duration. This module also provides a reference signal for system calibration.

HP 35656A Programmable DAC

This module uses a programmable digital-to-analog converter with 16 bits of resolution to generate arbitrary stimulus signals up to 51.2 kHz bandwidth. The data buffer size is selectable from 1 to 32768 words.

Ordering/Configuration Information

	Price
HP 35605A System Rack (for 2 mainframes)	$1,860
HP 35606A System Rack (for 4 mainframes)	$2,375
HP 35650A 8-Slot Mainframe	$6,500
HP 35650B 4-Slot Portable Mainframe	$4,650
HP 35651B Signal Processing Module	$6,200
HP 35652A 51.2-kHz Input Module	$2,675
HP 35652B 102.4-kHz Input Module	$3,000
HP 35653C 102.4-kHz Source Module	$2,010
HP 35654A Signal Processing Module	$14,400
HP 35655A 8-Channel Input Module	$10,300
HP 35656A Programmable DAC	$4,650
HP 35658A Tachometer/Trigger Module	$2,000
HP 35659A SCSI Interface Module	$5,500
Opt AMV 440 MB Internal Hard Disk	$3,500

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

SIGNAL ANALYZERS

Multichannel Spectrum/Network Analyzers, 64 μHz to 102.4 kHz

HP 3566A, 3567A

HP 3566A

HP 3566A, 3567A Signal Analyzers

Up to 16 Channels of Time and Frequency Measurements

A rich measurement set makes the HP 3566A and 3567A excellent for mechanical test, signal characterization, control systems, rotating machinery analysis, and production test where signals are below 102.4 kHz. These PC-based dynamic signal analyzers are configurable from 2 to 16 channels, and use modular HP 3565S hardware (see page 223) to achieve high system performance. Since the HP 3566A and 3567A are Microsoft Windows applications, measurement results are easily shared with other Windows applications, such as spreadsheets and word processors.

The HP 3566A and 3567A have the same measurement feature set but differ in maximum frequency span and hardware configuration. (See table below.) Each analyzer includes a source for stimulating circuits or systems. An optional programmable DAC module adds arbitrary waveform and chirp capability. For fast measurement processing, a powerful hardware signal processor module converts time data to frequency domain data using the latest FFT (Fast Fourier Transform) technology. If portability is important, the portable 4-slot HP 35650B mainframe and a portable PC make a very cost-effective multichannel system.

	HP 3566A	HP 3567A
Channel count	8 or 16	2 to 16
Cross channel accuracy	±0.1 dB	±0.1 dB
Phase	±0.5°	±.5°
Dynamic range	72 dB	80 dB
Maximum frequency span	12.8 kHz	102.4 kHz
Realtime Bandwidth[1]		
Display off	12.8 kHz	26.5 kHz
Display on	3.2 kHz	3.2 kHz
Transient capture rates		
Max samples/s per channel	32,768	262,144
Max samples/s to RAM	1.3 million	1.3 million
Max time samples in RAM[2]	7.5 million	7.5 million
Typical samples/s to SCSI disk[3]	750,000	750,000
Max time samples on SCSI disk	210 million	210 million
Waterfall display update[4]	10/s	10/s
Signal conditioning	ICP 2 mA[5]	Charge amp, ICP 4 mA

[1] 1 channel for 3567, 2 channels for 3566.
[2] With Option 116.
[3] For files ≤300 MB.
[4] Rate applies to eight traces, updated simultaneously.
[5] Transducers must be electrically isolated from the structure under test.

HP 3566A and 3567A Measurement Capability

Standard

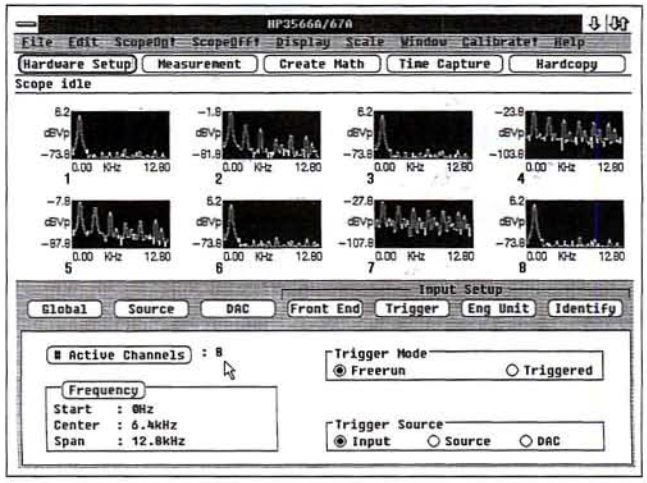
- Transient capture to RAM
- Time record
- RPM spectral map
- 1/3 and 1/1 octave (synthesized)
- Autocorrelation
- Cross-correlation
- Frequency response gain/phase
- Coherence
- Power spectrum
- Cross spectrum
- Filtered orbit diagram
- Linear spectrum
- Histogram (PDF, CDF)

Optional

- Order tracking
- Order ratio map
- Order ratio spectrum
- Swept-sine
- Record/playback
- Transient capture to SCSI disk
- Realtime octave 1/1, 1/3, and 1/12

Hardware Setup Display Simplifies Multichannel Testing

Setting up multichannel tests can be very difficult. The Hardware Setup mode displays, in one place, all pertinent information about the input channels, source, and DAC. High update rate displays monitor 2 to 16 channels simultaneously in the time or frequency domain. To simplify troubleshooting intermittent transducers, waterfall and spectrogram displays show how signals change with time.



HP 35636A Order Tracking Software (Optional)

Quickly distinguish between order-related and non–order-related rotating machinery signals. This optional software adds order ratio map and order-track measurements to the HP 3566A and 3567A capabilities. With it you can measure an accurate order spectrum independent of changing RPM. Using new HP technology, order ratio maps and order tracks are computed digitally, eliminating the errors and added expense of the ratio synthesizers, tracking filters, and RPM counters required by other FFT analyzers.

Filtered orbit displays provide orbits created from selected orders or combinations of orders. This greatly reduces noise and increases insight for diagnosing faults. For balancing shafts or looking at shaft dynamics, Bode plots of order tracks display the magnitude of the selected order and its phase. Polar plots of this data correlate magnitude and phase to physical locations on the shaft.

HP 35637A Swept-Sine Software (Optional)

Swept-sine techniques provide transfer functions with 132 dB dynamic range by changing source levels and input ranges for each frequency point measured. Research and development users can dramatically reduce measurement setup times by using auto-range, auto-level, and auto-resolution. Auto-resolution decreases measurement execution times by optimizing the frequency spacing between measurement points. Gain and phase margins are calculated just by pushing a button, simplifying control system analysis.

Production test users can further increase measurement speed by specifying all measurement parameters by frequency band. Up to ten separate bands allow performance optimization.

HP 35638A Real-Time Octave Software (Optional)

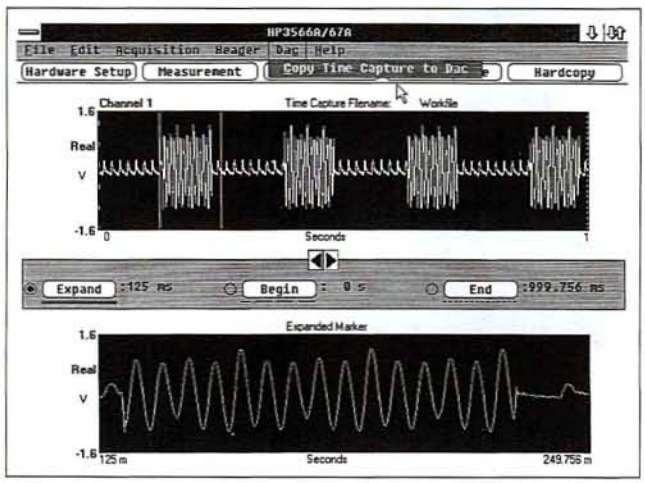
For real-time measurements, the data must be gap-free so no information is lost. When used with the HP 3567A, the optional HP 35638A 1/1, 1/3, and 1/12 real-time octave software provides real-time 1/3 octave measurements on 1 channel at 20 kHz, 2 channels at 10 kHz, or 4 channels at 5 kHz. When used with data throughput to the optional SCSI disk, 8 channels at 20 kHz are available. While the HP 3566A cannot perform real-time measurements on data from the input channels, it provides very cost-effective real-time 1/3 octave measurements on 16 channels at 10 kHz when used with data throughput to the optional SCSI disk.

DAC Provides Arbitrary Waveforms (Optional)

A programmable 16-bit DAC allows custom waveforms to be created and used as stimulus. A DAC editor and waveform calculator simplify their creation using built-in waveform types (sine, square, triangle, exponential, random, and impulse). Mathematical operations such as integration, differentiation, and filtering can be performed on the waveforms before they are output. In production test, chirp waveforms can be used to measure transfer functions extremely quickly.

High-Speed, Multichannel Transient Capture

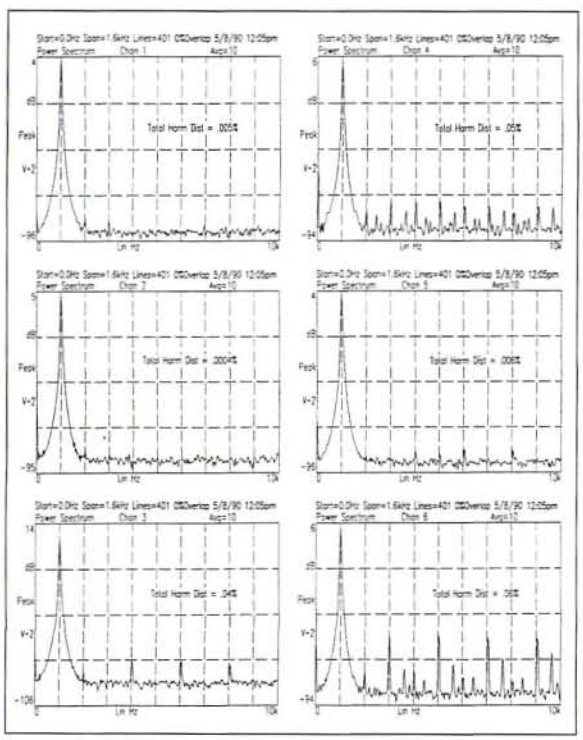
A special transient capture mode allows very high-speed transient captures to signal processor RAM or to the optional SCSI disk. (See specification table on previous page.) Simultaneously monitoring up to 16 channels while the throughput occurs helps prevent costly mistakes due to bad data. Captured signals can be viewed and portions can be selected for analysis using all HP 3566A and 3567A measurements except swept-sine. Transients captured to either RAM or SCSI disk can be played back through the DAC module while new measurements are run, recreating real-world stimulus.



Documentation of Results

A special Hardcopy Mode lets you document measurement results with up to six displays per page. Each display can include numerous individual annotations and pages can be labeled. Important measurement parameters and a time stamp can be automatically added to each display.

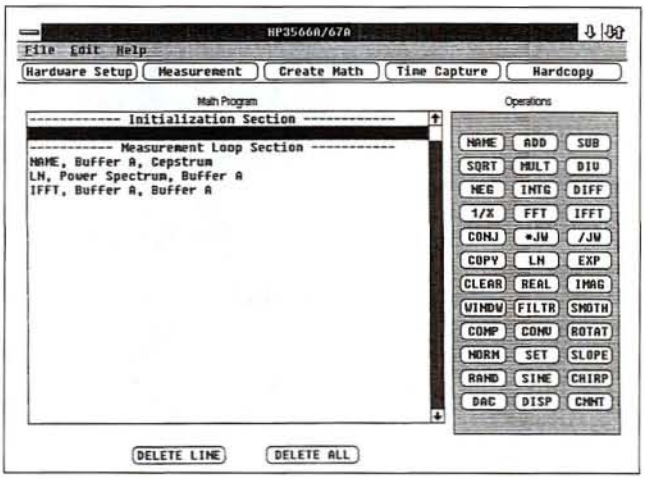
Prints and plots can be made to any Microsoft® Windows-supported graphics printer or HP-GL plotter (Centronics or RS-232 interface only). In addition, you can write reports using word processors and include HP 3566A and 3567A displays either by using Microsoft Windows "cut and paste" or by importing HP-GL plot files.



For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

Create Custom Measurements Easily

A full-function waveform calculator lets you create custom measurements and integrate them into the standard user interface. Mathematical functions can be performed on any measurement result, and the result of the operations can be displayed using the full display functionality or output through the programmable DAC.



Ordering Information

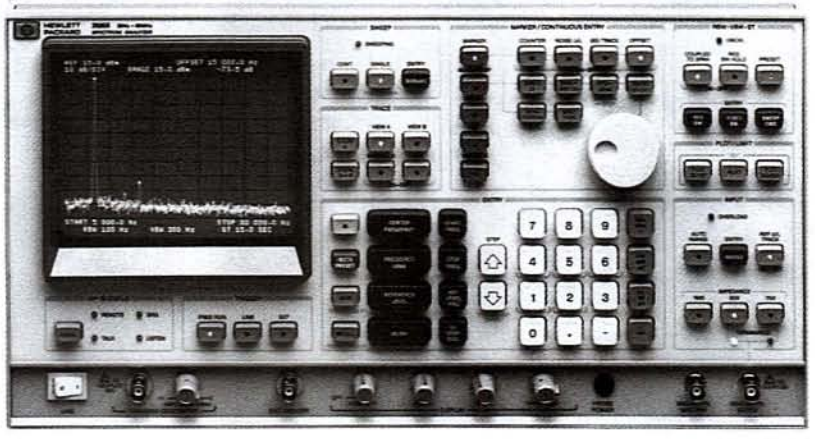
	Price
HP 3566A Spectrum/Network Analyzer Includes 1 HP 35650A mainframe, 1 HP 35655A 8-channel 12.8 kHz input module, 1 HP 35653C source module, 1 HP 35651B signal processor module with 4 MB RAM, 1 HP-IB cable, 90-day onsite hardware warranty, and HP 35634A time/frequency domain measurement software.	$27,500
Opt 010 Add 1 HP 35655A 8-Channel Input Module (maximum configuration is 2 HP 35655A modules)	+$10,300
Opt 116 Convert HP 35651B RAM to 16 MB	+$3,000
Opt 056 Add HP 35656B Programmable DAC Module (required for chirp stimulus, arbitrary waveform, and record/playback)	+$4,650
Opt B16 HP Vectra 486S with HP-IB card and software	+$7,700
Opt 050 Replace HP 35650A Mainframe with portable 4-slot, nonexpandable HP 35650B mainframe	−$1,850
Opt 059 HP 35659A SCSI Interface for External SCSI Disk (maximum is one HP 35659A)	$5,500
Opt 060 HP 35659A SCSI Interface with Built-In 420-MB Disk (maximum is one HP 35659A)	$9,000
HP 3567A Spectrum/Network Analyzer Includes 1 HP 35650A mainframe, 2 HP 35652B single-channel 102.4 kHz input modules, 1 HP 35653C source module, 1 HP 35651B signal processor module with 4 MB RAM, 1 HP-IB cable, 90-day onsite hardware warranty, and HP 35634A time/frequency domain measurement software.	$23,200
Opt 005 Add 1 HP 35650A Mainframe (maximum configuration is 3 HP 35650A mainframes)	+$6,500
Opt 010 Add One 102.4 kHz Input Module (max configuration is 16 HP 35652B modules)	+$3,000
Opt 116 Convert HP 35651B RAM to 16 MB	+$3,000
Opt 056 Add HP 35656A Programmable DAC Module (required for chirp stimulus, arbitrary waveform, and record/playback)	+$4,650
Opt B16 HP Vectra 486S with HP-IB card and software	+$7,700
Opt 050 Replace HP 35650A Mainframe with portable 4-slot, nonexpandable HP 35650B mainframe	−$1,850
Opt 059 HP 35659A SCSI Interface for External SCSI Disk (maximum is one HP 35659A)	$5,500
Opt 060 HP 35659A SCSI Interface with Built-In 420-MB Disk (maximum is one HP 35659A)	$9,000
HP 35636A Order Tracking (optional software)	$2,575
HP 35637A Swept-Sine (optional software)	$1,000
HP 35638A Real-Time Octave (optional software)	$2,500
HP 35634A Software ONLY for HP 3566A and HP 3567A (order only if you already have hardware)	$4,075

SIGNAL ANALYZERS

Spectrum Analyzer, 20 Hz to 40 MHz

HP 3585B

- Sweep gating option
- 80 to 100 dB dynamic range
- ±0.25 dB typical level accuracy
- 50, 75, 1 MΩ inputs
- 3 Hz resolution bandwidth
- Automatic limit testing



HP 3585B

DESIGNED FOR HP-IB SYSTEMS

HP 3585B Spectrum Analyzer

Uncompromising Baseband Signal Analysis

The HP 3585B spectrum analyzer delivers high performance where it counts—at baseband frequencies. With very high accuracy, resolution, and dynamic range, the HP 3585B is the best solution for signal analysis at the critical frequencies comprising voice, video, or digital information.

In today's high-speed, high-density information processing systems, maintaining the integrity of data signals requires more measurement performance than ever before. The HP 3585B provides 80 to 100 dB of spurious-free dynamic range, a sharp 3 Hz resolution bandwidth, and a 20 Hz to 40.1 MHz frequency range to easily cover most information bandwidths. Fully synthesized tuning (including sweeps) and typical amplitude accuracy to ±0.25 dB ensure complete measurement confidence.

Carefully Chosen Features for Better Measurements

Measurements are faster and easier with the optimized feature set. The automatic limit test function checks all 1000 measurement points against user-defined upper and lower limits in a fraction of a second. Pass/fail results are shown in the display and are available over HP-IB for improved productivity in automated applications.

The automatic peak search and signal track functions speed signal identification and analysis and make examination of drifting signals more convenient. In addition to locating the strongest signal in a display, the peak search function can also find successively smaller signals, or search to the right or left for peaks above a user-defined threshold.

Fast, Flexible Frequency Sweeps

Well-designed resolution bandwidth filters and a phase-continuous, synthesized local oscillator team up with exceptional dynamic range to give the HP 3585B very fast measurement speeds. A 40 MHz sweep using the 30 kHz resolution bandwidth takes only 200 milliseconds, fast enough for high-resolution spectrum surveillance. A 1 MHz sweep using a 1 kHz bandwidth takes only 2 seconds, yet yields an average noise floor of −85 dBc.

Powerful Marker Functions

The tunable marker readout of frequency and amplitude can display an absolute or relative (offset) value. With a single keystroke, enter the marker value as the center frequency, reference level, frequency span, or center frequency step size. This improves accuracy and efficiency in manual testing and reduces setup errors.

The built-in frequency counter provides additional accuracy when measuring the frequency of a signal in the display. It provides results in 0.3 seconds to 0.1 Hz resolution. Because the counter function is combined with the selectivity of the analyzer, it is possible to accurately measure small signals in the vicinity of much larger ones.

For noise measurements, the noise level marker function displays averaged rms noise density at the marker position, normalized to a standard 1 Hz bandwidth and corrected for the analyzer's characteristics. Combine this function with the relative measurement mode for fast, easy, signal-to-noise ratio measurements.

Measurement Hard Copy

Copying a complete display to a printer or plotter is as easy as pressing a button. The HP 3585B directly controls HP-GL compatible HP-IB plotters and graphics printers such as the HP ThinkJet.

Tracking Generator

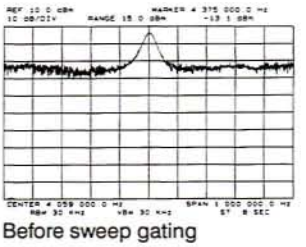
The standard 50 Ω tracking generator covers the full 40 MHz frequency range of the HP 3585B to provide easy scalar (amplitude-only) network analysis. The signal is fully synthesized in CW measurements and sweeps, and level is adjustable from 0 dBm to −11 dBm from the front panel.

Flexible Inputs with Autoranging

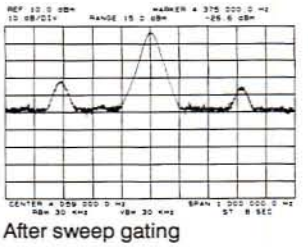
50, 75, and 1 MΩ input impedances are all standard and are electronically selectable to match your system. For sensitive circuits, the 50 Ω and 1 MΩ inputs and provided probe power, offer maximum compatibility with a variety of passive and active probes. With input autoranging, the HP 3585B automatically chooses the optimum input range for maximum dynamic range and lowest distortion. This eliminates the need to manually adjust attenuation and IF gain.

Burst Signal Analysis

Spectrum analysis on burst signals using traditional swept measurement techniques include not only the signal of interest but also the signal from the burst repetition period. This raises the effective noise floor of the measurement which masks the signal of interest, making accurate signal-to-noise and carrier-to-noise measurements impossible. The new sweep gating Option 001 reveals the signals you have missed.



Before sweep gating



After sweep gating

Specifications

Specifications describe the warranted performance of the HP 3585B over the temperature range 0° C to 55° C, except where noted. Supplemental characteristics describe typical but non-warranted performance; they are described as "typical" or "approximate" and apply over the temperature range 25 ±5° C.

Frequency

Measurement range: Specifications apply 20 Hz to 40.1 MHz
Start/stop, center, manual frequency range: 0 Hz to 40.1 MHz
Accuracy: (Same as frequency ref. accuracy)
Frequency span: 0 Hz to 40.1 MHz
Frequency reference accuracy: ± 1 × 10^{-7}/mo. of frequency
Marker frequency:
Readout accuracy: ±0.2% of frequency span ± resolution bandwidth.
Resolution: 0.1 Hz
Resolution bandwidth:
Bandwidth: 3 Hz to 30 kHz (3 dB bandwidth) in 1, 3, 10 sequence.
Selectivity: (60 dB / 3 dB) < 11:1
Video bandwidth: 1 Hz to 30 kHz in 1, 3, 10 sequence

Amplitude

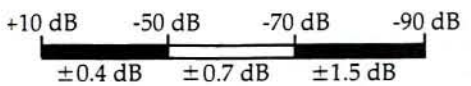
Display scale: 10 vertical division graticule with reference level (0dB) at top graticule line
Calibration: 1, 2, 5, 10 dB/division
Measurement range:
50/75 Ω input: −137 dBm to +30 dBm or equivalent level in dBV or volts
1 MΩ input: 31 nVrms to 7.08 Vrms
Input range settings: Autoranging, −25 dBm to +30 dBm in 5dB steps

Amplitude Accuracy

Accuracy note: Measurement accuracy is determined by the sum of reference level accuracy, amplitude linearity (if the signal is not at the reference level) and frequency response across the measurement span (if the signal is not at the center or manual frequency). In measurements where the signal is at the reference level and/or at the center or manual frequency, the amplitude linearity and/or frequency response uncertainties will not apply.

Reference Level

Range: −100 dB to +10 dB (relative to input range)
Accuracy: 50/75 Ω input (using 1 or 2 dB/div., measured at manual frequency or with sweep rate reduced by a factor of 4):

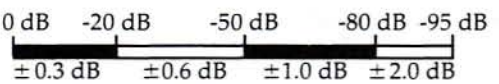


(For 5 or 10 dB/div. add 0.1 dB to the figures above)

Typical accuracy, +10 dB to −50 dB: ±0.25 dB.
For 1 MΩ input: Add to above specification ±0.7 dB for 20 Hz to 10 MHz; ±1.5 dB for 10 MHz to 40.1 MHz

Amplitude Linearity

50/75 Ω input (relative to reference level):



Typical linearity, 0 dB to −20 dB: ±0.2 dB

Frequency Response

50/75 Ω input (relative to center frequency): ±0.5 dB (±0.3 dB typ.)
For 1 MΩ input: Add to above specification ±0.7 dB for 20 Hz to 10 MHz, ±1.5 dB for 10 MHz to 40.1 MHz

Marker Amplitude Accuracy:

Center or manual frequency at the reference level: Use reference level accuracy from +30 dBm to −115 dBm; add amplitude linearity below −115 dBm.
Anywhere on screen: Add amplitude linearity and frequency response (same as display accuracy)

Dynamic Range

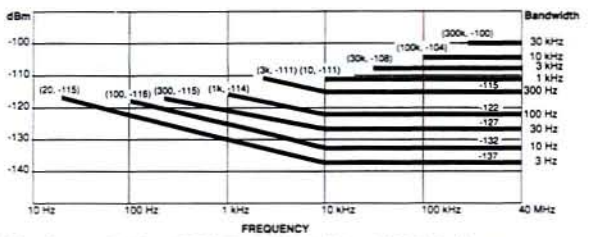
Spurious responses: (Image, out-of-band, and harmonic distortion)
50/75 Ω input: < −80 dB relative to a single signal at or below the input range setting.
Typical performance: −84 dB to (1 dB/dB below input range setting). Example: For a −8 dBm signal on the 0 dBm input range, the spurious responses would be −92 dB.
1 MΩ input: < −80 dB, except 2nd harmonic distortion < −70 dB

Intermodulation Distortion

50/75 Ω input: ≤ −80 dB relative to the larger of two signals, each ≥6 dB below input range setting except 2nd order IM from 10 MHz to 40 MHz < −70 dB
1 MΩ input: < −70 dB for 2nd order, < −80 dB for 3rd order
Residual responses (no signal at input): < −120 dBm using −25 dBm range, or 95 dB below input range setting
Residual phase noise (typical at 40 MHz, -10 dBm input):
5 kHz offset: −112 dBc/Hz
100 kHz offset: −120 dBc/Hz
Maximum dynamic range (typical): 92 dB spurious, harmonic and 3rd order IM; 115 dB signal to noise

Average Noise Level

50/75 Ω input:



1 MΩ input: Below 500 kHz add 12 dB to 50/75 Ω figure

Tracking Generator

Level: 0 dBm to −11 dBm, manual control from front panel
Frequency accuracy: ±1 Hz relative to analyzer tuning
Frequency response: ±0.7 dB; typically: ±0.5 dB
Impedance: 50 Ω, >14 dB return loss

Signal Input

50/75 Ω: >26 dB return loss, BNC connectors
1 MΩ: ±3% shunted by <30 pF, BNC connector

Maximum Input Level

50/75 Ω: 13V peak ac plus dc, relay protected for overloads to 42V peak
1 MΩ: 42V peak ac plus dc (derated by factor of two for each octave above 5 MHz)

External Trigger: Negative-going TTL level or contact closure initiates sweep

External Frequency Reference: 10 MHz or subharmonic to 1 MHz, 0 dBm minimum level

Opt 001 Sweep Gating Mode

Modes: Timed (start synch to ext trigger), External gate (start and stop synchronized to ext trigger)
Programmable gate delay range (typ): 10 μs-655 ms, 10μs steps
Programmable gate length range (typ): 100 μs, 200 μs-13.1 sec, 200 μs steps
Note: Measurement accuracy dependent on signal set-up time.

General

Weight: 36.7 kg (81 lb)
Size: 22.9 cm H × 42.6 cm W × 63.5 cm D (9 in × 16.75 in × 25 in)

Ordering Information

	Price
HP 3585B Spectrum Analyzer	$27,000
Opt W30 Extended Repair Service (see page 636)	+$605
Opt 001 Sweep Gating	+$1,560
Opt 002 Field Installable Sweep Gating Kit	+$2,100

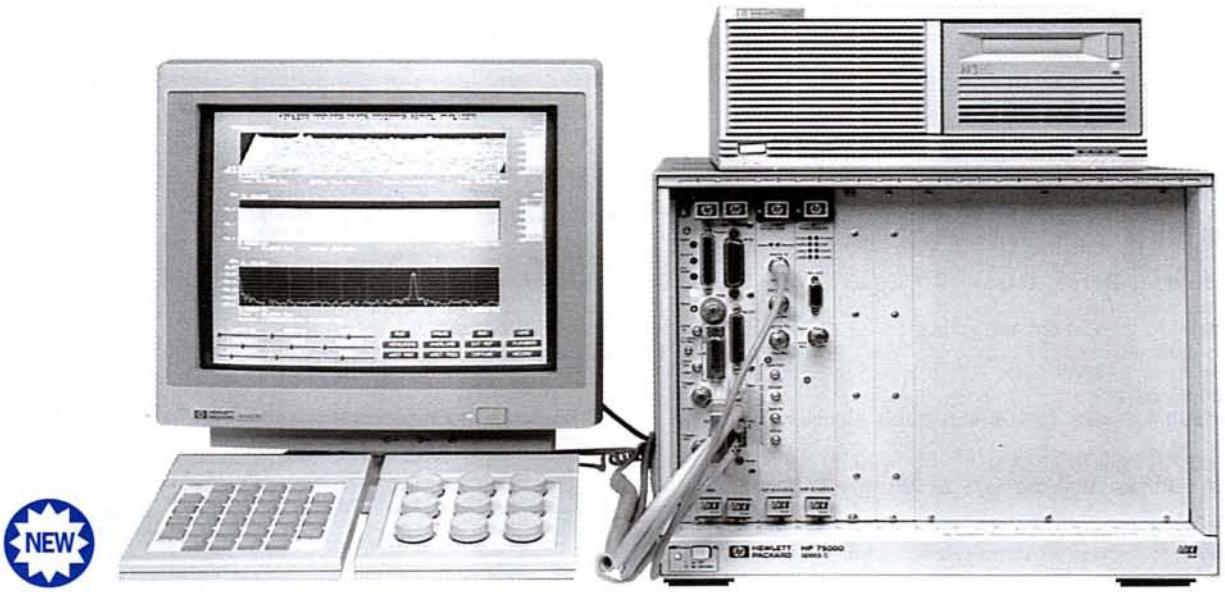
For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

SIGNAL ANALYZERS

Baseband Signal Analyzer

HP 3587S

- 4 MHz input range
- 1 MHz real time bandwidth
- 110 dBFS dynamic range
- Frequency, time, and amplitude domain
- Spectrogram and waterfall display



NEW

HP 3587S Baseband Signal Analyzer

The HP 3587S baseband signal analyzer has the measurement power and flexibility you need to characterize advanced electronic systems such as frequency-hopping radios. Its combination of state-of-the-art DSP technology and proprietary input circuitry provides fast measurements with better resolution and dynamic range than ever before in an analyzer capable of 1 MHz real-time analysis.

1 MHz Real-Time Bandwidth

The HP 3587S digital signal processing module contains five 32-bit Motorola 96002 floating-point DSP ICs. This computational power gives the HP 3587S 1 MHz real-time bandwidth. It also provides from 201 to 12,801 lines of frequency resolution on any frequency span.

A 4 MSample, high-speed, signal-capture buffer can capture the equivalent of 2048 spectra (4 MHz span, 801 line resolution), gap-free.

Dynamic Range and Sensitivity

The VXI input module for the HP 3587S includes an HP proprietary 23-bit, 10 MSample/s digitizer. This A/D reduces harmonic distortion to under -110 dBFS. Sensitivity is 2.4 nV/$\sqrt{\text{Hz}}$

Versatile Data Display

Monitor signals with a choice of displays. Frequency domain display types include single trace spectrums, multi-trace maps or waterfalls, and multiline spectrograms. Spectrograms update at up to 60 lines/s. Complete control of the apparent viewing angle of maps and spectrograms, whether paused or scrolling, is standard. Time domain display types include a time-trace display, a strip chart display, and a time-trace map. Histograms, probability density function (PDF), and cumulative density function (CDF) displays are standard. And, you can modify any data prior to display using the optional development environment.

Standard and User Definable Markers

Use markers to compare frequency, magnitude, and time data between different traces. Find the peak in a spectra or time waveform automatically, and measure power in a user-defined band. Create custom marker functions using the optional development environment.

System Advantages

The HP 3587S is a system that acts like an instrument. It includes all the hardware and software needed to make high-performance measurements. Software is loaded at the factory so you can take the system out of the box, hook up a few cables, and start making measurements. Knob and button controls provide the look and feel of an instrument.

Specifications

Frequency

Range: dc to 4 MHz
Spans: 0.24 Hz to 4.0 MHz, octave steps
Resolution: 201 to 12,801 lines
Real-time bandwidth: 1 MHz (801 lines, 0% overlap, spectrogram mode, rms averaging, 16-bit word width, 1024 × 768 pixel display)

Amplitude

Input ranges: +26 dBm to −34 dBm
Accuracy: ±0.06dB, f < 100 kHz, 23° C ± 5° C
Flatness across span: +0 dB/−0.4 dB, relative to 10 kHz for f < 4 MHz
Sensitivity: 2.4 nV/$\sqrt{\text{Hz}}$, −34 dBm range
Harmonic distortion: < −110 dBFS or −80 dBc, whichever is greater
Spurious/alias: < −110 dBFS, internal clock

Modes

Averaging modes: Off, rms, peak, nth
Marker modes: Single, relative (same trace, separate trace), marker to peak, marker to next peak right/left, band power
Memory modes: Save/recall, record/playback, signal capture
Triggering modes: Freerun, level, magnitude, external
Printer output: Print screen/print trace

Ordering Information

	Price
HP 3587S Baseband Signal Analyzer Includes: HP E1499A Workstation and 1024 × 768 monitor, HP C2214B 1300-MB disk drive with DAT tape, HP E1400B VXI chassis, HP E1485A DSP module, HP E1430A 10 MSa/s A/D with filter and FIFO, HP-UX operating system, HP 35687A measurement/control software	$85,000 *

*Price will vary with configuration.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Vector spectrum analysis
- Advanced, optimized time-gated spectrum analysis
- Digital modulation analysis (optional)
- Precision digital AM, FM, PM demodulation
- Flexible internal RF signal source (optional)
- Narrowband spectrum speed to 60 updates/s

HP 89440A dc to 1.8 GHz Vector Signal Analyzer

DESIGNED FOR HP-IB SYSTEMS

NEW

HP 89410A, 89440A Vector Signal Analyzers

Advanced Signal Analysis

Hewlett-Packard's new line of vector signal analyzers integrate frequency-domain and time-domain analysis to provide the most advanced measurements of complex and time-varying signals. Using state-of-the-art digitizing and signal processing technology, these analyzers offer complex signal analysis, such as digital modulation analysis and AM/FM/PM demodulation, vector spectrum analysis, and time-gated spectrum analysis. Simultaneous time and frequency domain measurements and displays improve productivity and enhance ease of use.

The HP 89410A covers baseband frequencies from dc to 10 MHz with one or two full-bandwidth input channels. The HP 89440A covers baseband through RF frequencies of dc to 1.8 GHz with a single RF input and an (optional) second baseband channel.

Both analyzers provide unprecedented speed and power. Complex time and spectrum measurements are made and displayed up to 60 times each second. Deep time-capture RAM is available with flexible post processing in time and frequency domains. A variety of display types are available, including log frequency, polar, and (optionally), eye and constellation diagrams.

High-Speed, Narrow-Resolution Vector Spectrum

Using high-speed signal processing, these analyzers can measure both the magnitude and phase (in the frequency domain) of CW and nonstationary or burst signals. Multiple signal processors and microprocessors display signal and circuit behavior in real time, and produce fast averaged measurements with enhanced signal-to-noise ratio.

High measurement speed is preserved even in narrowband measurements, with display updates orders of magnitude faster than traditional analyzers performing equivalent measurements. Resolution is also better, with resolution bandwidths as narrow as 0.001 Hz over the entire frequency range.

Waterfall and spectrogram display formats take full advantage of the high-measurement and display-update speed. Waterfalls display up to 250 successive spectra and scroll them through the display, while spectrograms use colors to indicate signal amplitudes. Both formats make it easy to monitor signal trends of short or long duration.

High-Resolution, High-Dynamic Range Time Domain

All measurements are made with a state-of-the-art A/D subsystem and proprietary signal processing. All frequency spans are image and alias protected, offering band-limited time-domain analysis not available in traditional oscilloscopes and waveform analyzers.

Both products feature a deep data memory of up to one million samples (optional). This memory can be used for long duration time capture, where the time-capture data can be selectively post-processed (internally) or transferred via HP-IB to an external computer for further analysis.

Precision Demodulation

Precision, high-resolution digitized time-series data allows for advanced signal analysis, such as AM, FM, and PM demodulation. Signals can be analyzed for instantaneous amplitude, frequency or phase versus time, and the resulting time-domain results can be translated into the frequency domain for further analysis. This is useful for characterizing phenomena such as phase noise, oscillator frequency transitions, and the amplitude or frequency behavior of

SIGNAL ANALYZERS

Vector Signal Analyzers, dc to 10 MHz and dc to 1.8 GHz (cont'd)

HP 89410A, 89440A

- Vector spectrum; AM/FM/PM demodulation
- Simultaneous time and frequency measurement
- 1 MSample time capture with postprocessing
- High-resolution, high-accuracy time domain
- One or two channels, full bandwidth

DESIGNED FOR HP-IB SYSTEMS

NEW

HP 89410A dc to 10 MHz Vector Signal Analyzer

transmitters at turn-on. Both deliberate and unintentional (or incidental) modulation can be characterized completely. Demodulation is selective, so that the type of modulation can be uniquely determined and separated from other types. FM and PM demodulation are made easier with an auto-carrier function.

Advanced Time-Selective Spectrum Analysis

For burst or time-varying signals, it may be necessary to examine only a selected part of the waveform. Time-selective spectrum analysis in the HP 89410A and 89440A allows the entire time-domain signal to be viewed and a specific portion selected for frequency-domain analysis. The selected data is identified clearly with gate markers and all of its traditional frequency domain parameters (including noise or signal/noise) can then be measured. A repetitive signal is not required for this time-selective analysis.

Powerful, Flexible Triggering

These vector signal analyzers have extremely flexible triggering to make the most of their time-selective analysis features. Measurements can be triggered from the analyzer's own signal source, an external source, HP-IB, an input channel (HP 89410A), or the analyzer's own band-limited IF. The IF trigger allows the analyzer to establish a trigger from a selected frequency band of the input signal, ensuring that the trigger event can always be seen. Both analyzers also provide pre- and post-trigger delays, along with manual, external, or automatic arming with programmable delay.

Advanced Data Analysis

The high-resolution time-domain data of the HP 89410A and 89440A allows for advanced data analysis functions. The built-in math functions can be used for scalar arithmetic and complex operations. Other advanced analysis capabilities include correlation functions, such as auto-correlation. This statistical function compares a signal with a delayed version of itself, useful in uncovering hidden periodic signals and analyzing multipath or other signal delays.

HP 89410A Baseband Vector Signal Analyzer

The HP 89410A covers a frequency range of dc to 10 MHz and offers an optional second channel. The second channel makes it possible to measure frequency response or vector network analysis, and the built-in math functions facilitate measurement calibration and correction.

Two-channel statistical measurements such as cross-correlation and coherence can also be made. Cross-correlation is similar to autocorrelation, but instead of comparing a signal with itself to see time delays or repetitions, one signal is compared with another. If the same repetitive signal is present in both waveforms it will be discovered in the cross-correlation measurement. This technique is also useful in analyzing multipath distortions.

Coherence is a measure of the power in the output signal related to the power in the input. It is useful for troubleshooting noise or signal propagation through a circuit or system. Coherence is also a good indication of the quality of a network measurement in a noisy environment.

Flexible Source

The HP 89410A provides a flexible source for circuit stimulation. Sinewaves, periodic chirps (sinewave sweeps), and pseudo-random noise are available, along with user-definable arbitrary waveforms. The arbitrary waveforms operate on a block of up to 4096 points.

Any of these signals can be used as a stimulus while spectrum measurements are made elsewhere in the circuit. Source level, dc offset, and the repeatability of the pattern are all controllable by the user.

HP 89440A RF Vector Signal Analyzer

The HP 89440A covers baseband through RF frequencies of dc to 1.8 GHz in scalar and vector analysis modes. The scalar RF instrument mode allows full-frequency coverage in spans to 1798 MHz. Vector RF mode offers exceptional speed and additional signal processing for enhanced time-domain characterization. Vector spans as wide as 7 MHz can be selected anywhere in the 1.8 GHz frequency range. A vector baseband mode is also available to provide all of the features and functionality of the HP 89410A.

In vector RF mode, both phase and amplitude characteristics are captured in the time-series data. This information can be processed for narrow resolution spectrum analysis, AM/FM/PM demodulation, time-selective analysis, and many other types of measurements.

Modulation Analysis

By using vector RF mode with demodulation and the optional second baseband channel, cross-correlation can be used to compare a demodulated RF signal with a baseband signal to locate a source of contamination (undesirable modulation).

In addition, optional digital-modulation analysis can be used with advanced display types to produce eye and constellation diagrams with automatic carrier, symbol locking, and selectable filtering.

RF Signal Source

In vector RF mode, the HP 89440A offers an optional flexible source with up to 7 MHz bandwidth, settable to any frequency in the 1800 MHz frequency range. As with the HP 89410A, sinewaves, periodic chirps (sinewave sweeps), and pseudo-random noise are available, along with user-definable arbitrary waveforms.

Measurement Automation and Convenience Features

Optional HP Instrument BASIC (a subset of HP BASIC) runs inside both analyzers to make repetitive measurements, to create custom displays and test sequences, and even to control other instruments in a test system. Automatic program generation is available with the "keystroke recording" feature, which creates complete executable programs by remembering keys pressed during an actual measurement.

These products include a set of disk utilities for PC analysis of measurement results and data conversions to PC-MATLAB and MATRIXx. They also include a standard PC-style keyboard interface supporting a variety of languages and a built-in 3½-in flexible disk drive with both LIF and DOS formats.

Microwave Measurements with Downconverter

The HP 89411A IF Downconverter works with the HP 89410A to provide narrowband vector signal analysis at RF and microwave frequencies. The HP 89411A converts a 21.4 MHz IF output from an external receiver to the input frequency range of the HP 89410A. This downconverter is also compatible with the HP 89440A.

This downconverter is designed for use with various HP microwave spectrum analyzers and other devices with compatible 21.4-MHz IF outputs. Frequency coverage is thus available over the complete frequency range of the microwave receiver or analyzer.

Specifications Summary

Please see the HP 89410A/89440A technical data sheets for full specifications. The following specifications apply from 0° to 55° C.

	HP 89410A	HP 89440A
Frequency		
Frequency range	dc to 10 MHz	dc to 1800 MHz
Frequency span	1 Hz to 10 MHz	1 Hz to 1798 MHz
Accuracy-initial	±0.2 ppm	±0.1 ppm
Aging rate	0.25 ppm/month	0.1 ppm/year
(Accuracy and aging shown with high-stability frequency reference)		
Resolution bandwidth	700 μHz to 1 MHz	700 μHz to 1 MHz
Phase noise (100 kHz offset, F=1800 MHz)		−105 dBc/Hz
Amplitude		
Input range 50 Ω	−34 dBm to +24 dBm	−40 dBm to +30 dBm
75 Ω	−36 dBm to +22 dBm	
1 MΩ	−34 dBm to +24 dBm	
Absolute accuracy	±0.5 dB	±0.5 dB
Scale fidelity (0 to −20 dB)	<0.10 dB	<0.10 dB
Frequency response		1.5 dB
Dynamic range		
Average noise level (narrowest RBW)	−170 dBm	−170 dBm
Optimum dynamic range (3rd order)	>80 dB typ. 75 dB specified	>80 dB typ. 75 dB specified
Residuals (−30 dBm range)	< −104 dBm	< −110 dBm
Source		
Signal types	Sine, periodic chirp, random noise, arbitrary	
Level range	−56 dBm to +24 dBm	−25 dBm to +15 dBm
Level accuracy	±1.0 dB	±2.5 dB typ.

Two-Channel Specifications, HP 89410A
(Requires optional second channel)
Channel match: ±0.25 dB, 0.2°

General Specifications

HP 89410A
Weight: 24.9 kg (55 lb)
Size: 426 mm W × 233 mm H × 530 mm D (16.7 in × 9.2 in × 21 in)
HP 89440A (IF section)
Weight: 24.9 kg (55 lb)
Size: 426 mm W × 233 mm H × 530 mm D (16.7 in × 9.2 in × 21 in)
HP 89440A (RF section)
Weight: 24.9 kg (55 lb)
Size: 426 mm W × 173 mm H × 495 mm D (16.7 in × 6.8 in × 19.5 in)
Operating Temperature: 0° to 55° C
Standard Instrument Includes:
3½-in flexible disk drive (1.44 MB), Manuals, Standard Data Format Utilities (LIF to DOS conversions, SDF conversions, data and instrument state display, PC-MATLAB and MATRIXx conversions)

Ordering Information

	Price
HP 89410A Vector Signal Analyzer	$28,500
HP 89440A Vector Signal Analyzer	$51,750
HP 89411A 21.4-MHz Downconverter	$9,595
Opt AY5 Precision Frequency Reference (HP 89410A only)	$700
Opt AY4 Delete High Precision Frequency Reference (HP 89440A only)	−$1,500
Opt AY8 Internal RF Source (HP 89440A only)	$5,500
Opt AYA Vector Modulation Analysis	$4,500
Opt AYB Waterfall and Spectrogram	$3,000
Opt AY7 Second 10-MHz Input Channel	$4,500
Opt AY9 Extend Time Capture to 1 MSample	$1,500
Opt UFG 4-MB Extended RAM and Additional I/O	$2,000
Opt 1C2 HP Instrument BASIC	$500
Opt PC-Style 101-Key Keyboard (available versions include U.S., German, Spanish, French, U.K., Italian, Swedish)	$170

For the most current prices and product information, contact your local Hewlett-Packard sales office, see page 665.

SIGNAL ANALYZERS

Spectrum/Network Analyzer, 10 Hz to 150 MHz

HP 3588A, 3589A

- Complete spectrum and vector network measurements (HP 3589A)
- Narrowband measurements hundreds of times faster
- Accuracy to 0.2 dB, spectrum; 0.05 dB, 1 degree network
- Optional time-gated spectrum analysis for burst signals (HP 3589A)
- Companion 2-port 50 Ω/75 Ω S-parameter test sets
- 80 to 112 dB dynamic range

HP 3588A

DESIGNED FOR HP-IB SYSTEMS

HP 3589A, 35689A

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HP 3588A Spectrum Analyzer
HP 3589A Spectrum/Network Analyzer

Complete Frequency Domain Analysis

The HP 3588A spectrum analyzer and HP 3589A spectrum/network analyzer provide comprehensive frequency-domain measurements and cover the baseband through IF frequency range of 10 Hz to 150 MHz. The HP 3588A offers high-performance spectrum measurements and simple scalar network measurements with its fully-synthesized tracking generator. The HP 3589A adds complete vector network measurements, support for analysis of RF and microwave downconverted signals, accessory 50 Ω and 75 Ω S-parameter test sets, and optional time-gated spectrum analysis.

Unprecedented Speed and Resolution

Narrow resolution measurements with conventional swept-tuned analyzers typically require long measurement times, which can increase development time and test costs. In contrast, the HP 3588A/3589A set new standards in speed while providing much greater frequency resolution.

Faster measurements are made possible with these analyzers' full-digital resolution-bandwidth filters. They offer an improved shape factor and sweep characteristics for measurements 4 to 40 times faster than those of conventional analyzers. A unique FFT "Narrowband Zoom" mode provides measurements up to 400 times faster and spans of 1 Hz to 40 KHz anywhere in the 150 MHz frequency range.

The HP 3589A also brings this speed and resolution to narrowband measurements at microwave frequencies, through enhanced features for interfacing with microwave analyzers receivers, or downconverters.

Full Network Capability

Because design tasks often require network or impedance measurements along with spectrum analysis, the HP 3589A provides a complete range of features and measurement accessories for comprehensive network analysis. Phase measurement functions include group delay, polar and Smith chart formats, and phase slope or electrical length compensation. Make all normal transmission measurements in 50 Ω and 75 Ω environments with the standard HP 3589A. For audio or broadband analysis, the analyzer also performs log sweeps and adds a 1 MΩ input.

Both 50 Ω and 75 Ω test sets are available for complete two-port network analysis. The test set enables easy, accurate measurement of VSWR, return loss, impedance, directivity, and other transmission and reflection parameters. To ensure optimum accuracy through cables and fixtures, full measurement calibration/error-correction functions are provided, comparable to dedicated network analyzers.

Burst Signal Analysis

You can find burst or time-varying signals in applications as diverse as communications, disk drives, video, sonar, ultrasound, and opto-electronics. The time-gated spectrum analysis option of the HP 3589A is meant for just these dynamic signals. Trigger the analyzer to measure only during the "valid" or desired portion of a complex signal, providing standard measurements such as signal-to-noise and distortion. Accurate measurement of these repetitive signal bursts is often impossible with a standard spectrum analyzer.

Measurement Automation and Convenience Features

Optional HP Instrument BASIC (a subset of HP BASIC) runs inside these analyzers to make repetitive measurements, create custom displays and test sequences, and even to control other instruments in a test system. Automatically program the analyzer with the "keystroke-recording" feature, which creates complete executable programs by remembering keys pressed during an actual measurement. The HP 3589A includes a set of disk utilities for PC analysis of measurement results and also includes a standard PC-style keyboard interface. Optional PC keyboards are available for the HP 3589A in a variety of languages.

Specifications Summary

Please see the HP 3588A and HP 3589A technical data sheets for full specifications. The following specifications apply from 0° to 55° C and from 10 Hz to 150 MHz.

Frequency Specifications

Frequency Range: 0 Hz to 150 MHz; 1 MΩ input specified from 10 Hz to 40 MHz.

Frequency Accuracy
Initial accuracy:

	Without Opt 1D5	With Opt 1D5
20° to 30° C	±0.5 ppm	±0.01 ppm
0° to 55° C	±3.0 ppm	±0.07 ppm
Aging	±0.25 ppm/mo.	±0.125 ppm/mo.

Frequency counter resolution: 0.1 Hz

Stability

Spectral purity: See chart below

Noise sidebands: Less than −105 dBc when measured at a 1 kHz offset from CW signal and normalized to a 1 Hz noise-power bandwidth.

Drift/Residual FM:

The HP 3589A uses a fully synthesized local oscillator and is phase-locked to the frequency reference throughout the sweep. See the frequency accuracy specifications stated earlier.

Amplitude Specifications

Amplitude Measurement Range:

(Maximum without degrading performance)

	50 Ω	75 Ω	1M Ω
Input dc:	±3 Vdc	±3 Vdc	±25 Vdc
Measured input:	20 dBm	22 dBm	±7 dBV

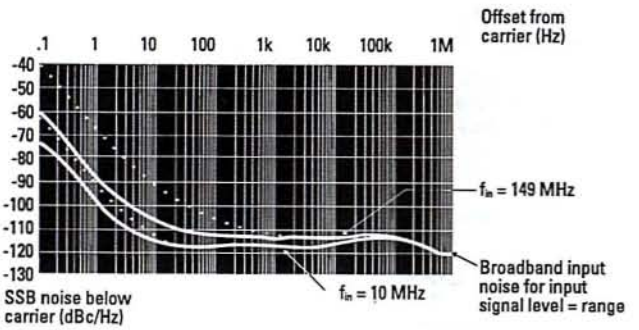
Input Range Settings (characteristics only):

50 Ω input (in 10 dB steps): +20 dBm to −20 dBm

75 Ω input (in 10 dB steps): +21.76 dBm to −18.24 dBm, with included BNC adapter and automatic corrections.

+ 25.72 dBm to − 14.28 dBm, with minimum loss pad (option) and automatic corrections

1 MΩ input (in 10 dB steps; HP 3589A only): +7 dBV to −33 dBV



Residual noise (excludes noise contributed by reference oscillator)

Absolute noise (includes noise contributed by Opt 1D5 frequency reference)

Note: Equivalent noise bandwidth is narrower than 1 Hz for spans below 150 Hz with the narrowband zoom measurement type, providing additional reduction in phase noise from that shown. This maintains good dynamic range, even for extremely small offset frequencies in narrow spans. Noise is reduced by 10*Log [1/noise bandwidth] dBc relative to the graph.

Display Resolution: 0.001 to 100 dB/div

Marker Resolution: 0.01 dB

Display Units: dBm, dBV, Vrms

Input Port: (Type-N connector)

Return loss: >20 dB

Impedance: 50 Ω, 1 MΩ, (75 Ω with included adapter or optional minimum-loss pad)

Source Specifications

Source Port: (Type-N connector)

Return loss: >20 dB

Impedance: 50 Ω (75 Ω with included adapter or optional minimum loss pad)

Frequency: 10 Hz to 150 MHz

Amplitude: +15 to −54.9 dBm (HP 3588A +10 to −59.9 dBm)

Absolute amplitude accuracy: ±1 dB

Frequency response: ±1 dB

Spurious: Harmonic < −30 dBc; Non-harmonic, < −40 dBc

Spectrum Measurements

Frequency

Frequency Span

Swept: Range 10 Hz to 150 MHz, and zero span

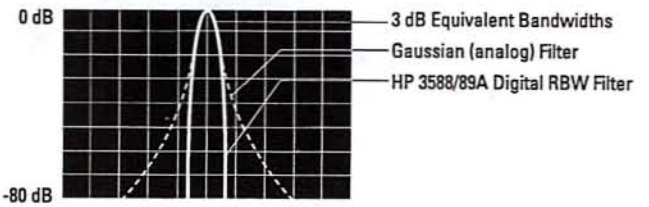
Start/stop frequency: 0 Hz to 150 MHz

Narrowband zoom: Range 1.23 Hz to 40 kHz in ×2 steps

Resolution Bandwidth

Swept: 1.1 Hz to 17 kHz ±10%

Narrowband zoom: (high-accuracy mode): 11 mHz to 360 Hz



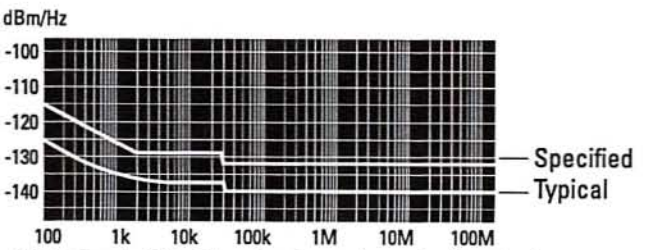
HP 3588A/3589A digital RBW filter shape (solid line) compared with a standard (Gaussian) analog RBW filter of equivalent 3 dB bandwidth.

Video Bandwidth: Entered in frequency values which are coupled to the current RBW and are from (1.54 * RBW) to (0.012 * RBW) in seven steps, and off.

Amplitude

Dynamic Range

A/D overload level: >2 dB (relative to selected range)



Noise level: (dBm/Hz using the marker noise function)

Specified for swept spectrum mode, with 50 Ω input, range set to −20 dBm and low-distortion mode off.

Note: Equivalent noise bandwidth is narrower than 1 Hz for spans below 150 Hz with the narrowband zoom measurement type, providing additional reduction in noise from that shown.

Spurious Responses

General Spurious: Unless specifically mentioned in other spurious specifications, spurious responses are < −70 dBc (< −80 dBc typical) for signal levels equal to input range.

Harmonic Distortion

50 Ω and 75 Ω inputs: < −80 dBc (< −90 dBc typical)

1 MΩ input: < −75 dBc (< −80 dBc typical)

Intermodulation Distortion

50 and 75 Ω inputs: < −80 dBc (< −90 dBc typical)

1 MΩ input: < −75 dBc (< −80 dBc typical)

Residual Responses: Below −110 dBm on the −20 dBm range

Amplitude Accuracy

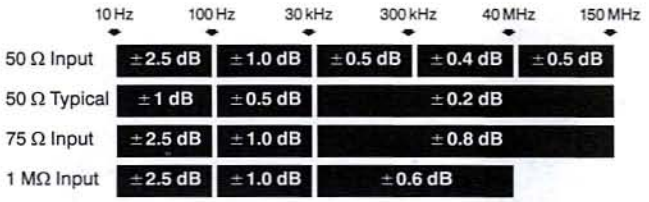
Measurement accuracy is determined by the sum of full-scale absolute accuracy and scale fidelity (linearity). For measurements made at full-scale (signal level = range), only full-scale accuracy need be considered. Recalibration due to change in center or manual frequency is not required for the accuracy shown.

SIGNAL ANALYZERS

Spectrum/Network Analyzer, 10 Hz to 150 MHz (cont'd)

HP 3588A, 3589A

Full-Scale Absolute Accuracy:
(Applies over entire 0° to 55° C temperature range.)
Accuracy is specified for manual frequency or for sweeps in which sweep time is increased by a factor of four. Add ±0.1 dB for auto-coupled sweep times.



Scale Fidelity (linearity) maximum cumulative error of log scale. Levels are relative to the specified range.

Level	Incremental	Typical
0 to −30 dB	<0.05 dB	0.02 dB
−30 to −40 dB	<0.1 dB	0.03 dB
−40 to −50 dB	<0.3 dB	0.05 dB
−50 to −60 dB	<0.5 dB	0.10 dB
−60 to −70 dB	<0.7 dB	0.10 dB
−70 to −80 dB	—	0.25 dB
−80 to −90 dB	—	0.25 dB
−90 to −100 dB	—	0.40 dB
−100 to −110 dB	—	0.70 dB
−110 to −120 dB	—	4.00 dB

Sweep Characteristics

Linear Swept Spectrum: The oversweep mode and digital IF filters of the HP 3589A provide sweep times 4 to 40 times faster than those of analog swept analyzers, without increased error.
Narrowband Zoom: Measurement speed >7 measurements/s (for spans ≥10 kHz)
Gated Sweep:
(HP 3589A Opt 1D6 only; not available in narrowband zoom mode.)
Gate length and trigger delay:

RBW (Hz)	Gate length minimum (ms)	Gate length maximum (ms)	Edge trigger default delay (ms)
17000	0.02	131	0.13
9100	0.04	131	0.2
4600	0.08	131	0.38

(For other bandwidths, see HP 3589A Technical Data Sheet.)

Network Measurements (HP 3589A only)

Frequency

Linear Sweep: For span and RBW, see swept spectrum mode
Log Sweep: Start/stop frequency: 10 Hz to 150 MHz

Amplitude

Dynamic Range

Sensitivity: Dynamic range limitation due to noise level and internal crosstalk between the source and receiver.

Impedance	10 Hz to 30 KHz	30 kHz to 40 MHz	40 MHz to 150 MHz
50/75 Ω	80 dB	100 dB	100 dB
50/75 Ω typical	85 dB	110 dB	110 dB
1 MΩ	75 dB	100 dB	–

Accuracy–Ratio Amplitude and Phase

Dynamic Accuracy: At stable temperature following a two-hour warmup, and within 5 minutes of normalization. (Typical within one minute of normalization.)

Level (dB)	Accuracy (dB)	Accuracy (deg)	Typical (dB)	Typical (deg)
0 to −5	<0.05	<1.0	<0.05	0.2
−5 to −30	<0.10	<1.5	0.10	0.5
−30 to −40	<0.15	<2.0	0.10	1.0
−40 to −50	<0.35	<3.0	0.10	1.0
−50 to −60	<0.55	<4.0	0.15	1.5
−60 to −70	<0.75	<6.0	0.15	2.5
−70 to −80	—	—	0.30	—
−80 to −90	—	—	0.30	—
−90 to −100	—	—	0.45	—

Group Delay (not available with log sweep)

Aperture Frequency: 0.5% to 16% of span in 2x steps
Accuracy: Dynamic phase acc./(360° aperture frequency) ±1 ns

Sweep Characteristics

Linear, log, and gated sweeps are available; see technical data sheet.

General Characteristics

Temperature (operating): 5° to 50° C; Storage: −20° to 60° C
Calibration Interval: 1 year
Power
115 Vac operation: 90 to 132 Vrms, 47 to 440 Hz
230 Vac operation: 198 to 264 Vrms, 47 to 66 Hz
Max. power dissipation: 450 VA
Weight: Net, 28 kg (62 lb); shipping, 38 kg (81 lb)
Size: 425.5 mm W × 222 mm H × 630 mm D (16.75 in × 8.75 in × 24.8 in)
External Keyboard: Compatible with PC-style 101 key

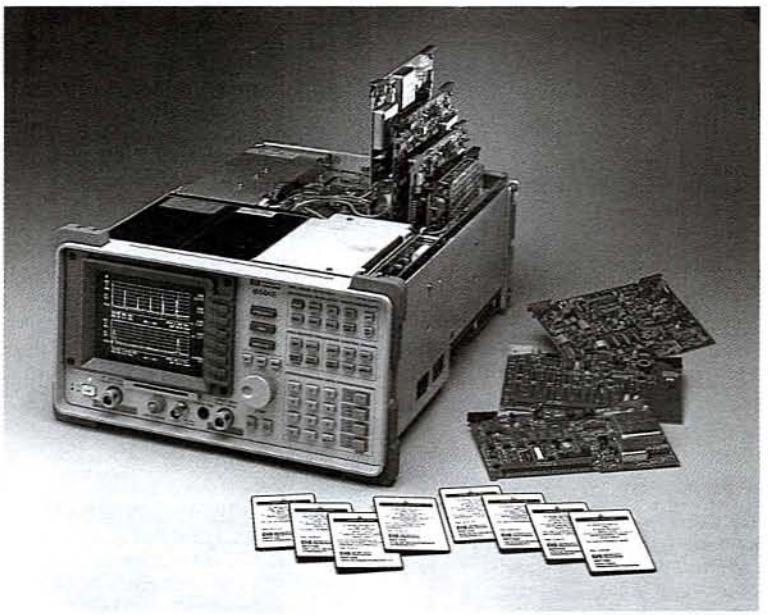
HP 35689A/B S-Parameter Test Sets

Frequency Range: 100 kHz to 150 MHz
Test Port Impedance: HP 35689A, 50 Ω; HP 35689B, 75 Ω
Directivity: >40 dB
Spectrum Port Insertion Loss: <0.5 dB typical (HP 35689A)
Power
115 Vac operation: 90 to 132 Vrms, 47 to 66 Hz
230 Vac operation: 198 to 264 Vrms, 47 to 66 Hz
Weight: Net, 7.8 kg (17 lb); shipping, 11.5 kg (25 lb)
Size: 426 mm W × 90 mm H × 584 mm D (16.75 in × 3.5 in × 22.75 in)

Ordering Information	Price
HP 3588A Spectrum Analyzer	$19,800
Opt 001 High-Stab. Freq. Reference	$850
Opt 003 Add 2 MB Memory	$1,500
Opt 1C2 HP Instrument BASIC	$500
HP 3589A Spectrum/Network Analyzer	$21,750
Opt 1D5 High-Stab. Freq. Reference	$850
Opt 1D6 Time-Gated Spectrum Analysis	$1,500
Opt 1C1 Add 2 MB Memory	$1,500
Opt 1C2 HP Instrument BASIC	$500
Opt 1D7 50 Ω to 75 Ω Minimum Loss Pads	$900
Opt PC-Style 101-Key Keyboard (Available keyboard versions include US, German, Spanish, French, UK, Italian, and Swedish)	$170
HP 35689A 50 Ω S-Parameter Test Set	$3,650
HP 35689B 75 Ω S-Parameter Test Set	$4,000

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Easy-to-use, portable spectrum analyzers
- Full range of price and performance options
- One-button measurements for FFT, TOI, ACP, and more
- Expanded memory and trace-storage capability
- Optional narrow resolution bandwidths
- New custom measurement personalities



NEW

DESIGNED FOR HP-IB SYSTEMS

HP 8591E with measurement personality and circuit card options

HP 8590 Series Spectrum Analyzers

The new HP 8590 E Series and 8590 D Series spectrum analyzers offer a wide range of performance, features, and prices designed to fit your budget. Choose from low-cost, basic performance analyzers or from higher-performance models with synthesizer accuracy. Whatever your choice, you'll find HP 8590 Series spectrum analyzers easy to use and reliable. Their expandable feature sets allow them to be easily configured to meet your growing measurement needs.

Application measurement personalities customize the analyzer for tasks such as CATV, EMC, digital cellular radio, RF communication, noise-figure, and scalar network analysis measurements (see page 236). You can also add a variety of printers, plotters, and other accessories.

One Spectrum Analyzer for Many Applications

You can change the test capabilities of these spectrum analyzers to fit specific measurement needs. A memory card reader enables you to load application measurement personalities. Complex measurement routines are reduced to a keystroke. An option cardcage, unique to the HP 8590 E Series, allows you to add circuit-card options for additional capability. Optional built-in tracking generators provide a synchronously swept signal source for stimulus-response measurements. Operating any HP 8590 Series spectrum analyzer requires only minimal training.

Easy-to-Use Features

Numerous features make it easier to control your measurements and to analyze the results. These portable spectrum analyzers have built-in, automatic calibration to ensure measurement consistency. Frequency panning lets you quickly reposition signals without repeated sweeps. The internal memory allows over 50 traces to be stored, and more can be stored on RAM cards using the memory-card reader. Time and date stamping come standard. Direct output to printer or plotter is available with either the HP-IB or the RS-232 interface option.

HP 8591E, 8593E, 8594E, 8595E, and 8596E Spectrum Analyzers

These new portable spectrum analyzers bring powerful, comprehensive measurement capabilities to RF, microwave, and digital applications. Five models offer a choice of frequency coverage starting at 9 kHz and extending to 26.5 GHz.

Performance specifications include low phase noise of −105 dBc at 30 kHz offset and frequency-synthesized accuracy of 7.6 kHz at 1 GHz, which can be improved to 240 Hz with an optional precision frequency reference. Second- and third-order dynamic ranges are 77 and 90 dB, respectively. Calibrated amplitude range is +30 to −130 dBm with Option 130, and calibrated onscreen display range is 70 dB.

Narrow resolution bandwidths of 30, 100, 200 EMI, and 300 Hz are available on an optional circuit card, which can be added to these analyzers at any time.

Standard Features

A new window capability divides the display into two horizontal areas, allowing you to zoom in on critical areas of a measurement trace or to display test data and the trace simultaneously. Many one-button measurements are standard, including a marker table, FFT, N dB bandwidths, third-order intercept, percent AM, and adjacent-channel power. Simple programs can be entered directly into the analyzer with the built-in DLP editor. In addition, a built-in memory card reader allows you to load measurement personalities, your own custom programs, and measurement data on 32-, 128-, 256-, and 512-K memory cards.

Option Flexibility

A growing number of circuit-card options provides even more measurement capability. Circuit cards are installed easily into a built-in cardcage, and most are retrofittable.

Circuit-card options include:

- Narrow resolution bandwidths of 30, 100, 200 EMI, and 300 Hz
- Time-gated spectrum analysis
- "Analog +" display
- AM/FM demodulator
- TV sync trigger
- Fast time-domain sweeps
- Quasi-peak detector
- Noise-figure measurements

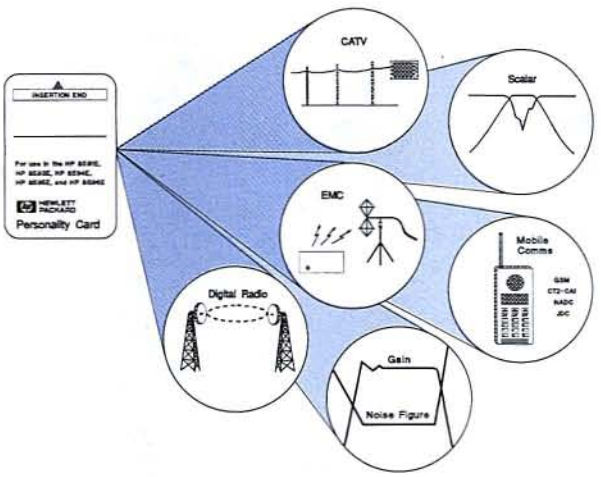
A built-in 1.8 GHz tracking generator (retrofittable) is available for the HP 8591E, and a 2.9 GHz tracking generator (not retrofittable) for the HP 8593E, 8594E, 8595E, and 8596E spectrum analyzers. For microwave scalar network measurements to 6.5 and 26.5 GHz, the HP 85644A and 85645A microwave tracking sources can be used. See page 245.

HP 8590D and 8592D Spectrum Analyzers

These models offer basic RF and microwave measurement performance at a low cost. The HP 8590D has a frequency range of 9 kHz to 1.8 GHz, amplitude range of −115 to +30 dBm, and an improved frequency accuracy option.

SIGNAL ANALYZERS
Spectrum Analyzers, Portable
HP 8590 Series

- Application-specific measurements
- New digital RF communication personalities



Measurement Personality Cards

HP's measurement personality cards are an economical way to customize your HP 8590 Series spectrum analyzer for easier, more accurate testing in a number of application areas. The measurement personalities are loaded into the analyzers by using the built-in memory-card reader (optional on the HP 8590D and 8592D).

Digital RF Communications

Measurement personalities give the HP 8590 Series spectrum analyzers specialized functions to simplify cellular radio and cordless telephone testing. These personalities simplify transmitter testing according to industry standards. Measurement displays and results are optimized for fast retrieval of test data. Limit-line masks and pass/fail messages speed go/no go testing. Numerical and graphic results can be sent directly to a printer or plotter. Real-time, interactive displays aid troubleshooting. (All personalities require HP 8590 A/E-Series Opt 004, 101, and 105; Opt 021 is recommended for general use. Other required options are listed below.)

HP 85715A GSM Measurement Personality

Based on GSM 11.10 and 11.20 recommendations for Pan-European digital cellular radio testing, the HP 85715A personality provides these measurements: mean transmitted carrier power, power versus time, output RF spectrum, spurious emissions, and intermodulation attenuation.

New HP 85717A CT2-CAI Measurement Personality

The HP 85717A personality provides all transmitter measurements in the MPT 1375 and I-ETS 300-131 specifications for second-generation cordless telephones with common air interface: mean carrier power, carrier-off power, adjacent-channel power, out-of-band power, spurious emissions, intermodulation attenuation, and frequency error and deviation. (The last measurement requires an HP 8590 A/E-Series Opt 110 or requires an Opt 021 and the HP 53310A modulation domain analyzer.)

New HP 85718A NADC-TDMA Measurement Personality

The HP 85718A personality simplifies the testing of time-division multiple-access transmitters for North American digital cellular radio (NADC) systems. Based on IS-54, -55, and -56 standards, it provides these measurements: carrier power, carrier-off power, adjacent-channel power, power versus time (for mobiles), and intermodulation (for bases). Other measurements are occupied bandwidth and combiner tuning (for bases). (To improve accuracy of the carrier-power measurement, use HP 8590 E-Series Opt 050.)

New HP 85720A JDC-TDMA Measurement Personality

The HP 85720A provides TDMA transmitter measurements for Japanese digital cellular radio (JDC) systems according to RCR STD-27 standards: carrier power, carrier-off power, occupied bandwidth, adjacent-channel power, power versus time (for mobiles), intermodulation (for bases), and spurious. Combiner tuning (for bases) is also included. (To improve accuracy of the carrier-power measurement, use HP 8590 E-Series Opt 050.)

Digital Radio Measurements

HP 85713A Digital Radio Measurement Personality

The HP 85713A personality for microwave spectrum analyzers includes five major agency masks for testing to U.S., U.K., and FRG digital radio specifications. Automatic compare-to-mask and mean power level measurements are made on the modulated signal. Functions include transient analysis monitoring and frequency response measurement. You can create and store your own masks for later use. More digital radio tests, including multipath fading margin, power measurements, and flatness, are available using the HP 11758 digital radio test system.

Cable Television Testing

Locate and troubleshoot system problems fast. Complementary CATV measurement personalities simplify manual and automatic testing.

HP 85716A CATV System Monitoring Personality

The HP 85716A provides nine automatic, non-interfering measurements that allow you to continuously monitor signal quality and make faster, easier system proof-of-performance tests: visual carrier frequency, visual carrier level, visual-to-aural frequency difference, visual-to-aural level difference, depth of modulation, power-line hum, visual carrier-to-noise ratio, system composite triple beat, and system composite second order distortion.

HP 85711A CATV Measurement Personality

This card is recommended for manual headend testing, proof-of-performance measurements, trunk maintenance, and (with a microwave analyzer) CARS-band testing. Measurements include channel selection by number and beats identification, carrier level, carrier-to-noise ratio, power-line hum, cross modulation, composite triple beat, depth of modulation, and non-intrusive frequency response. With spectrum analyzer options you can listen to AM and FM signals, measure modulation depth on individual TV lines, or view TV pictures on the CRT of the spectrum analyzer.

Component Test Measurements

HP 85719A Noise Figure Measurement Personality

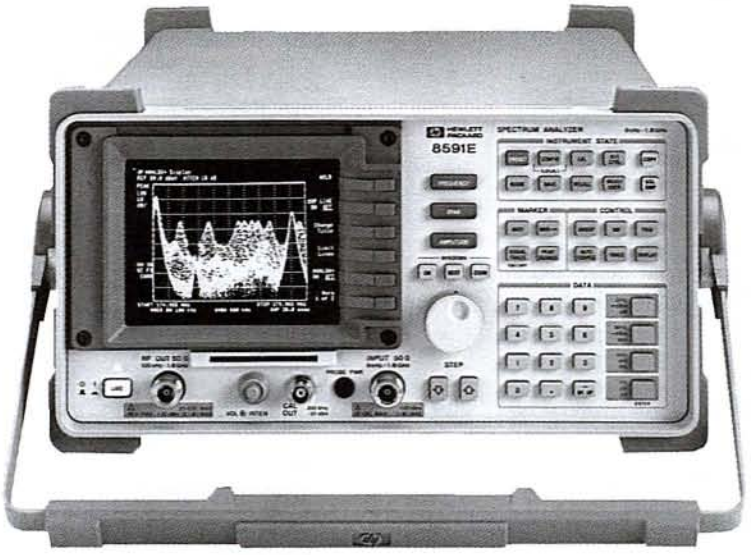
The new HP 85719A customizes an HP 8590 E-Series Option 119 spectrum analyzer for swept noise-figure and gain measurements. See page 245.

HP 85714A Scalar Measurement Personality

An HP 85714A personality and HP 8590 Series analyzer with optional built-in tracking generator make fast, accurate scalar transmission measurements from 300 kHz to 2.9 GHz or 100 kHz to 1.8 GHz. The personality card is also the interface for the HP 85630A scalar transmission/reflection test set. See page 245.

Electromagnetic Compatibility Testing

The HP 85712D electromagnetic compatibility (EMC) measurement personality simplifies EMC diagnostic and pre-compliance measurements. See page 255.



HP 8591E NEW

HP 8591E, 8593E, 8594E, 8595E, 8596E Specifications

Specifications apply to any of these analyzers unless otherwise noted.

Frequency

Frequency Range

HP 8591E

50 Ω: 9 kHz to 1.8 GHz

75 Ω: 1 MHz to 1.8 GHz

	dc-coupled	ac-coupled
HP 8594E:	9 kHz to 2.9 GHz	100 kHz to 2.9 GHz
HP 8595E:	9 kHz to 6.5 GHz	100 kHz to 6.5 GHz

HP 8596E

Band	LO harmonic=N	Center frequency
0	1	9 kHz to 2.9 GHz (dc-coupled)
0	1	100 kHz to 12.8 GHz (ac-coupled)
1	1	2.75 to 6.5 GHz
2	2	6.0 to 12.8 GHz

HP 8593E

Band	LO harmonic=N	Center frequency
0	1	9 kHz to 2.9 GHz
1	1	2.75 to 6.5 GHz
2	2	6.0 to 12.8 GHz
3	3	12.4 to 19.4 GHz
4	4	19.1 to 22 GHz
4	4 (Opt 026)	19.1 to 26.5 GHz

Frequency Reference

Aging: $\pm 2 \times 10^{-6}$/year; $\pm 1 \times 10^{-7}$/year (Opt 004)

Temperature stability: $\pm 5 \times 10^{-6}$; $\pm 1 \times 10^{-8}$ (Opt 004)

Initial achievable accuracy: $\pm 0.5 \times 10^{-6}$; $\pm 2.2 \times 10^{-8}$ (Opt 004)

Frequency Readout Accuracy (start, stop, center, marker): ± (frequency readout × freq ref error + span accuracy + 1% of span + 20% of RBW + 100 Hz × N)

Marker Count Accuracy

Span ≤ 10 MHz × N: ± (marker freq × freq ref error + counter res + 100 Hz × N)

Span > 10 MHz × N: ± (marker freq × freq ref error + counter res + 1 kHz × N)

Counter resolution

Span ≤ 10 MHz × N: Selectable from 10 Hz to 100 kHz

Span > 10 MHz × N: Selectable from 100 Hz to 100 kHz

Frequency Span

Range: 0 Hz (zero span) and

HP 8591E: 10 kHz to 1.8 GHz; 1 kHz min (Opt 130)

HP 8594E: 10 kHz to 2.9 GHz; 1 kHz min (Opt 130)

HP 8595E: 10 kHz to 6.5 GHz; 1 kHz min (Opt 130)

HP 8596E: [10 × N] kHz to 12.8 GHz; [1 × N] kHz min (Opt 130)

HP 8593E: [10 × N] kHz to 19.25 GHz; [1 × N] kHz min (Opt 130)

Resolution: Four digits

Accuracy

Span ≤ 10 MHz × N: ±2% of span

Span > 10 MHz × N: ±3% of span

Sweep Time

Range

Span = 0 Hz or > 10 kHz: 20 ms to 100 s

Span = 0 Hz (Opt 101): 20 μs to 100 s

Accuracy

20 ms to 100 s: ±3%

20 μs to < 20 ms (Opt 101): ±2%

Sweep trigger: Free run, single, line, video, external

Resolution Bandwidths: 1 kHz to 3 MHz (3 dB) in 1, 3, 10 sequence; 9 kHz and 120 kHz (6 dB) EMI bandwidths. Option 130 adds 30, 100, and 300 Hz (3 dB) bandwidths and 200 Hz (6 dB) EMI bandwidth.

Accuracy: ±20%

Selectivity (characteristic)

−60 dB/−3 dB:	3 to 10 kHz	15:1
	100 kHz to 3 MHz	15:1
	1 kHz, 30 kHz	16:1
−40 dB/−3 dB:	30 Hz to 300 Hz	10:1

Video Bandwidth Range: 1 Hz to 1 MHz in 1, 3 sequence

Stability

Noise sidebands (1 kHz RBW, 30 Hz VBW, sample detector)

>10 kHz offset from CW signal: ≤ −90 dBc/Hz + 20 log N

>20 kHz offset from CW signal: ≤ −100 dBc/Hz + 20 log N

>30 kHz offset from CW signal: ≤ −105 dBc/Hz + 20 log N

Residual FM (1 kHz RBW, 1 kHz VBW)

HP 8591E

1 kHz RBW, 1 kHz VBW: ≤250 Hz p-p in 100 ms

30 Hz RBW, 30 Hz VBW: ≤30 Hz p-p in 300 ms

HP 8593E, 8594E, 8595E, 8596E

1 kHz, RBW, 1 kHz VBW: ≤ (250 × N) Hz p-p in 100 ms

30 Hz RBW, 30 Hz VBW: ≤ (30 × N) Hz p-p in 300 ms

System Related Sidebands (> 30 kHz offset from CW signal): ≤ −65 dBc + 20 log N

Comb Generator (HP 8593E, 8596E): 100 MHz fundamental frequency; ±0.007% frequency accuracy

SIGNAL ANALYZERS
Spectrum Analyzers, Portable (cont'd)
HP 8590 Series

HP 8591E, 8593E, 8594E, 8595E, 8596E Specifications (cont'd)

Amplitude

Amplitude Range: Displayed average noise level to +30 dBm
HP 8591 Opt 001: Displayed average noise level to +75 dBmV
Maximum Safe Input (input attenuator ≥ 10 dB)
Average continuous power: +30 dBm (1 W)
HP 8591E Opt 001: +75 dBmV (0.4 W)
Peak pulse power
HP 8591E: +30 dBm (1 W)
HP 8591E Opt 001: +75 dBmV (0.4 W)
HP 8593E, 8594E, 8595E, 8596E: +50 dBm (100 W) for < 10 μs pulse width and < 1% duty cycle, input atten ≥ 30 dB
dc
HP 8591E: 25 Vdc
HP 8591E Opt 001: 100 Vdc
HP 8593E: 0 Vdc
HP 8594E, 8595E, 8596E: 0 V (dc-coupled); 50 V (ac-coupled)
Gain Compression (> 10 MHz): ≤ 0.5 dB (total power at input mixer = −10 dBm)
Displayed Average Noise Level (input terminated, 0 dB atten, 1 Hz VBW, sample detector)

	30 Hz RBW	1 kHz RBW
HP 8591E		
400 kHz to 1 MHz	≤ −130 dBm	≤ −115 dBm
1 MHz to 1.5 GHz	≤ −130 dBm	≤ −115 dBm
1.5 GHz to 1.8 GHz	≤ −128 dBm	≤ −113 dBm
HP 8591E Opt 001		
1 MHz to 1.5 GHz	≤ −78 dBmV	≤ −63 dBmV
1.5 GHz to 1.8 GHz	≤ −76 dBmV	≤ −61 dBmV
HP 8594E		
400 kHz to 5 MHz	≤ −122 dBm	≤ −107 dBm
5 MHz to 2.9 GHz	≤ −127 dBm	≤ −112 dBm
HP 8595E		
400 kHz to 2.9 GHz	≤ −125 dBm	≤ −110 dBm
2.75 to 6.5 GHz	≤ −127 dBm	≤ −112 dBm
HP 8596E		
400 kHz to 2.9 GHz	≤ −125 dBm	≤ −110 dBm
2.75 to 6.5 GHz	≤ −127 dBm	≤ −112 dBm
6.0 to 12.8 GHz	≤ −115 dBm	≤ −100 dBm
HP 8593E		
400 kHz to 2.9 GHz	≤ −127 dBm	≤ −112 dBm
2.75 to 6.5 GHz	≤ −129 dBm	≤ −114 dBm
6.0 to 12.8 GHz	≤ −117 dBm	≤ −102 dBm
12.4 to 19.4 GHz	≤ −113 dBm	≤ −98 dBm
19.1 to 22 GHz	≤ −107 dBm	≤ −92 dBm
HP 8593E Opt 026		
19.1 to 26.5 GHz	≤ −102 dBm	≤ −87 dBm

Spurious Responses
Second harmonic distortion
5 MHz to 1.8 GHz (HP 8591E): < −70 dBc for −45 dBm tone at input mixer
10 MHz to 2.9 GHz (HP 8593E): < −70 dBc for −40 dBm tone at input mixer
> 10 MHz (HP 8594E, 8595E, 8596E): < −70 dBc for −40 dBm tone at input mixer
> 2.75 GHz (HP 8593E, 8595E, 8596E): < −100 dBc for −10 dBm tone at input mixer (or below DANL)
Third-order intermodulation
HP 8591E (5 MHz to 1.8 GHz): < −70 dBc for two −30 dBm tones at input and > 50 kHz separation
HP 8593E, 8594E, 8595E, 8596E (> 10 MHz): < −70 dBc for two −30 dBm tones at input and > 50 kHz separation
Other input-related spurious (≥ 30 kHz offset, −20 dBm tone at input mixer)
HP 8591E, 8594E, 8595E, 8596E: < −65 dBc
HP 8593E: < −65 dBc (applied freq ≤ 18 GHz); < −60 dBc (applied freq ≤ 22 GHz)
Residual Responses (input terminated, 0 dB attenuation)
1 MHz to 1.8 GHz (HP 8591E Opt 001): < −38 dBmV
150 kHz to 1.8 GHz (HP 8591E): < −90 dBm
150 kHz to 2.9 GHz (HP 8594E): < −90 dBm
150 kHz to 6.5 GHz (HP 8593E, 8595E, 8596E): < −90 dBm
Display Range
Log scale: 0 to −70 dB from ref level is calibrated; 0.1, 0.2, 0.5 dB/div and 1 to 20 dB/div in 1 dB steps; 8 div displayed
Linear scale: 8 divisions
Scale units: dBm, dBmV, dBμV, V, W
Marker Readout Resolution
Log scale: 0.05 dB
Linear scale: 0.05% of ref level
Fast time sweep for zero span (Opt 101 or 301, 20 μs to 20 ms)
≤ 1 GHz: 0.7% of ref level for linear scale
> 1 GHz: 1.0% of ref level for linear scale
Reference Level
Range: Same as amplitude range
Resolution: 0.01 dB for log scale; 0.12% of ref level for linear scale
Accuracy: ±0.3 dB at −20 dBm
0 to −59.9 dBm: ±(0.3 dB + 0.01 × dB from −20 dBm)
Frequency Response (10 dB input attenuation)
Absolute (referenced to 300 MHz CAL OUT)
HP 8591E, 8594E: ±1.5 dB
HP 8595E: ±1.5 to ±2.0 dB
HP 8596E: ±1.5 to ±2.5 dB
HP 8593E: ±1.5 to ±5.0 dB (preselector peaked)
Relative flatness (referenced to midpoint between highest and lowest frequency response deviations)
HP 8591E, 8594E: ±1.0 dB
HP 8595E: ±1.0 to ±1.5 dB
HP 8596E: ±1.0 to ±2.0 dB
HP 8593E: ±1.0 to ±2.0 dB (preselector peaked)
Calibrator Output Amplitude: −20 dBm ±0.4 dB; +28.75 dBmV ±0.4 dB, HP 8591 Opt 001
Resolution Bandwidth Switching Uncertainty (ref to 3 kHz RBW, at ref level)
3 kHz to 3 MHz RBW: ±0.4 dB
1 kHz RBW: ±0.5 dB
30 Hz to 300 Hz RBW: ±0.6 dB
Log to Linear Switching: ±0.25 dB at ref level
Display Scale Fidelity
Log incremental accuracy (0 to −60 dB from ref level): ±0.4 dB/4 dB
Log maximum cumulative (0 to −70 dB from ref level)
1 kHz to 3 MHz RBW: ±(0.3 + 0.01 × dB from ref level)
30 to 300 Hz RBW: ±(0.4 + 0.01 × dB from ref level)
Linear accuracy: ±3% of ref level

General Specifications

Temperature
Operating: 0° to +55° C
Storage: −40° to +75° C
EMI Compatibility: Conducted and radiated interference CISPR Pub. 11 and Messempfaenger Postverfuegung 526/527/79
Audible Noise: < 37.5 dBA pressure and < 5.0 Bels power (ISODP7779)
Power Requirements
On (line 1): 86 to 127 or 195 to 250 V rms, 47 to 66 Hz; 103 to 126 V rms, 400 Hz ±10%; power consumption < 300 VA; < 100 W
Standby (line 0): Power consumption < 7 W
User Memory (nominal): 32 KB nonvolatile RAM
Data Storage (nominal): 50 states and traces, internal memory; 8 internal registers; 24 states and traces, HP 85700A memory card
Size (nominal, without handle, feet, or cover): 325 mm W × 163 mm H × 427 mm D
Weight: 14.5 kg (HP 8591E): 16.4 kg (HP 8593E, 8594E, 8595E, 8596E)

HP 8590D and 8592D Specifications

(Specifications apply to either analyzer unless otherwise noted.)

Frequency

Frequency Range

HP 8590D

50 Ω: 9 kHz to 1.8 GHz

75 Ω (Opt 001): 1 MHz to 1.8 GHz

HP 8592D: 9 kHz to 22 GHz

HP 8592D Opt 026: 9 kHz to 26.5 GHz

Band	LO harmonic=N	Center frequency
0	1	9 kHz to 2.9 GHz
1	1	2.75 to 6.5 GHz
2	2	6.0 to 12.8 GHz
3	3	12.4 to 19.4 GHz
4	4	19.1 to 22.0 GHz
4	4 (Opt 026)	19.1 to 26.5 GHz

Frequency Reference (HP 8590D Opt 013)

Aging: $\pm 2 \times 10^{-6}$/year

Temperature stability: $\pm 5 \times 10^{-6}$

Initial achievable accuracy: $\pm 0.5 \times 10^{-6}$

Frequency Readout Accuracy (start, stop, center, marker)

HP 8590D: ±(5 MHz + 1% of freq span)

HP 8590D Opt 013: ±(freq readout × freq ref error + span accuracy + 1% of span + 20% of RBW + 100 Hz)

HP 8592D: ±[(5 × N) MHz + 0.01% of center freq + 2% of freq span]

Marker Count Accuracy (HP 8590D Opt 013)

Span ≤10 MHz: ±(marker freq × freq ref error + counter resolution + 100 Hz)

Span >10 MHz: ±(marker freq × freq ref error + counter resolution + 1 kHz)

Counter resolution: Span ≤ 10 MHz, selectable from 10 Hz to 100 kHz; span > 10 MHz, selectable from 100 Hz to 100 kHz

Frequency Span

Range

HP 8590D: 0 Hz (zero span), 10 kHz to 1.8 GHz

HP 8592D: 0 Hz, [50 × N] kHz to 19.25 GHz

Resolution: Four digits

Accuracy: ±3% of span

Sweep Time

Range: 20 ms to 100 s

Accuracy: ±3%

Sweep trigger: Free run, single, line, video, external

Resolution Bandwidth (characteristic): 1 kHz to 3 MHz (3 dB) in 1, 3, 10 sequence ±20% accuracy; 9 kHz and 120 kHz (6 dB) EMI bandwidths

Video Bandwidth Range: 30 Hz to 1 MHz in 1, 3, 10 sequence

Stability

Noise sidebands (1 kHz RBW, 30 Hz VBW and sample detector): ≤ −95 dBc/Hz + 20 log N at > 30 kHz offset from CW signal

System-related sidebands: ≤ −65 dBc + 20 log N at > 30 kHz offset from CW signal

Comb Generator Frequency (HP 8592D): 100 MHz fundamental freq

Accuracy: ±0.007%

Amplitude

Amplitude Range

HP 8590D, 8592D: Displayed average noise level to +30 dBm

HP 8590D Opt 001: Displayed average noise level to +75 dBmV

Maximum Safe Input Level (input attenuator ≥ 10 dB)

Average Continuous Power

HP 8590D, 8592D: +30 dBm (1 W)

HP 8590D Opt 001: +75 dBmV (0.4 W)

Peak Pulse Power

HP 8590D: +30 dBm (1 W); +75 dBmV (0.4 W) (Opt 001)

HP 8592D: +50 dBm (100 W) for < 10 μs pulse width and < 1% duty cycle, input atten ≥ 30 dB

dc

HP 8590D: 25 Vdc; 100 Vdc (Opt 001)

HP 8592D: 0 Vdc

Gain Compression (> 10 MHz): ≤ 0.5 dB (total power at input mixer= −10 dBm)

Displayed Average Noise Level (input terminated, 0 dB atten, 1 kHz RBW, 30 Hz VBW)

HP 8590D: ≤ −115 to ≤ −113 dBm; ≤ −63 to ≤ −61 dBmV (Opt 001)

HP 8592D: ≤ −112 to ≤ −92 dBm; ≤ −112 to ≤ −87 dBm (Opt 026)

Spurious Responses

Second harmonic distortion (> 5 MHz)

HP 8590D: < −70 dBc for −45 dBm tone at input mixer

HP 8592D

10 MHz to 2.9 GHz: < −70 dBc for −40 dBm tone at input mixer

> 2.75 GHz: < −100 dBc for −10 dBm tone at input mixer (or below DANL)

Third-order intermodulation

HP 8590D

Distortion > 5 MHz: < −70 dBc for two −30 dBm tones at input mixer and > 50 kHz separation

Other input-related: < −65 dBc at ≥ 30 kHz offset, for −20 dBm tone at input mixer

HP 8592D

Distortion > 10 MHz: < −70 dBc for two −30 dBm tones at input mixer and > 50 kHz separation

Other input-related: < −65 dBc at ≥ 30 kHz offset, for −20 dBm tone at input mixer, ≤ 18 GHz; < −60 dBc for −20 dBm tone at input mixer, ≤ 22 GHz

Display Range

Log scale: 0 to −70 dB from ref level is calibrated; 0.1, 0.2, 0.5 dB/div and 1 to 20 dB/div in 1 dB steps; 8 div displayed

Linear scale: 8 divisions

Scale units: dBm, dBmV, dBμV, V, W

Marker readout resolution: 0.05 dB for log scale; 0.5% of reference level for linear

Reference Level

Range: Same as amplitude range

Resolution: 0.01 dB for log scale; 0.12% of ref level for linear

Accuracy: ±0.3 dB @ −20 dBm

0 dBm to −59.9 dBm: ±(0.3 dB + 0.01 × dB from −20 dBm)

Frequency Response (10 dB input attenuation)

Absolute (referenced to 300 MHz CAL OUT)

HP 8590D: ±1.5 dB

HP 8592D (preselector peaked in band > 0): ±1.5 to ±5.0 dB

Relative: ±1.0 dB, referred to midpoint between highest and lowest frequency response deviations

HP 8590D: ±1.0 dB

HP 8592D (preselector peaked in band > 0): ±1.0 to ±2.0 dB

Calibrator Output Amplitude: −20 dBm ±0.4 dB

HP 8590D Opt 001: +28.75 dBmV ±0.4 dB

Resolution Bandwidth Switching Uncertainty (ref to 3 kHz RBW, at ref level): ±0.4 dB for 3 kHz to 3 MHz RBW; ±0.5 dB for 1 kHz

Log to Linear Switching: ±0.25 dB at ref level

Display Scale Fidelity

Log incremental accuracy: ±0.4 dB/4 dB, 0 to −60 dB from ref level

Log maximum cumulative: ±(0.4 dB + 0.01 × dB from ref level), 0 to −70 dB from ref level

Linear accuracy: ±3% of ref level

General

Temperature Range

Operating: 0° to +55° C

Storage: −40° to +75° C

EMI Compatibility: CISPR Pub. 11 (1990) Group 1, Class A

Audible Noise: <37.5 dBA pressure and <5.0 Bels power (ISODP7779)

Power Requirements

On (line 1): 86 to 127 or 195 to 250 V rms, 47 to 66 Hz; 103 to 126 V rms, 400 Hz ±10%; power consumption < 300 VA: < 100 W

Standby (line 0): Power consumption < 7 W

SIGNAL ANALYZERS

Spectrum Analyzers, Portable (cont'd)

HP 8590 Series

Opts 010 and 011 Built-In Tracking Generators

Opt 010 (50 Ω) is available for all HP 8590 Series spectrum analyzers except the HP 8592D. Opt 011 (75 Ω) is available for the HP 8590D and 8591E only.

Frequency Range
- **Opt 010:** 100 kHz to 1.8 GHz (HP 8590D, 8591E); 300 kHz to 2.9 GHz (HP 8593E, 8594E, 8595E, 8596E)
- **Opt 011:** 1 MHz to 1.8 GHz (HP 8590D, 8591E)

Output Level

Range
- **Opt 010:** 0 to −15 dBm (HP 8590D); 0 to −70 dBm (HP 8591E); −1 to −66 dBm (HP 8593E, 8594E, 8595E, 8596E)
- **Opt 011:** +42.8 to −27.8 dBmV (HP 8590D); +42.8 to −27.2 dBmV (HP 8591E)

Resolution: 0.1 dB

Absolute accuracy: ±1.5 dB (HP 8590D); ±1.0 dB (HP 8591E); ±0.75 dB (HP 8593E, 8594E, 8595E, 8596E)

Vernier

Range: 15 dB (HP 8590D); 10 dB (HP 8591E); 8 dB (HP 8593E, 8594E, 8595E, 8596E)

Accuracy: ±1.0 dB (HP 8590D); ±0.25 dB (HP 8591E); ±0.8 dB (HP 8593E, 8594E, 8595E, 8596E)

Output Flatness: ±1.75 dB (HP 8590D, 8591E); ±2.0 dB, >10 MHz (HP 8593E, 8594E, 8595E, 8596E)

Spurious Output

Harmonic spurs: 0 dBm + 42.8 dBmV output, < −20 dBc (HP 8590D); < −25 dBc (HP 8591E); −1 dBm output, < −25 dBc (HP 8593E, 8594E, 8595E, 8596E)

Nonharmonic spurs: < −30 dBc

Dynamic Range (characteristic; max output level −TG feedthrough)
- **Opt 010:** 106 dB (HP 8590D, 8591E); 108 dB (HP 8594E, >400 kHz); 111 dB (HP 8595E, 8596E, >400 kHz); 113 dB (HP 8593E, >400 kHz)
- **Opt 011:** 100 dB

Power Sweep

Range
- **Opt 010:** −15 dBm to 0 dBm (HP 8590D); −75 dBm to 0 dBm (HP 8591E); −66 dBm to −1 dBm in 8 dB increments (HP 8593E, 8594E, 8595E, 8596E)
- **Opt 011:** −27.8 dBmV to +42.8 dBmV (HP 8590D); −32.2 to +42.8 dBmV (HP 8591E)

Resolution: 0.1 dB

Ordering Information

	Price
HP 8590D Spectrum Analyzer (9 kHz to 1.8 GHz)	$8,995
HP 8592D Spectrum Analyzer (9 kHz to 22 GHz)	$19,950
Opt 001 75 Ω Input (HP 8590D only)	+$0
Opt 003 Memory Card Reader	+$660
Opt 010 Tracking Generator (100 kHz to 1.8 GHz, HP 8590D only)	+$4,300
Opt 011 Tracking Generator (75 Ω, HP 8590D only)	+$4,300
Opt 021 HP-IB Interface	+$500
Opt 023 RS-232 Interface	+$500
Opt 026 26.5 GHz Frequency Extension, APC Connector (HP 8592D only)	+$2,000
Opt 027 26.5 GHz Frequency Extension, Type N Connector (HP 8592D only)	+$2,000
Opt 040 Front Panel Protective Cover With Storage	+$165
Opt 042 Protective Soft Carrying Case	+$250
Opt 908 Rackmount Without Handles	+$405
Opt 909 Rackmount With Handles	+$455
Opt 910 Additional Manual Set	+$95
Opt 915 Component Level Information and Service Guide	TBA
Opt W30 Two Additional Years Return-to-HP Service	
Opt W32 Two Additional Years Return-to-HP Calibration	
Opt W50 Five Additional Years Return-to-HP Service	
Opt W52 Five Additional Years Return-to-HP Calibration	
HP 8591E Spectrum Analyzer (9 kHz to 1.8 GHz	$11,500
HP 8594E Spectrum Analyzer (9 kHz to 2.9 GHz)	$13,950
HP 8595E Spectrum Analyzer (9 kHz to 6.5 GHz)	$19,980
HP 8596E Spectrum Analyzer (9 kHz to 12.8 GHz)	$24,100
HP 8593E Spectrum Analyzer (9 kHz to 22 GHz)	$26,250
Opt 001 75 Ω Input (HP 8591E only)	+$0
Opt 004 Precision Frequency Reference	+$1,500
Opt 010 Tracking Generator (100 kHz to 1.8 GHz, HP 8591E only)	+$4,900
Opt 010 Tracking Generator (300 kHz to 2.9 GHz)	+$6,500
Opt 011 Tracking Generator (75 Ω, HP 8591E only)	+$4,900
Opt 021 HP-IB Interface	+$500
Opt 023 RS-232 Interface	+$500
Opt 026 26.5 GHz Frequency Extension (HP 8593E only)	+$2,000
Opt 027 26.5 GHz Frequency Extension, Type N Connector (HP 8593E only)	+$2,000
Opt 040 Front Panel Protective Cover With Storage	+$165
Opt 042 Protective Soft Carrying Case	+$250
Opt 101 Fast Time Domain Sweeps and Analog+ Display	+$1,050
Opt 102 AM/FM Demodulator and TV Sync Trigger	+$500
Opt 103 Quasi-Peak Detector/AM-FM Demodulator	+$1,700
Opt 105 Time-Gated Spectrum Analysis	+$2,200
Opt 110 CT2 Demodulator	+$2,300
Opt 119 Noise Figure	$1,650
Opt 130 Narrow Resolution Bandwidths (30 to 300 Hz)	+$995
Opt 140 Narrow Bandwidths and Precision Frequency Reference	+$2,200
Opt 301 TV Sync Trigger, Fast Time Domain Sweeps, AM/FM Demodulator	+$1,550
Opt W30 Two Additional Years Return-to-HP Service	TBA
Opt W32 Two Additional Years Return-to-HP Calibration	TBA

Application Measurement Cards/Personalities

HP 85700A Blank 32-KB Memory Card	$105
HP 85711A CATV Measurement Personality	$620
HP 85712D EMC Measurement Personality	$1,300
HP 85713A Digital Radio Measurement Personality	$880
HP 85714A Scalar Measurement Personality	$985
HP 85715A GSM Measurement Personality	$2,080
HP 85716A CATV System Monitoring Personality	$1,395
HP 85717A CT2-CAI Measurement Personality	$2,010
HP 85718A NADC-TDMA Measurement Personality	$2,500
HP 85719A Noise-Figure Measurement Personality	$1,650
HP 85720A JDC-TDMA Measurement Personality	$2,500

Selected Accessories

HP 85901A Portable ac Power Source	$1,290 ☎
HP 11758 Digital Radio Test Set	$65,000
HP 11945A Opt E51 Close-Field Probe Set	$2,790 ☎
HP 11946A Quasi-Peak Adapter/AM-FM Demodulator Upgrade Kit	$1,960
HP 8447D Broadband Preamplifier (100 kHz to 1.3 GHz)	$1,700 ☎
HP 87405A Preamplifier (0.01 to 3 GHz)	$1,500
HP 41800A Active Probe (5 Hz to 500 MHz)	$1,740 ☎
HP 85024A High Frequency Probe (300 kHz to 3 GHz)	$2,500 ☎
HP 2225A/B ThinkJet Printer	$595 ☎
HP 7440A ColorPro Plotter	$1,395 ☎

☎ For off-the-shelf shipment, call 800-452-4844.

- New price/performance standard
- Continuous 30 Hz to 2.9, 6.5, or 26.5 GHz sweep
- Fast digital bandwidths of 1 to 100 Hz
- Improved phase noise and third-order dynamic range
- MIL-T-28800C rugged
- Standard precision frequency reference and mass memory module
- Adjacent channel power, occupied bandwidth, gated video
- Two-year calibration cycle

HP 8560 E-Series

NEW

DESIGNED FOR HP-IB SYSTEMS

Hewlett-Packard Instrument Drivers

HP 8560 E-Series Spectrum Analyzers

The new HP 8560 E-Series portable spectrum analyzers offer the measurement capabilities and performance traditionally found only in larger, more expensive benchtop analyzers. The HP 8560 E-Series combines outstanding phase noise, microwave sensitivity, narrow resolution bandwidths, and high dynamic range in a MIL-rugged package built to withstand harsh environmental conditions.

The HP 8560E has a frequency range of 30 Hz to 2.9 GHz; the HP 8561E, 30 Hz to 6.5 GHz; and the HP 8563E, 9 kHz to 26.5 GHz, with an option for 30 Hz low-end frequency. Using HP 11974 Series millimeter mixers, preselected coverage reaches 75 GHz, and with other mixers, unpreselected coverage can be extended higher. (See page 250 for information on HP millimeter mixers.)

The HP 8560 E-Series meets all MIL-T-28800 requirements, including those for temperature, pulse shock, and transit drop. The analyzers fully meet specifications at temperatures from −10° to +55° C and they can withstand 30 gs of shock.

High-Performance Spectrum Analysis

These spectrum analyzers are optimized for high-performance measurement applications. Key specifications include:

- Phase noise of −113 dBc/Hz at 10 kHz offset from the carrier
- 100 dB of third-order dynamic range
- −145 dBm sensitivity at 1 GHz, in a 1 Hz RBW

An image-enhanced harmonic mixer extends excellent performance into the microwave frequencies in the HP 8563E:

- −139 dBm sensitivity at 26.5 GHz, in a 1 Hz RBW
- ±3.5 dB flatness while continuously sweeping the entire 26.5 GHz frequency range

Fast Digital Resolution Bandwidths

Digitally implemented resolution bandwidths of 1, 3, 10, 30, and 100 Hz allow the HP 8560 E-Series spectrum analyzers to sweep up to 40 times faster than is possible with comparable analog filters. A narrow 5:1 shape factor allows you to view close-in, low-level signals easily. Digital bandwidths also provide the spectrum analyzer with a full 100 dB onscreen calibrated display.

Digitized, Fast Time Domain Sweeps

Add digitization to fast time domain (zero span) sweeps with Opt 007. Use markers, trace math, trace storage–and get hardcopy output–for measurements such as rise/fall times, pulse widths, and time between events.

Frequency Accuracy

A precision frequency reference is standard. At 1 GHz, it provides frequency accuracy of ±225 Hz after a 5-minute warmup and ±135 Hz after a 15-minute warmup.

Adjacent-Channel Power, Occupied Bandwidth, and Gated Video

Built-in keys for adjacent-channel power and occupied bandwidth measurements give you results quickly for these common measurements on communication systems. Time-gated signal analysis is another standard feature that allows you to easily measure time-varying signals such as pulsed RF, time-domain multiple access (TDMA), interleaved, and burst-modulated.

Specified Pulse Response

These portables easily capture and accurately display short-duration radar pulses. Specified pulse-digitization uncertainty is ±1.25 dB and typical repeatability is 0.2 dB.

Scalar Network Analysis Capability

The HP 85644A and 85645A tracking sources allow the HP 8560 E-Series to make high-performance scalar network analysis measurements at up to 6.5 or 26.5 GHz frequencies. See page 245. For RF testing, the HP 85640A tracking generator and the optional built-in tracking generator for the HP 8560E both cover 300 kHz to 2.9 GHz.

HP 85620A Mass Memory Module

This standard plug-in module adds measurement personality capability, enough memory to store 100 traces, memory-card capability, and computer capability without an external controller. Create complex measurement routines and save them as single-key measurements stored on memory cards or in the module's 128 KB of battery-backed RAM. A clock/calendar and automatic save and execute functions let you set the spectrum analyzer for unattended, automatic measurements.

HP 85629B Test and Adjustment Module

This accessory creates a whole new approach to servicing your spectrum analyzer. The module plugs into the rear panel of an HP 8560 series analyzer and automates high-level diagnostics, self-tests, and adjustment procedures. It performs more than 1,000 troubleshooting measurements. Readjustments are fast and accurate because the module controls internal analyzer settings as well as external test equipment.

SIGNAL ANALYZERS

Spectrum Analyzers, High-Performance Portable

HP 8560 E-Series

HP 8563E

NEW

DESIGNED FOR HP-IB SYSTEMS

Hewlett-Packard Instrument Drivers

HP 8560E and 8561E RF Spectrum Analyzers

The HP 8560E and 8561E offer excellent performance for RF design, manufacturing, and service applications. The HP 8560E has a frequency range of 30 Hz to 2.9 GHz and the HP 8561E extends this range up to 6.5 GHz. Both have synthesized tuning for drift-free, accurate measurements. They also have sensitivity of −145 dBm, noise sidebands typically less than −115 dBc/Hz at a 10-kHz offset from 1 GHz, more than 100 dB of spurious-free third-order dynamic range, and a TOI of up to +15 dBm. Digital resolution bandwidths range from 1 to 100 Hz, and analog filters cover the resolution bandwidth range from 300 Hz to 2 MHz. Both analyzers meet MIL-T-28800 specifications for ruggedness.

Manual control is simple with an easy-to-use combination of hardkeys and softkeys that minimizes the number of keystrokes required to make measurements. Built-in capabilities for communication measurements include adjacent-channel power (ACP), occupied bandwidth, time-gated spectrum analysis, delayed sweep, and AM/FM demodulation. Hard copies of results are easily obtained by using the analyzers' direct print and plot functions or by using a computer.

To automate measurements, you can use the instrument-control capabilities of downloadable programs and the HP-IB interface. Create simple one-button measurements to maximize test efficiency and produce results quickly. The mass memory module adds 128 KB of battery-backed RAM, limit line capability for pass/fail testing, and a clock/calendar with automatic execute and save functions.

Scalar measurement capability can be made available by adding an optional built-in tracking generator to the HP 8560E or by using the HP 85640A tracking generator or an HP 85644A tracking source with either analyzer. For millimeter applications that don't require full microwave coverage, the HP 8560E and 8561E provide lower-cost solutions. Both are compatible* with HP 11970 series harmonic mixers and HP 11974 Series preselected mixers.

HP 8563E Microwave Spectrum Analyzer

The HP 8563E extends the outstanding features and capabilities of the HP 8560 E-Series RF spectrum analyzers into the microwave frequency range. The HP 8563E has a standard preselected frequency range of 9 kHz to 26.5 GHz, with optional low-end frequency coverage to 30 Hz. The image-enhanced, double-balanced harmonic mixer of the HP 8563E achieves noise-figure performance similar to that of a fundamentally mixed front end, resulting in typical sensitivity of −139 dBm at 26.5 GHz in a 1 Hz RBW. Amplitude flatness across the full 26.5 GHz span is typically less than ±2.5 dB.

Scalar capability can be added using the HP 85640A, 85644A, or 85645A portable tracking sources. For millimeter-wave measurements, preselection can be extended to 75 GHz using the HP 11974 Series millimeter mixers. Unpreselected frequency range can be extended to 110 GHz using the HP 11970 Series mixers, and to 325 GHz using mixers from other manufacturers.

HP 85710A Digital Radio Measurement Personality

The HP 85710A digital radio measurement personality customizes the HP 8560 E-Series spectrum analyzers for digital radio measurements. It contains five agency masks for testing to U.S. FCC, U.K., and FRG specifications. A compare-to-mask function allows you to characterize spectral emissions. Other functions include mean power level, transient analysis monitoring, and frequency response measurements. You can also create and store your own custom masks.

* Millimeter-wave coverage is not available with Opt 002 on the HP 8560E.

Specifications

Frequency

Frequency Range

HP 8560E: 30 Hz to 2.9 GHz (dc-coupled); 100 kHz to 2.9 GHz (ac-coupled)

HP 8561E: 30 Hz to 6.5 GHz (dc-coupled); 100 kHz to 6.5 GHz (ac-coupled)

HP 8563E: 30 Hz to 26.5 GHz (Opt 006); 9 kHz to 26.5 GHz

Harmonic mode (N)	Frequency band
1	30 Hz to 2.9 GHz (Opt 006)
1	9 kHz to 2.9 GHz
1	2.75 to 6.46 GHz
2	5.7 to 13.2 GHz
4	12.4 to 26.5 GHz

Frequency Reference Accuracy		Opt 103
Temperature stability	$\pm 1 \times 10^{-8}$	$\pm 1 \times 10^{-6}$
Aging (per year)	$\pm 1 \times 10^{-7}$	$\pm 2 \times 10^{-6}$
Settability	$\pm 1 \times 10^{-8}$	$\pm 1 \times 10^{-6}$
Warmup (nominal), **5-minute**	$\pm 1 \times 10^{-7}$	
15-minute	$\pm 1 \times 10^{-8}$	

Frequency Readout Accuracy

Span > 2 MHz: ±(freq readout × freq ref accuracy + 5% × span + 15% × RBW + 10 Hz)

Span ≤ 2 MHz: ±(freq readout × freq ref accuracy + 1% × span + 15% × RBW + 10 Hz)

Marker Count Accuracy (S/N ≥ 25 dB): ±(marker freq × freq ref accuracy + 5 Hz × N + 1 LSD)

Delta Count Accuracy (S/N > 25 dB): ±(delta freq × freq ref accuracy + 10 Hz + 2 LSD)

Counter Resolution: Selectable from 1 Hz to 1 MHz

Frequency Span

Range

HP 8560E: 0 Hz, 100 Hz to 2.9 GHz

HP 8561E: 0 Hz, 100 Hz to 6.5 GHz

HP 8563E: 0 Hz, 100 Hz to 26.5 GHz

Accuracy: For span > 2 MHz, ±5%; for span ≤ 2 MHz, ±1%

Sweep Time

Range

Span = 0 Hz: 50 μs to 100 s

Span ≥ 100 Hz, RBW ≥ 300 Hz: 50 ms to 100 s

Span ≥ 100 Hz, RBW ≤ 100 Hz: 50 ms to 100 ks

Accuracy (span = 0 Hz)

Sweep time ≥ 30 ms: ±1% digital

Sweep time < 30 ms: ±10% analog

Sweep trigger: Delayed, free run, single, line, video, external

Resolution Bandwidth

Range (−3 dB): 1 Hz to 1 MHz in a 1, 3, 10 sequence and 2 MHz (3 MHz @ −6 dB)

Range (−3 dB, with Opt 103): 10 Hz to 1 MHz in a 1, 3, 10 sequence and 2 MHz (3 MHz @ −6 dB)

Accuracy

1 Hz to 300 kHz: ±10%

1 MHz: ±25%

2 MHz: +50%, −25%

Selectivity (−60 dB/−3 dB)

RBW ≥ 300 Hz: < 15:1

RBW ≤ 100 Hz: < 5:1

Video Bandwidth Range: 1 Hz to 3 MHz in a 1, 3, 10 sequence

Noise Sidebands (center frequency ≤ 1 GHz)

Offset		Opt 103
100 Hz	< −80 dBc/Hz	< −70 dBc/Hz
1 kHz	< −97 dBc/Hz	< −90 dBc/Hz
10 kHz	< −113 dBc/Hz	< −113 dBc/Hz
30 kHz	< −113 dBc/Hz	< −113 dBc/Hz
100 kHz	< −113 dBc/Hz	< −113 dBc/Hz

Residual FM (Zero Span): < 1 Hz p-p in 20 ms; < 0.25 Hz p-p in 20 ms (nominal); < 10 Hz p-p in 20 ms (Opt 103)

Amplitude

Range: Displayed average noise level to +30 dBm

Maximum Safe Input Level

Average continuous power: +30 dBm (1 W, input atten ≥10 dB)

Peak pulse power (< 10 μs pulse width and < 1% duty cycle): +50 dBm (100 W, input atten ≥30 dB)

dc volts: ±0.2 V (dc-coupled); ±50 V (ac-coupled, HP 8560E/8561E only)

Displayed Average Noise Level (0 dB input atten, 1 Hz VBW)

	HP 8560E/8561E		HP 8563E	
Frequency	**1 Hz RBW**	**10 Hz RBW**	**1 Hz RBW**	**10 Hz RBW**
30 Hz	−90 dBm	−80 dBm	−90 dBm	−80 dBm
1 kHz	−105 dBm	−95 dBm	−105 dBm	−95 dBm
10 kHz	−120 dBm	−110 dBm	−120 dBm	−110 dBm
100 kHz	−120 dBm	−110 dBm	−120 dBm	−110 dBm
1 to 10 MHz	−140 dBm	−130 dBm	−140 dBm	−130 dBm
10 MHz to 2.9 GHz	−145 dBm	−135 dBm	−145 dBm	−135 dBm
2.9 to 6.5 GHz	−145 dBm†	−135 dBm†	−148 dBm	−138 dBm
6.5 to 13.2 GHz			−145 dBm	−135 dBm
13.2 to 22.0 GHz			−140 dBm	−130 dBm
22.0 to 26.5 GHz			−139 dBm	−129 dBm

Gain Compression

10 MHz to 2.9 GHz: < 1 dB (mixer level = −5 dBm)

2.9 to 6.5 GHz (HP 8561E): < 1 dB (mixer level = −3 dBm)

2.9 to 26.5 GHz (HP 8563E): < 1 dB (mixer level = 0 dBm)

Maximum Dynamic Range

	HP 8560E/8561E		HP 8563E	
	1 Hz RBW	**10 Hz RBW**	**1 Hz RBW**	**10 Hz RBW**
Comp. to Noise				
10 MHz to 2.9 GHz	> 140 dB	> 130 dB	> 140 dB	> 130 dB
2.9 to 6.5 GHz	> 142 dB†	> 132 dB†	> 148 dB	> 138 dB
6.5 to 13.2 GHz			> 145 dB	> 135 dB
13.2 to 22.0 GHz			> 140 dB	> 130 dB
22.0 to 26.5 GHz			> 139 dB	> 129 dB
Signal to Distortion				
10 MHz to 2.9 GHz	> 88.5 dB	> 83.5 dB	> 88.5 dB	> 83.5 dB
2.9 to 4.0 GHz	> 98.5 dB†	> 93.5 dB†	> 111.5 dB	> 106.5 dB
4.0 to 6.5 GHz	> 98.5 dB†	> 93.5 dB†	> 114.5 dB	> 109.5 dB
Intermodulation				
10 MHz to 2.9 GHz	> 102.7 dB	> 96 dB	> 102.7 dB	> 96 dB
2.9 to 6.5 GHz	> 106.7 dB†	> 100 dB†	> 108.7 dB	> 102 dB

Spurious Responses

General spurious responses (mixer level −40 dBm)

HP 8560E, 8561E: < −75 dBc

HP 8563E: <(−75 + 20 log N) dBc

Second harmonic distortion

30 Hz to 1.45 GHz, mixer level −40 dBm

HP 8560E, 8561E: < −72 dBc

HP 8563E: < −70 dBc

1.45 to 3.25 GHz, mixer level −20 dBm

HP 8561E: < −72 dBc

1.45 to 2.0 GHz, mixer level −10 dBm

HP 8563E: < −85 dBc

2.0 to 13.25 GHz, mixer level −10 dBm

HP 8563E: < −100 dBc

Third-order intermod. distortion (two −30 dBm signals at mixer)

1 MHz to 2.9 GHz: < −78 dBc

2.9 to 6.5 GHz

HP 8561E and HP 8563E: < −90 dBc

6.5 to 26.5 GHz

HP 8563E: < −75 dBc

Images, multiples, out of band responses: < −80 dBc

Residual Responses: > 200 kHz, < −90 dBm

Display Range

Scale calibration: 10 × 10 divisions

Log scale: 10, 5, 2, 1 dB per division

Linear scale: 10% of ref level per division

Reference Level Range: log = −120 to +30 dBm in 0.1 dB steps; linear = 2.2 μV to 7.07 V in 1% steps

Frequency Response, Relative (dc-coupled, 10 dB input atten)

HP 8560E: ±1.0 dB, 30 Hz to 2.9 GHz

HP 8561E: ±1.0 dB, 30 Hz to 2.9 GHz; 1.5 dB, 2.9 to 6.5 GHz

HP 8563E: ±1.25 dB, 30 Hz to 2.9 GHz; ±1.5 dB, 2.9 to 6.5 GHz; ±2.2 dB, 6.5 to 13.2 GHz; ±2.5 dB, 13.2 to 22 GHz; ±3.3 dB, 22 to 26.5 GHz; ±3.5 dB, 30 Hz to 26.5 GHz

Calibrator Output: 300 MHz × (1 ± freq ref acc'y), −10 dBm ±0.3 dB

Input Attenuator

Switching uncertainty (ref to 10 dB; 30 kHz to 2.9 GHz, 20 to 70 dB settings): ±0.6 dB/10 dB step; ±1.8 dB max

Repeatability: ± 0.1 dB (nominal)

IF Gain Uncertainty (10 dB atten, 0 dBm to −80 dBm ref level): ±1 dB

Resolution Bandwidth Switching Uncertainty: ±0.5 dB

Display Scale Fidelity

Log (±0.1 dB/dB, 0 to −90 dB range): ±0.85 dB max

RBW ≥ 300 Hz: ±2.5 dB max over 0 to −100 dB range

RBW ≤ 100 Hz: ±1.5 dB max over 0 to −100 dB range

Linear: ±3% of reference level

† HP 8561E only.

SIGNAL ANALYZERS

Spectrum Analyzers, High-Performance Portable (cont'd)

HP 8560 E-Series

Pulse Digitization Uncertainty (pulse response mode, PRF > 720/sweep time)

	Log	Linear
RBW ≤ 1 MHz	< 1.25 dB p-p	< 4% of ref level
RBW = 2 MHz	< 3 dB p-p	< 12% of ref level

Time-Gated Spectrum Analysis

Gate Delay	Edge Mode	Level Mode
Range:	3 μs to 65.535 ms	≤0.5 μs
Resolution:	1 μs	

Accuracy: (from gate trigger input to positive edge of gate output): ±(1 μs + (0.05% × gate delay setting))

Gate Length
Range: 1 μs to 65.535 ms
Resolution: 1 μs
Accuracy (from positive edge to negative edge of gate output): ±(0.2 μs + (0.05% × gate length setting))

Delayed Sweep

Trigger Modes: Free run, line, external, video
Range: 2 μs to 65.535 ms
Resolution: 1 μs
Accuracy: ±(1 μs + (0.05% × delay sweep setting))

Demodulation (Spectrum)

Modulation Type: AM and FM
Audio Output: Speaker and phone jack with volume control

Inputs and Outputs (All values nominal)

Front-Panel Connectors
RF input (type N female, 50 Ω; HP 8563E Opt 026, APC 3.5 male)
VSWR (≥ 10 dB atten): < 1.5:1, < 2.9 GHz; < 2.3:1, > 2.9 GHz
LO emission level (avg with 10 dB atten): < 80 dBm
Second IF input (SMA female, 50 Ω)
Frequency: 310.7 MHz
Full screen level: −30 dBm
Gain compression: −20 dBm
First LO output (SMA female, 50 Ω)
Frequency: 3.000 to 6.8107 GHz
Amplitude: +16.5 dBm ± 2.0 dB; +14.5 dBm ± 3.0 dB (Opt 002)
Cal output: BNC female, 50 Ω
Probe power: +15 Vdc, −12.6 Vdc, and Gnd (150 mA max each)

Rear Panel Connectors
10 MHz reference in/out (shared BNC female, 50 Ω)
Output freq accuracy: 10 MHz ±(10 MHz × freq ref acc'y)
Output amplitude: 0 dBm
Input amplitude: +2 to −10 dBm
Video output (BNC, 50 Ω)
Amplitude (RBW ≥ 300 Hz): 0 to +1 V full scale
LO sweep/0.5 V per GHz output (shared BNC female, 2 kΩ)
Amplitude (LO sweep): 0 to 10 V, no load
Blanking/gate output: Shared BNC female 50 Ω TTL output
External/gate trigger input (shared BNC female, > 10 kΩ): settable to high TTL or low TTL
HP-IB (IEEE-488 bus connector)
Interface functions: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT0, C1, C28, E1
Direct printer output: HP 3630A PaintJet printer, HP 2225A ThinkJet printer
Direct plotter output: HP 7225A/7440A/7470A/7475A/7550B

General Specifications

Environmental
Military specs: Meets MIL-T-28800, Type III, Class 3, Style C
Calibration interval: 2 years
Warmup time: 5 min in ambient conditions
Temperature: −10° to +55° C (operating); −51° to +71° C (not operating)
Humidity: 95% @ 40° C for 5 days
Rain resistance: Drip-proof at 16 l/h/ft²
Altitude: 15,000 ft (operating); 50,000 ft (not operating)
Vibration
5 to 15 Hz: 0.060 in p-p excursion
15 to 25 Hz: 0.040 in p-p excursion
25 to 55 Hz: 0.020 in p-p excursion
Pulse shock (half sine): 30 g for 11 ms duration
Transit drop: 8-in drop on 6 faces and 8 corners
Electromagnetic compatibility: Conducted and radiated interference in compliance with CISPR Pub. 11 (1990). Meets MIL-STD-461C, part 4, with the following exceptions:
Conducted emissions: CE01 (narrowband), 1 to 15 kHz only. CE03 (narrowband), full limits. CE03 (broadband), 20 dB relaxation from 15 to 100 kHz.
Conducted susceptibility: CS01, full limits. CS02, full limits with 40 dB relaxation at IF frequencies. CS06, full limits.
Radiated emissions: RE01, test probe at 15 cm, front and rear panel search excluded. RE02, full limits < 1 GHz.
Radiated susceptibility: RS01, full limits. RS03, limited to 1 V/m from 14 kHz to 1 GHz with 40 dB relaxation at IF frequencies.
Power Requirements
115 Vac operation: 90 to 140 V rms, 3.2 A rms max, 47 to 440 Hz
230 Vac operation: 180 to 250 V rms, 1.8 A rms max, 47 to 66 Hz
Maximum Power Dissipation: 180 W
Audible Noise (nominal): < 5.0 Bels power at room temp (ISO DP7779)
Weight (carrying, nominal): 20 kg (44 lb)
Size (without handle, feet, or cover): 325 mm W × 163 mm H × 427 mm D

Option 002 Built-In Tracking Generator (HP 8560E only)

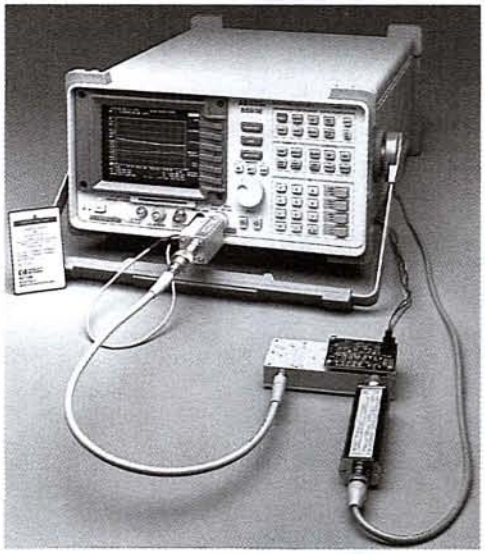
Frequency
Range: 300 kHz to 2.9 GHz
Accuracy (after peaking): ±(freq ref accy × tuned freq + 5% × span + 295 Hz)
Tracking drift (nominal): Usable in 1 kHz RBW after 5-min warm-up; usable in 300 Hz RBW after 30-min warmup
Minimum RBW: 300 Hz
Amplitude
Output level: −10 to +1 dBm; −10 to +2.8 dBm, typical
Resolution: 0.1 dB
Accuracy
Vernier: ±0.20 dB/dB, ±0.5 max (25° ±10° C)
Absolute: ±0.75 dB
Level flatness: ±2.0 dB
Dynamic range: 96 dB at 300 kHz to 1 MHz; 116 dB at 1 MHz to 2.7 GHz; 111 dB at 2.7 to 2.9 GHz
Power sweep: 10 dB range, 0.1 dB resolution
Inputs/outputs
RF output (front panel): type N female, 50 Ω (nominal)
Ext ALC input (rear panel): BNC female; use with negative detector

Ordering Information

	Price
HP 8560E Spectrum Analyzer (30 Hz to 2.9 GHz)	$26,000
HP 8561E Spectrum Analyzer (30 Hz to 6.5 GHz)	$31,000
HP 8563E Spectrum Analyzer (9 kHz to 26.5 GHz)	$36,000
Opt 001 Second IF Output	+$850
Opt 002 Built-In Tracking Generator (HP 8560E)	+$6,500
Opt 005 Alternate Sweep Out (cannot be used with Opt 002)	$0
Opt 006 30 Hz Frequency Coverage (HP 8563E)	+$1,000
Opt 007 Digitized Fast Time Domain Sweeps	Contact HP
Opt 026 APC 3.5 mm Input Connector (HP 8563E)	+$750
Opt 042 Protective Soft Carrying Case/Backpack	+$250
Opt 103 Delete Precision Frequency Reference	−$1,000
Opt 104 Delete Mass Memory Module	−$1,000
Opt 908 Rack Mount Kit Without Handles	+$415
Opt 909 Rack Mount Kit With Handles	+$465
Opt 910 Extra Manual Set	+$190
Opt 915 Service Guide	+$495
Opt 916 Extra Quick Reference Guide (English)	+$25
Opt W30 Three Years Return-to-HP Service	Price varies
Opt W32 Three Years Return-to-HP Calibration	Price varies
Opt W50 Five Years Return-to-HP Service	Price varies
Opt W52 Five Years Return-to-HP Calibration	Price varies
HP 41800A Active Probe (5 Hz to 500 MHz)	$1,740
HP 85024A High Frequency Probe (300 kHz to 3 GHz)	$2,500
HP 85640A Tracking Generator (300 kHz to 2.9 GHz)	$8,300
HP 85644A Tracking Source (300 kHz to 6.5 GHz)	$18,630
HP 85645A Tracking Source (300 kHz to 26.5 GHz)	$31,000
HP 85700A 32 KB RAM Memory Card	$105
HP 85702A 128 KB RAM Memory Card	$175
HP 85710A Digital Radio Measurement Personality	$950
HP 85901A Portable ac Power Source	$1,290

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

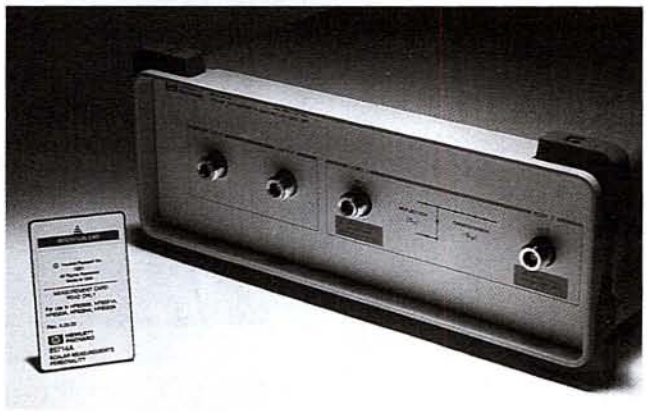
- New noise-figure measurement personality
- High-performance tracking sources



HP 85719A

NEW

- Scalar measurement personality
- Scalar test set for transmission/reflection measurements



HP 85630A and HP 85714A

Accessories for Noise-Figure Measurements

The new HP 85719A noise-figure measurement personality adds unique capability to an HP 8590 E Series spectrum analyzer with Option 119 noise-figure card. Combined with the HP 346B noise source and HP 87405A preamplifier, the measurement personality and spectrum analyzer provide displayed swept noise-figure and gain measurements from 10 MHz to 2.9 GHz. Features include one-point measurement capability for quick results, noise-figure and spectrum analyzer mode-switching for stray signal detection, selectable measurement bandwidths to directly measure narrowband devices, and a repeatability calculator to determine measurement time and repeatability tradeoffs.

The noise-figure personality makes use of many features found in the spectrum analyzer. For example, the save/recall functions and the memory-card reader are used to store measurement data, states, displays, and ENR data tables. Marker functions make it easy to read noise-figure and gain measurements for the entire sweep, and a menu-driven interface makes the entire system easy to use.

Accessories for Scalar Network Analysis

A variety of accessories are designed to enhance HP spectrum analyzers by adding scalar measurement capability. These powerful solutions allow you to meet both your scalar-network analysis and spectrum analysis needs.

HP 85644A and HP 85645A Tracking Sources

Two tracking sources add high-performance scalar-network analysis capability to HP spectrum analyzers. The HP 85644A has a frequency range of 300 kHz to 6.5 GHz; the HP 85645A, 300 kHz to 26.5 GHz. Both have leveled output power of up to 10 dBm and up to 140 dB of dynamic range. They are housed in a portable, rugged package for bench and field use; a System II cabinet is also available.

Because these sources can track many hosts, including spectrum analyzers and sweepers, they are suited to a number of applications. High dynamic range allows you to measure components and subsystems with the most demanding specifications. Synthesized offset tracking, typically greater than 1 GHz, lets you characterize frequency translation devices. Measure TOI faster than ever, with no gaps in frequency, using two tracking sources to make the measurement in a swept mode. For EMC testing, use the tracking sources for shield effectiveness and susceptibility measurements.

To generate continuous-wave signals, use an HP 85644A or HP 8565A as a portable, standalone source with frequency accuracy typically better than ±5 MHz. Synthesized frequency is obtained by locking the source to the LO of an HP spectrum analyzer.

The tracking sources are compatible with the following spectrum analyzers: HP 8566A/B, HP 8560 Series, HP 71209A, and HP 8593E, 8595E, and 8596E with Option 009. The tracking sources are compatible with the following sweepers: HP 8340A/B, HP 8341B, and HP 8350 Series RF plug-ins.

HP 85640A Portable Tracking Generator

This portable tracking generator provides the HP 8560 Series spectrum analyzers with scalar measurement capability from 300 kHz to 2.9 GHz. See page 251.

HP 85714A Scalar Measurement Personality
HP 85630A Scalar Transmission/Reflection Test Set

The HP 85714A is a downloadable program that enhances an HP 8590 Series spectrum analyzer and tracking generator for transmission measurements. With the addition of the HP 85630A scalar test set, it provides the user interface for a powerful yet economical transmission/reflection measurement system.

The scalar measurement personality adds a number of useful features to the scalar/spectrum analyzer system. These include guided OPEN/SHORT and THRU calibration, pass/fail limit line testing, an enhanced 120 dB display for high-dynamic-range measurements, a tabular display format, and one-button measurements for 3 or 6 dB bandwidth, insertion loss/gain, shape factor, Q, and center frequency measurements.

The scalar test set allows you to view transmission and reflection data simultaneously on the screen, so you can make adjustments on a device under test while monitoring the results. You can also make calibrated transmission and reflection measurements on a device using a single setup, without the usual need to recalibrate and reconfigure as with spectrum-analyzer–based systems.

Other capabilities provided by the test set include a reflection coefficient measurement marker, VSWR measurement markers, return loss measurement, automatic switching between transmission and reflection mode, and source attenuation.

Ordering Information	Price
HP 85630A Scalar Transmission/Reflection Measurement Test Set	$5,150
HP 85640A Portable Tracking Generator	$8,300
HP 85644A Tracking Source	$18,630
HP 85645A Tracking Source	$31,000
HP 85714A Scalar Measurement Personality	$985
HP 85719A Noise Figure Measurement Personality	$1,650
HP 8590 E Series Spectrum Analyzers	
Opt 119 Noise Figure Card	$1,650

SIGNAL ANALYZERS

Spectrum Analyzers, Bench, 100 Hz to 22 GHz

HP 8566B, 8567A, 8568B

- 100 Hz to 22 GHz coverage with synthesizer accuracy
- 10 kHz to 1.5 GHz coverage at a lower price
- 100 Hz to 1.5 GHz coverage with counter accuracy
- 2 to 22 GHz preselected range
- Trace markers with amplitude and frequency readout
- 16 KB of user RAM for trace data or custom routines

HP 8566B
with Turbo Option

Hewlett-Packard Instrument Drivers

DESIGNED FOR HP-IB SYSTEMS

HP 8566B, 8567A, 8568B Spectrum Analyzers

The HP 8566B, 8567A, and 8568B are high-performance spectrum analyzers for bench and ATE system use. The HP 8566B has the highest performance of the three, with a frequency range from 100 Hz to 22 GHz that can be extended to 325 GHz using external mixers. The HP 8567A and 8568B are RF spectrum analyzers with frequency coverage to 1500 MHz. See pages 247 and 248 for specification summaries on all analyzers.

Each analyzer is designed around its own internal bus and controlled by its own microcomputer to yield significant improvements in operational and data processing features as well as flexibility under computer control. Each analyzer has 16 KB of user RAM for storing trace data, instrument states, or custom downloadable programs (DLPs).

New HP 8566B Turbo Option

Increase the measurement speed of your HP 8566B spectrum analyzer. A new turbo option (Option 002) nearly doubles the analyzer's processing rate, so your measurements can be made up to 50 percent faster, with 25 percent improvement typical. If you already own an HP 8566B, a turbo retrofit kit is available as Option R02.

Performance

The exceptional frequency stability of both the HP 8566B and the HP 8568B makes it possible to make measurements with a 10 Hz resolution bandwidth. This narrow resolution bandwidth yields sensitivities to −135 dBm in both instruments. Excellent frequency stability, sensitivity, and frequency-reference accuracy combine to allow very accurate measurement of small signals in the presence of large ones.

For applications that don't require the high performance of the HP 8568B, the HP 8567A offers the same speed, versatility, and automatic operation capability at a lower price. Resolution bandwidths as narrow as 1 kHz yield sensitivities as low as −115 dBm.

Flexibility

These spectrum analyzers fit into many applications, such as EMC testing (see page 252), broadband signal surveillance, and component stimulus-response testing. The HP 8444A Option 059 tracking generator adds stimulus-response capabilities to the RF models for a minimal cost. The HP 85644A and 85645A tracking sources add 6.5 GHz and 22 GHz high-performance scalar capability to the HP 8566B (see page 245). Preselected external mixers simplify millimeter-wave measurements from 26.5 to 75 GHz (see page 250).

Usability

The instrument control settings are conveniently shown on the CRT for easy reference. Functions are activated by pressing a front-panel key, then selecting the function value using the knob, step keys, or numeric keyboard. To maintain a calibrated display, certain functions are automatically coupled in the analyzer. For example, resolution bandwidth, video bandwidth, and sweep time are automatically adjusted by the instrument when the frequency span is reduced.

Up to four tunable display markers are available to aid in measuring and analyzing signals. Two markers can be used to make relative measurements by displaying their amplitude and frequency differences. Marker information allows you to step between evenly spaced portions of a spectral display (such as signal harmonics) or "zoom in" on a selected portion of the spectrum. Analyzer control settings can be saved in the non-volatile memory of the analyzer.

Versatile CRT Display and Plotting Capabilities

All displayed information resides in the analyzer's digital memory, which refreshes the CRT at a flicker-free rate. Multiple traces can be displayed to measure residual FM or drift, or to conduct real-time surveillance over a wide frequency range.

By adding an HP-IB plotter, hard copy of all information on the display of the analyzer can be made for analysis, documentation, or presentation. Plots can be produced directly or with the aid of a controller.

Custom Softkey Programming

You can create complex measurement routines on an external controller, store the programs in user RAM, and execute them using a single custom softkey.

Simple measurement routines can be entered from the instrument front panel, stored in user RAM, and executed using a single custom softkey.

Specification Summary

Frequency	HP 8568B	HP 8567A
Frequency Range	100 Hz to 1500 MHz (dc-coupled) 100 kHz to 1500 MHz (ac-coupled)	10 kHz to 1500 MHz
Frequency Span	100 Hz to 1500 MHz + zero span	100 Hz to 1500 MHz + zero span
Frequency Reference Accuracy		
Aging Rate	$<2.5 \times 10^{-7}$/year	$<5 \times 10^{-6}$/year
Temperature Stability	$<7 \times 10^{-9}$ (0° to 55° C)	$<1 \times 10^{-5}$ (5° to 55° C)
Resolution Bandwidth (−3 dB)	10 Hz to 3 MHz in 1,3,10 sequence	1 kHz to 3 MHz in 1,3,10 sequence
Video Bandwidth	1 Hz to 3 MHz in 1,3,10 sequence	1 Hz to 3 MHz in 1,3,10 sequence
Residual FM (peak-to-peak, <100 kHz span)	<3 Hz (res BW ≤30 Hz)	<100 Hz (res BW 1 kHz)
Drift (per minute of sweeptime, after 1-hour warmup)	<10 Hz (freq span ≤100 kHz)	<100 Hz (freq span ≤100 kHz)
Phase Noise (30 kHz offset)	−107 dBc	−105 dBc
Amplitude		
Amplitude Range	−135 to +30 dBm	−115 to +30 dBm
Log Display Range	1, 2, 5, or 10 dB/div for 10, 20, 50, or 90 dB display	1, 2, 5, or 10 dB/div for 10, 20, 50, or 90 dB display
Scale Fidelity—incremental	±0.1 dB/dB; 0 to 90 dB	±0.1 dB/dB; 0 to 80 dB
Cumulative (20° to 30° C)	≤±1.0 dB; 0 to 80 dB ≤±1.5 dB: 0 to 90 dB	≤±1.0 dB; 0 to 80 dB ≤±1.5 dB; 0 to 90 dB
Calibrator Uncertainty	±0.3 dB	±0.3 dB
Frequency Response (input atten ≥10 dB)	±1.5 dB, 100 Hz to 1500 MHz/±1 dB, 100 kHz to 1500 MHz	±1 dB, 10 kHz to 1500 MHz
Spurious Responses (< −40 dBm at mixer)	< −70 dBc (<10 MHz input sig) < −75 dBc (>10 MHz input sig)	< −70 dBc
Second Harmonic Distortion (−30 dBm at mixer)	< −70 dBc (sig ≥10 MHz) < −60 dBc (sig <10 MHz)	< −70 dBc (sig ≥10 MHz) < −60 dBc (sig <10 MHz)
Third Order Intercept (TOI)	+10 dBm (sig >10 MHz)	+10 dBm (sig >10 MHz)
Residual Responses (0 dB attn, no input signal)	< −105 dBm	< −100 dBm
Gain Compression (≤ −10 dBm at mixer)	<0.5 dB	<1.0 dB
Displayed Average Noise Level (0 dB attn, 1 Hz Video BW)	< −112 dBm, 500 Hz to 1 MHz (10 Hz res BW) < −135 dBm, >1 MHz (10 Hz res BW)	< −92 dBm, 50 kHz to 1 MHz (1 kHz res BW) < −115 dBm, >1 MHz (1 kHz res BW)
Sweep Time: Zero Span	1 μs to 1500 s	1 μs to 1500 s
Swept	20 ms to 1500 s	20 ms to 1500 s

General Specifications
(apply to both HP 8568B and 8567A unless noted)

Environmental

Temperature: Operation: 8568B, 0° to 55° C; 8567A, 5° to 55° C; Storage: −40° to +75° C

EMI: Conducted and radiated interference is within the requirements of MIL-STD461B, CE03/part 2 and RE02/part 7, and the requirements of CISPR Pub. 11 and FTZ 526/1979

Power Requirements: 100, 120, 220, or 240 Vac (+5%, −10%), 50 to 60 Hz or 400 Hz with Opt 400

Warmup Time

Operation: 30 min from cold start

Frequency Reference

HP 8568B: Freq. within 1×10^{-8} of final stable freq within 30 min

HP 8567A: Freq. within 5×10^{-5} of final stable freq within 30 min

Size (w/out handles): 425.5 mm W × 279.4 mm H × 558.8 mm D (16.75 in × 11 in × 22 in)

Weight: Net, 45 kg (100 lb)

Inputs

RF in (Type N), RF in (BNC, 8568B only), ext freq ref in, ext sweep trig in

Quasi-Peak: Video in, IF in

Outputs

Cal out, display X, Y, and Z out, horiz sweep out, video out, penlift out, 21.4 MHz IF, 1st LO, freq ref, probe power out (HP 8568B only)

Quasi-Peak: Video out, IF out

Ordering Information

	Price
HP 8568B Spectrum Analyzer	$40,000
HP 8567A Spectrum Analyzer	$30,715
Opt 001 75 Ω (BNC) RF input	+$210
Opt 016 Installed EMI Receiver Functions	+$265
Opt 044 Add HP 8444A Opt 059 Tracking Generator (HP 8567A only)	+$7,600
Opt W30 Three-Year Customer Return Repair (see page 636)	
HP 8568B	+$1,060
HP 8567A	+$670
Opt W32 Three-Year Customer Return Calibration (see page 636)	
HP 8568B	+$2,125
HP 8567A	+$2,035
Opt W50 Five-Year Customer Return Repair	
HP 8568B	$2,120
HP 8567A	$1,340
Opt 400 400 Hz Power Line Frequency Operation	
HP 8568B	+$425
HP 8567A	+$740
Opt 010 Rack Mount Slide Kit	+$475
Opt 908 Rack Flange Kit (instrument w/out handles)	
HP 8568B	+$70
HP 8567A	+$70
Opt 913 Rack Flange Kit (instrument w/handles)	
HP 8568B	+$170
HP 8567A	+$170
Opt 910 Add Extra Set of User's Manuals	+$365
Opt 915 Add Service Manuals	
HP 8568B	+$825
HP 8567A	+$825
Opt 462 Impulse Bandwidths for EMI Measurements (HP 8568B only)	+$2,110
Opt 031 HP 8568B German Operating Manual	$0
Opt 080 HP 8568B Information Card in Japanese	$0
Opt 081 HP 8568B Information Card in French	$0

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

SIGNAL ANALYZERS

Spectrum Analyzer, Bench, 100 Hz to 22 GHz

HP 8566B

HP 8566B Specification Summary

Frequency

Frequency Range: 100 Hz to 22 GHz with internal mixer; extendable to 110 GHz with HP 11970 external mixers, to 75 GHz with HP 11974 series preselected mixers, and to 325 GHz with mixers from other suppliers

Frequency Span: 0 Hz, 100 Hz to 22 GHz, variable in approximately 1% increments

Frequency Reference Error: Aging rate, $<1 \times 10^{-9}$/day, $<2.5 \times 10^{-7}$/year

Temperature Stability: $<7 \times 10^{-9}$, 0° to 55 ° C

Resolution Bandwidth: 3 dB bandwidths of 10 Hz to 3 MHz in a 1, 3, 10 sequence

Bandwidth Selectivity, 60 dB/3 dB ratio: <12:1, 30 Hz to 1 kHz; <13:1, 3 kHz to 30 kHz; <15:1, 100 kHz to 3 MHz

Bandwidth Shape: synchronously tuned, 4- or 5-pole filters, approximately Gaussian shape

Video Bandwidth: 1 Hz to 3 MHz in a 1, 3, 10 sequence

Residual FM (typical peak-to-peak, fundamental mixing mode): <50 kHz peak-to-peak, frequency span >5 MHz

Drift (typical, after 1-hour warmup at stabilized temperature): <10 Hz/min of sweep time, frequency span ≤ 100 kHz; <500 Hz/min of sweep time, frequency span 100 kHz to 5 MHz; <5 kHz/min of sweep time, frequency span ≥ 5 MHz

Spectral Purity

Noise Sidebands (center frequency 100 Hz to 5.8 GHz): 320 Hz offset, <-80 dBc/Hz; 1 kHz offset, <-85 dBc/Hz; 10 kHz offset, <-90 dBc/Hz; 100 kHz offset, <-105 dBc/Hz

Amplitude

Amplitude Range (dBm): −134 to +30, 1 MHz to 2.5 GHz; −132 to +30, 2 to 5.8 GHz; −125 to +30, 5.8 to 12.5 GHz; −119 to +30, 12.5 to 18.6 GHz; −114 to +30, 18.6 to 22 GHz

Log Display Range: 1, 2, 5, or 10 dB/division for 10, 20, 50, or 90 dB displays, respectively

Scale Fidelity: ±0.1 dB/dB over 0 to 80 dB display (20° to 30° C); ±1.0 dB max over 0 to 80 dB display; ±1.5 dB max over 0 to 90 dB display

Calibrator Uncertainty: ±0.3 dB

Frequency Response (10 dB input atten): 100 Hz to 2.5 GHz, ±0.6 dB; 2 to 12.5 GHz, ±1.7 dB; 12.5 to 20 GHz, ±2.2 dB; 20 to 22 GHz, ±3.0 dB, res BW ≥ 30 Hz

Dynamic Range

- **Spurious responses:** <-70 dBc for mixer levels ≤ −40 dBm
- **Second harmonic distortion**
  - **Unpreselected, mixer levels ≤ −40 dBm:** <-70 dBc, 100 Hz to 2.5 GHz; <-80 dBc, 50 to 700 MHz
  - **Preselected, mixer levels ≤ −10 dBm:** <-100 dBc, 2 to 22 GHz
- **Third order intercept (TOI):** > +5 dBm, 100 Hz to 5 MHz; > +7 dBm, 5 MHz to 5.8 GHz; > +5 dBm, 5.8 to 18.6 GHz
- **Image responses:** <-70 dBc, 2 GHz to 18.6 GHz; <-60 dBc, 18.6 to 20 GHz; <-50 dBc, 20 to 22 GHz
- **Multiple responses:** <-70 dBc, 2 GHz to 22 GHz
- **Out-of-band responses:** <-60 dBc, 2 to 22 GHz (tuned freq.)
- **Residual responses** (0 dB input atten, no input signal): <-100 dBm, 100 Hz to 5.8 GHz; <-95 dBm, 5.8 to 12.5 GHz; <-85 dBm, 12.5 to 18.6 GHz; <-80 dBm, 18.6 to 22 GHz
- **Gain compression** (≤ −5 dBm at mixer): <1.0 dB, 100 Hz to 22 GHz
- **Displayed average noise level** (0 dB input atten, 10 Hz res BW)
  - **Unpreselected:** <-95 dBm, 100 Hz to 50 kHz; <-112 dBm, 50 kHz to 1 MHz; <-134 dBm, 1 MHz to 2.5 GHz
  - **Preselected:** <-132 dBm, 2 to 5.8 GHz; <-125, 5.8 to 12.5 GHz; <-119 dBm, 12.5 to 18.6 GHz; <-114 dBm, 18.6 to 22 GHz

Sweep Time

Zero Span: 1 μs to 1500 s

Swept: 20 ms to 1500 s

Accuracy: ±10% ≤ 200 s sweep times; ±30% > 200 s sweep times

Trigger: Free run, line, video, external, continuous, and single

General Specifications

Environmental

Temperature: Operation, 0° to 55° C; storage, −40 to +75 °C

Humidity: Operation type-tested to 95% RH, 25° to 40° C

EMI: Conducted and radiated interference is within the requirements of MIL-STD-461C, Part 7, REO2 and CEO3 (Air Force), and the requirements of CISPR Pub. 11, FTZ 526/527/79, VDE 0871

Power Requirements: 100, 120, 220, or 240 Vac (+5%, −10%), 50 to 60 Hz or 400 Hz with Opt 400

Warmup Time Operation: 30 min from cold start (0° to 55° C)

Frequency reference: Frequency within 1×10^{-8} of final stable frequency within 30 min

Size (w/out handles): 425.5 mm W × 279.4 mm H × 598.5 mm D (16.75 in × 11 in × 23.56 in)

Weight: Net, 50 kg (112 lb)

Inputs

RF in (Type N), ext freq ref in, ext sweep trig in

Quasi-Peak: Video in, IF in

Outputs

Cal out, 1st LO out, IF out, sweep + tune out, display X, Y, Z out, horiz sweep out, video out, penlift out, 21.4 MHz IF out, freq ref, 10 MHz

Quasi-Peak: Video out, IF out

Ordering Information

	Price
HP 8566B Spectrum Analyzer	$66,750
Opt 002 Turbo Option	$2,500
Opt R02 Turbo Retrofit Kit	$3,105
Opt 016 Installed EMI Receiver Functions	+$265
Opt 400 400 Hz Power-Line Frequency Operation	+$425
Opt W30 Three-Year Customer Return Repair (see page 636)	$1,730
Opt W32 Three-Year Customer Return Calibration (see page 636)	$2,875
Opt W50 Five-Year Customer Return Repair (see page 636)	$3,460
Opt W52 Five-Year Customer Return Calibration (see page 636)	$5,175
Opt 462 Impulse Bandwidths for EMI Measurements	+$2,110
Opt 010 Rack Mount Slide Kit	+$475
Opt 908 Rack Flange Kit (instrument w/out handles)	+$65
Opt 913 Rack Flange Kit (instrument w/handles)	+$170
Opt 910 Add Extra Set of User's Manuals	+$365
Opt 915 Add Service Manuals	+$825
Opt 031 German Operating Manual	$0
Opt 080 Information Card in Japanese	$0
Opt 081 Information Card in French	$0
Opt 1BN MIL-STD 45622A Calibration Certification	$200
Opt 1BP MIL-STD 45622A Calibration Certification With Test Data	$500
HP 8566AB Retrofit Kit to Convert HP 8566A to HP 8566B	$3,900

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Highest performance (100 Hz to 40 GHz)
- Automated, reconfigurable systems
- HP 8566B code compatibility

HP 71209A

DESIGNED FOR HP-IB SYSTEMS

HP 70000 Series Spectrum Analyzers

The HP 70000 Series spectrum analyzers are part of HP's growing modular measurement system (MMS) family. Four factory-configured spectrum analyzers combine high performance, ease of use, and the benefits of modularity for RF and microwave applications:

- HP 71100C RF spectrum analyzer, 100 Hz to 2.9 GHz
- HP 71200C microwave spectrum analyzer, 50 kHz to 22 GHz, with optional preselection
- HP 71209A microwave spectrum analyzer, 100 Hz to 26.5 GHz, with an outstanding set of performance features
- HP 71210C microwave spectrum analyzer, 100 Hz to 22 GHz, with ultimate sensitivity and a dynamic tracking preselector

Measurement capabilities can be extended to 325 GHz using external mixers. The HP 71209A has a built-in external mixer interface, and the HP 70907B external mixer interface module adds millimeter capability. Preselected coverage is available to 75 GHz with HP 11974 Series mixers, and unpreselected coverage to 110 GHz with HP 11970 Series harmonic mixers. See page 250.

All four spectrum analyzers feature a color display with color editor, a custom hardkey panel with the most commonly used spectrum-analyzer functions, downloadable programming capability, and a memory card reader. You can copy data directly to a printer, plotter, or external disk or store data internally. Compatible MMS modules add other capabilities to the systems, including scalar analysis, CW phase, power-meter measurements, and waveform analysis. You can also build custom modules. See page 88 for selected details on the HP 70000 system and products.

HP 71209A Microwave Spectrum Analyzer

The HP 71209A is the MMS standard for microwave spectrum analysis, offering exceptional performance for a lower price. Special features include a built-in mixer interface for completely preselected coverage from 100 Hz to 75 GHz (using HP 11974 Series mixers), programming code compatibility with the HP 8566B spectrum analyzer, similar performance to that of the HP 71210C, an IF output with AGC, a 5-dB step attenuator, a built-in baseband limiter, and compatibility with the new HP 85644A and 85645A tracking sources.

New 40 GHz Spectrum Analyzer

The new HP 71209A Option Z40 extends frequency coverage to 40 GHz. It has all the capabilities of a standard HP 71209A spectrum analyzer, plus the following measurement features:

- 100 Hz to 40 GHz frequency range, continuous sweep
- Single 2.4 mm input connector
- Calibrated amplitude measurement over entire frequency range
- RF preselection from 2.7 to 40 GHz

Free MMS Catalog

A complete list of all MMS products with full descriptions, specifications, and services is available. For a free copy of the new *HP 70000 Modular Measurement System* catalog, contact your local HP sales office listed on page 665. Ask for HP p/n 5091-4897E.

Ordering Information	Price
HP 71100C Spectrum Analyzer, 100 Hz to 2.9 GHz	$49,000
HP 71200C Spectrum Analyzer, 50 kHz to 22 GHz (not preselected)	$55,400
Opt 002 Preselection to 22 GHz	+$8,870
HP 71209A Spectrum Analyzer, 100 Hz to 26.5 GHz	$67,700
Opt Z40 Spectrum Analyzer, 100 Hz to 40 GHz	+$22,150
HP 71210C Spectrum Analyzer, 100 Hz to 22 GHz	$86,000

HP 70000 Series Spectrum Analyzer Specification Summary

	HP 71100C	HP 71200C (without preselection)	HP 71200C (with preselection)	HP 71209A	HP 71210C
Frequency range (tunable in 1-Hz increments)	100 Hz to 2.9 GHz (dc-coupled) 100 kHz to 2.9 GHz (ac-coupled)	50 kHz to 22 GHz	50 kHz to 22 GHz/ 50 kHz to 26.5 GHz	100 Hz to 26.5 GHz (100 Hz to 40 GHz Opt Z40)	100 Hz to 22 GHz
With external mixers	75 GHz with HP 11974 preselected mixers; 110 GHz with HP 11970 harmonic mixers; 325 GHz with other mixers				
Resolution bandwidth range	10 Hz to 300 kHz; 3 MHz option			10 Hz to 3 MHz	
Phase noise	−108 dBc/Hz at 10 kHz offset	−108 dBc/Hz at 10 kHz offset, to 6.2 GHz			
Optimum dynamic range (2nd/3rd order)	82 dB/92 dB	70 dB/88 dB	84 dB/91 dB	99 dB/96 dB	96 dB/98 dB
Amplitude accuracy (relative frequency + lesser of scale fidelity or IF gain accuracy)	±2 dB (±0.9 dB)[1]	±2 dB (±0.9 dB)[1]		±2 dB (±0.9 dB)[1]	±2.5 dB (±0.9 dB)[1]
Displayed average noise level, 10 Hz RBW at 2.9 GHz at 22 GHz at 26.5 GHz	−131 dBm	< −129 dBm < −116 dBm < −115 dBm	Bypassed / Filtered < −127 dBm / < −119 dBm < −111 dB / < −96 dBm < −109 dBm / < −95 dBm	−136 dBm −128 dBm −126 dBm	−139 dBm −133 dBm
Displayed average noise level with HP 70620 Series preamplifiers at 2.9 GHz at 22 GHz at 26.5 GHz	−156 dBm	−140 dBm −119 dBm −115 dBm		−155 dBm −148 dBm −145 dBm	−155 dBm −150 dBm

[1] ±0.9 dB transfer accuracy using the HP 70100A - H01 modular power meter.

SIGNAL ANALYZERS
Millimeter Mixers
HP 11970 Series and 11974 Series

- Preselected mixers to eliminate signal identification
- State-of-the-art technology
- Easier automated measurements
- Low conversion loss
- Individually amplitude-calibrated
- No bias or tuning adjustments
- High 100-mW safe input level

HP 11970, 11974 Series Mixers

HP 11974 Series Preselected Millimeter Mixers

Eliminate the need for signal identification at millimeter frequencies. The HP 11974 Series mixers are preselected from 26.5 to 75 GHz for faster, easier testing of millimeter devices and systems. Preselection reduces mixer overload from broadband signals and reduces radiation of local oscillator harmonics back to the device under test. Equipment operators can quickly locate true signals, and software development for automated measurements is greatly simplified.

HP 11974 Series preselected mixers are available in four bands:

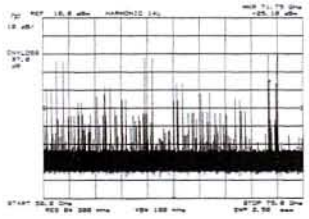
HP Model	Frequency Range (GHz)	Sensitivity[1] (displayed avg. noise level/10 Hz) (dBm)	Calibration Accuracy[1] (dB)	Image Rejection[1] (dB)	1 dB Gain Compression (dBm)
11974A	26.5 to 40	−111	< ±2.3	−54	+6
11974Q	33 to 50	−106	< ±2.3	−50	+0
11974U	40 to 60	−109	< ±2.6	−50	+0
11974V	50 to 75	−100	< ±4.5	−50	+3

[1]Specifications apply when connected to the HP 8566B or 70000 Series spectrum analyzers.

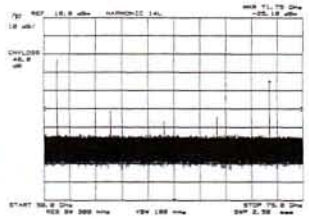
These mixers feature advanced barium-ferrite technology and come with a standalone power supply. They are particularly useful for broadband millimeter signal analysis, millimeter electromagnetic-interference (EMI) measurements, and unattended monitoring of millimeter signals.

Compatibility

Upgrade kits are available to assure the compatibility of HP 8566A/B spectrum analyzers and the HP 70907A external mixer interface module. Consult your HP sales representative to determine requirements. All HP 8560 E Series spectrum analyzers and the HP 70907B external mixer interface modules are fully compatible with the HP 11974 Series.



50 to 75 GHz Sweep Without Preselection



50 to 75 GHz Sweep Using HP 11974 Series Mixer

HP 11970 Series Harmonic Mixers

The HP 11970 Series waveguide mixers are general-purpose harmonic mixers. They employ a dual-diode design to achieve flat frequency response and low conversion loss. These are achieved without external dc bias or tuning stubs. Manual operation and computer-controlled hardware operation are simplified because mixer bias and tuning adjustment are not required.

HP 11970 Series harmonic mixers are available in six bands:

HP Model	Frequency Range (GHz)	LO Harm Number	Conversion Loss (dB)	Noise Level (dB) 1 kHz RBW	Freq[1] Response (dB)	Gain Compression (dBm)
11970K	18 to 26.5	6+	24	−105	±1.9	−3
11970A	26.5 to 40	8+	26	−102	±1.9	−5
11970Q	33 to 50	10+	28	−101	±1.9	−7
11970U	40 to 60	10+	28	−101	±1.9	−7
11970V	50 to 75	14+	40	−92	±2.1	−3
11970W	75 to 110	18+	46	−85	±3.0	−1

[1]Frequency of the mixers is reduced by 1 dB for LO range of 14 to 18 dBm.

Compatibility

The HP 11970 Series mixers extend the frequency range of the HP 8560 E Series portable spectrum analyzers; of the HP 8566B spectrum analyzer (used with the HP 11975A amplifier); and of the HP 70000 modular measurement system (used with the HP 70907A/B external mixer interface modules).

HP 11970 and 11974 Series Specifications

IF Range: dc to 1.3 GHz
LO Amplitude Range: +14 to +16 dB; +16 optimum
Calibration Accuracy: +2 dB for HP 11970 Series with optimum LO amplitude
Typical RF Input SWR: <2.2:1, <3.0:1 for HP 11974 Series
Bias Requirements: None
Typical Odd-Order Harmonic Suppression: >20 dB (does not apply to HP 11974 Series)
Maximum CW RF Input Level: +20 dBm (100 mW), +25 dBm for HP 11974 Series
Maximum Peak Pulse Power: 24 dBm (250 mW) with < 1 μs pulse (avg. power = +20 dBm)
Bandwidth: 100 MHz minimum (HP 11974 Series only)
Environmental: Meets MIL-T-28800, Type III, Class 3, Style C
IF/LO Connectors: SMA (female)
TUNE IN Connector: BNC
LO Range: 3 to 6.1 GHz

Ordering Information

	Price
HP 11974A 26.5- to 40-GHz Preselected Mixer	$14,600
HP 11974Q 33- to 50-GHz Preselected Mixer	$15,300
HP 11974U 40- to 60-GHz Preselected Mixer	$16,000
HP 11974V 50- to 75-GHz Preselected Mixer	$17,000
Opt 003 Delete Power Supply (HP 11974 Series only)	−$520
HP 11970K 18- to 26.5-GHz Mixer	$2,100
HP 11970A 26.5- to 40-GHz Mixer	$2,200
HP 11970Q 33- to 50-GHz Mixer	$2,275
HP 11970T 18- to 40-GHz Mixers, Hardwood Case, Cables, Tools	$4,295
Opt 001 Add 40- to 60-GHz Mixers (HP 11970 Series only)	+$2,550
Opt 002 Add 33-to 50-GHz Mixers (HP 11970 Series only)	+$2,300
HP 11970U 40- to 60-GHz Mixers	$2,550
HP 11970V 50- to 75-GHz Mixers	$3,000
HP 11970W 75- to 110-GHz Mixers	$3,400
HP 11970	
Opt 009 Mixer Connection Set adds three 1-m low-loss SMA cables, wrench, Allen driver for any HP 11970 Series mixer.	+$490
HP 11969A Carrying Case for 1 to 5 HP 11970 Series mixers. Includes SMA cables and tools as in Opt 009.	$695
HP 11975A 2 to 8 GHz Amplifier	$5,200
HP 281A/B Coaxial-to-Waveguide Adapters	
R281A 26.5 to 40 GHz, 2.4 mm (f)	$850
R281B 26.5 to 40 GHz, 2.4 mm (m)	$800
Q281A 33 to 50 GHz, 2.4 mm (f)	$850
Q281B 33 to 50 GHz, 2.4 mm (m)	$800

HP 85644A

HP 85644A and 85645A Tracking Sources

Two portable tracking sources add versatile, high-performance scalar network analysis capability to a variety of HP spectrum analyzers. The HP 85644A has a frequency range of 300 kHz to 6.5 GHz; the HP 85645A, 300 kHz to 26.5 GHz. Features include:

- Leveled output range of +10 to −80 dBm
- Offset tracking, typically >1 GHz
- Up to 140 dB dynamic range
- Swept intermodulation-distortion measurement capability
- Rugged, portable package or optional system cabinet

Compatible spectrum analyzers are the HP 8566A/B; the HP 8560 series; the HP 71209A; and the HP 8593E, 8595E, 8596E Option 009. Tracking sources are also compatible with the HP 83590 Series, HP 8340, and 8341 sweepers.

HP 85640A Portable Tracking Generator

This portable, rugged tracking generator adds scalar analysis capability from 300 kHz to 2.9 GHz to an HP 8560 Series portable spectrum analyzer. Measure gain, frequency response, compression, flatness, and return loss on components and subsystems. A built-in attenuator gives an output power range of −80 to 0 dBm. Together, the spectrum analyzer and tracking generator have a dynamic range greater than 100 dB.

HP 8444A Option 059 Tracking Generator

Used with the HP 8568B RF spectrum analyzer, this model adds stimulus response-response capability for a minimal cost. It allows swept-frequency testing of components and subsystems. Frequency range is 500 kHz to 1.5 GHz.

HP 8447 Series RF Amplifiers

These amplifiers, with a frequency range of 9 kHz to 1.3 GHz, have low noise and wide bandwidths. They improve spectrum analyzer sensitivity and noise figure while providing input isolation. Broad frequency coverage, flat frequency response, and low distortion assure accurate measurements. See page 393.

HP 8449B Preamplifier

This high-gain, low-noise preamplifier has a frequency range of 1 to 26.5 GHz. It increases the sensitivity of any microwave spectrum analyzer for detection and analysis of very low-level signals. Its improved sensitivity can also dramatically reduce measurement time. See page 393.

HP 87405A Preamplifier

The HP 87405A preamplifier has a frequency range of 0.01 to 3 GHz, reliable gain, and low noise figure to improve overall system performance and reduce systematic errors. Compact size, 22 to 27 dB gain, 6.5 dB noise figure, and convenient probe-power bias connection make this preamplifier ideal for use with a number of instruments, including the new HP 8590 E Series spectrum analyzers.

HP 85901A Portable ac Power Source

This easy-to-carry power source can be used as a standalone battery for over 1 hour of operation at 100 W continuous load, or can be connected to an external 12 Vdc source for longer use. It shuts off automatically when the charge gets low, and can be recharged in 6 hours or less. Over-voltage, short-circuit, and overload protection on the inverter output are built in. Also included are over-voltage protection on the inverter input and over-charge and over-discharge protection on the internal battery.

HP 11867A and 11693A Limiters

Protect the input circuits of spectrum analyzers, counters, amplifiers, and other instruments from high power levels with minimal effect on measurement performance. The HP 11867A RF limiter (dc to 1.8 GHz) reflects signals up to 10 W average power and 100 W peak power. Insertion loss is less than 0.75 dB. The HP 11693A microwave limiter (100 MHz to 12.4 GHz, usable to 18 GHz) guards against input signals over 1 mW up to 1 W average power and 10 W peak power.

HP 11694A 75 Ω Matching Transformer

From 3 to 500 MHz, this transformer allows measurements in 75 Ω systems while retaining amplitude calibration with a 50 Ω spectrum analyzer input. VSWRs are less than 1.2; insertion loss is less than 0.75 dB.

HP 86205A and 86207A RF Bridges

These bridges combine the directivity and broadband frequency range of directional bridges with the low insertion loss and flat coupling factor of directional couplers. Directivity is 40 dB and the wide RF frequency ranges are 300 kHz to 6 GHz for the 50-Ω HP 86205A and 300 kHz to 3 GHz for the 75-Ω HP 86207A. Low insertion loss is nominally ±1.5 dB. Frequency response of the coupled arm is within ±0.2 dB of the nominal 16 dB value. The RF bridges are ideal for use with spectrum analyzers, scalar network analyzers, and vector network analyzers.

HP 85024A High-Frequency Probe

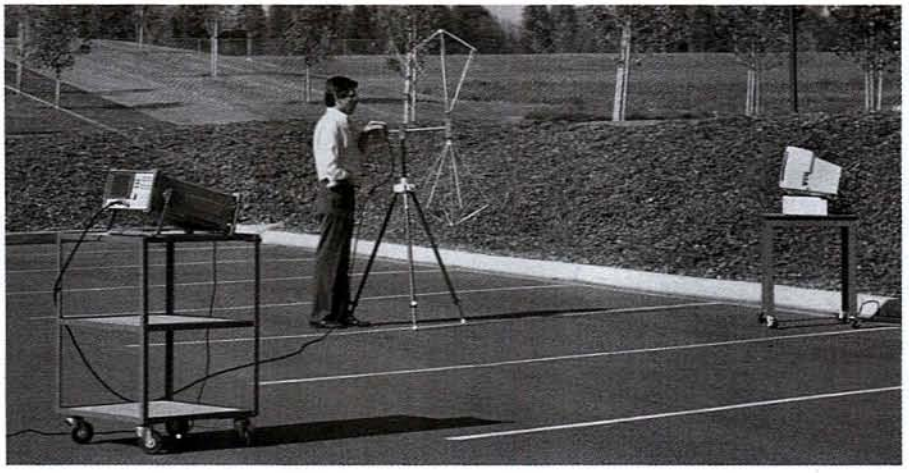
In-circuit measurements are easy with this probe. Input capacitance of only 0.7 pF shunted by 1 M Ω resistance permits high-frequency probing without adverse loading of the circuit under test. Excellent frequency response and unity gain guarantee highly accurate swept measurements. High sensitivity and low distortion levels allow measurements taking advantage of full analyzer dynamic range. This probe is directly compatible with many HP RF spectrum and network analyzers.

Ordering Information	Price	
HP 85644A Tracking Source	$18,630	
HP 85645A Tracking Source	$31,000	
HP 85640A Portable Tracking Generator	$8,300	
HP 8444 Opt 059 Tracking Generator	$8,300	
HP 8447A Preamplifier	$1,600	
HP 8447D Preamplifier	$1,700	☎
HP 8447E Power Amplifier	$1,925	
HP 8447F Preamplifier-Power Amplifier	$2,790	
HP 8449B Preamplifier	$7,530	
HP 87405A Preamplifier	$1,500	
HP 85901A Portable ac Power Source	$1,290	☎
HP 11867A RF Limiter	$505	
HP 11693A Microwave Limiter	$695	
HP 11694A 75 Ω Matching Transformer	$205	
HP 85024A High-Frequency Probe	$2,500	☎
HP 86205A RF Bridge (50 Ω)	$1,300	
HP 86207A RF Bridge (75 Ω)	$1,300	

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office, see page 665.

SIGNAL ANALYZERS
EMC Measurement Systems
HP 84000 Series



DESIGNED FOR HP-IB SYSTEMS

HP 84110B EMC Pre-Production Evaluation System

HP 84000 Series EMC Measurement Systems

The best way to eliminate problems of electromagnetic compatibility is to attack them at all states of product development. For this you need the right test equipment. HP now offers a full line of EMC measurement systems to help you with all aspects of this task—from testing of initial designs through formal compliance measurements. Whether you need simple EMC design tools or a fully automated EMI compliance test system, you will find a solution to improve your productivity. All HP 84000 series EMC measurement systems reflect HP's extensive knowledge and experience of EMC testing and are backed by our proven quality and worldwide support.

HP 84100B EMC Design Development System

The sooner you consider the EMC performance of a new product design, the fewer EMC problems you will encounter later in the product-development cycle. The HP 84100B system gives you the right tools for quickly locating EMC problems at the breadboard and prototype levels. The heart of the system is a portable spectrum analyzer with a 9-kKz to 1.8-GHz frequency range. The analyzer has a built-in tracking generator for making quick immunity and shielding-effectiveness measurements. An EMC measurement personality installed in the system makes EMC measurements easy for beginners and supplies advanced capabilities for experienced troubleshooters. Two calibrated magnetic-field probes are included for locating emission hot spots on printed circuit boards, cables, and power supplies. And the system has an HP-IB interface for one-button output to printers and plotters.

To further enhance your design-development skills, HP offers a two-day course on "Designing for EMC." See page 255 for details.

HP 84110B EMC Pre-Production Evaluation System

If you send your products to consultants or independent test facilities for final compliance measurements, pre-compliance testing can save you time and money at final compliance test time. The HP 84110B takes the mystery out of finding the right equipment for this job. The system includes an easy-to-use portable spectrum analyzer with the bandwidths (200 Hz, 9 kHz, and 120 kHz) and detectors (average, peak, and quasi-peak) required by CISPR*.The analyzer is enhanced with EMC diagnostic capabilities as well as capabilities for making conducted and radiated measurements. Accessories include a line impedance stabilization network (LISN), a transient limiter, two calibrated magnetic-field probes, two antennas, and a tripod. An HP-IB interface allows one-button output to printers and plotters.

While not intended for formal compliance testing, the HP 84110B offers impressive pre-test capabilities for a fraction of the price of a full EMC compliance test system.

HP 84130B EMI Commercial Compliance Measurement System

This test system has the accuracy and capabilities you need to be confident of your EMI compliance measurement results. Built around the HP 8574B EMI receiver, it meets the requirements of CISPR Publication 16*. This high performance system offers outstanding capabilities not available in conventional EMI receivers.

Frequency range of the HP 84130B is 9 kHz to 1.5 GHz. The EMI receiver has full RF preselection; peak, quasi-peak, and average detection; and specialized bandwidths that meet or exceed CISPR specifications. A powerful software program automates the system for conducted-emission and radiated-emission measurements made inside shielded enclosures and radiated-emission measurements made at open-area test sites. The automated system tests to specifications of the FCC, VDE, FTZ, VCCI, DOC, and other international regulatory agencies.

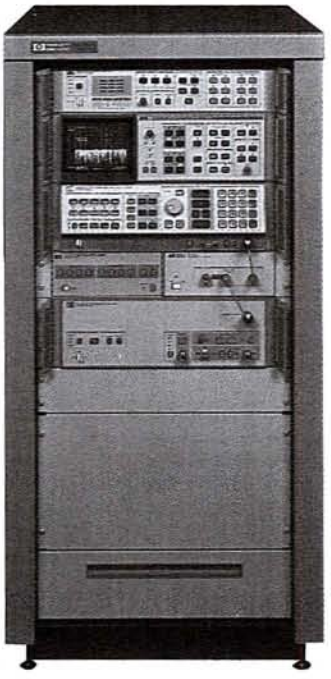
Accessories include antennas, automatic antenna-positioning mast, automatic turntable, LISN, transient limiter, coaxial cables and adapters, HP-IB cables, and power cords. An optional site-attenuation package gives you the hardware needed to characterize an outdoor range or semi-anechoic chamber.

Ordering Information	Price
HP 84100B EMC Design Development System	$21,500
Opt 103 Quasi-Peak Detection and AM/FM Demodulation	+$1,700
HP 84110B EMC Pre-Production Evaluation System	$27,145
Opt 010 Tracking Generator	+$4,900
HP 84130B Commercial EMI Compliance Measurement System	$127,000
Opt 657 Site-Attenuation Kit	+$17,000

* CISPR Publication 16 is the Comite International Special des Perturbations Radioelectrique specification for radio interference measuring apparatus and measurement methods.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Built to CISPR Publication 16* recommendations
- Automatic or manual commercial and military compliance testing
- Diagnostic EMI measurements



HP 8571A and 8572A

DESIGNED FOR HP-IB SYSTEMS

HP 8571A and 8572A Microwave EMI Receivers

These EMI receivers are capable of making your most demanding measurements over a wide (20 Hz to 22 GHz) frequency range. They are specifically designed to make essential military and commercial EMI measurements easily and quickly. The HP 8571A receiver includes an HP 8566B spectrum analyzer with Options 002 and 462, an HP 85685A RF preselector, an HP 11713A attenuator/switch driver, and an HP 8449B Option H02 preamplifier. The HP 8572A includes the same equipment, but adds an HP 85650A quasi-peak adapter for CISPR-based commercial EMI tests. Both receivers are completely configured and verified by HP and come with an individual calibration sheet to ensure ±2 dB amplitude accuracy. They are shipped in a system cabinet.

HP 8573B and 8574B EMI Receivers

For EMI compliance testing that requires less frequency range, these CISPR 16* receivers have everything you need to make fast, accurate measurements to 1.5 GHz in accordance with commercial and military regulations. Each includes an HP 85650A quasi-peak adapter, an HP 85685A RF preselector, and an HP 8567A or 8568B spectrum analyzer. For easy startup, each receiver is completely configured and verified at the factory and shipped to you in a system cabinet.

EMI Diagnostics

In addition to final compliance measurements, all HP EMI receivers are excellent for diagnostics. You can quickly identify problem areas using the swept frequency features of the spectrum analyzer in the system.

Accessories and Optional Configurations

Complete your EMI receiver system by choosing from a full line of accessories for conducted and radiated measurements: line impedance stabilization networks (LISN), antennas, positioning equipment, and transducers (see page 250). Or order the HP EMI measurement system for commercial compliance. It offers a complete measurement setup that includes all accessories and transducers required for designated EMI compliance tests (see page 252).

Ordering Information	Price
HP 8571A EMI Receiver (with HP 8566B Opt 002 and Opt 462 Spectrum Analyzer)	$105,000
HP 8572A EMI Receiver (with HP 8566B Opt 002 and Opt 462 Spectrum Analyzer)	$111,000
HP 8573B EMI Receiver (with HP 8567A Spectrum Analyzer)	$63,000
HP 8574B EMI Receiver (with HP 8568B Spectrum Analyzer)	$72,200
Opt 630 HP 85869A EMI Measurement Software (3½-in single-sided disk)	$7,000
Opt 632 HP 85869A EMI Measurement Software (3½-in double-sided disk)	$7,000
HP 85869A EMI Measurement Software	$7,200

*CISPR Publication 16 is the Comité International Spécial des Perturbations Radioélectriques specification for radio interference measuring apparatus and measurement methods.

SIGNAL ANALYZERS

RF Preselector, 20 Hz to 2 GHz/Quasi-Peak Adapter/EMI Receiver Functions

HP 85685A, 85650A, 85867A

- Automatic filter tracking
- Input overload protection
- Low system noise
- Quasi-peak detection
- CISPR-specified bandwidths
- Bypass for regular spectrum analyzer operation

HP 85685A

HP 85650A

DESIGNED FOR HP-IB SYSTEMS

HP 85685A RF Preselector

This instrument turns an HP 8566B, 8567A, or 8568B spectrum analyzer into a test receiver for specialized applications. The RF preselector has tracking filters and preamplifiers covering the 20 Hz to 2 GHz range. This improves spectrum analyzer measurement sensitivity while providing overload protection from out-of-band signals. The resulting test receiver system, operated in the presence of high-level interference, has a measurement range 30 dB greater than that of a spectrum analyzer alone.

Together the preselector and spectrum analyzer measure signals within the filter passband of the preselector and reject out-of-band interference by 40 dB. This enables low-level signals to be monitored in the presence of high-level ambients. The preselector decreases input overload from out-of-band signals, thereby increasing the range for measuring low-level signals. Fast, wideband measurements mean a reduction in measurement time.

Combining the HP 85685A RF preselector with an HP 8566B, 8567A, or 8568B spectrum analyzer and the HP 85650A quasi-peak adapter gives you an EMI receiver that meets the recommendations of CISPR Publication 16*.

The RF preselector adds the measurement sensitivity and overload protection needed for FCC, VDE, and VCCI radiated emission testing. For commercial and MIL-STD conducted EMI tests, the low-frequency input withstands large impulses and line impedance stabilization network (LISN) transients. A built-in calibrator ensures ±2.0 dB absolute-amplitude accuracy as required by the regulatory agencies and a convenient linearity check tests for system overload.

Operating the test receiver is easy. Use only the spectrum analyzer controls—the RF preselector automatically adjusts input-filter tracking, and the spectrum analyzer reports preselector operating conditions on the CRT. The receiver system is fully HP-IB programmable, and the HP 85685A comes equipped with the hardware needed to connect it to any compatible spectrum analyzer.

HP 85650A Quasi-Peak Adapter

The HP 85650A quasi-peak adapter works with the HP 8566B, 8567A, and 8568B spectrum analyzers and with the 85685A RF preselector to complete an EMI test receiver system. The quasi-peak adapter adds the special bandwidth filters and quasi-peak detection capability specified in CISPR Publication 16*. These bandwidth filters (200 Hz, 9 kHz, and 120 kHz) have 6 dB resolution and may be selected using either peak, quasi-peak, or average detection.

A bypass switch enables the spectrum analyzer to bypass the quasi-peak adapter, and a normal mode allows use of the three CISPR bandwidths whether or not the quasi-peak detector is being used. The HP 85650A is fully programmable over the HP-IB for automated measurements, and it has both an internal speaker and an audio output jack (for external headphones) for monitoring signals.

HP 85867A EMI Receiver Functions

This set of softkey programs simplifies commercial EMI measurements performed manually using HP EMI receivers (see page 253). An external computer is not needed after the softkeys are downloaded into spectrum analyzer nonvolatile RAM. You can select a CISPR* band, make automatic quasi-peak measurements at up to six discrete frequencies, and directly print or plot measurement data using front-panel softkeys.

Features of the EMI Receiver Functions include a quasi-peak softkey that automatically chooses resolution bandwidths, video bandwidths, CISPR bandwidths, and sweeptimes for fast, accurate quasi-peak measurements. Up to six quasi-peak markers and numeric values can be displayed at the same time. This lets you simultaneously view a wide frequency span and the quasi-peak values of up to six signals. A numeric keypad overlay for the spectrum analyzer is included to help you select the right softkey, and a help function gives the purpose of each softkey. Options are available for factory installation of this product.

Ordering Information	Price
HP 85685A RF Preselector	$23,770
Opt 010 Rack Mount Slide Kit	+ $405
Opt 908 Rack Flange Kit without Handles	+ $35
Opt 910 Extra Manual	+ $50
Opt 913 Rack Flange Kit with Handles	+ $35
HP 85650A Quasi-Peak Adapter	$5,965
Opt 908 Rack Flange Kit without Handles	+ $25
Opt 910 Extra Manual	+ $10
Opt 913 Rack Flange Kit with Handles	+ $30
HP 85867A EMI Receiver Functions	
Opt 630 3½-in Media (single- and double-sided disk)	$300
Opt 655 5½-in Media (single-sided disk)	$300

*CISPR Publication 16 is the Comité International Spécial des Perturbations Radioélectrique specification for radio interference measuring apparatus and measurement methods.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- EMC design-evaluation tools
- Automated EMI compliance testing
- Test libraries for major regulatory agencies
- Complete, customized test reports

HP 85712D EMC Measurement Personality Card

This memory card customizes the HP 8590 E-series portable spectrum analyzers for electromagnetic compatibility testing. Evaluation capabilities include limit lines, antenna-factor correction, quasi-peak measurements, average measurements, narrowband and broadband discrimination, EMC diagnostic keys, and EMC pre-compliance measurement keys. The EMC-measurement–enhanced analyzer works with the HP 11945A set of close-field probes to quickly locate EMI hot spots in your product, allowing you to read magnetic-field strength in dBμA/m at the probe tip. (For more information on the HP 8590 E-series portable spectrum analyzers, see page 235.)

HP 85869A EMI Measurement Software

The EMI measurement software is a general-purpose program that makes radiated- and conducted-emission measurements automatically up to 2 GHz according to commercial and military regulations. The program is designed for use with the HP 8571A, 8572A, 8573B, and 8574B EMI receivers. The program takes advantage of the ability of these receivers to quickly measure wide frequency spans and locate device emissions by using peak detection. For commercial measurements, quasi-peak and average data can be taken as appropriate. Save time and effort in your MIL-STD measurements by using the software to automatically discriminate between narrowband and broadband signals.

The HP 85869A has an easy setup procedure, allowing you to design your own tests or to choose from the examples given in the software. These reside in the test library and include MIL-STD, FCC, and VDE/FTZ emission tests.

Computer Compatibility

The HP 85869A runs on HP 9000 Series 200 Models 236, 236C; Series 300 Models 310, 319, 320, 330, 332, 340, 350, 360, 362, 370, 375, 380, 382. It also runs on HP personal computers and selected IBM-compatible PCs using HP BASIC language processors, 3 MB of RAM, and VGA monitors. For more information, contact your local HP sales office, listed on page 665.

HP 85875A Conducted Commercial EMI Compliance Software and HP 85877A General Commercial EMI Compliance Software

These Microsoft® Windows–based software packages automate both radiated and conducted commercial EMI compliance measurements (with the HP 85877A) and conducted EMI measurements (with the HP 85875A). Both programs are designed for use with the HP 8572A, 8573B, and 8574B EMI receivers. These products greatly simplify EMI measurements, with a graphical user interface provided for easy test-system definition and powerful data-manipulation capability. High throughput is achieved by applying time-saving test algorithms that determine those subparts of the measurement frequency range where signals are present. A built-in test sequence generator provides a high degree of flexibility by allowing definitions of new measurement procedures, automatic data manipulation, and automatic tower/turntable and EUT control.

Separate Ambient Signals from EUT Emissions

HP 85877A general commercial EMI compliance software uses dedicated algorithms to distinguish between ambient signals present in the test environment and emissions from the EUT. Ambient signals can be characterized by frequency, amplitude, and modulation content—even transient signals can be captured. Amplitude maximization, involving simultaneous tower and turntable movement, can be applied automatically along with the required signal detection after EUT emissions have been identified. Furthermore, the HP 85877A includes routines to perform tasks related to radiated EMI measurements such as antenna calibration, site attenuation, signal substitution, and quick site checks to verify test-system functionality.

Testing to Regulatory Agency Specifications

The HP 85875A and 85877A include libraries of tests for all major agencies such as the FCC, VDE/FTZ, VCCI, and European Norms (ENs). These test definitions contain all the necessary information about receiver settings, test procedures, limit lines, and transducer factors. You can easily reconfigure tests by using the graphical system setup editor to incorporate your specific measurement hardware. The test sequence generator allows modifications of existing test procedures or their new definitions. Reports can be generated by using either the generic report templates provided or commercially available word processors for Microsoft Windows.

Use with Selected PCs

Both the HP 85875A and 85877A run on HP Vectra PCs or IBM-compatible PCs with the following configuration: 80386/25 MHz or later CPU, VGA or higher resolution monitor, a minimum of 16 MB of RAM, a minimum of 100 MB of hard disk, a 3½- or 5¼-inch floppy disk drive, Microsoft Windows–compatible mouse, and National Instruments NI-488.2 interface card. MS-DOS 5.0 or higher, along with Microsoft Windows 3.1 or higher, is the required operating system.

Compatibility

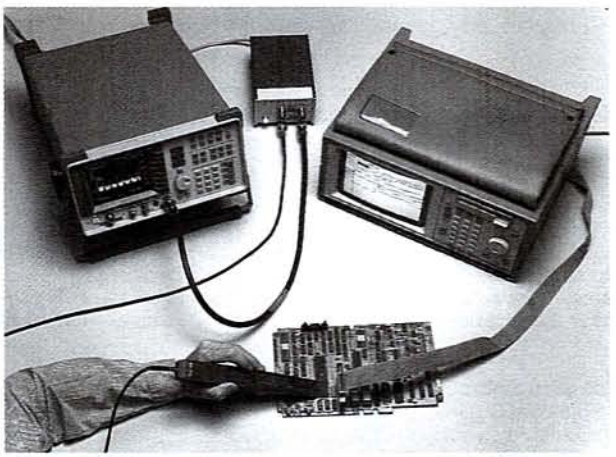
The HP 85869A, 85875A, and 85877A are compatible with the following equipment. Compatible firmware codes vary. See data sheets for details.

Spectrum Analyzers:** HP 8566B, 8567A, 8568B
RF Preselector: HP 85685A
Quasi-Peak Adapter: HP 85650A
EMI Receivers: HP 8571A†, 8572A, 8573B, 8574B
Antenna Towers: HP 11968G (HP-IB), 11968B
Turntables: HP 11968H (HP-IB), 11968E
Tower/Turntable Controller‡: HP 11968F
Transducers: HP 11966 Series
Plotters§: HP 7440A, 7475A, 7550B
Printers§: HP 2225A ThinkJet, HP 2227A QuietJet Plus, DeskJet 500, DeskJet 500C, LaserJet IIIP, LaserJet II Plus

Ordering Information	Price
HP 85712D EMC Measurement Personality Card	$1,240
HP 11946A Quasi-Peak Detector/AM-FM Demodulator Upgrade Kit	$1,960
HP 85869A EMI Measurement Software	$0
Opt 630 3½-in Disks (single-sided)	$7,200
Opt 632 3½-in Disks (double-sided)	$7,200
Opt 655 5¼-in Disks (double-sided)	$7,200
Opt 830 Upgrade Kit for HP 85864A/B/C and 85869A software to 85869A Rev.A.02.01, 3½-in Disks (single-sided)	$725
Opt 832 Upgrade Kit for HP 85864A/B/C and 85869A software to 85869A Rev.A.02.01, 3½-in Disks (double-sided)	$725
Opt 855 Upgrade Kit for HP 85864A/B/C and 85869A software to 85869A Rev.A.02.01, 5¼-in Disks (single-sided)	$725
HP 85875A Conducted Commercial EMI Measurement Software	$6,000
HP 85877A General Commercial EMI Measurement Software	$13,000
Opt 001 Software Development Environment	$3,000
Opt 200 Tower/Turntable Controller (for single-cable interconnection) HP 85877A Only	$3,500
Opt 222 Tower/Turntable Controller (for dual-cable interconnection) HP 85877A Only	$3,500
Opt 488 GPIB 488.2 Interface Card	$700

**Minimum equipment required.
†Compatible with HP 85869A only.
‡Compatible with HP 85875A, 85877A (for use with HP 11968G and 11968H).
§Use with HP 85869A requires HP-IB interface; 85875A and 85877A require serial or parallel peripheral interface.

SIGNAL ANALYZERS
EMC Development Products and Accessories
Various Models



HP can show you how to design for electromagnetic compatibility.

HP 11950X EMC Design Course

"Designing for EMC" is a custom course for engineers who face issues of electromagnetic compatibility. Emphasis is placed on evaluating and solving EMC problems early in the design phase of a product, rather than during final EMC compliance testing. Expert instruction and many demonstrations provide EMC fundamentals, methods of measuring EMC, and principles of incorporating proven EMC design into products.

The course covers the following topics: overview of EMC design, non-conducted coupling, common impedance coupling, radiation from digital circuits, cables, advanced cables, conducted emissions, susceptibility, electrostatic discharge, shielding, and diagnostics. The 11-chapter handbook used in class becomes a permanent reference.

The HP 11950X EMC design course is offered for a fixed fee at the site of your choice. For more information, contact your local HP sales office (listed on page 665).

HP 8566B/68B Option 462 Impulse Bandwidths

Option 462 for the HP 8566B and 8568B spectrum analyzers provides impulse bandwidths for making MIL-STD and DEF STAN EMI measurements. Standard HP 8566B and 8568B models have 12 resolution bandwidth filters (10 Hz to 3 MHz in a 1, 3, 10 sequence), specified in terms of their 3 dB bandwidth. Option 462 modifies the 1 kHz to 3 MHz resolution bandwidth filters to correspond to their impulse bandwidths instead.

In addition to enhancing instrument capability for MIL-STD 461A/B/C and 462 EMI measurements, spectrum analyzers with Option 462 can still make all commercial EMI and general-purpose measurements. Option 462 spectrum analyzers are compatible with the HP 85650A quasi-peak adapter, HP 85685A RF preselector, HP 85869A EMI measurement software, HP 85879A radiated emissions measurement software, and HP 85867A EMI receiver functions program. Existing HP 8566B and 8568B spectrum analyzers can be modified to include this option. For more information, contact your local HP sales office (listed on page 665).

EMC Accessories Catalog

More complete descriptions and specifications for HP's growing line of accessories and transducers can be found in the EMC Accessories Catalog, HP literature number 5091-4995. This free catalog is available from your HP local sales office (listed on page 665).

HP 11940A and 11941A Close-Field Probes

These hand-held probes are designed to measure magnetic-field radiation from surface currents, slots, cables, and ICs for EMC diagnostic and troubleshooting measurements. Their unique design results in a high level of electric-field rejection. This significantly reduces errors, thus allowing calibrated and repeatable measurements.

The HP 11941A operates from 9 kHz to 30 MHz; the HP 11940A, from 30 MHz to 1 GHz. Five antenna factors appear on each probe for calculating absolute magnetic-field strength (dBμA/m) from the dBμV reading of a spectrum analyzer. Each probe is calibrated and comes with a 2-meter RG-223 coaxial cable, an SMA(f)-to-type-N(m) adapter, and an SMA(f)-to-BNC(m) adapter.

HP 11945A Close-Field Probe Set

The close-field probe set includes both the HP 11940A and 11941A probes for full coverage from 9 kHz to 1 GHz. Option E51 adds the HP 8447F Option H64 dual preamplifier, a 36-in (914-mm) Type N cable, and a carrying bag for storage and protection of the entire set.

HP 11947A Transient Limiter

This limiter protects a spectrum analyzer input from damage caused by high-level transients from line impedance stabilization networks (LISNs) during EMI testing for conducted emissions. Frequency range is 9 kHz to 200 MHz and insertion loss is 10 dB. The transient limiter can withstand inputs as high as 10 kW for 10 μs, or 2.5 W of average power. The built-in high-pass filter helps reduce 60 Hz line feedthrough that could impede conducted-emission measurements. This limiter is not required for HP 8573B and 8574B EMI receivers or other systems employing the HP 85685A RF preselector.

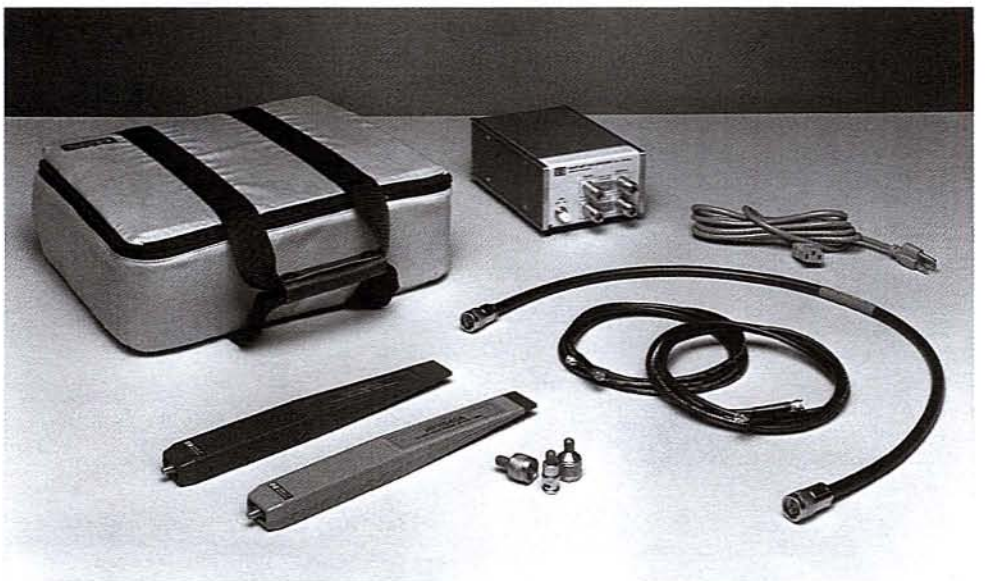
HP 11951A Infrared Controller

This IR controller allows an HP 8590 E-series spectrum analyzer to be controlled remotely from up to 30 feet. It eliminates the need to leave the test chamber to make changes to the spectrum analyzer settings. The IR receiver unit connects to the keyboard input of the analyzer, and the operator activates functions using a handheld IR transmitter, which is aimed at the spectrum analyzer through a chamber window.

HP 11966 Series Antennas

These antennas are individually calibrated and shipped with a calibration certificate showing actual performance data. The series includes the following products:

HP Model	Frequency Range
HP 11966A Active Loop H-Field Antenna	10 kHz to 30 MHz
HP 11966B Active Rod E-Field Antenna	100 Hz to 50 MHz
HP 11966C Biconical Antenna	30 to 300 MHz
HP 11966D Log Periodic Antenna	200 MHz to 1 GHz
HP 11966E Double-Ridged Waveguide Horn Antenna	1 to 18 GHz
HP 11966F Conical Log Spiral Antenna	200 MHz to 1 GHz
HP 11966G Conical Log Spiral Antenna	1 to 10 GHz
HP 11966H Dipole Antenna Set	28 MHz to 1 GHz
HP 11966I Double-Ridged Waveguide Horn Antenna	200 MHz to 2 GHz
HP 11966J Double-Ridged Waveguide Horn Antenna	18 to 40 GHz
HP 11966K Magnetic Field Pickup Coil	20 Hz to 50 kHz
HP 11966N Log Periodic Antenna	200 MHz to 5 GHz



HP 11967 Series Current Probes

This series is designed for MIL-STD 461/462 conducted-emission measurements on power and interconnecting leads. Used with 10 μF capacitors, HP part number 0160-6683.

HP Model	Frequency Range
11967A Current Probe	15 kHz to 50 MHz, dc to 60 Hz powerlines
11967B Current Probe	20 Hz to 2 MHz, dc to 400 Hz powerlines

HP 11967C Line Impedance Stabilization Network

Used for commercial, CISPR-based conducted emission measurements, this single-phase unit meets the requirements of the FCC and VDE for conducted emission testing. Includes color-coded pin plugs for constructing a power cord to connect with the LISN.

HP 11968 Series Positioning Devices

This series includes motorized and manually operated antenna masts and turntables.

HP Model	Description
11968B	Manually operated antenna-positioning mast
11968C	Non-metallic antenna tripod; minimizes unwanted reflections in the test environment
11968E	Manually operated turntable
11968G	Motorized, HP-IB programmable antenna-positioning mast
11968H	Motorized, HP-IB programmable equipment-testing turntable

HP 11968F Tower/Turntable Controller

The HP 11968F tower/turntable controller consists of a special board that plugs into the HP Vectra or an IBM-compatible PC ISA bus and a converter that interfaces with a motorized tower or turntable. Any two of these peripherals can be controlled simultaneously using the HP 85877A general commercial EMI compliance software. The controller supports both types of tower and turntable designs (one- and two-cable interconnection between peripheral and controller).

11729-60014 Low-Noise Preamplifier

This amplifier provides the sensitivity needed for MIL-STD 461C CE-06 receiver/transmitter key-up testing. Frequency range is 10 Hz to 25 MHz.

HP 8447F Option H64 Dual Preamplifier

Improve receiver and spectrum analyzer sensitivity for more accurate radiated-emission measurements. This dual preamplifier is ideal for use with the HP 11940A and 11941A close-field probes to detect low-level signals from a device under test. Frequency range is 9 kHz to 1.3 GHz. See page 393.

HP 8449B Microwave Preamplifier

This high-gain, low-noise preamplifier adds sensitivity for MIL-STD radiated measurements. Frequency range is 1 to 26.5 GHz. See page 393.

Ordering Information	Price
HP 11950X "Designing for EMC" Course (per site)	$12,800
HP 8566B/8568B Opt 462 Impulse Bandwidths	$2,110
HP 11940A Close-Field Probe, 30 MHz to 1 GHz	$700
HP 11941A Close-Field Probe, 9 kHz to 30 MHz	$700
HP 11945A Close-Field Probe Set, 9 kHz to 1 GHz	$1,215
Opt 001 Rotary Joints	+$810
Opt 003 Delete Cables and Adapters (2 sets)	−$215
Opt E51 Add HP 8447F Option H64 Preamplifier, Carrying Bag, 36-in Type N Cable	+$2,790
HP 11947A Transient Limiter, 9 kHz to 200 MHz	$510
HP 11951A Infrared Controller	$900
HP 11966A Active Loop H-Field Antenna, 10 kHz to 30 MHz	$2,535
HP 11966B Active Rod E-Field Antenna, 100 to 50 MHz	$2,235
HP 11966C Biconical Antenna, 30 to 300 MHz	$1,650
HP 11966D Log Periodic Antenna, 200 MHz to 1 GHz	$1,920
HP 11966E Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	$3,310
HP 11966F Conical Log Spiral Antenna, 200 MHz to 1 GHz	$1,975
HP 11966G Conical Log Spiral Antenna, 1 to 10 GHz	$1,815
HP 11966H Dipole Antenna Set, 28 MHz to 1 GHz	$3,850
HP 11966I Double-Ridged Waveguide Horn Antenna, 200 MHz to 2 GHz	$6,500
HP 11966J Double-Ridged Waveguide Horn Antenna, 18 to 40 GHz	$4,500
HP 11966K Magnetic Field Pickup Coil, 20 Hz to 50 kHz	$670
HP 11966N Log Periodic Antenna, 200 MHz to 5 GHz	$3,800
HP 11967A Current Probe, 15 kHz to 50 MHz	$1,250
HP 11967B Current Probe, 20 Hz to 2 MHz	$1,350
HP 11967C Line Impedance Stabilization Network	$2,880
HP 11968B Manual Antenna-Positioning Mast	$3,075
HP 11968C Antenna Tripod	$775
HP 11968E Manual Equipment-Testing Turntable	$2,000
HP 11968F Tower/Turntable Controller	$3,500
HP 11968G Motorized Antenna-Positioning Mast	$19,500
HP 11968H Motorized Equipment-Testing Turntable	$12,600
Opt 222 Replace standard single cable interconnection with dual cable interconnection	$0
11729-60014 Low-Noise Preamplifier, 10 Hz to 25 MHz	$525
HP 8447F Option H64 Dual Preamplifier, 9 kHz to 1.3 GHz	$2,790
HP 8449B Microwave Preamplifier, 1 to 26.5 GHz	$7,530

For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

SIGNAL ANALYZERS

Selective Level Meter and Feedback Control Systems Accessories

HP 3586C, 35280A, 35281A, 35282A

HP 3586C

DESIGNED FOR HP-IB SYSTEMS

HP 35280A, HP 35281A, and HP 35282A

NEW

HP 3586C Selective Level Meter

The HP 3586C selective level meter finds applications in general-purpose wave analysis for the design, manufacture, and maintenance of electronic systems. The HP 3586C is fully HP-IB programmable and covers the frequency range of 50 Hz to 32.5 MHz. This allows you to measure audio, sonar, and other low-frequency systems, as well as high-frequency communications subsystems. The HP 3586C provides input impedances of 50, 75, and 600 Ω with 10 kΩ bridging for maximum measurement flexibility in a wide variety of applications. Measure signal levels with up to ± 0.2 dB accuracy down to −80 dB, with 0.01 dB resolution and bandwidth choices of 20, 400, or 3100 Hz. The built-in counter and narrow-resolution bandwidths allow harmonic and intermodulation measurements to be made with ease. Frequency can be set or measured with 0.1 Hz resolution and ±10 ppm stability (± 0.2 ppm optional).

For frequency response measurement of high-Q filters and other selective networks, the companion HP 3336C synthesizer/level generator functions as a full-featured, HP-IB programmable tracking generator. Frequency range for the HP 3336C is 10 Hz to 21 MHz, with precise output levels from −70 to +8 dBm.

HP 3586C Specifications (abbreviated)

Frequency
- **Range:** 50/75 Ω unbalanced input, 50 Hz to 32.5 MHz; 600 Ω balanced input, 100 Hz to 108 kHz
- **Resolution:** 0.1 Hz
- **Center frequency accuracy:** $\pm 1 \times 10^{-5}$/year ($\pm 2 \times 10^{-7}$/year with Option 004)

Selectivity
- **3dB bandwidth:** ±10%: 20 Hz, 400 Hz, 3100 Hz
- **Pass band flatness:** ±0.3 dB

Level Accuracy (+20 to −80 dB):
- ± 0.20 dBm, 20 kHz to 18 MHz
- ± 0.25 dBm, 18 MHz to 32.5 MHz

Ordering Information

	Price
HP 3586C Selective Level Meter	$12,700
Opt 004 High-Stability Frequency Reference	+ $775
Opt 907 Front Panel Handles	+ $68
Opt 908 Rack Flange Kit	+ $37
Opt 909 Rack Flange & Handle Combination Kit	$95
Opt W30 Extended Repair Service (see page 636)	$280

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

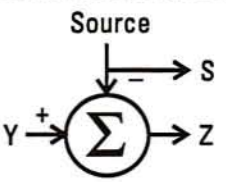
Hewlett-Packard offers three accessories to let you inject signals into your feedback control systems, such as disk drives, power supplies, AGC, and PLL circuits. You can characterize loop gain using Y/S, Y/Z, or other measurement techniques. These accessories are compatible with a wide range of network and dynamic signal analyzers, including the HP 35670A, HP 35665A, HP 3562A, HP 3563A, and HP 3577B.

HP 35280A Summing Junction

The HP 35280A summing junction allows you to float the injected signal source from ground up to ±42 V. You can also adjust the source gain by −20 dB. Includes the required line power module.

Specifications

Frequency Range: dc to 1 MHz (< 10° phase shift)
Voltage Range: ±10 V pk
Maximum Float Voltage: ±42 V pk
Gain: 1 (0 dB)
Input Impedance: 100 kΩ
Output Impedance: < 15 Ω
Source Attenuator: 0 dB or −20 dB, switch selectable



Functional block diagram
HP 35280 (see AN 243-5)

HP 35281A Clip-on Transformer

The HP 35281A clip-on transformer lets you inject a test signal into higher frequency servo control loops and other feedback loops, such as AGC circuits and switch mode power supplies. This transformer lets you clip on to an existing lead for injecting a test signal without physically breaking the circuit.

Specifications

Frequency Range: 300 Hz to 10 MHz (roll-off < 6 dB)
Maximum Source Primary Voltage: 0.1 V pk (freq = 300 Hz) increasing to 5 V pk (freq ≥ 10 kHz)
Maximum Secondary Float Voltage: ±42 V pk
Primary-to-Secondary Turns Ratio: 100 to 1

HP 35282A Signal Injection Transformer

The HP 35282A signal injection transformer allows you to inject signals into your control loops that have large offsets from ground. This device allows offsets of up to ±600 V pk and provides signal attenuation of 0 or −20 dB.

Specifications

Frequency Range: 30 Hz to 200 kHz (roll-off < 6 dB)
Maximum Source Primary Voltage: 0.05 V pk (freq = 30 Hz) increasing to 5 V pk (freq ≥ 1 kHz)
Maximum Secondary Float Voltage: ±600 V pk
Primary to Secondary Turns Ratio: 1 to 1
Source Attenuator: 0 dB or −20 dB, switch selectable

For ordering information, contact your local HP sales representative.

Calibrated, Automated Phase Noise Measurements

- Specified amplitude accuracy of ±2 dB
- Offset frequency range of 0.01 Hz to 40 MHz
- Carrier frequency range from 5 MHz to beyond 110 GHz
- Spurs separated from noise spectra

HP 3048A Phase Noise Measurement System controlled by an HP 98580C desktop computer.

HP 3048A Phase Noise Measurement System

The HP 3048A Phase Noise Measurement System uses the power of a flexible software program to automate phase noise carrier measurements. The basic HP 3048A system includes the HP 11848A Phase Noise Interface, which contains phase detectors and phase-lock loop circuitry, the HP 3561A Dynamic Signal Analyzer, and measurement software. Using the HP 98580C desktop computer (or PC-compatible with Opt 301), the basic system measures carrier frequencies from 5 MHz to 1.6 GHz (18 GHz with Opt 201) and characterizes the demodulated phase noise over a frequency range of 0.01 Hz to 100 kHz. Adding an RF spectrum analyzer—such as the HP 3585A/B—provides automated measurements at offsets up to 40 MHz. A variety of signal generators—such as the HP 8662A, HP 8663A, or HP 8642A/B—can also be added to the system to provide a low-noise reference signal up to a frequency of 2.56 GHz.

Phase Noise Measurement Software

Measurement menus allow the operator to specify the measurement process, including the calibration of the system. Several output formats are available to the user, including plots of the single sideband phase noise power of the signal, integrated noise power, or the calculated Allen variance. A real-time measurement mode is available to monitor the level of phase noise and discrete spurs as changes are made to the device under test. The phase noise measurement software is available for RMB workstations or MS-DOS* PC-compatible formats.

Measurements Above 1.6 GHz

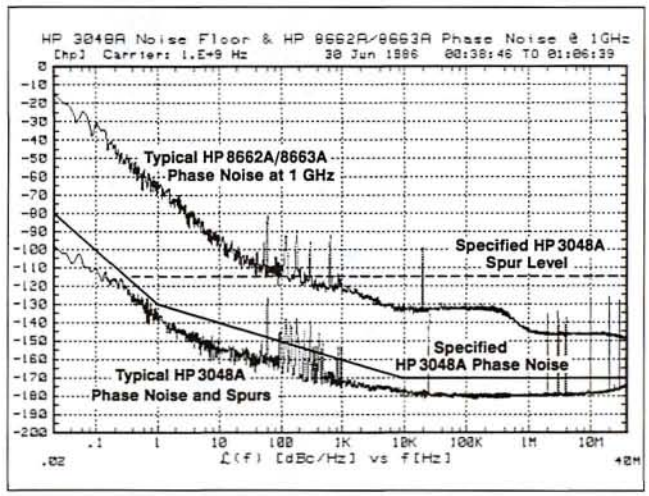
For measuring phase noise above 1.6 GHz, the HP 71707A or HP 11729C downconverters can be used. The HP 71707A and HP 11729C downconvert microwave signals from 1.5 to 26.5 GHz and 1.28 to 18 GHz, respectively. The frequency range of the HP 3048A can be extended to 110 GHz using external mixers with the HP 71707A or by ordering special options for the HP 11729C. (An HP 8662A or HP 8663A Opt 003 is required for the HP 11729C as a reference source.)

*MS-DOS is a U.S. registered trademark of Microsoft Corp.

Specifications Summary

Sensitivity

The following graph indicates the sensitivity of the HP 3048A system as limited by its own internally generated noise for a signal under test at +15 dBm. Also plotted is the phase noise for a 1 GHz signal using the phase detector method and an HP 8662A or HP 8663A as a reference source.



Carrier Frequency Range

Internal mixer: 5 MHz to 1.6 GHz, optional to 18 GHz
External (user-supplied) mixer: The frequency range of the carrier is limited only by the frequency range of the external mixer.
Offset frequency range: 0.01 Hz to 100 kHz, extended to 40 MHz with an optional spectrum analyzer such as the HP 3585A/B.
Amplitude accuracy: ±2 dB to 1 MHz offsets; ±4 dB for offsets greater than 1 MHz. Accuracy is verified by the system at time of measurement. If any accuracy degradation occurs, the system will advise the user during the measurement.

Ordering Information

	Price
HP 3048A Phase Noise Measurement System includes the HP 11848A Phase Noise Interface, HP 3561A Dynamic Signal Analyzer, and RMB workstation based measurement software.	$34,500
Key Options	
Opt 001 Adds HP 8662A Opt 003 Synthesized Signal Generator	+$42,525
Opt 002 Adds HP 8663A Opt 003 Synthesized Signal Generator	+$58,475
Opt 003 Adds HP 11729C Carrier Noise Test Set	+$28,035
Opt 004 Adds HP 11729C Opt 130 Carrier Noise Test Set with AM Noise Detection	+$30,015
Opt 006 Adds HP 8642B Opt 001 Synthesized Signal Generator	+$44,240
Opt 201 Adds 1.6 GHz to 18 GHz Input to HP 11848A	+$2,540
Software Option	
Opt 301 Replaces standard RMB workstation phase noise software with MS-DOS PC-compatible phase noise software. A graphics dump utility is supplied with this option.	$0
+**24A** Adds operator training course, contact sales office	

Supported System Computers

HP 3048A Standard: HP 98580C Opt 104 and HP-HIL knob (HP 46083A).
HP 3048A Opt 301: IBM PC/AT/XT and true compatibles with 640 KBytes RAM; MS-DOS 3.0 or later; EGA or compatible color display and video card with 128 KBytes video RAM; HP-IB card (recommend HP 82335A HP-IB card). For additional details on system options and ordering information, see the HP 3048A Phase Noise Measurement System technical data (p/n 5091-4994).

SIGNAL ANALYZERS
Automated Spectrum Analysis
HP 71707A, 11729C

- Downconverts 1.5 to 26.5 GHz signals
- State-of-the-art phase noise performance
- AM noise detection standard
- Coverage to 110 GHz using external mixers
- Specified spurious performance

HP 71707A

NEW

- Downconverts 1.28 to 18 GHz signals
- "Good" phase noise performance
- AM noise detection optional
- Options available for coverage to 110 GHz

HP 11729C

HP 71707A Microwave Downconverter

The HP 71707A Microwave Downconverter translates microwave signals to low RF frequencies with minimum added phase and amplitude modulated noise. The HP 71707A can be controlled automatically by the HP 3048A Opt 301 and consists of a 4/8's (MMS) width HP 70427A microwave downconverter module and an HP 70004A color display/mainframe.

Specifications Summary

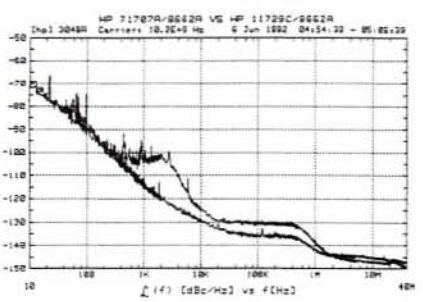
Downconverter
Frequency range: 1.5 to 26.5 GHz
Input power: −40 dBm min, +30 dBm max
IF output
Frequency range: 5 MHz to 1200 MHz
Level: 0 to +5 dBm

General

Operating Temperature Range: 0° to +55° C
Power: 260 W maximum (provided by the HP 70004A)
Weight: Net, 28.75 kg (63.3 lb)
Size: 425.4 mm W × 222 mm H × 526 mm D (8.74 in × 16.75 in × 20.7 in)

Ordering Information

	Price
HP 71707A Microwave Downconverter (1.5 GHz to 26.5 GHz)	$70,700
Opt 910 Provides a total of two sets of user guides (p/n 70427-90002) and component level information packets (p/n 70427-90004)	+$600
Opt W30 Extended Repair Service (see page 636)	+$1,735



Phase noise plot at 10 GHz of HP 71707A (bottom) and HP 11729C (top).

HP 11729C Carrier Noise Test Set

The HP 11729C is a fully programmable microwave downconverter used primarily as an accessory to the HP 3048A Phase Noise Measurement System. The input frequency range of the HP 11729C is 1.28 to 18 GHz and IF bandwidth is 5 to 1280 MHz. With Option 130, the HP 11729C can be used as an AM noise demodulator for carriers from 10 MHz to 18 GHz. The baseband demodulated signal is input to the HP 3048A for calibrated AM noise measurements.

Specifications Summary

Downconverter
Frequency range: 1.28 to 18 GHz in 8 bands
Input power: +7 dBm min, +18 dBm maximum
IF output
Frequency range: 5 to 1280 MHz
Level: +7 dBm minimum

General

Operating Temperature Range: 0° to +55° C
Power: 100, 120, 220, 240 V, +5%, -10%; 48 to 66 Hz; <75 VA max
Weight: Net, 10.4 kg (23 lb); shipping, 13.6 (30 lb)
Size: 425 mm W × 99 mm H × 551 mm D (21.7 in × 16.8 in × 3.9 in)

Ordering Information

	Price
HP 11729C Carrier Noise Test Set (10 MHz to 18 GHz)*	$28,035
Note: Each of Options 003 through 027 (only one may be ordered) also includes 0.005 to 1.28 GHz coverage, which is not used for downconversion.	
Opt 003 (1.28 to 3.2 GHz) Limited Frequency Coverage	−$8,500
Opt 007 (3.2 to 5.76 GHz) Limited Frequency Coverage	−$8,500
Opt 011 (5.76 to 8.32 GHz) Limited Frequency Coverage	−$8,500
Opt 015 (8.32 to 10.88 GHz) Limited Frequency Coverage	−$8,500
Opt 019 (10.88 to 13.44 GHz) Limited Frequency Coverage	−$8,500
Opt 023 (13.44 to 16.0 GHz) Limited Frequency Coverage	−$8,500
Opt 027 (16.0 to 18.0 GHz) Limited Frequency Coverage	−$8,500
Opt 130 AM Noise Detection	+$1,980
Opt 140 Rear Panel Connectors	+$570
Opt 907 Front Handle Kit (5061-9688)	+$57
Opt 908 Rack Flange Kit (5061-9674)	+$36
Opt 909 Rack Flange Kit with Front Handles (5061-9675)	+$82
Opt 910 A total of two sets of operation and service manuals (11729-90017)	+$36
Opt W30 Extended Repair Service (see page 636)	+$140

*Extends to 10 MHz for AM detection only

For off-the-shelf shipment, call 800-452-4844.

- Displays phase and amplitude modulation vs. time
- 350 MHz I, Q baseband signal analysis
- Markers for measuring phase, amplitude, and time
- 12-bit digitizing for HP-IB measurements
- 50 to 200 MHz modulated IF input frequency range
- Other bands available to 1400 MHz
- Automatic internal/external demodulator calibration

HP 8981B

DESIGNED FOR HP-IB SYSTEMS

HP 8981B Vector Modulation Analyzers

The HP 8981B vector modulation analyzer analyzes analog I and Q signals. Because it contains a calibrated demodulator it can also be connected to the IF of the modulator. This gives you the flexibility to examine changes in modulation down through the receiver chain and isolate faults quickly.

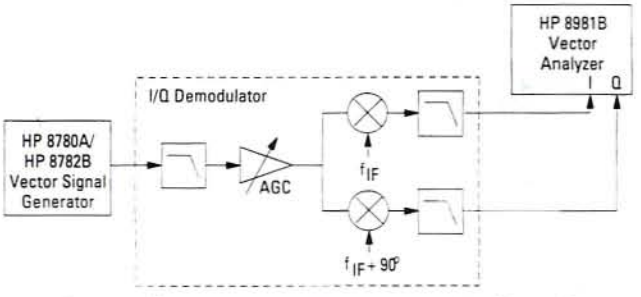
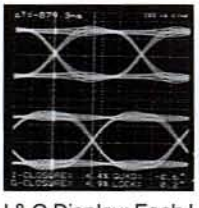


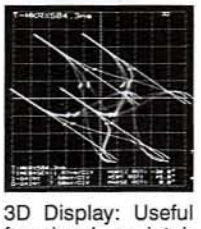
Fig. 1. I/Q demodulator measurement with HP 8981B

The HP 8981B Vector Modulation Analyzer and HP 8780A/8782B Vector Signal Generators can be used to adjust and troubleshoot I/Q modulators, demodulators, and I/Q modulated signals used in digital mobile radio, microwave radio, and the transmission of digital video. The analyzers can be connected to the I/Q outputs of a demodulator in a receiver, or to IF test points. Once connected, the HP 8981B vector modulation analyzer displays constellations, EYE diagrams, and vector diagrams of digital modulation formats such as QPSK, 16QAM, 64QAM, and 256QAM. The analyzer also makes statistical measures of system quality such as closure, lock angle error, and quadrature error. Through these "constellation analysis" techniques, transmission quality can be measured and monitored to detect degradations in the transmission link before link bit error rates reach unacceptable levels.



I & Q Display: Each I and Q channel is displayed vs. time on a separate grid, one above the other.

Constellation Display: Displays Q vs. I at the instant defined by the time marker.



3D Display: Useful for visual, or intuitive, analysis of Q vs. I vs. time waveforms. Signal can be rotated about any of 3 axes for optimal viewing.

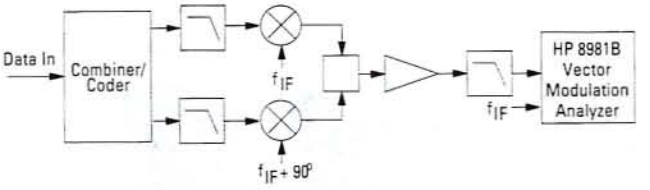
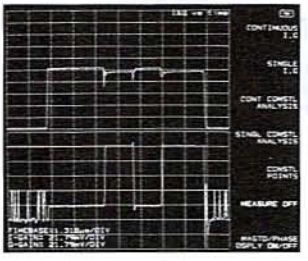


Fig. 2. I/Q Modulator Measurement with HP 8981B



The HP 8981B's new magnitude and phase vs. time display is an ideal tool for analyzing signal transitions. Both magnitude and phase transients can be measured on signals such as the phase-coded pulse shown here. The top trace, magnitude, shows the variations in pulse amplitude. The bottom trace, phase, shows the position and behavior of the phase transitions.

Specifications

HP 8981B I/Q Mode Specifications

I and Q Channels

Bandwidth (−3dB): 350 MHz dc-coupled
dc vector accuracy using internal adc: ±1% of full scale
Input termination: 50 Ω or 75 Ω
Input coupling: Each channel independently: ac, dc, or ground

Power Requirements

Voltage: 100, 120, 220, 240 Vac, −10% to 10%; 48 to 66 Hz
Power: 245 W, 320 VA maximum

Size: 5¼-in rack height, one module width 23D HP System II cabinet
Weight: Net, approximately 20 kg (45 lb); shipping, approximately 24 kg (53 lb)

HP 8981B Demod Mode Specifications

Modulated IF input frequency range: <50 to 200 MHz
Modulated IF input level range: −5 to −20 dBm
Coherent reference input frequency range: 50 to 200 MHz
Coherent reference input level range: +10 to −20 dBm
Baseband bandwidth (3 dB): 100 MHz with external filters. Supplemental characteristic of 35 MHz with internal filters.
Corrected vector dc accuracy at 70 MHz: (typical from 50 to 200 MHz) <2% of full scale IF input

Supplemental Characteristics

Quadrature error: Corrected: < ±0.5°; uncorrected: < ±1°
I/Q gain imbalance (dc to 10 kHz): Corrected, < ±0.1 dB; uncorrected, < ±0.25 dB

Optional Demodulators

	Frequency range	RF BW	Calibrated modulation analysis	Calibrated I/Q outputs
HP 8981B	50 to 200 MHz	70 MHz	Yes	No
Opt H20	200 to 350 MHz	100 MHz	Yes	No
Opt H32	321.4 MHz	200 MHz	Yes	Yes
Opt H35	350 to 500 MHz	150 MHz	Yes	No
Opt H36	360 to 550 MHz	200 MHz	Yes	No
Opt H50	500 to 900 MHz	300 MHz	Yes	No
Opt H75	750 to 1250 MHz	500 MHz	Yes	No
Opt H85	850 to 1400 MHz	500 MHz	Yes	No

Ordering Information

	Price
HP 8981B Vector Modulation Analyzer	$35,000
HP 11748A Active Probe System	$4,500

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

SIGNAL ANALYZERS

Audio Analyzer, 20 Hz to 100 kHz; Distortion Analyzer, 20 Hz to 100 kHz

HP 8903B, 8903E

- Measures distortion, SINAD, signal-to-noise
- Measures true-rms ac volts, dc volts, frequency
- Low-distortion programmable source
- rms, average, and quasi-peak detection

- Measures distortion, SINAD
- Measures true-rms ac volts, dc volts, frequency
- rms, average, and quasi-peak detection

Hewlett-Packard Instrument Drivers

HP 8903B

DESIGNED FOR HP-IB SYSTEMS

HP 8903E

DESIGNED FOR HP-IB SYSTEMS

HP 8903B Audio Analyzer and HP 8903E Distortion Analyzer

The HP 8903B audio analyzer and HP 8903E distortion analyzer provide unparalleled versatility and performance for audio measurements from 20 Hz to 100 kHz. The HP 8903B combines the functionality of a low-distortion audio source, high-performance distortion analyzer, frequency counter, ac voltmeter, dc voltmeter, and SINAD meter into one compact package. With microprocessor control of source and analyzer, the HP 8903B can perform stimulus-response measurements, such as signal-to-noise ratio and swept distortion, automatically with no additional equipment. The HP 8903E distortion analyzer is the analyzer portion of the HP 8903B audio analyzer. (The HP 8903E has no source.)

For ease of use, most measurements on the HP 8903B and HP 8903E are made with only one or two keystrokes. Both instruments automatically tune and autorange for maximum accuracy and resolution. For quick identification of input signals, the analyzer counts and displays the input frequency in all ac measurement modes.

Low-Frequency Applications

The HP 8903B/E have many features that make difficult audio measurements easy. These include flexible data display formats, a selectable balanced or unbalanced input, plug-in filters, and automatic notch filter tuning. With the ratio key, you can establish a reference in % or dB and directly make frequency-response and 3 dB bandwidth measurements without computation. A fully balanced analyzer input allows testing of the bridged power amplifiers found in many radios and car stereos, as well as professional balanced audio equipment.

With 2 internal plug-in filter slots and 6 optional filters to choose from, we simplify your audio measurements by providing the filter networks required by international standards. (See the next page for a complete list of filters.) The HP 8903B and HP 8903E both use true-rms detection (for all signals with crest factor 3) for accurate measurement of complex waveforms and noise. Average and quasi-peak detectors are also available. (Quasi-peak is selectable only via HP-IB on the HP 8903E.) Accurate distortion measurements typically can be made down to less than −90 dB (0.003%) from 20 Hz to 20 kHz.

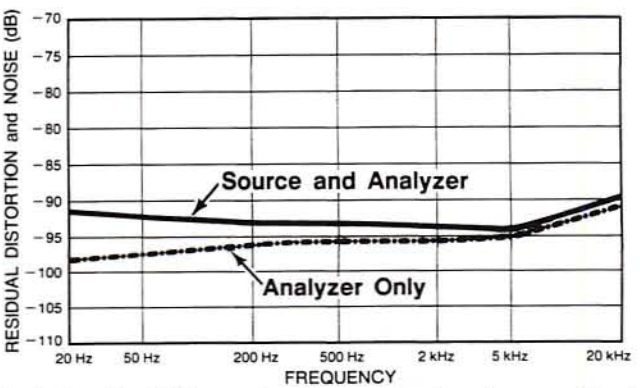
For receiver testing, both instruments have a tunable SINAD notch filter. On the HP 8903B, the filter is automatically tuned to the source frequency. With the HP 8903E, a front-panel key allows the operator to lock the notch filter at any given input frequency.

HP 8903B and HP 8903E Specifications

System Specifications (HP 8903B only, source and analyzer combined)

Distortion

Residual Distortion and Noise (the higher of):
80 kHz BW: −80 dB (0.01%) or 17 μV, 20 Hz to 20 kHz
500 kHz BW: −70 dB (0.032%) or 50 μV, 20 Hz to 50 kHz
−65 dB (0.056%) or 50 μV, 50 kHz to 100 kHz



Typical residual THD + noise for source and analyzer combined (source voltage set to 1.5 V, 80 kHz BW). Dashed line represents typical residual THD + noise for the analyzer only.

Signal-to-Noise

Frequency Range: 50 Hz to 100 kHz
Display Range: 0 to 99.99 dB
Accuracy: ±1 dB
Input Voltage Range: 50 mV to 300 V
Residual Noise (the higher of): −85 dB or 17 μV, 80 kHz BW; −70 dB or 50 μV, 500 kHz BW

Source Specifications (HP 8903B only)

Frequency

Range: 20 Hz to 100 kHz
Resolution: 0.3%
Accuracy: 0.3% of setting

Output Level

Range: 0.6 mV to 6 V open circuit
Resolution: 0.3% or better
Accuracy (open circuit): 2% of setting 60 mV to 6 V, 20 Hz to 50 kHz; 3% of setting 6 mV to 6 V, 20 Hz to 100 kHz; 5% of setting 0.6 to 6 mV, 20 Hz to 100 kHz

Flatness (1 kHz reference): ±0.7% (±0.06 dB), 20 Hz to 20 kHz; ±2.5% (±0.22 dB), 20 Hz to 100 kHz
Distortion and Noise (the higher of):
80 kHz BW: −80 dB (0.01%) or 15 μV, 20 Hz to 20 kHz
500 kHz BW: −70 dB (0.032%) or 38 μV, 20 Hz to 50 kHz
−65 dB (0.056%) or 38 μV, 50 to 100 kHz
Impedance: 600 Ω ±1% or 50 Ω ±2%, front-panel selectable (HP-IB programmable)
Sweep Mode: Log sweep with up to 500 points per decade or 255 points total between entered start and stop frequencies.

Analyzer Specifications (both HP 8903B and HP 8903E)

Distortion
Fundamental Frequency Range: 20 Hz to 100 kHz
Display Range: 0.001% to 100% (−99.99 to 0 dB)
Accuracy: ±1 dB, 20 Hz to 20 kHz; ±2 dB, 20 kHz to 100 kHz
Input Voltage Range: 50 mV to 300V
Residual Distortion and Noise (the higher of):
80 kHz BW: −80 dB (0.01%) or 15 μV, 20 Hz to 20 kHz
500 kHz BW: −70 dB (0.032%) or 45 μV, 20 Hz to 50 kHz
−65 dB (0.056%) or 45 μV, 50 kHz to 100 kHz
Supplemental Characteristics
3 dB measurement bandwidth: 10 Hz to 500 kHz
Detection: true rms or rms calibrated average

SINAD
Fundamental Frequency Range: 20 Hz to 100 kHz
Display Range: 0 to 99.99 dB
Residual Distortion and Noise: Same as listed under Distortion
Accuracy: ±1 dB, 20 Hz to 20 kHz; ±2 dB, 20 to 100 kHz
Input Voltage Range: 50 mV to 300 V
Supplemental Characteristics
Detection: True rms or rms-calibrated average
Tuning: HP 8903B: Notch filter is tuned to the internal source frequency. HP 8903E: Notch filter is tuned to the counted input frequency. Notch filter hold function available on front panel.

ac Level
Full Range Display: 300 V, 30 V, 3 V, 0.3 V, 30 mV, 3 mV, 0.3 mV
Overrange: 33%, except on 300 V range
Accuracy: ±2%, 50 mV to 300 V, 20 Hz to 20 kHz; ±4%, 0.3 to 50 mV, 20 Hz to 100 kHz; ±4%, 50 mV to 300 V, 20 to 100 kHz
Supplemental Characteristics
ac converter: True-rms responding for signals with crest factor up to 3, rms-calibrated average detection and quasi-peak
3 dB measurement bandwidth: >500 kHz

dc Level
Full Range Display: 300 V, 48 V, 16 V, 4 V
Overrange: 33%, except on 300 V range
Accuracy: ±1.0% of reading, 600 mV to 300 V
±6 mV, V_{dc} <600 mV

Frequency Measurement
Measurement Range: 20 Hz to 150 kHz (20 Hz to 100 kHz in distortion and SINAD modes)
Resolution: 5 digits (0.01 Hz for input frequencies <100 Hz)
Accuracy: ±(0.004% + 1 digit)
Sensitivity: 50 mV in distortion and SINAD modes, 5.0 mV in ac level and signal-to-noise (HP 8903B only) modes

Standard Audio Filters
30 kHz Low-Pass Filter
3 dB cutoff frequency: 30 kHz ±2 kHz
Rolloff: Third-order Butterworth; 18 dB/octave or 60 dB/decade
80 kHz Low-Pass Filter
3 dB cutoff frequency: 80 kHz ±4 kHz
Rolloff: Third-order Butterworth; 18 dB/octave or 60 dB/decade

Internal Plug-In Filter Options
Both the HP 8903B and HP 8903E have two internal plug-in filter slots, each of which will accept one of 6 optional filters. The standard HP 8903B/E come with 30 kHz and 80 kHz low-pass filters, but with no plug-in filters. The appropriate filter options must be ordered for the analyzers to have any of the filters listed below. Each filter option has two option numbers: the 010 series for the left filter slot and the 050 series for the right filter slot. Each filter option ordered (maximum of two) adds additional cost to the instrument.

	Option Numbers Filter Position	
Filters	**Left Slot**	**Right Slot**
400 Hz High-Pass	010	050
CCITT Weighting Filter	011	051
CCIR Weighting Filter	012	052
C-MESSAGE Weighting Filter	013	053
CCIR/ARM Weighting Filter	014	054
"A" Weighting Filter	015	055

Analyzer Input
Input Type: Balanced (full differential)
Input Impedance: 100 kΩ ±1% shunted by <300 pF, each side to ground. (In dc-level mode the input resistance is 101 kΩ ±1%.)
Max Input (maximum peak input voltage, any combination of ac/dc):
HP 8903B: 425 V peak, applied differentially or between either input to ground
HP 8903E: 42 V peak, low side to ground
425 V peak, differentially or high side to ground
CMRR: >60 dB, 20 Hz to 1 kHz, V_{dc} <2 V; >45 dB, 20 Hz to 1 kHz; >30 dB, 20 Hz to 20 kHz

General
Temperature: Operating, 0° to 55° C; storage, −55° to 75° C
Power: 100, 120, 220, or 240 V (+5, −10%); 48 to 66 Hz. 100 or 120 V (+5, −10%); 48 to 440 Hz. 100 VA maximum
Weight: HP 8903B: Net, 12.3 kg (27 lb); shipping, 16.4 kg (36 lb). HP 8903E: Net, 11.8 kg (26 lb); shipping, 15.9 kg (35 lb)
Size: 146 mm H × 425 mm W × 462 mm D (5.75 in × 16.8 in × 18.2 in)

Ordering Information

	Price
Analyzer mainframes	
HP 8903B Audio Analyzer[1]	$6,720
Opt 001 Input/Output Connectors on Rear Panel Only	+$115
Opt 910 Two sets of Operation/Calibration (08903-90079) and Service Manuals (08903-90062)	+ $285 ☎
Opt 915 Service Manual (08903-90062)	+ $120 ☎
Opt W30 Extended Repair Service (see page 636)	+ $150
Opt W32 Calibration Service (see page 636)	+ $765
HP 8903E Distortion Analyzer[1]	$4,610
Opt 001 Input/Output Connectors on Rear Panel Only	+ $225
Opt 910 Additional Operation and Calibration Manual (08903-90053) and Two Service Manuals (08903-90065)	+ $295 ☎
Opt 915 Add Service Manual (08903-90065)	+ $132 ☎
Opt W30 Extended Repair Service (see page 636)	+ $95
Opt W32 Calibration Service (see page 636)	+ $405
Options for both HP 8903B and HP 8903E	
Opt 010 or 050 400 Hz High-Pass Filter	+ $235
Opt 011 or 051 CCITT Weighting Filter	+ $235
Opt 012 or 052 CCIR Weighting Filter	+ $235
Opt 013 or 053 C-Message Weighting Filter	+ $235
Opt 014 or 054 CCIR/ARM Weighting Filter	+ $235
Opt 015 or 055 "A" Weighting Filter	+ $235
Opt 907 Front Handle Kit (5061-9689)	+ $55 ☎
Opt 908 Rack Flange Kit (5061-9677)	+ $32.50 ☎
Opt 909 Rack Flange Kit (5061-9683) with Front Handles	+ $80 ☎

[1]HP-IB cables not included. For description and price, see page 124.

☎ For off-the-shelf shipment, call 800-452-4844.

SIGNAL ANALYZERS

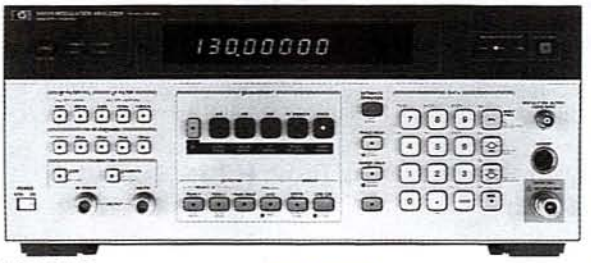
Modulation Analyzer, 150 kHz to 1300 MHz, AM/FM Test Source

HP 8901A, 8901B, 11715A

- Measures AM and FM to 1% accuracy
- Measures RF frequency
- Measures RF power
- Low internal noise
- Completely automatic

HP 8901A

DESIGNED FOR HP-IB SYSTEMS



HP 8901B

DESIGNED FOR HP-IB SYSTEMS

HP 8901A and HP 8901B Modulation Analyzers

The HP 8901A and HP 8901B modulation analyzers combine the capabilities of several RF instruments to give complete, accurate characterization of modulated signals in the 150 kHz to 1300 MHz frequency range. Both instruments very accurately measure modulation and recover the modulation signal. They determine RF frequency and measure RF power. The major additional capabilities of the HP 8901B are its improved power-meter accuracy, its ability to use external power sensors, its ability to make adjacent-channel power measurements or carrier-noise measurements (with Options 030 through 037), and its ability to count audio frequencies and measure distortion on 400 Hz and 1 kHz signals. Both instruments are fully automatic and make all major measurements at the press of a key or under HP-IB control.

Transmitter Testing

The HP 8901A/B have the features required to perform standard transmitter measurements. They measure transmitter power, count frequency, and measure the signal modulation very accurately. The HP 8901B also characterizes the demodulated audio signal's frequency, level, and distortion. With Option 030 the HP 8901B can quickly and accurately make adjacent-channel power measurements to CEPT standards.

RF Signal Characterization

The HP 8901A/B are excellent lab & production tools for accurately characterizing RF signals.

Use the HP 8901A/B to make accurate AM/ΦM and FM/AM conversion measurements of phase- and amplitude-sensitive devices such as bandpass filters and multiple-channel receivers. Excellent isolation between AM and FM make it simple to separate the AM and ΦM of AM stereo, the incidental AM of FM transmitters, and the AM, FM, and ΦM components of complex signals.

Automatic Test Systems

The HP 8901A/B are important components of automatic RF test systems. All functions are fully automatic and easily programmed. With these measurements combined into one instrument, interfacing requirements, hardware costs, and software-development time are reduced.

HP 8901A and HP 8901B Specifications

RF Input

Frequency Range: 150 kHz to 1300 MHz
Operating Level: 12 mV rms to 7 V rms
Input Impedance: 50 Ω nominal
Tuning: Manual frequency entry, automatic, or track
Acquisition Time (automatic operation): ~1.5 s
Maximum Safe Input Level (typical): 35 V rms (25 W for source SWR <4), ac; 40 V, dc

Frequency Modulation

Rates: 20 Hz to 200 kHz
Deviations: To 400 kHz
Accuracy:
±2% of reading ±1 digit, 20 Hz to 10 kHz rates, 250 kHz to 10 MHz;
±1% of reading ±1 digit, 50 Hz to 100 kHz rates, 10 to 1300 MHz
Demodulated Output Distortion: <0.1% THD
AM Rejection (for 50% AM at 400 Hz and 1 kHz rates): <20 Hz peak deviation measured in a 50 Hz to 3 kHz BW
Residual FM (50 Hz to 3 kHz BW): <8 Hz rms @ 1300 MHz, decreasing linearly with frequency to <1 Hz rms for 100 MHz and below
Maximum Deviation Resolution: 1 Hz
Stereo Separation (50 Hz to 15 kHz): >47 dB typical

Phase Modulation

Carrier Frequency: 10 to 1300 MHz
Rates: 200 Hz to 20 kHz; typically usable from 20 Hz to 100 kHz with degraded performance
Deviation: To 400 radians
Maximum Deviation Resolution: 0.001 radian
Accuracy: ±3% of reading ±1 digit
Demodulated Output Distortion: <0.1% THD
AM Rejection (for 50% AM at 1 kHz rate): <0.03 radian peak deviation (50 Hz to 3 kHz BW)

Amplitude Modulation

Rates: 20 Hz to 100 kHz
Depth: To 99%
Accuracy
±2% of reading ±1 digit, 50 Hz to 10 kHz rates, 150 kHz to 10 MHz
±1% of reading ±1 digit, 50 Hz to 50 kHz rates, 10 to 1300 MHz
Flatness (variation in indicated AM depth for constant depth on input signal): ±0.3% of reading ± 1 digit
Demodulated Output Distortion: <0.3% THD
FM Rejection (at 400 Hz and 1 kHz rates, 50 Hz to 3 kHz BW): <0.2% AM
Residual AM (50 Hz to 3 kHz BW): <0.01% rms
Maximum Depth Resolution: 0.01%

Frequency Counter

Range: 150 kHz to 1300 MHz
Accuracy: ±3 counts of least significant digit ± reference accuracy
Internal Reference
Frequency: 10 MHz
Aging rate: $<1 \times 10^{-6}$/month (optional: 1×10^{-9}/day)
Maximum Resolution
HP 8901A: 10 Hz for frequencies <1 GHz; 100 Hz for frequencies ≥1 GHz
HP 8901B: 1 Hz

HP 8901A RF Level (Peak Voltage Responding, RMS Sine Wave Power Calibrated)

Range: 1 mW to 1 W
Instrumentation Accuracy: ±1.5 dB
SWR: ≤1.3, 150 kHz to 650 MHz; ≤1.5, 650 to 1300 MHz
Maximum Resolution: 0.001 mW for levels <0.01 W

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 8901B RF Level (True RMS)

Frequency Range with HP 11722A: 100 kHz to 2.6 GHz
Power Range: −20 to +30 dBm
RF Range-to-Range Change Error: ±0.02 dB/RF range change from reference range
Input SWR: <1.15, using HP 11722A sensor module
Zero Set (digital settability of zero):
±0.5% ±1 digit of full scale on lowest range (decrease by a factor of 10 for each high range)
RF Power Resolution:
0.1% of full scale in watts or volts mode
0.001 in dBm or dB relative mode

HP 8901B Selective Power Measurements (Options 030 Through 037)

Frequency Range: 10 MHz to 1.3 GHz
Carrier Power Range: +30 to −20 dBm, 12.5, 25 and 30 kHz filters; +30 to −10 dBm, carrier noise filter
Dynamic Range: 115 dB
Carrier Rejection (temp. ≤35° C): >90 dB for offsets ≥1 channel spacing or 5 kHz, whichever is larger
Relative Accuracy: ±0.5 dB, levels ≥ −95 dBc or levels ≥ −129 dBc/Hz

Power Reference

Power Output: 1.00 mW, factory set to ±0.7%, traceable to the U.S. National Institute of Standards and Technology
Accuracy: ±1.2% worst case (±0.9% rss) for one year (0° to 55° C)

Audio Filters

High-Pass (3 dB cutoff frequency): 50 Hz and 300 Hz
Low-Pass (3 dB cutoff frequency except >20 kHz filter): 3 kHz, 15 kHz, >20 kHz
De-emphasis Filters: 25 μs, 50 μs, 75 μs, and 750 μs

Calibrators (Standard HP 8901B, Option 010 HP 8901A)

AM Calibrator Depth and Accuracy: 33.33% depth, nominal; internally calibrated to an accuracy of ±0.1%
FM Calibrator Deviation and Accuracy: 34 kHz peak deviation, nominal; internally calibrated to an accuracy of ±0.1%

General Characteristics

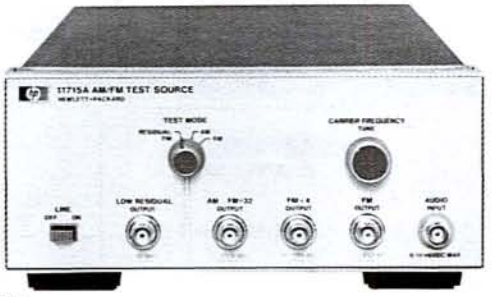
Operating Temperature Range: 0° to 55° C
Power Requirements: 100, 120, 220, or 240V (+5%, −10%); 48 to 66 Hz; 200 VA max
Weight: HP 8901A: Net, 20 kg (44 lb); shipping, 25 kg (55 lb); HP 8901B: Net, 23 kg (52 lb); shipping, 31 kg (69 lb)
Size: HP 8901A: 190 mm H × 425 mm W × 468 mm D (7.5 in × 16.8 in × 18.4 in); HP 8901B: 190 mm H × 425 mm W × 551 mm D (7.5 in × 16.8 in × 21.7 in)

Ordering Information

	Price
HP 8901A/HP 8901B	
HP 8901A Modulation Analyzer[1]	$11,045
Opt 001 RF Connectors on Rear Panel Only	+$260
Opt 002 1×10⁻⁹/Day Internal Reference	+$880
Opt 003 Connections for External Local Oscillator	+$490
Opt 004 Operation from 48 to 440 Hz Power (temp. <40° C)	+$330
Opt 010 AM and FM Calibrators	+$730
Opt 907 Front Handle Kit (5061-9690)	$67
Opt 908 Rack Flange Kit (5061-9678)	$36
Opt 909 Front Handle & Rack Flange Kit (5061-9684)	$93
Opt 910 2 sets of Operating (08901-90135) and Service Manuals (08901-90136)	+$255
Opt 915 Service Manual (08901-90136)	+$103
Opt W30 Extended Repair Service (see page 636)	+$235
Opt W32 Calibration Service (see page 636)	+$520
HP 8901B Modulation Analyzer[1]	$15,475
Opt 021 Add HP 11722A Sensor Module	+$2,480
Opt 030 High Selectivity (select only 2 filter options) (Options 032 through 037 require Option 030; Option 030 includes Option 003 connections for external local oscillators.)	+$2,860
Opt 032 12.5 kHz Filter	$0
Opt 033 20.0/25.0 kHz Filter	$0
Opt 035 Cellular Radio Filter	$0
Opt 037 Carrier Noise Filter	$0

[1]HP-IB cables not included. For description and prices, see page 124.

Opt 910 2 sets of Operation/Calibration (08901-90113) and Service Manuals (08901-90114)	+$370
Opt 915 Service Manual (08901-90114)	+$155
Opt W30 Extended Repair Service (see page 636)	+$335
Opt W32 Calibration Service (see page 636)	+$520



HP 11715A

HP 11715A AM/FM Test Source

The HP 11715A AM/FM test source provides very flat, wide-bandwidth, and low-distortion amplitude- or frequency-modulated RF signals. Designed primarily for performance tests and adjustments of the HP 8901A/B modulation analyzer and HP 8902A measuring receiver, it will also serve as a high-quality modulated test oscillator where its frequency ranges apply.

The major components of the HP 11715A are a low-noise voltage-controlled oscillator (VCO), 2 digital dividers, and a double-balanced mixer. The VCO is the primary signal source, with a typical frequency range of 330 to 470 MHz at the FM output. FM is produced by directly coupling the external modulation source to the VCO's tune input, providing very wide bandwidth modulation with low phase shift. This design also ensures very little incidental AM.

The HP 11715A can also be used in conjunction with an HP 8901A/B and an HP 8902A as a calibrated signal source for special applications. In particular, the U.S. commercial FM broadcast band of 88 to 108 MHz is covered by the FM ÷ 4 output of the HP 11715A.

HP 11715A Specifications

FM Outputs

Frequency Range:
11 to 13.5 MHz, AM FM ÷ 32 output
88 to 108 MHz, FM ÷ 4 output
352 to 432 MHz, FM output
Peak Deviation:
>12.5 kHz, 11 to 13.15 MHz carrier
>100 kHz, 88 to 108 MHz carrier
>400 kHz, 352 to 432 MHz carrier
Distortion: <0.025% THD (< −72 dB) for

Carrier Frequency	Peak Deviation	Modulation Rate
12.5 MHz	12.5 kHz	<10 kHz
100 MHz	100 kHz	<100 kHz
400 MHz	400 kHz	<100 kHz

Flatness:
±0.1%, dc to 100 kHz rates ±0.25%, dc to 200 kHz rates
Stereo Separation (88 to 108 MHz carrier, 75 kHz peak deviation, 1 kHz rate): >60 dB typical

AM Output

Frequency Range (AM/FM ÷ 32 output): 11 to 13.5 MHz
Depth: To 99%
Distortion:
<0.05% THD (< −66 dB), 50% AM, 20 Hz to 100 kHz rates
<0.1% THD (< −60 dB), 95% AM, 20 Hz to 100 kHz rates
Flatness: ±0.1%, 50 Hz to 50 kHz rates;
±0.25%, 20 Hz to 100 kHz rates
Linearity: ±0.1%, <95% AM; ±0.2%, <99%

Ordering Information

	Price
HP 11715A AM/FM Test Source	$2,910
Opt 910 a total of 2 sets of Operating and Service Manuals (11715-90004)	+$25

For off-the-shelf shipment, call 800-452-4844.

SIGNAL ANALYZERS

Measuring Receiver, 150 kHz to 1300 MHz

HP 8902A

- RF power: digital power meter accuracy
- Tuned RF level: 0 to −127 dBm dynamic range
- Carrier noise: AM and phase noise measurements to −140 dBc/Hz
- AM and FM: 1% accuracy; ØM: 3% accuracy
- RF frequency: 1 Hz resolution
- Audio: level, frequency, and distortion

HP 8902A

DESIGNED FOR HP-IB SYSTEMS

HP 8902A Measuring Receiver

The HP 8902A measuring receiver combines 6 precise measurement functions into one fully automatic, HP-IB programmable instrument. It accurately measures RF power, tuned RF level, carrier noise/adjacent channel power, modulation, and RF frequency, and characterizes audio signals. For precise signal analysis, the HP 8902A measuring receiver provides the performance you need.

Metrology and Calibration

The HP 8902A measuring receiver makes signal generator and attenuator calibration easier than ever before. As the main component in the HP 8902AT attenuator calibration system and the HP 8902SG signal generator test system, the HP 8902A provides exceptional accuracy, wide dynamic range, and a broad range of measurements.

The HP 8902A quickly and accurately measures your signal generator's RF frequency, RF level flatness, output level accuracy to −127 dBm, AM and FM with 1% accuracy, incidental and residual AM, FM and phase modulation, and carrier noise down to −140 dBc/Hz, and characterizes the demodulated audio signals.

For attenuator calibration and other relative measurements, the HP 8902A gives you great accuracy and dynamic range. Option 050 provides ±(0.015 dB + 0.005 dB/10 dB) relative power accuracy to test attenuators to the most stringent specifications.

RF Signal Characterization

The HP 8902A measuring receiver is an excellent lab and production tool for accurately characterizing RF signals from 150 kHz to 1300 MHz.

Level measurements down to −127 dBm with superb accuracy make the HP 8902A ideal for testing devices such as antennas, multiplexers, log/linear amplifiers, filters, and mixers. Unlike diode detectors, the HP 8902A's power meter accurately measures signals with harmonics and spurious.

The HP 8902A makes accurate AM-to-ØM and FM-to-AM conversion measurements of phase- and amplitude-sensitive devices, such as bandpass filters and multiple-channel receivers. Excellent isolation between AM and FM makes it simple to separate the AM and ØM of AM stereo, the incidental AM of FM transmitters, and the AM, FM, and ØM components of complex signals.

Automatic Test Systems

The HP 8902A is an important component of automatic RF test systems. All functions—power, level, frequency count, carrier noise, modulation, audio analysis—are fully automatic and easily programmed. With these measurements combined in one instrument, interfacing requirements, hardware costs, and software development time are reduced.

HP 8902A Specifications

RF Power (with HP 11722A Sensor Module)

Range: +30 dBm (1W) to −20 dBm (10 μW)
Frequency Range: 0.1 MHz to 2.6 GHz
Linearity: ±0.02 dB (within range) ±0.02 dB per range change from reference range ± 1 count LSD
Input SWR: <1.15

Tuned RF Level

Range: 0 to −127 dBm
Frequency Range: 2.5 to 1300 MHz
Relative Accuracy: ±0.02 dB ± 0.02 dB per IF range change ±0.04 dB per RF range change ± 1 digit
Worst-Case Cumulative Relative Power Accuracy (with Opt 050[1,2]): ±0.005 dB/10 dB step (0 to −100 dBm)
±0.050 dB/10 dB step (−100 to −120 dBm)
±0.015 dB ±1 digit

Selective Power Measurements (Carrier Noise, Options 030 to 037)

Frequency Range: 10 to 1300 MHz
Carrier Power Range:
+30 dBm to −20 dBm: 12.5 kHz, 25 kHz and 30 kHz filters
+30 dBm to −10 dBm: carrier noise filter
Relative Measurement Accuracy:
±0.5 dB; levels > −95 dBc: 12.5 kHz, 25 kHz and 30 kHz filters
±0.5 dB; levels > −129 dBc/Hz: carrier noise filter
Filter Bandwidths: 2.5 kHz, carrier noise filter; 8.0 kHz, 12.5 kHz filter; 16.0 kHz, 25 kHz filter; 30.0 kHz, cellular radio filter

RF Frequency

Range: 150 kHz to 1300 MHz
Maximum Resolution: 1 Hz

Amplitude Modulation

Rates: 20 Hz to 100 kHz
Depths: To 99%
Accuracy: ±1% of reading ±1 digit, for rates 50 Hz to 50 kHz and depths ≥5%

Frequency Modulation

Rates: 20 Hz to 200 kHz
Deviations: To 400 kHz
Accuracy: ±1% of reading ±1 digit, for rates 50 Hz to 100 kHz

Phase Modulation

Rates: 200 Hz to 20 kHz
Deviations: To 400 radians
Accuracy: ±3% of reading ±1 digit

Audio Level, Frequency, and Distortion Capability

Audio Level Accuracy: ±4% of reading, 100 mV to 3V
Audio Frequency Display Resolution: 6 digits, to 250 kHz
Audio Distortion Accuracy: ± 1 dB, 400 Hz and 1 kHz

[1]Specifications are warranted when using a Hewlett-Packard synthesized source with less than 100 Hz peak residual FM measured in a 3 kHz post-detection bandwidth over a 30-second period.
[2]Accuracy specifications do not include mismatch uncertainty.

Ordering Information	Price
HP 8902A Measuring Receiver[1]	$28,985
Opt 001 Rear Panel Instead of Front Panel Connections for Input, Modulation Output, and Calibrators	+$260
Opt 002 1×10^{-9}/Day Internal Reference Oscillator	+$880
Opt 003 Rear Panel External LO Connectors	+$490
Opt 004 Operation from 48 to 440 Hz Power Line (temp. <40°C)	+$330
Opt 021 Add HP 11722A Sensor Module	+$2,480
Opt 030 High Selectivity (select only two filter options)	+$2,860
(Options 032 to 037 require Option 030. Option 030 includes Option 003 connections for external local oscillator.)	
Opt 032 12.5 kHz Filter	$0
Opt 033 25.0 kHz Filter	$0
Opt 035 Cellular Radio Filter	$0
Opt 037 Carrier Noise Filter	$0
Opt 050 Increased Power Measurement Accuracy	+$4,160
Opt 907 Front Handle Kit (5061-9690)	+$67
Opt 908 Rack Flange Kit (5061-9678)	+$36
Opt 909 Rack Flange Kit (5061-9684) with Front Handles	+$93
Opt 910 Additional Operation and Calibration Manual (08902-90029) and 2 Service Manuals (08902-90031)	+$370
Opt 915 Add Service Manual (08902-90031)	+$155
Opt W30 Extended Repair Service (see page 636)	$380
Opt W32 Calibration Service (see page 636)	$475

☎ For off-the-shelf shipment, call 800-452-4844.

[1]HP-IB cables not included. For description and prices, see page 124.

HP 11812A

HP 11812A Verification Kit

The HP 11812A verification kit is available to verify the performance of the HP 8902A Option 050 tuned RF level function to ±(0.015 dB + 0.010 dB/10 dB step). The kit consists of a step attenuator, two 10 dB pads semi-permanently attached, a cable, and a case.

HP 11812A Specifications

Frequency: 30 MHz
HP 11812A Accuracy: ±(0.003 dB + 0.003 dB/10 dB step)
Option 050 Worst-Case Cumulative Tuned RF Level Accuracy Verified with the HP 11812A:
±0.010 dB/10 dB step (0 to −100 dBm)
±0.050 dB/10 dB step (−100 to −120 dBm)
±0.015 dB ±1 digit

Ordering Information	Price
HP 11812A Verification Kit	$2,315

HP 11722A Sensor Module (100 kHz to 2.6 GHz)[1]

The HP 11722A sensor module was designed for use with the HP 8901B modulation analyzer and the HP 8902A measuring receiver. The HP 11722A contains a silicon monolithic thermocouple as a power-sensing element.

With the HP 11722A sensor module, you get all the performance of the HP 8901B or HP 8902A, plus superb power-measurement accuracy, at a single connector. You can characterize a signal without switching back and forth between the power sensor and the analyzer's RF input.

Ordering Information	Price
HP 11722A Sensor Module (100 kHz to 1300 MHz)	$2,480

Extend the HP 8902A to Microwave with the HP 8902S Measurement System

HP 8902S System

The HP 8902S system extends the frequency range of the HP 8902A by adding the HP 11793A microwave converter and a local oscillator. With the HP 11792A sensor module, the system delivers the accuracy and resolution of a high-performance power meter to 26.5 GHz from +30 to −100 dBm. The extended system counts signals to 26.5 GHz with 10 Hz resolution and excellent long-term frequency stability.

HP 11793A Microwave Converter

The HP 11793A microwave converter downconverts microwave signals to the frequency range of the HP 8902A measuring receiver. For signals above 1.3 GHz, the HP 11793A routes the signal through its internal mixer. Below 1.3 GHz, signals are routed directly to the input of the HP 8902A.

The HP 11793A requires +8 dBm leveled output from the local oscillator. For LOs with insufficient power above 18 GHz, the HP 11793A offers an optional 18 to 26.5 GHz amplifier.

HP 11792A Sensor Module (50 MHz to 26.5 GHz)[1]

The HP 11792A sensor module gives you all the performance of the HP 8902S system, plus superb power-measurement accuracy, at a single connector. You can characterize a signal without manually switching between the power sensor and the receiver input.

Ordering Information	Price
HP 8902S Measuring System	
(For complete ordering information see HP 8902S Measurement System Ordering Information guide, or call your HP sales office.)	
HP 11793A Microwave Downconverter	$8,585
Opt 001 Add 18 to 26.5 GHz Amplifier	+$11,635
Opt 010 Front Right LO Input Connector	+$230
Opt 011 Amplifier and Front Right LO Connector	+$11,850
Opt 020 Rear Panel Connector	+$230
Opt 021 Amplifier and Rear Panel Connector	+$11,850
Opt 907 Front Handle Kit (5062-3988)	+$50
Opt 908 Rack Mount Flange Kit (5062-3974)	+$31
Opt 909 Handles w/Rack Mount Flange Kit (5062-3975)	+$73
HP 11792A Sensor Module (50 MHz to 26.5 GHz)	$4,440

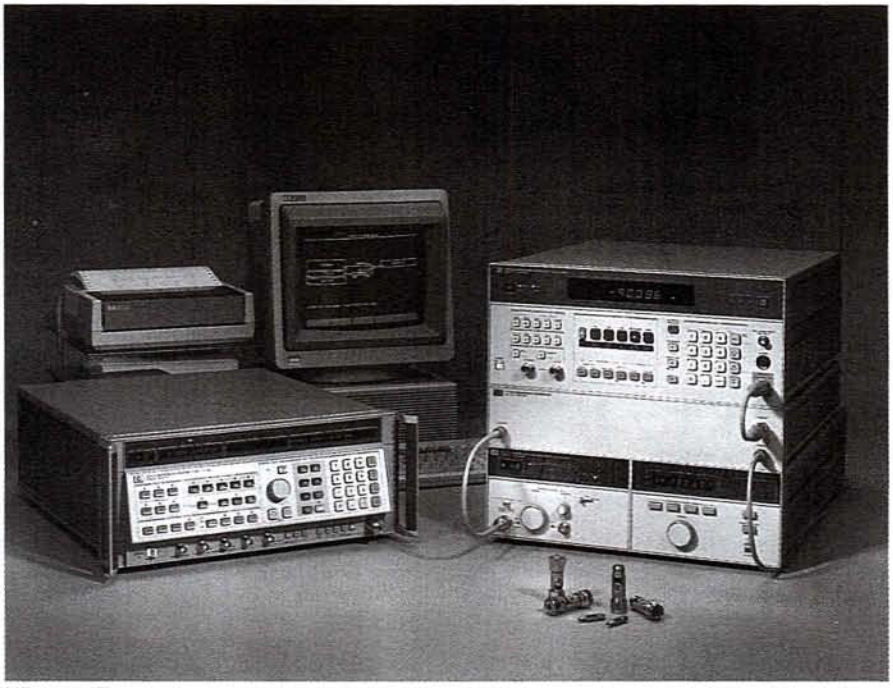
[1]Each HP 11722A and HP 11792A sensor module is individually calibrated, traceable to the U.S. National Institute of Standards and Technology. The calibration factors are printed on the sensor module for fast reference. Enter these factors into the HP 8902A's non-volatile memory and the instrument automatically compensates for the power sensor's efficiency and mismatch loss at each frequency.

SIGNAL ANALYZERS

Attenuator Calibration System

HP 8902AT, 11806B, 11823A/B/C

- Exceptional accuracy
- 100 dB dynamic range
- Tests fixed, manual, and programmable attenuators
- 10 MHz to 26.5 GHz



HP 8902AT

HP 8902AT Attenuator Calibration System

The HP 8902AT offers an automated solution for attenuator calibration. It is configured for optimal performance from 10 MHz to 18 GHz. Option 026 extends its performance to 26.5 GHz. The HP 8902AT combines the exceptional accuracy of the HP 8902A Option 050 with HP 11806B attenuator test software to give you precise results with the speed provided by automation.

The HP 8902AT minimizes measurement uncertainty by specifying attenuation accuracy, monitoring the output power of the attenuator source, and automatically adjusting for any amplitude instabilities. This provides you with state-of-the-art accuracy, simply and repeatably.

The HP 8902AT includes the HP 11806B attenuator test software, the HP 8902A Option 050 measuring receiver, the HP 11793A Option H05 microwave converter, a local oscillator, an attenuator source, a power splitter, a power sensor, an attenuator accessory kit, and an SWR accessory kit. For a detailed list of equipment, see the HP 8902S Ordering Guide.

Accessory Kits

The HP 8902AT attenuator calibration system includes an attenuator accessory kit and an SWR accessory kit. The HP 11823A/B attenuator accessory kit includes 10 dB matching attenuators and adapters to test attenuators, with Type N, APC-3.5, and APC-7 connectors. The HP 11823C SWR accessory kit includes precision SWR bridges, opens, shorts, and terminations.

HP 11806B Attenuator Test Software

The HP 11806B attenuator test software provides the efficiency and repeatability of automation for attenuator calibration. By entering a table of frequencies, levels, and specification limits, you can test any RF or microwave attenuator—fixed, manual or programmable—quickly and accurately.

The HP 11806B offers flexibility and ease of use with user-selectable averaging, various output formats, and flexible hardware configurations. With additional features such as statistical analysis, multiple test frequencies, and support of multiple attenuator sources, the HP 11806B is the ideal software for all your attenuator-calibration needs.

HP 8902AT Specifications

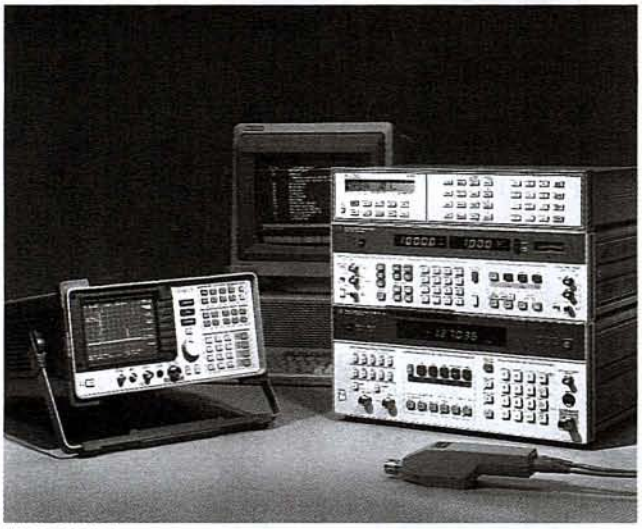
Frequency Range: 10 MHz to 18 GHz
10 MHz to 26.5 GHz, Opt 026

Dynamic Range: +10 to −117 dBm, 10 to 1300 MHz
0 to −100 dBm, 1300 MHz to 18 GHz
0 to −95 dBm, 18 GHz to 26.5 GHz

Ordering Information	Price
HP 8902AT Attenuator Calibration System	$148,170
Opt 026 26.5 GHz Coverage	+$44,520
HP 11806B Attenuator Test Software	+$3,500
HP 11823A Attenuator Accessory Kit (18 GHz systems)	+$6,210
HP 11823B Attenuator Accessory Kit (26.5 GHz systems)	+$7,340
HP 11823C SWR Accessory Kit (18 GHz systems)	+$22,055

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Frequency coverage to 26.5 GHz
- Powerful software for ease of test modification
- Fully automated system: more thorough testing in less time
- Fast, accurate, and repeatable measurements



HP 8902SG

HP 8902SG Signal Generator Operation Verification System

The HP 8902SG signal generator operation verification system provides a versatile and powerful solution for testing RF and microwave signal generators. System hardware provides accurate measurements; dedicated software adds flexibility, speed, and ease of use.

The standard system includes an HP 8902A measuring receiver, an HP 8903B audio analyzer, an HP 8562B spectrum analyzer, and an HP 3488A switch control unit to provide complete automation. The HP 11808A signal generator operation verification software is included, as are all cables and adapters required to complete the system. Options 018 and 026 add the HP 11793A microwave converter and a synthesized local oscillator to extend measurement capabilities to microwave frequencies.

Many common signal generator performance tests can be run with the HP 8902SG. Tests such as Output Level Accuracy, Output Flatness, and AM and FM Accuracy are but a few of those available. The system can be expanded to offer additional tests, such as Pulse Rise/Fall Time and Third Order Intermodulation Distortion. The system is intended to provide a 90% confidence level for the operation of the synthesizers tested.

HP 8902SG Specifications

HP 8902A Abbreviated Specifications

RF Frequency

Range: 150 kHz to 1300 MHz, standard system
150 kHz to 18 GHz, Opt 018
150 kHz to 26.5 GHz, Opt 026

RF Power

Range: +30 dBm to −20 dBm, standard system
+30 dBm to −20 dBm, Opts 018 and 026
Frequency Range: 100 kHz to 2600 MHz, standard system
50 MHz to 18 GHz, Opt 018
50 MHz to 26.5 GHz, Opt 026

Tuned RF Level

Frequency Range: 2.5 to 1300 MHz, standard system
2.5 MHz to 18 GHz, Opt 018
2.5 MHz to 26.5 GHz, Opt 026
Range: +10 to −117 dBm, 2.5 to 1300 MHz,
0 to −100 dBm, 1300 MHz to 18 GHz (Opts 018 and 026)
0 to −95 dBm, 18 to 26.5 GHz (Opt 026)
Relative Accuracy: ±0.02 dB per IF range change ±0.04 dB per RF range change ±1 digit.

Amplitude Modulation

Rates: 20 Hz to 100 kHz
Depths: To 99%
Accuracy: ±1% of reading ±1 digit, for rates 50 Hz to 50 kHz and depths ≥5%

Frequency Modulation

Rates: 20 Hz to 200 kHz
Deviations: To 400 kHz
Accuracy: ±1% of reading ±1 digit, for rates 50 Hz to 100 kHz

Phase Modulation

Rates: 200 Hz to 20 kHz
Deviations: To 400 radians
Accuracy: ±3% of reading ±1 digit

HP 8903B Abbreviated Specifications

Audio Source

Frequency Range: 20 Hz to 100 kHz
Frequency Accuracy: 0.3% of setting

Audio Analyzer

Distortion Frequency Range: 20 Hz to 100 kHz fundamentals
Distortion Accuracy: ±1 dB, 20 Hz to 20 kHz

General

Temperature: Operating, 0° to 55° C; storage, −25° to 75° C
Power: 100, 120, 220, or 240V (+5%, −10%); 48 to 66 Hz

HP 11808A Signal Generator Performance Test Software

The HP 11808A software provides 29 common performance tests for RF and microwave signal generators. The software is structured so that tests are defined by data files; data files for many HP signal generators are included with the software and others can be created through simple screen entries.

The software supports the equipment in the HP 8902SG configurations as well as other types, such as digital scopes, digital voltmeters, and function generators. Instruments in the system can be indicated quickly in the program through the use of softkeys and the configuration can be stored for later use.

Ordering Information	Price
HP 8902SG Signal Generator Test System	$92,350
Opt 018 Extension to 18 GHz Operation	+$43,650
Opt 026 Extension to 26.5 GHz Operation	+$70,450
HP 11808A Signal Generator Performance Test Software	$6,255

ANTENNA & RADAR CROSS-SECTION MEASUREMENTS

Antenna/RCS Measurement Systems, 45 MHz to 110 GHz

HP 85301B/C, 8530A

HP 85301B antenna/RCS measurement system in a compact test range

- Measurement speeds of up to 5000 points/second
- Fast multiple-channel measurements
- Excellent microwave performance and accuracy
- Manual or automated operation
- Built-in graphical display and analysis capability

HP 85301B/C Antenna/RCS Measurement Systems

Systems Designed for Productivity

Maintaining a competitive edge requires a measurement system with the greatest accuracy, reliability, and productivity available. Hewlett-Packard measurement systems provide complete solutions with the excellent performance, accuracy, and features you need. HP also offers complete system support you can depend on.

Antenna Measurement Systems

A complete antenna measurement solution must have the flexibility to measure a variety of antennas, as well as the features and performance to test the most challenging and complex antennas. The HP 85301B/C antenna measurement systems meet these demanding requirements.

The HP 85301B system includes an HP 8530A microwave receiver and an HP 85310A distributed frequency converter with remote mixers. These mixers can be located directly at the antenna under test. This system provides the best microwave performance, highest measurement sensitivity, and greatest measurement flexibility available. It features broadband coaxial mixers that cover the 0.3- to 50-GHz frequency range, and it has the ability to extend frequency coverage to 110 GHz by using the HP 85325A millimeter-wave subsystems. Standard options allow for 26.5-, 40-, or 50-GHz transmit sources, transmit amplifiers, remote local oscillator, and time domain and network-analysis capability.

The HP 85301C antenna measurement system includes an HP 8530A microwave receiver with an HP 8511A or HP 8511B frequency converter. It features good microwave performance, an economical price, and broad frequency coverage from 45 MHz to 26.5 or 50 GHz.

Radar Cross-Section Measurement Systems

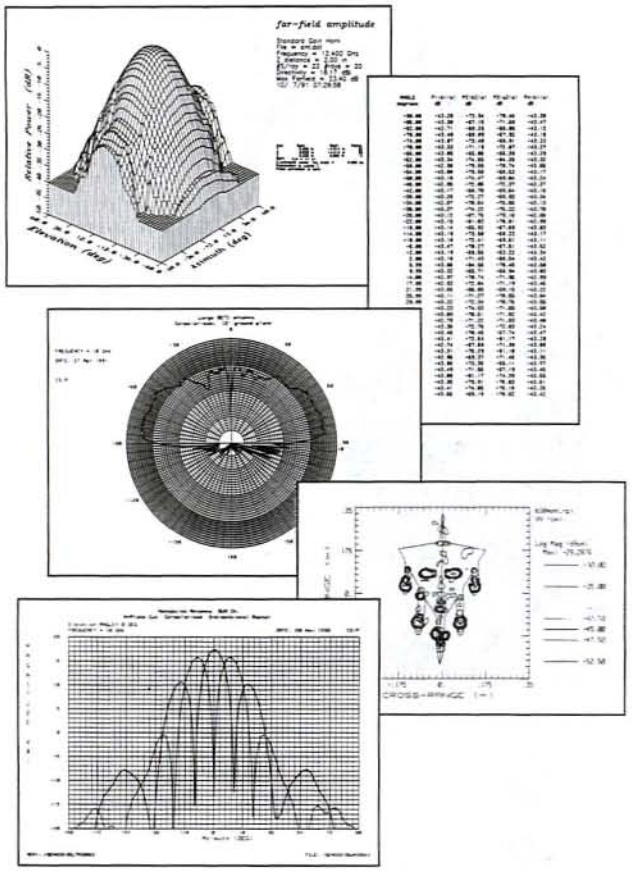
Today's RCS measurements place the greatest demands on measurement systems. The targets are complex and require fine resolution. And complete target characterization requires significant amounts of data. You need a test system that maximizes productivity without compromising accuracy and that is versatile enough to measure any type of target.

The HP 85301B/C measurement systems fulfill the demanding needs of RCS measurements. These systems feature broad frequency capability from 45 MHz to 110 GHz; a choice of frequency downconverters; excellent measurement sensitivity and accuracy; and fast frequency agility, data acquisition speeds, and multiple-channel capability. HP instrumentation is meeting the challenges of RCS measurements in hundreds of RCS facilities worldwide.

Near-Field Antenna Measurement Systems

Complete characterization of an antenna by using near-field measurement techniques requires accurate measurement of thousands of amplitude and phase data points. Maximizing the throughput of the antenna test requires instrumentation with very fast data acquisition speeds, frequency agility, and channel-switching capability.

The HP 85301B/C antenna measurement systems provide data acquisition speeds of up to 5000 data points per second and channel-switching speeds of 250 μs (including data acquisition). Plus, HP systems give you the extremely accurate measurement data required for accurate far-field patterns.



Typical data available from the measurement systems

Measurement Automation Software

HP offers measurement automation software for more productive measurements. Also available are several third-party software programs that provide a variety of acquisition, presentation, and analysis capabilities. By selecting the software that meets your needs, you can standardize your testing, improve your productivity, and make your system easier to use.

Complete Support for Your System

To help ensure complete success, HP offers full support for your system. Support starts with on-site installation, performance verification, and operator training, and it continues with on-site maintenance and repair if required.

Easy Upgrades for Existing Antenna Ranges

The HP 8530A microwave receiver can be a replacement receiver for existing antenna or RCS range receivers. With the HP 85370A antenna positioner encoder, the HP 8530A microwave receiver can be interfaced to virtually any positioning system. Whether you upgrade one component or a complete system, HP provides the reliable instrumentation you need.

Microwave Receiver Upgrade Kits

Any HP 8510 network analyzer can be upgraded to an HP 8530A microwave receiver and still retain network analyzer capability. The HP 85395A/B/C kits provide an on-site upgrade of your existing network analyzer. An HP 8510 upgrade is an economical way to get all the great features that the HP 8530A microwave receiver brings to antenna or RCS testing. HP's upgrade paths protect your capital investment in your measurement systems.

HP 8530A Microwave Receiver

HP 8530A Microwave Receiver

The HP 8530A is a fast and accurate microwave receiver designed for both manual and automated antenna measurement and radar cross-section measurement applications. It features fast data acquisition speeds, excellent sensitivity, wide dynamic range, multiple test channels, and fast frequency agility—without compromising measurement accuracy. The receiver provides broad frequency coverage from 45 MHz to 26.5 GHz, with extensions to 110 GHz.

Productivity features include a large color display of antenna patterns. On-screen active markers provide quick data analysis for manual measurements. For permanent data storage, measured data can be archived to the built-in disk drive or sent to a plotter or printer. The internal serial plotter/printer buffer allows the next measurement to proceed while data is being plotted. Built-in antenna and RCS calibrations enhance the manual measurement capability.

Fast Multiple-Channel Measurements

Fast multiple-channel measurements are easy with the many options available from HP. You can choose from a complete line of PIN switches, with multiple test ports covering 45 MHz to 50 GHz, or you can use internal IF switching within the microwave receiver. HP satisfies the most demanding switching requirements at speeds of up to 5000 switches per second.

Optional Network Analyzer Capability

To increase the utility of the HP 8530A microwave receiver, optional network analyzer capability is available. Additional firmware transforms the HP 8530A to the capabilities of an HP 8510C network analyzer. When used with an S-parameter test set, it can be used to make traditional network analysis measurements on components and materials.

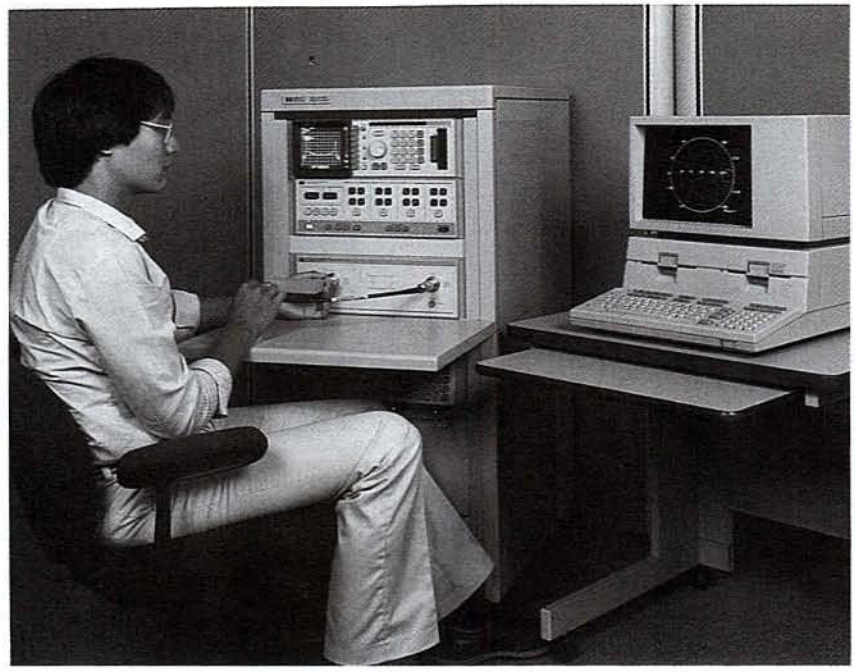
Customized Systems to Meet Your Requirements

The HP 85301B/C measurement systems are customized to fit your individual requirements. HP offers a variety of options to expand the capabilities of the standard systems and also offers customization services to meet unique measurement requirements. HP has microwave systems engineers worldwide who understand your measurement needs and who will work with you to configure a measurement system that meets your specific requirements.

Ordering Information

Please call your local HP sales representative for detailed information about these and other antenna products.
HP 85301B Antenna/RCS Measurement System
HP 85301C Antenna/RCS Measurement System
HP 8530A Microwave Receiver

NETWORK ANALYZERS
Complete Characterization of Linear Networks



Why Network Analysis?

Characterizing the behavior of linear networks that will be stimulated by arbitrary signals and interfaced with a variety of other networks is a fundamental problem in both synthesis and test processes. For example, the engineer designing a multi-component network must predict with some certainty the final network performances from knowledge of the individual components. Similarly, a production manager must know allowable tolerances on the products manufactured and whether the final products meet the specified tolerances. Network analysis offers a solution to these problems through complete description of linear network behavior in the frequency domain. Additionally, some network analyzers offer the capability to transform measurement data, taken in the frequency domain, to the time domain providing further insight into the behavior of linear networks.

Network analysis accomplishes the description of both active and passive networks by creating a data model of such component parameters as impedances and transfer functions. However, these parameters not only vary as a function of frequency but are also complex variables in that they have both magnitude and phase. Swept network analyzers now measure magnitude and phase (the total complex quantity) as a function of frequency with less difficulty than conventional CW measurements. Impedance and transfer functions can then be conveniently displayed on a swept CRT, as in Figure 1, X-Y recorder, or peripherals such as a printer and/or a plotter.

Thus, network analysis satisfies the engineering need to characterize the behavior of linear networks quickly, accurately, and completely over broad frequency ranges. Hewlett-Packard manufactures a full line of scalar network analyzers (magnitude only) and vector network analyzers (both magnitude and phase).

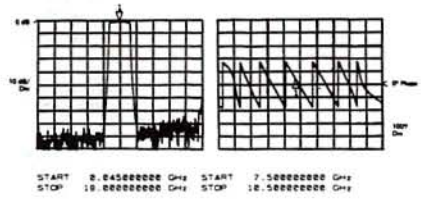


Figure 1. 45 MHz to 18 GHz measurement of magnitude and phase in a single sweep.

What Is Network Analysis?

Network analysis is the process of creating a data model of the transfer and/or impedance characteristics of a linear network through stimulus-response testing over the frequency range of interest. All network analyzers in the HP product line operate according to this definition.

At frequencies above 1 MHz, lumped elements actually become "circuits" consisting of the basic elements plus parasitics like stray capacitance, lead inductance, and unknown absorptive losses. Since parasitics depend on the individual device and its construction they are almost impossible to predict. Above 1 GHz component geometries are comparable to a signal wavelength, intensifying the variance in circuit behavior due to device construction.

Network analysis is generally limited to the definition of linear networks. Since linearity constrains networks stimulated by a sine wave to produce a sine wave output, sine wave testing is an ideal method for characterizing magnitude and phase response as a function of frequency. For non-linear measurements, refer to the sections on spectrum analyzers, wave analyzers (signal analyzers) and vector modulation products in this catalog.

Network Analyzers

Hewlett-Packard network analyzers are instruments that measure transfer and/or impedance functions of linear networks through sine wave testing. A network analyzer system accomplishes these measurements by configuring its various components around the device under test. The first requirement of the measurement system is a sine wave signal source to stimulate the device under test. Since transfer and impedance functions are ratios of various voltages and currents, a means of separating the appropriate signals from the measurement ports of the device under test is required. Finally, the network analyzer itself must detect the separated signals, form the desired signal ratios, and display the results.

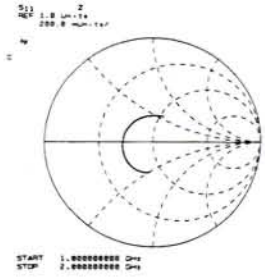


Figure 2. Input impedance of microcircuit amplifier is read directly with Smith Chart overlay for Polar Display.

Signal Sources and Signal Separation

In the general case, any sine wave source meeting the network analyzer's specifications can be used to stimulate the device under test. If the analyzer is capable of swept

measurements, great economies in time can be achieved by stimulating the device under test with a sweep oscillator or synthesized sweeper. This allows quick and easy characterization of devices over broad frequency ranges.

At high frequencies the problem of signal separation usually involves traveling waves on transmission lines and becomes correspondingly more difficult. Hewlett-Packard manufactures test sets applicable for separating the appropriate traveling waves in a variety of high frequency measurements.

Broadband and Narrowband Detection

After the desired signals have been obtained from the test set they must be detected by the network analyzer; HP network analyzers can use one of two detection methods. Broadband detection accepts the full frequency spectrum of the input signal while narrowband detection involves tuned receivers that convert CW or swept RF signals to a constant IF signal. There are certain advantages to each detection scheme.

Scalar analyzers usually employ broadband detection techniques. Broadband detection reduces instrument cost by eliminating the IF section required by narrowband analyzers but sacrifices noise and harmonic rejection. However, noise is not a factor in many applications. Finally, broadband systems can make measurements where the input and output signals are not of the same frequency, as in the measurement of the insertion loss of mixers and frequency doublers. Narrowband systems cannot make these measurements.

Vector network analyzers normally employ narrowband detection techniques. Narrowband detection makes a more sensitive low noise detection of the constant IF possible. This allows increased accuracy and dynamic range for frequency selective measurements (as compared to broadband systems).

Signal Processing and Display

Once the RF has been detected, the network analyzer must process the detected signals and display the measured quantities. All HP network analyzers are multi-channel receivers utilizing a reference channel and at least one test channel; absolute signal levels in the channels, relative signal levels (ratios) between the channels, or relative phase difference between channels can be measured depending on the analyzer.

Relative ratio measurements are usually made in dB, which is the log ratio of an unknown signal (Test Channel) with a chosen reference signal (Reference Channel). This allows the full dynamic range of the instrumentation to be used in measuring variations of both high and low level circuit responses. For example, 0 dB implies the two signal levels have a ratio of unity while ±20 dB implies a 10:1 voltage ratio between two signals.

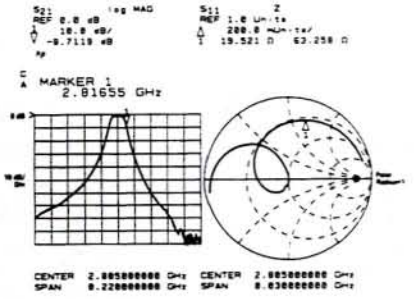


Figure 3. Simultaneous measurement of transmission response and passband reflection coefficient.

All network analyzer phase measurements are relative measurements with the reference channel signal considered to have zero phase. The analyzer then measures the phase difference of the test channel with respect to the reference channel.

Phase information complements amplitude data in the measurement of low frequency parameters. Phase is more sensitive to network behavior and it is a required component of complex impedance and transfer functions.

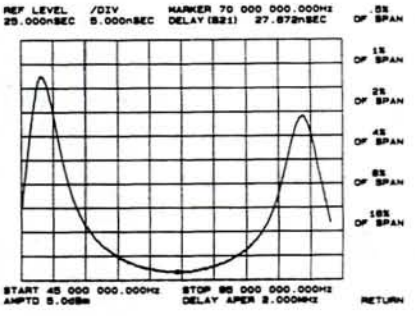


Figure 4. Direct measurement of group delay with digital readout at marker.

Phase data is also required to measure delay distortion or group delay of networks. Delay distortion occurs when different frequency components of a complex waveform experience nonlinear phase shifts as they are transmitted through a network. Group delay is a measure of this distortion and is defined as:

$$Tg = -\frac{d\theta}{d\omega}$$

An alternative method for measuring phase distortion is deviation from linear phase or differential phase. Deviations from linear phase can be measured by introducing enough electrical length in the network analyzer's reference channel to linearize a device's phase shift.

Scattering parameters, or S-parameters, were developed to characterize linear networks at high frequencies. S-parameters define the ratios of reflected and transmitted traveling waves measured at the network ports. A two-port device is modeled with S-parameters in Figure 5. S_{11} is the complex

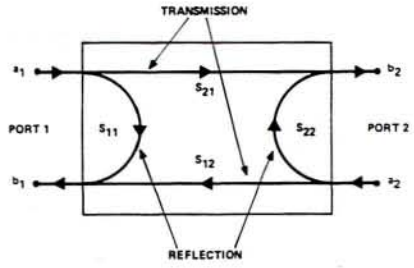


Figure 5. S-parameter model for a two-port linear network.

reflection coefficient at port 1 and is the ratio of b_1/a_1, if $a_2 = 0$ (port 2 terminated in its characteristic impedance). S_{21} is the complex transmission coefficient from port 1 to port 2, b_2/a_1, if $a_2 = 0$. The "a" and "b" signals represent the amplitude and phase of the incident and emerging or reflected traveling waves. By reversing the ports and terminating port 1 in its characteristic impedance, S_{22} and S_{12} can be similarly defined.

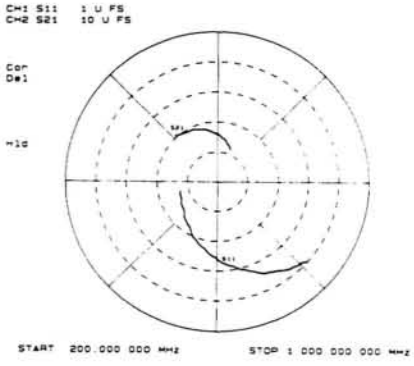


Figure 6. Simultaneous measurement of transistor S-parameters.

Additional Capabilities

Precision design work and manufacturing tolerances demand highly accurate measurements, but most errors in network measurements are complex quantities that vary as a function of frequency. By characterizing and virtually removing these systematic errors, measurement accuracies are improved by several orders of magnitude. Hewlett-Packard now offers network analyzers with built-in, high-speed computational hardware that can perform the complex mathematics required for sophisticated error correction.

Computer controlled network analyzers can be programmed to set up and make many measurements automatically. The measurement process is further accelerated by the computer's ability to store, transform, summarize, and output data in a variety of formats to a number of peripherals. These capabilities make the computer controlled network analyzer ideal for both computer aided design or automatic production testing.

NETWORK ANALYZERS
Complete Characterization of Linear Networks (cont'd)

Network Analyzer Product Line Summary

HP Model	Frequency Range	Source	Measurement Capabilities
HP 35665A Dual-Channel Dynamic Signal Analyzer (page 220)	122 μHz to 51.2 kHz	Swept and fixed sine chirp, random, burst random, and arbitrary waveform	Transfer functions, magnitude/phase, 20-pole/20-zero curve fitter, frequency-response synthesis, time-domain functions, and spectrum analysis. HP-IB programmable.
HP 3563A/3562A Dual-Channel Control Systems Analyzer (page 221)	64 μHz to 100 kHz	Analog and digital swept and fixed sine, chirp, burst chirp, random noise, burst random noise, step, pulse, ramp, and arbitrary	Transfer functions, magnitude/phase, 40-pole/40-zero curve fitter (S- and Z-domains), frequency-response synthesis (S- and Z-domains), time-domain functions, and spectrum analysis with analog or digital input signals. HP-IB programmable. Note: 3562A provides analog interface only.
HP 3577B Network Analyzer (page 283)	5 Hz to 200 MHz	Integrated synthesized source	Transfer functions, magnitude/phase, group delay, S-parameters, insertion loss, gain/attenuation, electrical length, gain compression, SWR, impedance, HP Instrument BASIC optional. HP-IB programmable.
HP 3589A Spectrum/Network Analyzer (page 232)	10 Hz to 150 MHz	Integrated synthesized source	Transfer functions, magnitude/phase, group delay, S-parameters, impedance, SWR, spectrum analysis, including gating. HP Instrument BASIC optional. HP-IB programmable.
HP 4195A Network/Spectrum/ Impedance Analyzer (page 285)	10 Hz to 500 MHz	Integrated synthesized source	Transfer functions, magnitude/base, insertion loss/gain, attenuation, group delay, S-parameters, return loss, SWR, complex impedance, accuracy enhancement. HP-IB programmable.
HP 8751A Network Analyzer (page 287)	5 Hz to 500 MHz	Integrated synthesized source	Transfer functions, magnitude/phase, insertion loss/gain, attenuation, gain compression, S-parameters, electrical length, group delay, deviation from linear phase. Impedance-magnitude/phase: return loss, R + jX. Full accuracy enhancement. HP Instrument BASIC capability. Built-in 3.5-in flexible disk (LIF/DOS format). HP-IB capability.
HP 87510A Gain/Phase Analyzer (page 289)	100 kHz to 300 MHz	Integrated synthesized source	Transfer functions, magnitude/phase, insertion loss/gain, group delay, attenuation. Impedance-magnitude/phase. Electrical delay. HP IBASIC capability. Built-in 3½-in flexible disk (LIF/DOS format). HP-IB capability.
HP 8752A/B Network Analyzer (page 294)	300 kHz to 1.3/3.0 GHz	Integrated synthesized source, test set and receiver	Transfer functions - magnitude/phase, insertion loss/gain, attenuation, gain compression, S-parameters, electrical length, group delay, deviation from linear phase. Impedance-magnitude/phase, return loss, r + jx, accuracy enhancement, time-domain capability. HP-IB programmable.
HP 8753C Network Analyzer (page 296)	300 kHz to 3 GHz/6 GHz	Integrated synthesized source 8752A: 50 Ω 8752B: 75 Ω	Transfer functions – magnitude/phase, insertion loss/gain, attenuation, gain compression, S-parameters, electrical length, group delay, deviation from linear phase. Impedance - magnitude/phase - Return Loss, r + jx. Full accuracy enhancement. Time-domain capability. Harmonic measurement capability. HP-IB programmable.
HP 8719C/8720C/8722C Network Analyzers (page 302)	50 MHz to 13.5 GHz (8719C) 50 MHz to 20 GHz (8720C) 50 MHz to 40 GHz (8722C)	Integrated synthesized source (1 Hz resolution optional)	Transfer functions - magnitude/phase, insertion loss/gain, attenuation, S-parameters, electrical length, group delay, deviation from linear phase. Impedance - magnitude/phase - Return Loss, r + jx. Full accuracy enhancement. Time-domain capability. HP-IB programmable.
HP 8510 Series Network Analyzers (page 305)	45 MHz to 110 GHz	HP 8350 Series Sweep Oscillators HP 8340B, 8341B Synthesized Sweepers HP 8360 Series Synthesized Sweepers	Transfer functions - magnitude/phase, insertion loss/gain, attenuation, S-parameters, electrical length, group delay, deviation from linear phase, impedance, return loss, R + jx. Active device characterization. Full accuracy enhancement. Time-domain capability. HP-IB programmable.

Vector Voltmeter

HP Model	Frequency Range	Source	Measurement Capabilities
HP 3575A Gain Phase Meter (page 283)	1 Hz to 13 MHz	None	Gain, phase, and amplitude
HP 8508A Vector Voltmeter (page 291)	0.1 MHz to 1 GHz 0.3 MHz to 2 GHz	None	Voltage, impedance Transfer functions, phase and amplitude HP-IB programmable

Scalar Analyzer

HP Model	Frequency Range	Source	Measurement Capabilities
HP 8757D/E Scalar Network Analyzers (page 275)	10 MHz to 110 GHz	HP 8350B Sweeper HP 8340B or 8341B Synthesized Sweepers HP 8360 Series Synthesized Sweepers	Scalar transmission/reflection measurements 50 Ω coax measurements 10 MHz to 50 GHz 75 Ω coax measurement 10 MHz to 2.4 GHz Waveguide measurements 26.5 to 110 GHz Open/short averaging, normalization, averaging, limit testing Storage registers, HP-IB programmable
HP 8711A RF Network Analyzer (page 292)	300 kHz to 1.3 GHz	Integrated synthesized source, T/R test set and receiver	Transmission/reflection measurements 50 Ω and 75 Ω measurements HP Instrument BASIC (IBASIC) Narrowband/broadband receivers Internal calibration, averaging, limit testing, internal disk and storage registers

- 76 dB dynamic range
- Optional power calibrator
- 40 dB directivity bridges
- 40 GHz in coax, 110 GHz in waveguide
- Buffered plotter/printer output
- External disk and internal register save/recall
- Limit testing built in
- Color display

DESIGNED FOR HP-IB SYSTEMS

HP 8757E and HP 8757D Option 001

HP 8757D/E Scalar Network Analyzers

Measure insertion loss, gain, return loss, SWR, and power quickly and accurately with either the HP 8757D or HP 8757E Scalar Network Analyzers. With high-performance detectors and directional bridges, and a companion HP source and digital plotter, the HP 8757D and 8757E become the basis of a complete measurement system with superb performance.

A Choice of Two Analyzers

For an economical measurement solution, choose the HP 8757E Scalar Network Analyzer. The HP 8757E features three detector inputs and two independent display channels, allowing simultaneous ratioed or non-ratioed measurement of your device's transmission and reflection characteristics, 76 dB dynamic range (+16 to −60 dBm) for measuring high rejection devices, and a choice between ac (square wave modulated) or dc detection techniques. The internal plotter/printer buffer allows you to send your measurement data directly to a plotter and then proceed to the next measurement, typically in less than 5 seconds. The HP 8757E includes a user-friendly interface, and menu-driven, direct-access softkeys, which simplify its operation.

When your application demands maximum system versatility, choose the HP 8757D Scalar Network Analyzer. It offers all of the performance of the HP 8757E, plus more standard features, limit testing, external disk save/recall, and a color display. Limit testing reduces test time by letting the analyzer make quick and objective pass/fail decisions. External disk save/recall allows your measurement state to be preconfigured by an engineer or skilled specialist and then automatically recalled by production technicians. The result is reduced setup time and greater test integrity at each production station. The precision color display simplifies the separation of measurement information while providing a pleasant display for the technician.

Increase Absolute Power Measurement Accuracy

For near power meter measurement accuracy, configure a system which includes the HP 8757D Option 002 and the HP 85037 Series precision detectors. Option 002 on the HP 8757D adds an internal power calibrator used to characterize the HP 85037 Series detectors' accuracy versus power. In addition, each HP 85037 Series precision detector incorporates a dual diode detector to improve power measurement accuracy when harmonics are present, plus internal frequency correction factors, read by the HP 8757D, for more accurate power versus frequency measurements. The result is a system optimized for swept absolute power measurements.

Systems from 10 MHz to 110 GHz

You can conveniently obtain a 20 GHz or 40 GHz coaxial measurement system by ordering the HP 8757XA (10 MHz to 20 GHz) or HP 8757XB (10 MHz to 40 GHz) scalar measurement system. Or, you can configure your own system to 50 GHz in coax or 110 GHz in waveguide.

The HP 8350B sweeper family offers the benefits of a modular system with choices in source frequency range and output power. When testing narrowband, frequency-selective devices, choose a synthesized sweeper from the HP 8360 Series or an HP 8340B or 8341B. The HP 8360 Series, 8340B, and 8341B provide excellent frequency stability and up to 1 Hz frequency resolution.

Feature	HP 8757D			HP 8757E
Display	Color			Monochrome
Display channels	4			2
Detector inputs	3 standard 4 with Option 001			3
Dynamic range	76 dB			76 dB
AC/DC detection mode	Yes			Yes
Measurement points: Selectable values	101, 201, 401, 801, 1601			101, 201, 401
Channels displayed	3 or 4	2	1	1 or 2
Max points per channel	401	801	1601	401
Plotter/printer buffer	Yes			Yes
Noise figure display capability	Yes			Yes
External disk save/recall	Yes			No
Internal save/recall registers	9			9
Limit testing (channels 1 and 2)	Yes			No
Adaptive normalization	Yes			No
Cursor search functions	Max, Min, bandwidth, n dB			Max, min
SWR display mode	Yes			Yes
Non-standard sweep mode	Yes			Yes
Auxiliary voltage display mode	Yes			Yes
Optional power calibrator	Yes			No
Compatible with HP 85037 series precision detectors	Yes			No

NETWORK ANALYZERS
Scalar Network Analyzers/System Specifications
HP 8757

System Accuracy

Transmission Loss or Gain Measurement Accuracy

Transmission loss or gain measurements are made relative to a 0 dB reference point established at calibration.

Transmission measurement uncertainty
= dynamic power accuracy + mismatch uncertainty

Dynamic power accuracy is the measurement uncertainty due to the change in power level between calibration and the measurement. Mismatch uncertainty is the uncertainty due to reflections in the measurement setup. The frequency response errors of the source, detectors, bridge, and power splitter are removed via calibration.

Transmission Measurement Uncertainty Examples

Assumptions:
- Measurement frequency = 10 GHz
- DUT input/output SWR = 1.5
- Change in power after calibration <30 dB (+0 to −30 dBm range)

Uncertainty Component	HP 85037B precision detector	HP 85025E detector	HP 11664E detector
Dynamic accuracy (±dB)	0.11	0.40	0.30
Mismatch (±dB)	0.45	0.33	0.61
Uncertainty Total (±dB)	0.56	0.73	0.91

Absolute Power Measurement Accuracy:

This specification is useful for determining the accuracy of power measurements in dBm when using the HP 85037 Series precision detectors or the HP 85025 Series precision detectors in DC mode.

Absolute power uncertainty = absolute power accuracy at 50 MHz
+ frequency response + mismatch uncertainty

Absolute Power Measurement Uncertainty Examples

Assumptions:
- Measurement frequency = 10 GHz
- DUT input/output SWR = 1.5
- Measured power = 0 dBm

Uncertainty Component	HP 85037B detector	HP 85025E detector
Absolute power accuracy at 50 MHz (±dB)	0.11	0.40
Frequency response (±dB)	0.18	0.50
Mismatch (±dB)	0.18	0.10
Uncertainty Total (±dB)	0.47	1.00

HP 8757D Option 002 Power Calibrator

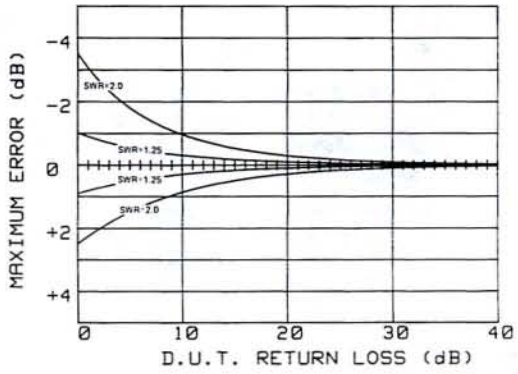
The HP 8757D's internal power calibrator provides a 50 MHz reference standard for characterizing the absolute power accuracy and dynamic power accuracy of the HP 85037 Series precision detectors.

Frequency: 50 MHz ±0.2 MHz
Accuracy at 0 dBm: ±0.05 dB
Linearity: (over any 10 dB range)
±0.08 dB (+20 to +10 dBm)
±0.04 (+10 to −30 dBm)
±0.06 (−30 to −50 dBm)

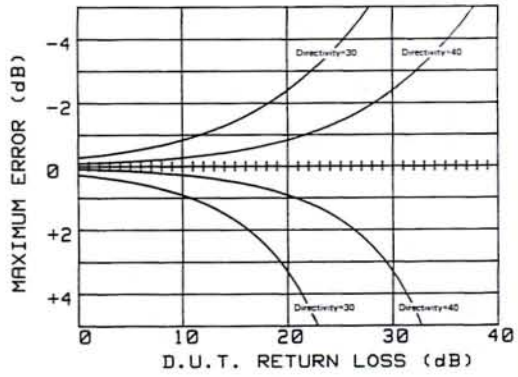
Reflection Measurement Accuracy

Uncertainties due to calibration error and the frequency response of the source, detectors, and bridges are removed via open/short averaging. The remaining uncertainties are primarily the sum of directivity uncertainty, effective source match uncertainty, and dynamic power accuracy. As shown in the graphs below, directivity is the dominant error term when measuring small reflected signals (high return loss) and source match is dominant when measuring large reflected signals (low return loss).

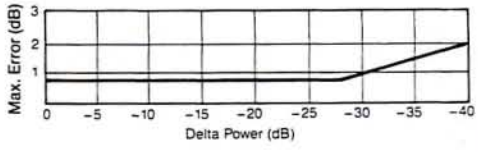
Effect of effective source match on reflection uncertainty:



Effect of directivity on reflection uncertainty:



Dynamic Power Accuracy (HP 85027/20 bridges, 50 MHz, 25 ±5°C, +7 dBm input):



HP 85037 Series Precision Detectors (ac/dc)

The HP 85037 Series precision detectors are designed specifically for operation with the HP 8757D scalar network analyzer and may be used in either ac or dc detection modes. These dual diode detectors contain internal frequency correction factors in an internal EEPROM (read automatically by the HP 8757D) for improved measurement accuracy versus frequency. When used in conjunction with the HP 8757D's internal power calibrator (Option 002), these detectors provide the maximum absolute power measurement accuracy. The HP 85037 Series detectors are not compatible with the HP 8757E, 8757A, 8756A, or 8755.

HP 85025 and 85026 Series Detectors (ac/dc)

The HP 85025 and 85026 Series detectors are designed specifically for operation with the HP 8757 scalar network analyzer and are not compatible with either the HP 8756 or the 8755. The HP 85025/26 detectors detect either a modulated (ac) or an unmodulated (dc) microwave signal.

HP 11664 Series Detectors (ac only)

The HP 11664 Series detectors are designed to operate with the HP 8757, 8756, and 8755 scalar analyzers in ac mode only.

HP 85025C and 11664C Detector Adapters

The HP 85025C and 11664C detector adapters match the scalar analyzer display to most standard crystal, silicon, and gallium arsenide detectors. This enables the user to operate up to 110 GHz with the HP 8757 and 8756. The HP 85025C detector adapter is designed for use with the HP 8757 only, and can operate in either ac or dc detection modes. The HP 11664C detector adapter is designed for use with the HP 8757, 8756, and 8755 scalar analyzers.

Precision Detector Summary, HP 85037 Series
For use with the HP 8757D in either ac or dc detection modes

Model	Frequency Range	Connector Type	Dynamic Range	Frequency	Return Loss	Frequency Response	Power (@ 50 MHz)	Dynamic Accuracy[4]	Absolute Accuracy[5]
HP 85037A[1]	10 MHz to 18 GHz	Type-N (m) 7 mm[2]	ac mode +20 to −55 dBm dc mode +20 to −50 dBm	0.01 to 0.04 GHz 0.04 to 18.0 GHz	10 dB 20 dB	±0.35 dB ±0.18 dB	20 dBm 10 dBm −30 dBm −50 dBm	±0.25 dB ±0.11 dB ±0.11 dB ±0.85 dB	±0.25 dB ±0.11 dB ±0.11 dB ±0.85 dB
HP 85037B[1]	10 MHz to 26.5 GHz	3.5 mm (m)	ac mode +20 to − 55 dBm dc mode +20 to −50 dBm	0.01 to 0.04 GHz 0.04 to 18.0 GHz 18 to 26.5 GHz	10 dB 20 dB 18 dB	±0.35 dB ±0.18 dB ±0.22 dB	20 dBm 10 dBm −30 dBm −50 dBm	±0.25 dB ±0.11 dB ±0.11 dB ±0.85 dB	±0.25 dB ±0.11 dB ±0.11 dB ±0.85 dB

Coaxial Detector Summary, HP 85025 and 11664 Series
For use with the HP 8757 only in either ac or dc detection modes

Model	Frequency Range	Connector Type	Dynamic Range	Frequency	Return Loss	Frequency Response	Power (@ 50 MHz)	Dynamic Accuracy[4]	Absolute Accuracy[5]
HP 85025A[3]	10 MHz to 18 GHz	Type-N (m) 7 mm[2]	ac mode +16 to −55 dBm dc mode +16 to −50 dBm	0.01 to 0.04 GHz 0.04 to 4 GHz 4 to 18 GHz	10 dB 20 dB 17 dB	±0.8 dB ±0.5 dB ±0.5 dB	16 dBm 6 dBm −35 dBm −50 dBm	±0.8 dB ±0.4 dB ±0.4 dB ±1.3 dB	±0.8 dB ±0.4 dB ±0.4 dB ±1.3 dB
HP 85025B[3]	10 MHz to 26.5 GHz	3.5 mm (m)	ac mode +16 to −55 dBm dc mode +16 to −50 dBm	0.01 to 0.04 GHz 0.04 to 4 GHz 4 to 18 GHz 18 to 26.5 GHz	10 dB 20 dB 17 dB 12 dB	±0.8 dB ±0.5 dB ±0.5 dB ±2.0 dB	16 dBm 6 dBm −35 dBm −50 dBm	±0.8 dB ±0.4 dB ±0.4 dB ±1.3 dB	±0.8 dB ±0.4 dB ±0.4 dB ±1.3 dB
HP 85025D[3]	10 MHz to 50 GHz	2.4 mm (m)	ac mode +16 to −55 dBm dc mode +16 to −50 dBm	0.01 to 0.1 GHz 0.1 to 20 GHz 20 to 26.5 GHz 26.5 to 40 GHz 40 to 50 GHz	10 dB 20 dB 20 dB 15 dB 9 dB	±0.8 dB ±0.5 dB ±1.0 dB ±2.5 dB ±3.0 dB	16 dBm 6 dBm −35 dBm −50 dBm	±1.0 dB ±0.4 dB ±0.4 dB ±1.3 dB	±1.0 dB ±0.4 dB ±0.4 dB ±1.3 dB
HP 85025E[3]	10 MHz to 26.5 GHz	3.5 mm (m)	ac mode +16 to −55 dBm dc mode +16 to −50 dBm	0.01 to 0.1 GHz 0.1 to 18 GHz 18 to 25 GHz 25 to 26.5 GHz	10 dB 25 dB 25 dB 23 dB	±0.8 dB ±0.5 dB ±0.5 dB ±1.4 dB	16 dBm 6 dBm −35 dBm −50 dBm	±1.0 dB ±0.4 dB ±0.4 dB ±1.3 dB	±1.0 dB ±0.4 dB ±0.4 dB ±1.3 dB

For use with the HP 8757, 8756, or 8755 in ac detection mode only

Model	Frequency Range	Connector Type	Dynamic Range	Frequency	Return Loss	Frequency Response	Power (@ 50 MHz)	Dynamic Accuracy[4]
HP 11664A	10 MHz to 18 GHz	Type-N (m) 7 mm[2]	+16 to −60 dBm	0.01 to 0.04 GHz 0.04 to 4 GHz 4 to 12 GHz 12 to 18 GHz	10 dB 20 dB 18 dB 16 dB	±0.5 dB ±0.5 dB ±0.5 dB ±0.5 dB	16 dBm 6 dBm −35 dBm −60 dBm	±0.4 dB ±0.3 dB ±0.3 dB ±1.2 dB
HP 11664E	10 MHz to 26.5 GHz	3.5 mm (m)	+16 to −60 dBm	0.01 to 0.04 GHz 0.04 to 6 GHz 6 to 18 GHz 18 to 26.5 GHz	10 dB 20 dB 16 dB 12 dB	±0.5 dB ±0.5 dB ±0.5 dB ±1.0 dB	16 dBm 6 dBm −35 dBm −60 dBm	±0.4 dB ±0.3 dB ±0.3 dB ±1.2 dB

[1] The HP 85037A/B specifications are applicable when used with the HP 8757D scalar network analyzer. The absolute power accuracy and dynamic power accuracy specifications apply after a calibration via the HP 8757D Opt 002's internal power calibrator.
[2] Opt 001 changes to 7 mm connector.
[3] The HP 85025 and 85026 series detectors and the HP 85025C detector adapter require HP 8757A firmware revision 2.0 or higher. To upgrade previous revisions, order the HP 11614A Firmware Enhancement.
[4] Dynamic accuracy refers to measurement accuracy as power varies (in dB) from a 0 dBm reference. 25 ±5°C, 50 MHz.
[5] dc mode, 25 ±5°C

NETWORK ANALYZERS

HP 8757 System Accessories

HP 85025C, 11664A/C/D/E, R/Q/U85026A, 85020A/B, 85027A/B/C/D/E

Waveguide Detectors and Detector Adapters Summary
For use with the HP 8757 only in either ac or dc detection modes

Model	Frequency Range	Connector Type	Dynamic Range	Return Loss	Frequency Response	Dynamic Accuracy
HP R85026A[1]	26.5 to 40 GHz	WR-28	+10 to −50 dBm (ac mode) +10 to −45 dBm (dc mode)	12 dB	±1.5 dB	±(0.3 dB + 0.03 dB/dB)
HP Q85026A[1]	33 to 50 GHz	WR-22	+10 to −50 dBm (ac mode) +10 to −45 dBm (dc mode)	12 dB	±2.0 dB	±(0.3 dB + 0.03 dB/dB)
HP U85026A	40 to 60 GHz	WR-19	+10 to −50 dBm (ac mode) +10 to −45 dBm (dc mode)	12 dB	±2.0 dB	±(0.3 dB + 0.03 dB/dB)
HP 85025C Opt K57[3]	50 to 75 GHz	WR-15	+10 to −45 dBm (typical)	9.5 dB (typical)		
HP 85025C Opt K71[3]	75 to 110 GHz	WR-10	+10 to −45 dBm (typical)	9.5 dB (typical)		
HP 85025C[1]	[2]	SMA (m)	[2]	[2]	[2]	[2]

For use with the HP 8757, 8756, or 8755 in ac detection mode only

Model	Frequency Range	Connector Type	Dynamic Range	Return Loss	Frequency Response	Dynamic Accuracy
HP 11664D	26.5 to 40 GHz	WR-28	+10 to −50 dBm	12 dB	±1.5 dB	±0.5 dB @ 10 dB ±0.2 dB @ 0 to −35 dB ±1.02 dB @ −50 dB
HP 11664C	[2]	SMA (m)	[2]	[2]	[2]	[2]

HP 85020A/B Direction Bridges (ac only)

The HP 85020A/B directional bridges offer high directivity and excellent test port match to 4.3 GHz. These bridges may be used with the HP 8757, 8756, or 8755 scalar network analyzers in ac detection mode. The HP 85020A is designed for 50 ohm environments while the HP 85020B is designed for 75 ohm environments.

HP 85027 Series Directional Bridges (ac/dc)

The HP 85027 series directional bridges are designed to operate with either the HP 8757 in ac or dc detection modes or with the HP 8756 or 8755 in ac detection mode. These bridges offer high directivity, excellent test port match, and a measurement range of up to 50 GHz in coax.

Directional Bridge Summary
For use with the HP 8757, 8756, or 8755 in ac detection mode only

Model	Frequency Range	Nominal Impedance	Connector Input	Connector Test Port	Frequency	Directivity (dB)	Frequency	Test Port Match (SWR)
HP 85020A	10 MHz to 4.3 GHz	50 Ω	Type-N (f)	Type-N (f)	0.01 to 3 GHz 3 to 4.3 GHz	40 dB 34 dB	0.01 to 3 GHz 3 to 4.3 GHz	<1.20 <1.25
HP 85020B	10 MHz to 2.4 GHz	75 Ω	Type-N (f)	Type-N (f)	40 dB		0.01 to 1.3 GHz 1.3 to 2.4 GHz	<1.25 <1.39

For use with the HP 8757 in ac or dc detection mode or with the 8756 or 8755 in ac detection mode only

Model	Frequency Range	Nominal Impedance	Connector Input	Connector Test Port	Frequency	Directivity (dB)	Frequency	Test Port Match (SWR)
HP 85027A	10 MHz to 18 GHz	50 Ω	Type-N (f)	7 mm	0.01 to 18 GHz	40 dB	0.01 to 8.4 GHz 8.4 to 12.4 GHz 12.4 to 18 GHz	<1.15 <1.25 <1.43
HP 85027B	10 MHz to 26.5 GHz	50 Ω	3.5 mm (f)	3.5 mm (f)	0.01 to 20 GHz 20 to 26.5 GHz	40 dB 36 dB	0.01 to 8.4 GHz 8.4 to 20 GHz 20 to 26.5 GHz	<1.15 <1.43 <1.78
HP 85027C	10 MHz to 18 GHz	50 Ω	Type-N (f)	Type-N (f)	0.01 to 12.4 GHz 12.4 to 18 GHz	36 dB 34 dB	0.01 to 8.4 GHz 8.4 to 12.4 GHz 12.4 to 18 GHz	<1.15 <1.25 <1.43
HP 85027D	10 MHz to 50 GHz	50 Ω	2.4 mm (f)	2.4 mm (m)	0.01 to 20 GHz 20 to 26.5 GHz 26.5 to 40 GHz 40 to 50 GHz	36 dB 32 dB 30 dB 25 dB	0.01 to 16 GHz 16 to 30 GHz 30 to 40 GHz 40 to 50 GHz	<1.18 <1.27 <1.57 typically <2.00
HP 85027E	10 MHz to 26.5 GHz	50 Ω	3.5 mm (f)	3.5 mm (m)	0.01 to 20 GHz 20 to 26.5 GHz	40 dB 36 dB	0.01 to 8.4 GHz 8.4 to 20 GHz 20 to 26.5 GHz	<1.15 <1.43 <1.78

[1] The HP 85025 and 85026 series detectors and the HP 85025C detector adapter require HP 8757A firmware revision 2.0 or higher. To upgrade previous revisions, order the HP 11614A Firmware Enhancement.

[2] Depends upon the particular detector being used

[3] Must be used with the HP 85025C or 11664C detector adapter

HP 11679A

HP 85022A

HP 85028A

HP 85023C

HP 11668A High Pass Filter

The HP 11668A high pass filter accessory is recommended when making measurements on active devices that have gain below 50 MHz. Use of the HP 11668A, placed after the HP 11665B, reduces the modulator drive feedthrough from 8 mV to 1 mV and prevents possible amplifier saturation. Use of the HP 11668A filter is not necessary for passive measurements since the feedthrough from the HP 11665B is −65 dBm and causes no degradation in system performance.

Frequency Range: 50 MHz to 18 GHz

	Insertion Loss	Return Loss
50 to 100 MHz	≤2.5 dB	≥12 dB
100 MHz to 8 GHz	≤1.0 dB	≥16 dB
8 to 12 GHz	≤1.0 dB	≥14 dB
12 to 18 GHz	≤1.5 dB	≥14 dB

Maximum Input: +27 dBm
Connectors: N-female, N-male
Weight: Net, 0.13 kg (5 oz); shipping, 0.28 kg (10 oz)

HP 11678A Low Pass Filter Kit

The HP 11678A low pass filter kit contains five filters. Low pass filters reduce harmonics generated by the RF source when making precision measurements.

Frequency Range (low pass filters, cutoff frequency fc)
HP 11688A: 2.8 GHz
HP 11689A: 4.4 GHz
HP 11684A: 6.8 GHz
HP 11685A: 9.5 GHz
HP 11686A: 13.0 GHz
Insertion Loss: <1.1 dB at 0.95 fc
Rejection (at 1.25 fc): Greater than 40 dB
Impedance: 50 Ω normal
Connectors: N-Female, N-Male
Weight: Net, 0.44 kg (1 lb); shipping, 1.2 kg (2.9 lb)

HP 11679A/B Extension Cables

Function: These cables extend the distance between the scalar network analyzer and the detector or bridge to a maximum of 200 feet without degradation of performance.
HP 11679A: 7.6 m (25 ft) extension cable
HP 11679B: 61 m (200 ft) extension cable

HP 85023A/B/C/D/F Verification Kits

The HP 85023 Series system verification kits each contain a set of precision components used to perform a system verification procedure for the HP 8757 scalar network analyzer system. This procedure, which is in the HP 8757/56 Operating and Service Manuals, checks system installation and can be used as a daily functional test.

Choose a system verification kit to match your device under test. For 7mm applications, select the HP 85023A. If you are measuring SMA or 3.5mm devices, choose the HP 85023B. For 50 Ω, Type-N applications, select the HP 85023C. These kits (HP 85023A/B/C) all include an open, short, 10 dB fixed attenuator, 50 Ω termination, and a source to directional bridge adapter of the corresponding connector type. The HP 85023D verification kit, for 75 Ω Type-N measurements, consists of a short, a 75 Ω termination, a 50 Ω 10 dB fixed attenuator, and two HP 11852B 50 to 75 Ω minimum loss pads (for 50/75 Ω impedance conversion).

The HP 85023F verification kit includes 2.4 mm standards for verifying performance of the HP 8757 system to 50 GHz. Included are a 2.4 mm female open, short and 50 Ω load, a 10 dB attenuator, and female to female adapter.

Model	Frequency range	Connector type	Characteristic impedance
HP 85023A	dc to 18 GHz	7 mm	50 Ω
HP 85023B	dc to 26.5 GHz	3.5 mm	50 Ω
HP 85023C	dc to 18 GHz	Type-N	50 Ω
HP 85023D	dc to 1.3 GHz	Type-N	75 Ω
HP 85023F	dc to 50 GHz	2.4 mm	50 Ω

Weight: Net, 0.5 kg (1.2 lb); shipping, 1.2 kg (2.9 lb)

HP 85022A System Cable Kit

The HP 85022A contains all the BNC and HP-IB cables to connect an HP 8350B sweep oscillator (or the HP 8360 series, HP 8340B/41B synthesized sweepers), an HP Series 300 computer, and a printer to the HP 8757 or 8756. This kit contains 3 one-meter HP-IB cables (HP 10833A), 3 two-foot BNC (m-m) cables (HP 11170B), and 1 four-foot BNC (m-m) cable (HP 11170C).

BNC Impedance: 50 Ω
Weight: Net, 0.5 kg (1.2 lb); shipping, 1.2 kg (2.9 lb)

HP 85028A 7mm Directivity Verification Standards for HP 85021A/85027A

The HP 85028A allows on-site verification of the 40 dB directivity of the HP 85021A and 85027A directional bridges. For frequencies below 2 GHz, a precision 52 dB return loss load is used. For frequencies from 2 to 18 GHz, a sliding mismatch is used to establish a ripple pattern from which the directivity can be calculated. The HP 85028A includes a precision 50 Ω termination, a high-performance sliding mismatch, a 7 mm open/short, a 7 mm connector gage kit, and a torque wrench.

Weight: Net, 2.0 kg (4.5 lb); shipping, 3.5 kg (8.0 lb)

HP 8757C/D/E Upgrade Kits

Increase your analyzer's measurement capability and performance with an HP 8757 upgrade kit. Upgrade kits are available for the HP 8757C, 8757D, and 8757E.

The HP 86383A upgrade kit upgrades your HP 8757E to the HP 8757D. This kits adds a color display, measurement channels 3 and 4, external disk save/recall, up to 1601 measurement points, extended display range (up to +80 dBm), compatibility with the HP 85037 Series precision detectors, the ability to add the internal power calibrator, etc. Installation at an HP service center (return to HP) is also included with the kit.

The HP 86383B upgrade kit upgrades your HP 8757C to the HP 8757D. This kit adds front panel hardkeys for channels 3 and 4, extended display range (+80 dBm), compatibility with the HP 85037 Series precision detectors, the ability to add the internal power calibrator, etc. Installation is not included with this kit.

The HP 86383C upgrade kit allows you to add the fourth detector input to your HP 8757D (86383C Option 001) and/or the internal power calibrator (HP 86383C Option 002). Installation is not included with this kit.

NETWORK ANALYZERS

HP 8757 System Accessories

HP 11613B, 11636A/B; 11665B, 11852B, 11667A/B/C

HP 11665B

HP 11613B

HP 11613B Calibrator

HP 8757 and 8756 verification/calibration is recommended every 12 months. This can be accomplished at an HP service center or on-site using the HP 11613B calibrator and an HP 9000 Series 200 or Series 300 computer.

The HP 11613B is a dedicated transfer standard for calibration of the HP 8757 and 8756. The HP 11613B provides the standard a 27.778 kHz source and a series of precision attenuators. The calibrator includes software (both 3½- and 5¼-inch formats) that operates on an HP 9000 Series 200 or Series 300 computer, the BASIC operating system (BASIC 2.0, and above) and a GP-IO cable for use when calibrating the HP 8756. The software verifies (and adjusts if necessary) the internal calibration parameters stored in the non-volatile memory of the HP 8757 and 8756. All HP 8757 and 8756 detector inputs can be calibrated in a matter of minutes. Re-calibration of the HP 11613B is recommended every two years.

Memory Requirement: 0.5 MB, does not include HP BASIC memory requirement

Hardware Requirement: HP 98622A 16-bit GP-IO interface card for use with HP 8756

Size: 40 H × 185 W × 203 mm D (1.5 in × 7.3 in × 8.0 in)

Cable length: 1.22 m (48 in)

Weight: Net, 0.91 kg (2 lbs); shipping, 1.4 kg (3 lbs)

HP 11636A/B Power Dividers

The HP 11636A/B power dividers/combiners are recommended when making wideband comparison measurements without ratioing, and in fault location measurements with the HP 8757/85016. Detailed specifications are on page 370.

HP 11665B Modulator

Function: Absorbtive on-off modulator designed for and powered by the HP 8757, 8756, or 8755 scalar network analyzers

Frequency range	Return loss on and off	Insertion loss on	Insertion loss off
15 to 40 MHz	≥10 dB	≤7.0 dB	≥35 dB
40 MHz to 4 GHz	≥15 dB	≤3.2 dB	≥35 dB
4 to 8 GHz	≥12 dB	≤4.3 dB	≥45 dB
8 to 12.4 GHz	≥8 dB	≤3.8 dB	≥40 dB
12.4 to 18 GHz	≥8 dB	≤5.0 dB	≥45 dB

Modulator Drive Feedthrough: ≤8 mV (peak) at 27.8 kHz at either port when powered by the HP 8757, 8756, or 8755. Reduced to ≤ 1mV (peak) using the HP 11668A. (See HP 11668A High Pass Filter.)

Drive Current: Nominally +50 mA in On condition, −50 mA Off condition

Weight: Net, 0.17 kg (6 oz); shipping, 0.9 kg (2 lb)

HP 11852B 50 Ω/75 Ω Minimum Loss Pad

The HP 11852B is a low SWR minimum loss pad required between 75 Ω devices and 50 Ω sources and detectors. For more information, see page 299.

HP 11667A

HP 11667C

HP 11667A/B/C Power Splitters

The HP 11667A/B/C power splitters are recommended when making wideband ratio measurements using the HP 8757, 8756, or 8755 scalar network analyzer. These two-resistor type splitters provide excellent output SWR at the auxiliary arm when used for source leveling or ratio measurement applications. The tracking between output arms over a frequency range from dc to 50 GHz allows wideband measurements to be made with a minimum of uncertainty.

Frequency Range
HP 11667A: dc to 18 GHz
HP 11667B: dc to 26.5 GHz
HP 11667C: dc to 50 GHz

Impedance: 50 Ω nominal

Insertion Loss
HP 11667A/B: 6 dB nominal
HP 11667C: 8.5 dB nominal

HP 11667A	dc to 4 GHz	dc to 8 GHz	dc to 18 GHz
Input SWR:	≤1.15	≤1.25	≤1.45
Equivalent Output SWR: (leveling or ratio measurements)	≤1.10	≤1.20	≤1.33
Output Tracking (dB): (between output arms)	≤0.15	≤0.20	≤0.25
Typical Phase Tracking (deg): (between output arms)	0.5	1.5	3.0

HP 11667B/C	dc to 18 GHz	dc to 26.5 GHz	dc to 40 GHz	dc to 50 GHz
Input SWR:				
HP 11667B	≤1.22	≤1.29		
HP 11667C	≤1.22	≤1.38	≤1.50	≤1.65
Equivalent Output SWR: (leveling or ratio measurements)				
HP 11667B	≤1.22	≤1.22		
HP 11667C	≤1.29	≤1.29	≤1.50	≤1.65
Output Tracking (dB): (between output arms)				
HP 11667B	≤0.25	≤0.40		
HP 11667C	≤0.30	≤0.35	≤0.40	≤0.40
Typical Phase Tracking (deg): (between output arms)				
HP 11667B	1.5	2.5		
HP 11667C	2.0	2.5	3.0	3.0
Typical Insertion Loss (dB):				
HP 11667C	6.0	7.0	8.0	8.5

Maximum Input Power: +27 dBm

Connectors
HP 11667A: N-female on all ports
HP 11667B: 3.5 mm female on all ports
HP 11667C: 2.4 mm female on all ports

Size
HP 11667A: 46 mm H × 52 mm W × 19 mm D (1.8 in × 2.0 in × 0.7 in)
HP 11667B: 40 mm H × 47 mm W × 10 mm D (1.6 in × 1.9 in × 0.4 in)
HP 11667C: 36 mm H × 36 mm W × 10 mm D (1.4 in × 1.4 in × 0.4 in)

Weight
HP 11667A: Net, 0.14 kg (0.31 lb); shipping, 0.22 kg (0.5 lb)
HP 11667B: Net, 0.06 kg (0.13 lb); shipping, 0.14 kg (0.3 lb)
HP 11667C: Net, 0.06 kg (0.13 lb); shipping, 0.14 kg (0.3 lb)

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

Ordering Information

The HP 8757 Scalar Network Analyzer is ordered with multiple line items to give you maximum flexibility in specifying a system that meets your needs. Consult your local HP sales office if you would like assistance.

	Price
Complete Measurement Systems	
HP 8757XA 20 GHz Coaxial Scalar System	$40,695
Includes:	
HP 8757D Scalar Network Analyzer	
HP 8350B Sweep Oscillator	
HP 83592C RF Plug-in (0.01 to 20 GHz)	
HP 85027E Directional Bridge (3.5 mm)	
HP 85025E Detector (3.5 mm)	
HP 85022A Cable Kit	
HP 8757XB 40 GHz Coaxial Scalar System	$54,740
Includes:	
HP 8757D Scalar Network Analyzer	
HP 8350B Sweep Oscillator	
HP 83597A RF Plug-in (0.01 to 40 GHz)	
HP 85027D Directional Bridge (2.4 mm)	
HP 85025D Detector (2.4 mm)	
HP 85022A Cable Kit	
Analyzer	
HP 8757D Scalar Network Analyzer	$9,300
Opt 001 Fourth Detector Input	+$1,600
Opt 002 Internal Power Calibrator	+$2,500
Opt 802 HP 9122C Disk Drive and an HP 10833A HP-IB cable	+$1,745
Opt W03* 90-Day On-Site Warranty Conversion	$0
Opt W30 Two-Year Extended Service	+$230
HP 8757E Scalar Network Analyzer	$7,600
Opt W03* 90-Day On-Site Warranty Conversion	$0
Opt W30 Two-Year Extended Service	$190
Sweepers	
Choose either HP 8350B with an RF Plug-In, HP 8360 Series, 8340B, or 8341B.	
Precision Detectors	
HP 85037A 0.01 to 18 GHz, Type-N(m)	$1,750
Opt 001 7 mm Connector	+$50
HP 85037B 0.01 to 26.5 GHz, 3.5 mm(m)	$1,850
Directional Bridges	
HP 85027A 0.01 to 18 GHz, 7 mm, 50 Ω	$2,670
HP 85027B 0.01 to 26.5 GHz, 3.5 mm (f), 50 Ω	$3,170
HP 85027C 0.01 to 18 GHz, Type-N (f), 50 Ω	$2,670
HP 85027D 0.01 to 50 GHz, 2.4 mm (m), 50 Ω	$3,600
HP 85027E 0.01 to 26.5 GHz, 3.5 mm (m), 50 Ω	$3,170
HP 85020A 0.01 to 4.3 GHz, Type-N (f), 50 Ω	$1,300
HP 85020B 0.01 to 2.4 GHz, Type-N (f), 75 Ω	$1,450
Detectors	
HP11664A 0.01 to 18 GHz, Type-N (m)	$590
Opt 001 7 mm Connector	+$50
HP 11664E 0.01 to 26.5 GHz, 3.5 mm (m)	$760
HP 11664D 26.5 to 40 GHz, WR-28 Waveguide	$1,400
HP 11664C Detector Adapter	$375
HP 85025A 0.01 to 18 GHz, Type-N (m)	$940
Opt 001 7 mm Connector	+$50
HP 85025B 0.01 to 26.5 GHz, 3.5 mm (m)	$1,010
HP 85025D 0.01 to 50 GHz, 2.4 mm (m)	$1,600
HP 85025E 0.01 to 26.5 GHz, 3.5 mm (m)	$1,200
HP R85026A 26.5 to 40 GHz, WR-28 Waveguide	$1,700
HP Q85026A 33 to 50 GHz, WR-22 Waveguide	$1,900
HP U85026A 40 to 60 GHz, WR-19 Waveguide	$1,900
HP 85025C Detector Adapter	$600
System Verification Kits	
HP 85028A 7 mm Directivity Verification Standards	$5,500
HP 85023A 7 mm, 50 Ω	$760
HP 85023B 3.5 mm, 50 Ω	$1,000
HP 85023C Type-N, 50 Ω	$700
HP 85023D Type-N, 75 Ω	$1,050
HP 85023F 2.4 mm, 50 Ω	$2,300
Filter Kits	
HP 11668 High Pass Filter Kit	$750
HP 11678 Low Pass Filter Kit	$2,500
System Cable Kit	
HP 85022A System Cable Kit	$390
Computer	
HP A2240A Opt AMR Series 300, Model 362	$6,490
Includes:	
SPU with 2 MB RAM	
3½-in Floppy Disk Drive	
14-in VGA Color Monitor	
52 MB Internal Disk Drive w/HP BASIC Installed	
Note: Must order Keyboard Kit A1099A separately.	
Disk Drive	
HP 9122 3½-in Dual Flexible-Disk Drive	$1,465
Software (Choose one option)	
HP 85016B Measurement Automation and Transmission Line Test Software for HP 8757	$3,000
Opt 630 3½-in Double-Sided Format Disks	$0
Opt 655 5¼-in Double-Sided Format Disks	$0
Recommended Accessories	
Printer	
HP 2225A ThinkJet Printer	$595
HP 2227B QuietJet Printer	$849
HP 3630A Opt 002 PaintJet Color Graphics Printer	$1,395
Plotter	
HP 7440A Opt 002 Eight-Pen Graphics Plotter (8½-in × 11 in)	$1,195
HP 7550B Eight-Pen Vector Plotter (11 in × 17 in)	$4,495
Optional Accessories	
(For ratio and/or modulation measurements)	
HP 11636A Power Divider dc to 18 GHz	$600 ☎
HP 11636B Power Divider dc to 26.5 GHz	$1,050
HP 11665B Modulator	$1,050 ☎
HP 11667A Power Splitter dc to 18 GHz	$990
Opt 001 N-male on Input Port; N-female on Output Ports	$0
Opt 002 N-female on Input Port; 7 mm on Output Ports	+$75
HP 11667B Power Splitter dc to 26.5 GHz	$1,070
HP 11667C Power Splitter dc to 50 GHz	$1,570
HP 11679A Detector Extension Cable, 7.6m (25 ft)	$125
HP 11679B Detector Extension Cable, 61m (200 ft)	$375
HP 11852B 50 to 75 Ω Minimum Loss Pad	$500
Service and Support Products	
HP 11613B Calibrator	$1,075
Upgrade Kits	
HP 86383A Upgrade Kit, HP 8757E to 8757D	$2,000
HP 86383B Upgrade Kit, HP 8757C to 8757D	$900
HP 86383C Upgrade Kit for HP 8757D	
Opt 001 Adds Fourth Detector Input	$1,800
Opt 002 Adds Internal Power Calibrator	$2,700

☎ For off-the-shelf shipment, call 800-452-4844.

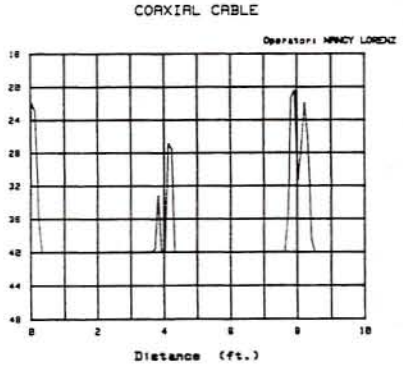
*Only where available

NETWORK ANALYZERS

Scalar Analyzer Software, Transmission Line Test System

HP 85016B, 8328A

- Custom tests without programming
- Friendly menu operation
- Measure insertion loss and return loss
- Plot or store data
- Test coax and waveguide
- Locate faults in transmission lines



HP 85016B Measurement Automation and Transmission Line Test Software

Using the HP 85016B Measurement Automation and Transmission Line Test software for the HP 8757, you can create and run complete scalar measurements without programming. The software guides you all the way from setup to output making all the necessary settings on the scalar analyzer and source to provide fast, accurate measurements that can be stored for later reference.

Easy to Learn

Use the BASIC mode to get up to speed quickly on the software's operation. It prompts you with a few simple questions, then sets up your source and analyzer automatically. The software prompts you to make all the connections necessary for calibration and measurement sequences, then automatically plots the data on the CRT display. For a permanent record, send the plot to a graphics plotter with a single keystroke.

Customized Measurement Setups

Use the GENERAL and ADVANCED modes to access more of the software's powerful features. Define up to 4 measurements in one sequence. Specify particular power levels for your test device and enter your specifications limits as point, line, or sloped lmits. These limit lines allow simple pass/fail testing, or real time adjustment to within the specified limits. Finish by outputting the data using your own customized format with labels, limit lines, and "out-of-spec" indicators. Store the data on computer disc for archival purposes, then recall it later for futher analysis.

Compatible Sources

The HP 85016B software is compatible with HP 8757 scalar network analyzer systems configured with an HP 8350B sweep oscillator and HP 83500 series RF plug-in or an HP 8340B or 8341B synthesized sweeper. For HP 8360 compatibility with the HP 85016B, order HP 85016B Option H01.

Test Transmission Lines with the HP 85016B

The HP 85016B test software also provides fault location for complete testing of coax and waveguide of transmission lines. Test frequency response (insertion and return loss), the find faults (mismatches) that affect the signals in your frequency range. Troubleshoot your ECM, radar, or communication system quickly and without guesswork.

HP 8328A

HP 8328A Transmission Line Test System

The HP 8328A transmission line test system tests the performance of waveguide runs and coaxial cables with swept frequency measurement of insertion loss and return loss. Additionally the HP 8328A system can make fault location tests to fine impedance mismatches as a function of distance, quickly and without guesswork.

The HP 8328A is a dedicated transmission line test system for tests from 10 MHz to 18 GHz. It is configured in a rugged, transportable container. The system is self-contained for ease of use and is ideal for accessing transmission lines in difficult-to-reach installations such as aircraft. Although all testing can be done automatically, full manual capability is available.

Measurement Capability

- Measurements versus distance: return loss (dB), SWR, or reflection coefficient
- Resolution (distance between data points as a percentage of the transmission line length): 1% (101 pts), 0.5% (201 pts), 0.25% (401 pts)
- Measurements versus frequency: insertion loss, gain, return loss, SWR, reflection coefficient, and power in dBm, dBW, or mW
- Resolution: user selectable up to 1024 points for swept measurement or stepped CW measurements

Ordering Information

The HP 85016B software package comes with 5 disks, including a data disk. Order the option that corresponds to your computer configuration. The HP 85016B can run on BASIC 5.0 or greater and requires 2 MB of RAM memory.

	Price
HP 85016B Measurement Automation and Transmission Line Test Software	$3,000
Opt 630 3½-in Disks	$0
Opt 655 5¼-in Disks	$0
Opt H01 HP 8360 Series Compatibility	+$1,000
HP 8328A Transmission Line Test System	$68,000
Opt 001 10 MHz to 8.4 GHz only	−$4,300
Opt 100 Adds support software	+$250
Opt W30 Two years extended service	+$1,600
Opt 043 Add floppy disk drive	+$500

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- High-speed/high-accuracy measurements
- .001 dB, .005 degree, 1 ps, and .001 Hz resolution
- Discrete sweep and limit lines
- Optional HP Instrument BASIC

HP 3577B

DESIGNED FOR HP-IB SYSTEMS

HP 3577B Network Analyzer

The HP 3577B is a high-performance, yet economical, two-channel, (optional three-channel) network analyzer for use in both research and development and manufacturing. It is used to measure magnitude/phase, insertion loss, group delay, SWR, electrical length, and gain compression from 5 Hz to 200 MHz. When used with the HP 35676A/B reflection/transmission kit, it can also measure return loss, reflection coefficient, and impedance.

With the optional HP Instrument BASIC, the HP 3577B can execute user-written programs designed to automate measurement systems, compute parameters (such as pass band ripple and 3 dB bandwidth) or customize the user-interface. This includes system control of other HP-IB instruments and peripherals via the HP-IB. A programmable I/O port, located on the rear panel, extends HP Instrument BASIC control to non-HP-IB devices, such as device handlers, environmental chambers, and even the device-under-test itself.

Of course, the HP 3577B is fully programmable, either internally with HP Instrument BASIC, or externally via the Hewlett-Packard Interface Bus (HP-IB).

An optional high-stability frequency reference oven is available for those users not having an in-house frequency standard. HP also offers a wide range of accessories, including S-parameter and reflection/transmission test sets, as well as signal injection devices for feedback control systems such as power supplies and servo loops. Contact your local HP office for a full listing.

Unprecedented Measurement Precision

This network analyzer has the accuracy and resolution required to characterize the most demanding narrowband devices and the flexibility to quickly characterize wideband devices. Dynamic magnitude and phase accuracy are 0.02 dB and 0.2 degree, respectively. Device response can be examined in fine detail with 0.001 dB, 0.005 degree, and 1 ps resolution. A built-in synthesized LO and tracking generator provide superb frequency accuracy with 0.001 Hz resolution. The 100 dB plus dynamic range and −130 dBm noise floor meet the needs of the most demanding measurements.

Built-in three-term error correction removes errors due to directivity, frequency response, and source mismatch for one-port measurements. Similarly, vector normalization enhances the accuracy of two-port measurements.

High-Throughput for Manufacturing

The HP 3577B brings high-throughput network analysis to manufacturing without compromising accuracy. Take advantage of features such as discrete sweep, comparison to limit lines, and PASS/FAIL testing to speed your manufacturing test of crystals, filters, and other devices.

Specifications Summary

Source

Frequency

Range: 5 Hz to 200 MHz
Resolution: 0.001 Hz
Stability (Opt 1 only/instrument on ≥ 48 hrs): $\pm 5 \times 10^{-8}$/day, 0 to 55° C

Amplitude

Range: +15 dBm to −49 dBm (1.26 Vrms to 793μ Vrms: 2dBV to −62 dBV) into a 50 Ω load
Resolution: 0.1 dB
Accuracy: ±1 dB at + 15 dbm and 100 kHz. Below + 15 dBm, add the greater of ±0.02 dB/dB or 0.2 dB
Flatness: 1.5 dBp-p from 5 Hz to 200 MHz
Impedance: 50 Ω; > 20 dB return loss at all levels
RF output connector: 50 Ω Type N female
Sweep types: Linear, discrete, alternate, cw and log frequency; log amplitude
Sweep time: 100 ms/span to 6553 sec/span for frequency sweep; 1 ms/step to 16 s/step for amplitude sweep
Sweep modes: Continuous, single, manual
Trigger modes: Free run, immediate, line, external

Input Characteristics

Frequency range: 5 Hz to 200 MHz
Inputs: Two receiver inputs (A,R); third receiver input (B) is optional
Input impedance: Selectable 50 Ω with > 25 dB return loss, or 1 MΩ in parallel with approximately 30 pF
Input connectors: 50 Ω Type N female
Resolution bandwidth: Selectable 1 kHz, 100 Hz, 10 Hz, or 1 Hz.

Magnitude Characteristics

Range: Full scale input to sensitivity
Display units: dB, dBm, dBV, V, and linear ratio
Accuracy (at 100 kHz, 25° C, and full scale input)
Absolute (A, B, R): ±0.2 dB
Ratio (A/R, B/R, A/B): ±0.15 dB (50 Ω); ±0.2 dB (1 MΩ)

Dynamic Accuracy

Error (Resolution Bandwidth)		Input Level Relative to Full Scale Input
1 kHz, 100 Hz, 10 Hz	1 Hz	
±.04 dB	±.04 dB	0 dB to −10 dB
±.02 dB	±.02 dB	−10 dB to −50 dB
±.05 dB	±.05 dB	−50 dB to −60 dB
±.15 dB	±.25 dB	−60 dB to −80 dB
±.75 dB	±.75 dB	−80 dB to −90 dB
±.75 dB	± 3.00 dB	−90 dB to −100 dB

Frequency Response: (when driven from a 50 Ω source and with 50 Ω receiver input impedance)
Absolute (A,B,R): 0.3 dBpp from 20 Hz to 20 MHz; 0.6 dBpp from 5 Hz to 200 MHz
Ratio (A/R, B/R, A/B): 0.3 dBpp from 20 Hz to 20 MHz; 0.4 dB from 5 Hz to 200 MHz

Stability

Temperature: Typically < ±0.02 dB/° C
Time: Typically ±0.05 dB/hour at 25° C

Phase Characteristics (A/R, B/R, A/B)

Range: ±180 degree
Accuracy: At 100 kHz, 25° C, and Full Scale Input: ±2.0°

Dynamic Accuracy

Error	Input Level Relative to Full Scale Input
±.4 degree	0 dB to −10 dB
±.2 degree	−10 dB to −50 dB
±.5 degree	−50 dB to −60 dB
±1.5 degree	−60 dB to −80 dB
±7.5 degree	−80 dB to −100 dB

Temperature stability: Typically < ±0.05 degree/° C
Time stability: Typically < ±0.05 degree/hr at 25° C

Delay Characteristics

Range: 1 ps to 20,000s
Resolution: 0.01 ns/div to 1000s/div

Limit Test: Twenty segments for each trace per limit test. Delay between sweeps approximately 10 to 120 ms.

Network Analyzers

Audio/Video/Baseband/IF Network Analyzer, 5 Hz to 200 MHz

HP 3577B, 35677A/B, 35676A/B

General Characteristics

Traces

Number of traces: Two simultaneous traces may be present with a rectangular graticule. One trace with polar or Smith graticules.

Markers: Each trace has one main marker and an offset marker.

Graticules

Rectangular graticule: 0% to 100% full scale deflection in 0.05% increments. Logarithmic and linear.

Polar/Smith chart graticule: ±500 degree in 0.001 degree increments.

Limit Test

Twenty segments for each trace per limit test. Delay between sweeps approximately 10 to 120 ms.

Noise Averaging

Type: Exponentially weighted vector averaging on successive sweep data.

Averaging factor: Selectable 1 (off), 4, 8, 16, 32, 64, 128, 256

Linear Phase Slope Compensation: Provides linear phase slope offset of −72,000 degree/span to +72,000 degree/span.

Calibration

Transmission: Both traces can be normalized to measured data with full accuracy and resolution.

Reflection: Corrects for directivity, frequency response, and source match errors

Programming

Remote programming: Via the Hewlett-Packard Interface Bus (HP-IB). The HP 35677A/B S-parameter test sets are programmable through the HP 3577A interface only.

Plotter control: Directly compatible with HP-IB graphics plotters that use Hewlett-Packard Graphics Language (HP-GL) with listen-only capability.

Save/recall: Front-panel setups can be stored in non-volatile memory locations 1 through 5. Last state is saved when power is removed.

Operating Conditions

Temperature: 0° C to +55° C

Power: 115 V + 10%, −25% (47 Hz to 440 Hz), or 230 V + 10%, −15% (47 Hz to 66 Hz), 450 VA maximum

Weight: Net, 31 kg (67 lb); shipping, 41 kg (90 lb)

Size: 222 mm H × 426 mm W × 578 mm D (8.7 in × 16.75 in × 22.75 in)

HP 35677A/B S-Parameter Test Set

The HP 35677A/B test set is used to make transmission and reflection measurements in both the forward and reverse directions without changing device connections. The HP 35677A is used for 50-Ω systems and the HP 35677B is used for 75-Ω systems.

HP 35677A/B S-Parameter Test Set Specifications

Frequency Range: 100 kHz to 200 MHz

Test Port Impedance: HP 35677A: 50 Ω; HP 35677B: 75 Ω

Directivity: >40 dB

Frequency Response

Transmission (S21, S12): ± 1 dB, ± 5 degrees

Reflection (S11, S22): ± 1 dB, ± 5 degrees

Accessories

All accessories needed to connect the test set to the analyzer are provided.

General Characteristics

Weight: Net, 6 kg (13 lb); shipping, 122 kg (25 lb)

Size: 90 mm H × 425 mm W × 584 mm D (3.5 in × 16.75 in × 22.75 in). Add 1⅛ inch to depth for front panel connectors.

HP 35676A/B Reflection/Transmission Test Kits

Operating in conjunction with internal calibration routines in the HP 3577B, the HP 35676A/B test kit provides measurements of reflection,transmission and impedance from 5 Hz to 200 MHz. Each test kit contains a precision resistive divider, a reference load, a coaxial short, a carrying case, and miscellaneous cables and hardware.

HP 35676A/B Operating Characteristics*

Frequency Range: 5 Hz to 200 MHz

Test Port Impedance: 50 Ω ±2% typical (HP 35676A) 75 Ω ±2% typical (HP 35676B)

Equivalent Directivity: 40 dB typical

Equivalent Source Match: 30 dB typical (HP 35676A); 25 dB typical (HP 35676B)

*Typical, assuming proper calibration with accessories supplied.

Ordering Information	Price
HP 3577B Network Analyzer	$20,510
Opt 001 Frequency Reference	+$900
Opt 002 Third Receiver	+$3,600
Opt 1C2 HP Instrument BASIC/ 640 Kbytes RAM	+$950
Opt 907 Front Handle Kit	+$79
Opt 908 Rack Mount Kit	+$42
Opt 909 Rack Mount and Front Handle Kit	+$105
Opt 910 Extra Operating and Service Manual	+$250
Opt 911 Extra HP Instrument BASIC Manual	+$10
Opt W30 Extended Repair Service (see page 636)	+$450
HP 35676A 50 Ω Reflection/Transmission Test Kit	$1,518
Opt W30 Extended Repair Service (see page 636)	+$45
HP 35676B 75 Ω Reflection/Transmission Test Kit	$1,817
HP 35677A 50 Ω S-Parameter Test Set	$4,431
HP 35677B 75 Ω S-Parameter Test Set	$4,431
Opt 907 Front Handle Kit	+$52
Opt 908 Rack Mount Kit	+$27
Opt 909 Rack Mount and Front Handle Kit	+$63
Opt 910 Extra Operating and Service Manuals	+$47
HP 35678A 50 Ω type N Calibration Kit	$856
HP 35678B 75 Ω type N Calibration Kit	$1,618
HP 35679A 50 Ω type N Port Extension Cables	$572
HP 35679B 75 Ω type N Port Extension Cables	$1,892
HP 85024A High-Frequency Probe	$2,300

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

NETWORK ANALYZERS

Combined Network/Spectrum Analysis, 10 Hz to 500 MHz

HP 4195A

- Linear and nonlinear device measurement and analysis
- High accuracy and resolution
- User functions
- Color graphics, graphics analysis, and direct copy capability
- Direct save/recall with internal disk drive

HP 4195A

DESIGNED FOR HP-IB SYSTEMS

HP 4195A Analyzer

The HP 4195A is a high-performance, cost-effective, and intelligent analyzer with combined vector network and spectrum analysis capabilities. The frequency is covered from 10 Hz through 500 MHz with an excellent 0.001 Hz resolution for audio, baseband, HF, VHF, and IF applications. It directly measures amplitude ratio, phase, group delay, and spectrum level needed for characterizing linear/non-linear analog circuits or components used in communications, telecommunications, consumer electronics, and other equipment.

The HP 4195A's excellent accuracy and resolution meet the severe measurement requirements for developing advanced equipment. A color display allows you to readily differentiate among multiple traces. Convenient softkey operation and marker functions make deriving device parameters quick and easy. Measurement results can be directly copied to printer or plotter without an external computer. Furthermore, the HP 4195A has internal user functions for computing and a self-controlling capability. User Program, User-Defined Function and User Math allow you to quickly customize the setups most suited to your application without using an external computer. A built-in 3½-inch disk drive can save the instrument state, data, and user functions.

Specifications

Network Measurement

Source
- **Frequency:** 10 Hz to 500 MHz, 1 mHz resolution
- **Power:** −50 dBm to +15 dBm, 0.1 dB resolution
- **Sweep Parameters:** Frequency, power, and dc bias level
- **Sweep Types:** Linear, log, cw, program, and partial
- **Output:** 2 outputs
- **dc bias level:** ±40V, 10 mV resolution

Receiver
- **Frequency:** 10 Hz to 500 MHz
- **Input:** 4 inputs, 50 Ω nominal
- **Resolution Bandwidth:** 3 Hz to 300 kHz, 1 or 3 step
- **Input Crosstalk:** ≤ −100 dB

Magnitude Ratio
- **Dynamic range:** >100 dB
- **Resolution:** 0.001 dB
- **Dynamic accuracy (23 ±5° C), −30 dBm R input:** ±0.05 dB @ −70 dBm to −30 dBm T input

Phase
- **Range:** ±180°
- **Resolution:** 0.01°
- **Dynamic accuracy (23 ± 5° C, −30 dBm input):** ±0.3° @ −70 to −30 dBm T input

Delay
- **Range:** 10 ps to 500 s
- **Resolution:** 10 ps @ 3.6 MHz aperture
- **Accuracy:** Depends on phase accuracy

Error Compensation
- **Mode:** Normalization, 1 port partial cal, 1 port full cal and port extension

Spectrum Measurement

Frequency
- **Measurement range:** 10 Hz to 500 MHz
- **Resolution:**
  - **RBW:** 3 Hz to 300 kHz, 1 or 3 step
  - **Selectivity (60/3dB):** 4.5 for 3 Hz to 30 Hz, 9 for 100 Hz to 10 kHz, 8.5 for 30 kHz to 300 kHz.
  - **Noise sideband:** < −100 dBc/Hz @ 1 kHz offset; < −90 dBc/Hz @ 100 Hz offset

Amplitude
- **Measurement range:** −135 dBm to +20 dBm
- **Accuracy:** ±1.0 dB @ 50 MHz
- **Linearity** (23 ±5° C): ±0.1 dB @ −40 to 0 dB; ±0.2 dB @ −60 to −40 dB
- **Frequency response:** ±1.5 dB

Dynamic Range (23 ±5° C)
- **Second harmonic distortion:** ≤ −70 dBc @ ≥ 2 MHz
- **T.O.I distortion:** ≤ −80 dBc @ ≥ 2 MHz
- **Residual response:** −110 dB @ ≥ 100 kHz
- **Average noise level:** Typically −140 dBm @ 10 Hz RBW, ≥2 MHz

Sweep
- **Sweep type:** Linear, log, cw, program and partial
- **Sweep mode:** Continuous, single and manual
- **Sweep time:** Approximately 3.5 sec @ 500 MHz span, 300 kHz RBW

Input
- **Number of inputs:** 4 inputs
- **Impedance:** 50 Ω nominal
- **Damage level:** +30 dBm
- **Attenuator:** 0 to 50 dB, 10 dB step

Display

Display: 7.5-in color CRT
Phase Display Expansion: Display phase continuously more than ±180°
Video Filter: Digital video filtering reduces random noise

User Functions

User Math, User Defined Function, User Program

Hardcopy

Hardcopy of traces, measurement data, results of analysis, and annotations are produced by the HP 4195A and HP plotters or printers with LISTEN only capability.

Storage

Instrument state, trace data, table of Program Sweep, and User Program can be independently saved or recalled from the built-in 3½-in floppy disk memory via SAVE/GET function.

Remote Programming

HP-IB interface operates according to IEEE 488-1987 and IEC 625 standards and IEEE 628-1982 recommended practices.

Interface Function: SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E1

Transfer Formats: ASCII; 32/64 bit IEEE 754 floating-point format

NETWORK ANALYZERS

Combined Network/Spectrum Analysis, 10 Hz to 500 MHz

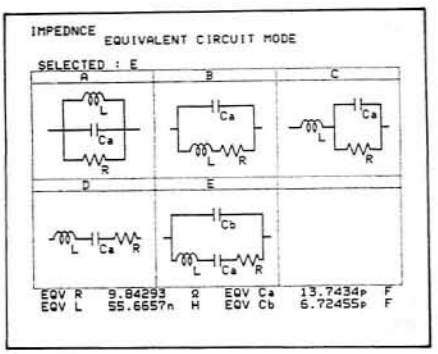
HP 4195A, 41951A, 41952A/B, 41800A

General Characteristics

Operating Conditions:
Temperature: 0° C to +45° C
Humidity: 95% RH at 40° C
Non-Operating Conditions:
Temperature: −40° C to +70° C
Safety: Based on IEC-348, UL-1244
Power: 100, 120, 220 V ±10%, 240 V −10% +5%, 48 Hz to 60 Hz, 500 VA (max)
Size: 425 mm W × 375 mm H × 620 mm D (16.75 in × 14.8 in × 24.4 in)
Weight: Approximately 41 kg (90.4 lb)

HP 41951A Impedance Test Kit

The HP 41951A can be used for impedance measurements from 100 kHz to 500 MHz when used with the HP 4195A.
Measured Parameters: |Z|, |Y|, θ, L, C, R, X, G, B, D, and Q
Error Compensation: 1 port cal, open/short offset, and port extension
Equivalent Circuit Analysis: Circuit constants approximation and simulation of frequency characteristics
Available Accessories: Refer to page 347



HP 41951A

HP 41952A/B Transmission/Reflection Test Sets

Two test sets of the HP 41952A or 41952B (Option 009) allow the HP 4195A to perform full S-parameters measurement without having to remove and reverse the device. The HP 41952A is used for 50 Ω application, and the HP 41952B is used for 75 Ω application.

Specifications

	HP 41952A	HP 41952B
Impedance:	50 Ω	75 Ω
Frequency range:	100 kHz to 500 MHz	100 kHz to 500 MHz
Directivity:	40 dB @ 300 kHz to 200 MHz	35 dB @ 800 kHz to 200 MHz
Frequency response: *1		
Transmission magnitude, phase (@ ≥300 kHz):	±1 dB, ±5 deg	±1 dB, ±5 deg
Reflection magnitude, phase (@ ≥1 MHz):	±1 dB, ±5 deg	±1 dB, ±5 deg
Effective source match: test port	>20 dB @ ≥ 300 kHz	>20 dB @ ≥ 300 kHz
Connector: test port	50 Ω type N-(f)	75 Ω type N-(f)
Accessories furnished	50 Ω N cable Operating Note Carrying Case	50 Ω N cable HP 11852B M. L. Pad Operating Note Carrying Case

Note: HP 41952B Opt. 009 deletes 50 Ω N cable and HP 11852B.
*1: Typical

HP 41952A

HP 41800A

HP 41800A Active Probe

The HP 41800A Active Probe is a high-input impedance probe that covers the frequency from 5 Hz to 500 MHz, and makes it easy to perform signal analysis of circuits in audio, video, HF, and VHF band.

Specifications

Bandwidth: 5 Hz to 500 MHz
Input R, C (nominal): 100 k Ω, 3 pF (probe alone)
Average Noise Level (typical): 10 nV/√Hz 300 kHz to 500 MHz
2nd Harmonic Distortion: < −50 dBc −20 dBc input
Output Connector: 50 Ω type N male
Accessories Furnished: 10:1 divider, hook tip, ground leads, spare tips, BNC male adapter, and so on

Accessories Available

HP 85044A/B Transmission/Reflection Test Set (see page 297.)
HP 85024A High Frequency Probe (see page 277)

Ordering Information

	Price
HP 4195A Network/Spectrum Analyzer	$26,200
Opt W30 Extended Repair Service (see page 636)	+$550
Opt 001 High Stability Frequency Reference	+$850
HP 41951A Impedance Test Kit	$1,610
HP 41952A 50 Ω Transmission/Reflection Test Set	$2,245
HP 41952B 75 Ω Transmission/Reflection Test Set	$2,765
Opt 009 Delete 50 Ω N Cable and 11852B	−$500
HP 41800A Active Probe	$1,740

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

NETWORK ANALYZERS

Baseband, IF and RF Network Analyzer, 5 Hz to 500 MHz

HP 8751A

- 5 Hz to 500 MHz
- 0.001 Hz, 0.001 dB, 0.001 degree, 10 ps resolution
- Full 2-port and interpolative calibration
- Conjugate matching analysis
- Built-in 1.44 Mbyte disk drive for save/recall
- Crisp color display with RGB output
- 10 updates of 201 sweep points per second
- 0.4 ms/point fast list sweep
- Up to 4 traces simultaneous measurement/display
- 8 active trace markers per channel
- HP Instrument BASIC for customization
- HP 41802A 1 MΩ input adapter

HP 8751A
with HP 87511A

HP 8751A Network Analyzer

The HP 8751A network analyzer is a high-throughput instrument with lab precision that covers 5 Hz to 500 MHz. The 8751A provides resolution of 0.001 Hz, 0.001 dB, 0.001 degree, and 10 ps for characterizing the linear behavior of either passive or active networks, devices, or components in the lab and the production test areas. The built-in 1.44 MB disk drive is for direct save/recall of instrument state, calibration data, and application programs for your customization. Dedicated 50/75 Ω S-parameter test sets, 50/75 Ω T/R test kits, and the 1 M Ω input adapters are all available.

Lab Precision

Versatile display format and built-in accuracy enhancement (2-port full cal, 1-port full cal, and interpolative calibration) are provided for high-precision measurement in lab environments. The 8751A's unique conjugate matching capability gives you the optimum power transfer to make designing easier.

Production Throughput

Unprecedented total throughput is a key feature of the HP 8751A. 0.4 ms/point measurement time is now applicable not only to linear sweep, but also to list sweep (programmable with IFBW and OSC output power) and to log sweep. The 8751A can also simultaneously measure/display up to four parameters with simple softkey operations. GO/NO-GO limit testing with an I/O handler control capability and HP Instrument BASIC are available to enhance total production test throughput.

Data Storable in LIF/DOS formatted floppy disk

A 1.44 MB disk drive is standard with the HP 8751A for easy save/recall of the instrument states, measurement data, calibration data, and application programs. Both HP LIF and DOS formats are supported. Saving data in DOS format enables you to see and manipulate data on a PC.

HP Instrument BASIC

HP Instrument BASIC (IBASIC) is available as an option. IBASIC enables you to easily create application programs for a measurement on the HP 8751A without using an external computer. IBASIC increases the productivity of a measurement, and reduces additional investment.

HP 8751A Specifications

Source

Frequency Characteristics

Range: 5 Hz to 500 MHz
Resolution: 1 mHz
Accuracy: ± 20 ppm, ± 1.0 ppm (Opt 001)
Stability: ± 2.5×10^{-9}/8 hours (typical 23 ± 5° C with Opt 001)

Output characteristics

Power Range: −50 to +15 dBm
Resolution: 0.1 dB
Flatness: ±2.0 dB @ 5 Hz ≤ freq. ≤ 500 MHz (23 ±5° C, +0 dBm, relative to 50 MHz)
Level Accuracy: ±0.5dB (50 MHz, 0 dBm)
Level Linearity: ± 0.5dB @ output level ≥ −35dBm
± 1.5dB @ output level < −35dBm
(50 MHz, relative to 0 dBm)
Impedance: 50 Ω

NETWORK ANALYZERS

Baseband, IF and RF Analyzer, 5 Hz to 500 MHz (cont'd)

HP 8751A

Receiver

Frequency Range: 5 Hz to 500 MHz
Input Range: 0 dBm @ ATT = 20 dB
−20 dBm @ ATT = 0 dB
IF Bandwidth: 2 Hz, 20 Hz, 200 Hz, 2 kHz, 4 kHz
Noise Level: −130 dBm @ IFBW=20 Hz, ATT=0 dB, frequency≥100 kHz
Maximum Input Level: 0 dBm
Impedance: 50 Ω
Crosstalk: < −100 dB
Dynamic Accuracy: ±0.05 dB, ± 0.3° (input level −10 to −60 dB, 20 Hz IFBW)
Delay Characteristics:
Aperture Frequency: 0.5 to 20%
Display Range: 10 ps to 500 s
Accuracy: (Phase accuracy)/(360 × aperture)
Size: 425 mm W × 235 mm H × 553 mm D (16.75 in × 9.25 in × 21.77 in)
Weight: 28 kg (61.6 lb)

HP 8751A Accessories

HP 87511A 50 Ω S-Parameter Test Set
HP 87511B 75 Ω S-Parameter Test Set

The HP 87511A/B S-parameter test sets provide the capability to measure reflection and transmission characteristics (including S-parameters) of 2 port devices in either direction with a single connection. The frequency range of the HP 87511A/B test sets is 100 kHz to 500 MHz. The test sets are controlled from the HP 8751A.

HP 87511A/B Specifications

	HP 87511A	HP 87511B
Impedance	50 Ω	75 Ω
Frequency range	100 kHz to 500 MHz	100 kHz to 500 MHz
Directivity	≥35 dB from 300 kHz to 500 MHz	33 dB from 300 kHz to 500 MHz
Typical tracking S21, S12 S11, S22	 ±1 dB, ±5° ±1 dB, ±5°	 ±1 dB, ±5° ±1 dB, ±5°
Nominal insertion loss RF input to Port 1,2 RF input to R,A,B Port 1,2 to A,B	 13 dB 19 dB 6 dB	 19 dB 31 dB 6 dB
Max operating level	+20 dBm	+20 dBm
Damage level	+23 dBm	+23 dBm
Size	426 W × 90 H × 553 mm D	426 W × 90 H × 553 mm D
Weight	5.7 kg	5.7 kg

HP 87512A 50-Ω Transmission/Reflection Test Kit
HP 87512B 75-Ω Transmission/Reflection Test Kit

The HP 87512A/B transmission/reflection test kits provide the capability to measure transmission and reflection characteristics. The frequency range of the HP 87512A/B test kits is dc to 2 GHz.

HP 87512A/B Specifications

	HP 87512A	HP 87512B
Impedance	50 Ω	75 Ω
Insertion loss	10 ± 1 dB typical	
Equivalent directivity	>40 dB typical	
Equivalent source match	>30 dB typical	>25 dB typical

HP 41802A 1-MΩ Input Adapter

The HP 41802A 1 MΩ input adapter provides the capability to perform high-impedance measurement using HP network and spectrum analyzers. The frequency range of the HP 41802A input adapter is 5 Hz to 100 MHz. Passive probe is required for measurement (probing).

HP 41802A

HP 41802A Specifications

Frequency Range: 5 Hz to 100 MHz
Adaptor Gain: 0 dB ±0.5 dB @ 1 MHz
Input R, C (typical): 1 MΩ, 12 pF
1dB Gain Compression: 0.32 Vrms (+ 3dBm, 50 Ω terminated)
Damage Level: 2 Vrms, ± 50 Vdc
Size: 28 mm H × 42 mm W × 100 mm D (1.1 in × 1.65 in × 3.94 in)
Weight: 400 g (0.88 lb)

Other Accessories

HP 85031B Precision 7 mm calibration kit
HP 85032B 50 Ω type-N calibration kit
HP 85033C Precision 3.5 mm calibration kit
HP 85036B 75 Ω type-N calibration kit
HP 11850C 50 Ω power splitter
HP 11850D 75 Ω power splitter
HP 11853A 50 Ω type-N accessory kit
HP 11854A 50 Ω BNC accessory kit
HP 11855A 75 Ω type-N accessory kit
HP 11856A 75 Ω BNC accessory kit

Ordering Information

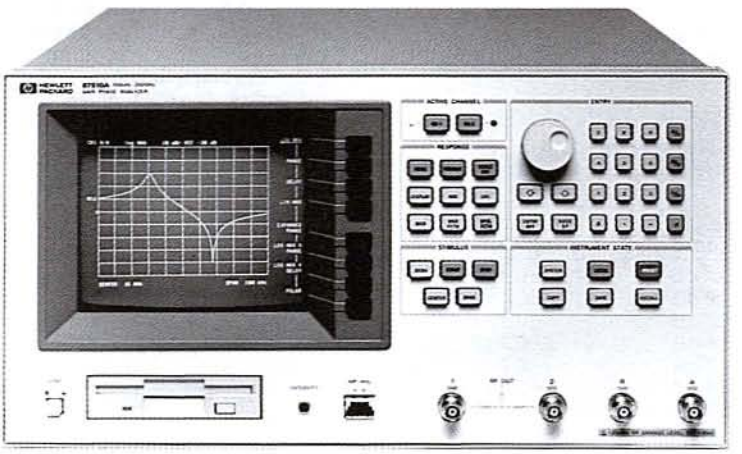
	Price
HP 8751A Network Analyzer	$22,500
Opt 001 High-Stability Frequency Reference	+$850
Opt 002 HP Instrument BASIC and 1 MB RAM	+$1,000
Opt 907 Front Handle Kit	+$75
Opt 908 Rack Mount Kit	+$40
Opt 909 Rack Flange and Handle Kit	+$105
Opt 910 Extra Operating Manual	+$160
Opt 915 Add Service Manual	+$140
HP 87511A 50 Ω S-Parameter Test Set	$5,000
Opt 001 N-Type Port	$0
HP 87511B 75 Ω S-Parameter Test Set	$5,000
Options (common for the HP 87511A/B)	
Opt 907 Front Handle Kit	+$50
Opt 908 Rack Mount Kit	+$31
Opt 909 Rack Flange and Handle Kit	+$72.50
Opt 910 Extra Operating Manual	+$50
HP 87512A 50 Ω Transmission/Reflection Test Kit	$2,000
HP 87512B 75 Ω Transmission/Reflection Test Kit	$2,500
HP 41802A 1 MΩ Input Adapter	$900
HP 41800A Active Probe	$1,740

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Vector transmission measurement
- 0.25 ms–per–point high-speed measurement
- Automatic and fast filter, and resonator parameter-extraction commands
- Built-in disk drive and RAM disk for results and program storage
- HP Instrument BASIC for easy automation
- 24-bit digital I/O for machine interface

DESIGNED FOR HP-IB SYSTEMS

NEW



HP 87510A

HP 87510A Gain-Phase Analyzer

The HP 87510A gain-phase analyzer is a 100-kHz to 300-MHz high-speed analyzer designed for use in high-volume production lines. Optimized for manufacturing, the HP 87510A improves productivity in resonator and filter production lines as well as for any application that requires reliable gain- and phase-transmission measurements. Many advanced features are standard with the HP 87510A, including automatic parameter-extraction commands; HP Instrument BASIC (HP I-BASIC); 3½-in disk drive; RAM disk; built-in power splitter; digital I/O; and single-keystroke −3 dB bandwidth function.

Fast Measurement and Analysis

The HP 87510A not only measures transmission characteristics, but—without using markers—analyzes the measured data in a very short time. More than 30 commands are provided for this purpose. The combination of fast sweep and fast analysis dramatically reduces test time in the high-volume production line. Also, advanced list-sweep capability provides the fastest measurement with optimum dynamic range.

Automation Features

HP Instrument BASIC is furnished with the HP 87510A for both standalone automation and controlling an automated test system. Programs can be created and fully edited with the optional HP-HIL keyboard. To control the external non-HP-IB equipment, the HP 87510A's digital I/O provides 24 TTL control lines. Limit line functions and a BIN sort function provide fully automated adjustment and pass/fail testing.

Ease of Use

To simplify device connection, a power splitter is built into the HP 87510A. No extra test set or accessory is required. The 1.4-MB disk drive can be used for storing many different setups, and RAM disk can be used for faster storage. Single-keystroke −3 dB bandwidth function and resonator equivalent-circuit calculations are provided to ensure quick analysis of filters and resonators.

Specifications

Signal Source Characteristics
- **Frequency range:** 100 kHz to 300 MHz
- **Frequency resolution:** 1 mHz
- **Stability:** $\pm 5 \times 10^{-6}$/day, typical, at 23° ±5° C. With Opt 001, $\pm 2.5 \times 10^{-9}$/8 h, typical, at 23° ±5° C, 48 h after power-up.
- **Accuracy:** ±20 ppm + 1 mHz at 23° ±5° C. With Opt 001, ±1 ppm +1 mHz at 0° to 55° C, 20 min after power-up.

Output Level
- **Range:** −15 dBm to +5 dBm, at output connector
  −45 dBm to +15 dBm, at output connector (Opt 010)
- **Resolution:** 0.2 dB
- **Accuracy:** ±1 dB, at 50 MHz, 0 dBm, 23° ±5° C
- **Flatness:** +2/−4 dB, at 23±5° C, 0 dBm, relative to 50 MHz
  +2.5/−4.5 dB, at 23±5° C, 0 dBm, 300 kHz to 100 MHz, relative to 50 MHz (Opt. 010)
- **Linearity:** ±1 dB at 23° ±5° C, 50 MHz, relative to 0 dBm

Power Splitter (except Opt 004)
- **Insertion loss:** 6 dB (nominal)
- **Tracking:** 0.1 dB (100 kHz to 100 MHz, typical), 0.2 dB (> 100 MHz, typical)
- **Equivalent output SWR:** 1.2 (100 kHz to 100 MHz, typical), 1.4 (> 100 MHz, typical)

Signal Purity
- **Harmonic distortion:** < −35 dBc at −10 dBm output level (except Opt 010)
- **Nonharmonic spurious:** < −45 dBc at 0 dBm output level, ≤ 300 MHz
- **Phase noise:** < 75 dBc/Hz at 10 kHz offset from carrier, at 0 dBm

Other:
- **Allowable reverse power:** 20 dBm, 50 Vdc, typical
- **Output connectors:** BNC, 50 Ω two channels (one with Opt 004)

Receiver Characteristics

Input characteristics:
- **Frequency range:** 100 kHz to 300 MHz
- **IF Bandwidth** (IFBW): 20 Hz, 200 Hz, 1 kHz, 4 kHz, 8 kHz
- **Input impedance:** 50 Ω (nominal)
- **Input return loss:** 20 dB (100 kHz to 100 MHz, typical), 15 dB (≤ 300 MHz, typical)
- **Maximum input level:** 0 dBm at 100 kHz to 300 MHz
- **Damage level:** 20 dBm, 50 Vdc, typical
- **Noise level:**

IFBW = 8 kHz: −70 dBm
IFBW = 4 kHz: −85 dBm
IFBW = 1 kHz: −90 dBm
IFBW = 200 Hz: −100 dBm
IFBW = 20 Hz: −110 dBm
at 100 kHz to 300 MHz, A ch, 23° ±5° C

- **Input crosstalk:** −100 dB (except Opt 004)

NETWORK ANALYZERS

Gain-Phase Analyzer, 100 KHz to 300 MHz (cont'd)

HP 87510

Source crosstalk: < −110 dB; typical, at +5 dBm output level
Residual response: −90 dBm, except the following frequencies: 170.14125 MHz, 170.9275 MHz, 227.379166667 MHz, 228.4275 MHz
Input connector: BNC, 50 Ω, two inputs (R, A). With Opt 003, Type N (for A ch), BNC (for R ch), 50 Ω, two inputs. With Opt 004, one input (A).
Measurement modes: A/R, A, R. With Opt 004, A.

Absolute Measurement Characteristics
Absolute measurement accuracy: ±1 dB at A ch, −10 dBm, 23° ±5° C
Display range: ±500 dB
Display resolution: 0.001 dB/div to 500 dB/div
Frequency response: ±0.5 dB (100 kHz to 100 MHz), ±1 dB (> 100 MHz) at 23° ±5° C, relative to −10 dBm; does not apply to Opt 004. Frequency response can be calibrated out.
Dynamic accuracy:

Input level	Standard	With Opt 004
0 to −10 dBm	±0.4 dB	±0.4 dB
−10 to −20 dBm	±0.08 dB	±0.1 dB
−20 to −50 dBm	±0.05 dB	±0.1 dB
−50 to −60 dBm	±0.06 dB	±0.1 dB
−60 to −70 dBm	±0.1 dB	±0.2 dB
−70 to −80 dBm	±0.3 dB	±0.6 dB
−80 to −90 dBm	±0.9 dB	—
−90 to −100 dBm	±3 dB	—

At 23° ±5° C, IFBW = 20 Hz, R ch = −10 dBm, A ch = −20 dBm; with Opt 004, applies immediately after calibration
Trace noise: < 0.01 dBrms (−10 dBm at R ch, A ch, IFBW = 1 kHz; does not apply to Opt 004)
Stability: 0.02 dB/°C, typical. With Opt 004, 0.05 dB/°C, typical.

Phase Measurement Characteristics
Measurement modes: Normal and expanded
Display range: ±100,000° in normal mode
Display resolution: 0.01 to 500°/div in normal mode
Marker resolution: 0.01° in normal mode
Frequency response: ±2.5° (100 kHz to 100 MHz), ±5° (>100 MHz)
Dynamic accuracy:

Input level	Standard	With Opt 004
0 to −10 dBm	±3°	±3°
−10 to −20 dBm	±0.5°	±1.5°
−20 to −60 dBm	±0.3°	±1.5°
−60 to −70 dBm	±0.6°	±2.4°
−70 to −80 dBm	±1.8°	±3.6°
−80 to −90 dBm	±6°	—
−90 to −100 dBm	±18°	—

At 23° ±5° C, IFBW = 20 Hz, R ch = −10 dBm, A ch = −20 dBm; with Opt 004, applies immediately after calibration
Trace noise: < 0.05° rms (−10 dBm at R ch, A ch, IFBW = 1 kHz; does not apply to Opt 004)
Stability: 0.05°/° C, typical. With Opt 004, ±1°/° C, typical.

Group Delay Measurement Characteristics
Aperture frequency: 200/(N − 1)% to 100% of SPAN, where N = number of measurement points
Display range: ±10 ps to ±0.5 s
Display resolution: 10 fs/div to 10 s/div
Accuracy: Phase accuracy (°)/[360° × aperture frequency (Hz)] (s) at 23° ±5° C. Phase accuracy is dependent on dynamic accuracy.

General Characteristics
Operating temperature: 10° to 50° C
Humidity: 15 to 80% RH
Warmup time: 30 min
Line power: 100/120/220/240 V, ±10%, 47 to 66 Hz, 350 VA (maximum)
Weight: 27 kg, typical
Size: 425 mm W × 235 mm H × 553 mm D, typical

Supplemental Characteristics
Measurement functions
Number of display channels: Two (CH1, CH2)
Measurement parameters: A/R, A, R
Display formats: Cartesian and polar
Source control
Sweep parameter: Frequency, power (with Opt 010)
Sweep type: LIN, LOG, list sweep
Measured points per sweep (NOP): 2 to 801
Measurement calibration: Through, isolation, three-term
Data processing: Averaging, smoothing
Display: 7-in CRT, green display
Flexible-disk drive: 1.44 MB, LIF or DOS formats, binary or ASCII format
RAM disk: 58 KB, battery backup
Programming: HP Instrument BASIC
Sweep time
IFBW: Sweep time per point
8 kHz: 0.25 ms
4 kHz: 0.4 ms
1 kHz: 1 ms
200 Hz: 6 ms
20 Hz: 60 ms
at sweep time = AUTO
Display time (in ms):

Measurement	Number of measurement points			
	51	201	401	801
Amplitude	25	75	135	265
Phase	25	75	135	265
Group delay	30	100	190	370
Amplitude/phase	30	95	180	350
Amplitude/delay	35	120	230	450

At sweep time = AUTO
Rear panel:
EXT reference input: 1, 2, 5, and 10 MHz
Internal reference output: 10 MHz ±20 ppm
Reference oven output (Opt 001): 10 MHz ±1 ppm
External trigger input: BNC female, TTL level
External program control: Run/continue, BNC female, TTL level
Parallel I/O port: 24-bit output, 8-bit input. With Opt 005, 8-bit output, 4-bit input. With Opt 006, 24-bit output, 8-bit input.

Accessories

HP 41800A active probe
HP 41802A 1 MΩ input adapter

Ordering Information

	Price
HP 87510A Gain-Phase Analyzer	$17,000
Opt W30 Three-Year Repair Warranty	+$425
Opt W32 Three-Year Calibration Warranty	+$475
Opt 001 High-Stability Frequency Reference	+$850
Opt 002 Keyboard for HP I-BASIC	+$260
Opt 003 Type-N Input Connector	+$60
Opt 004 Delete Reference Channel	−$900
Opt 005 Digital I/O Mode A	$0
Opt 006 Digital I/O Mode B	$0
Opt 010 Extended Output Power Range	+$670
Opt 907 Front Handle Kit	+$75
Opt 908 Rack Mount Kit (no handles)	+$40
Opt 909 Rack Flange and Handle Kit	+$105
Opt ABA U.S.—English Localization	$0
Opt ABB Europe (HPSA)—English Localization	$0
Opt ABK Intercon—English Localization	$0
Opt AR5 Intercon—Japanese Localization	$0
Opt 009 Delete Manual Set	−$160
Opt 910 Add Manual Set	+$160
Opt 0B3 Add Service Manual	+$140

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- RF voltage and phase measurements
- 100 kHz to 1 GHz high-impedance probe inputs
- 300 kHz to 2 GHz 50 ohm inputs

HP 8508A Option 001

HP 8508A and HP 70138A Vector Voltmeters

The HP 8508A and HP 70138A vector voltmeters are fully automatic tuned receivers that make RF voltage and phase measurements easy. Their narrowband measuring technique gives a dynamic range of over 90 dB and a sensitivity of 10 μV to trace even the smallest signal. These vector voltmeters also measure the phase difference between their two input channels with at least 0.1 degree resolution over a full +180 to −180 degree range, so they can be used for another complete set of measurements—such as electrical length, phase distortion, or impedance. The standard unit is supplied with the HP 85081B Input Module, which has two high-impedance probe inputs that operate from 100 kHz to 1 GHz. Its ability to store a reference and use it in later measurements means individual circuit sections can be characterized and adjusted independently. Any CW source can be used as a stimulus—even a source that is part of the device being tested—so measurements can be made under normal operating conditions. To adapt the probe inputs for measurements in a 50 Ω environment, the HP 11570A Accessory Kit provides two HP 11536A Probe Tees, an HP 11549A Power Splitter, and two HP 908A 50 Ω Terminations. Option 050 is supplied with the HP 85082A Input Module. Its 50 Ω inputs operate from 300 kHz to 2 GHz, and provide the accuracy and dynamic range to make measurements on active and passive components.

HP 8508A and 70138A with HP 85081B High-Impedance Input Module Specifications

Frequency Range: 100 kHz to 1 GHz (300 kHz to 2 GHz*)
Maximum Input: 2V peak ac (+16 dBm*), ±50V dc
A (ref) Channel Minimum: 10mV (−47 dBm*), 100 kHz to 300 kHz 1 mV (−47 dBm*), 300kHz to 3MHz 300μV, 3MHz to 1GHz (−57dBm, 3MHz to 2GHz*)
B Channel Noise Level: 10μV (−87 dBm*)
Input Crosstalk: >100 dB, 1 MHz to 500 MHz >80 dB, 500 MHz to 1 GHz (>70 dB, 1 GHz to 2 GHz*)
Magnitude Accuracy

Absolute accuracy (A, B 100 mV, 15° to 30° C):	+1/−1.5 dB, 100 kHz to 300 kHz ±.5 dB, 300 kHz to 1 MHz ±.3 dB, 1 MHz to 100 MHz ±.6 dB, 100 MHz to 300 MHz ±1 dB, 300 MHz to 1 GHz (±1 dB, 300 MHz to 1.5 GHz*) (+1/−2 dB, 1.5 GHz to 2 GHz*)
Ratio accuracy (A, B 100mV, 15° to 30° C):	±1 dB, 100 kHz to 300 kHz ±.4 dB, 300 kHz to 1 MHz ±.2 dB, 1 MHz to 100 MHz ±.4 dB, 100 MHz to 300 MHz ±.6 dB, 300 MHz to 1 GHz (±.6 dB, 300 MHz to 1.5 GHz*) (±1 dB, 1.5 GHz to 2 GHz*)

HP 70138A

DESIGNED FOR HP-IB SYSTEMS

Phase Accuracy (A, B 100mV, 15° to 30° C)	±4, 300 kHz to 1 MHz ±1, 1 MHz to 100 MHz ±4, 100 MHz to 300 MHz ±6, 300 MHz to 1 GHz (±6, 300 MHz to 1.5 GHz*) (±12, 1.5 GHz to 2 GHz*)

Search and Lock Time: Lockup (within one range): 40ms, frequencies up to 3 MHz; 20 ms, frequencies greater than 3MHz.
(*Specifications apply to HP 85082A 50 Ω Input Module only.)

General: HP 8508A only

Power: 100, 120, 220, or 240V +5%/−10%, 48 to 440Hz, 40VA
Size: 133 mm H × 425.5 mm W × 473.3 mm D (5.25 in × 16.75 in × 18.65 in) Opt 001: 158.8 mm H × 524.5 mm W × 524.5 mm D (6.25 in × 19.75 in × 20.65 in).
Weight: Net, 8.1 kg (18 lb); shipping, 11 kg (24 lb). Opt 001: net, 9.4 kg (21 lb); shipping 12.5 kg (28 lb).

HP 11570A Accessory Kit

50 Ω Tee: For monitoring signals on 50 Ω transmission line. Kit contains two each with Type N female connectors.
50 Ω Power Splitter: All connectors Type N female
HP 908A 50 Ω Termination: For terminating 50 Ω coaxial systems in their characteristic impedance. Kit contains two each with Type N male connectors.
HP 11512A Short: Type N male

HP 85089A Grounding Clip

The HP 85089A grounding clip fits over the probe tip of the HP 85081B to provide a ground return when making in-circuit measurements. It also acts as a shorting bar when the probe is not in use to reduce susceptibility to electrostatic damage.

Ordering Information

HP 8508A Vector Voltmeter (includes HP 85081B)	$6,200 ☎
Opt 001 Add bail handle and front protective cover.	+$250
Opt 801 Add 2 each HP 11576A 10:1 Divider and HP 10216A Isolators.	+$630
HP 70138A Vector Voltmeter	$5,930
Opt 050 Replace HP 85081B Input Module with HP 85082A Input Module.	$0
Opt 100 Delete Input Module.	−$1,500
HP 85081B Input Module (100 kHz to 1 GHz, high impedance probe inputs)	$1,500
HP 85082A Input Module (300 kHz to 2 GHz, 50 Ω Type N inputs)	$1,500
HP 11570A Accessory Kit (measurement in 50 Ω systems with standard HP 8508A and 70138A)	$1,100
HP 85089A Grounding Clip	$10

☎ For off-the-shelf shipment, call 800-452-4844.

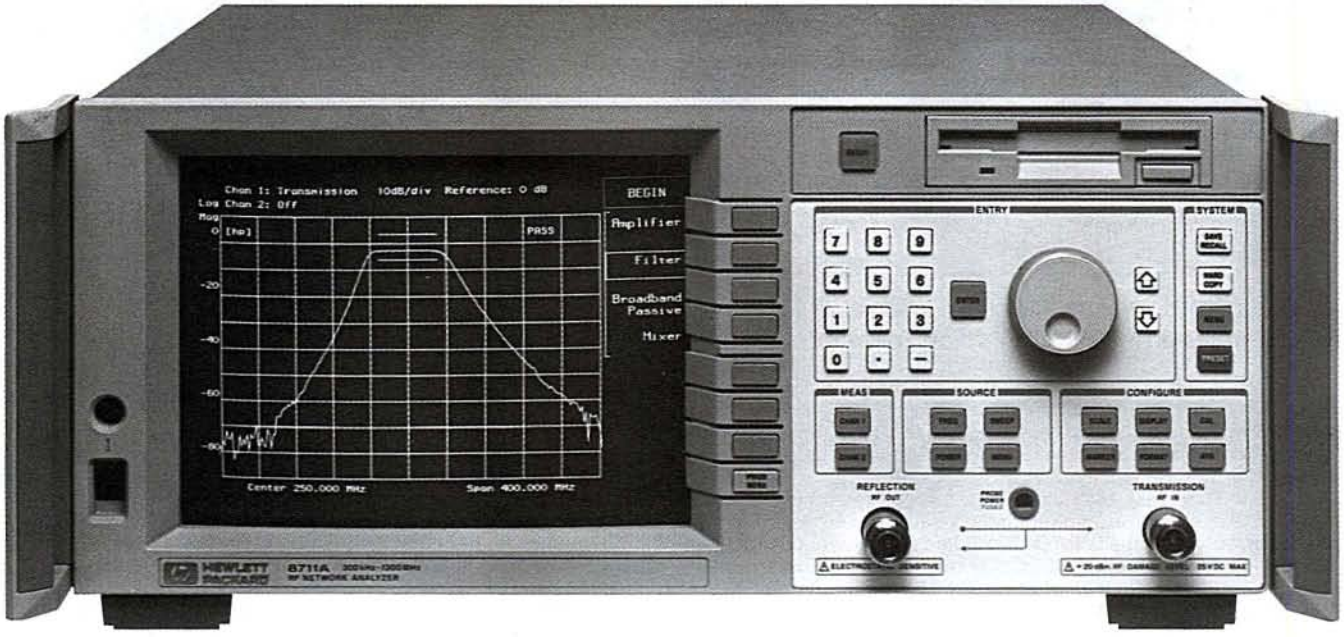
For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

NETWORK ANALYZERS

RF Network Analyzer, 300 kHz to 1300 MHz

HP 8711A

- 300 kHz to 1300 MHz
- Internal 3.5 in disk drive (LIF/DOS)
- Narrowband/broadband detection
- "Real time" sweep speed (50 ms/sweep)
- Integrated transmission/reflection test set
- Synthesized 1 Hz resolution source
- Internal HP Instrument BASIC
- 90 dB of system dynamic range
- Simple and easy to use



HP 8711A

DESIGNED FOR HP-IB SYSTEMS

HP 8711A RF Network Analyzer

The HP 8711A provides speed, accuracy, and measurement versatility at a price that makes it ideal for RF manufacturing. Characterize the transmission/reflection frequency response or measure the insertion loss, gain, return loss, conversion loss, power, or SWR of a variety of RF components. The HP 8711A is a compact, integrated network analyzer that provides fast, simple, and accurate RF testing.

Integrated synthesized source and transmission/reflection test set enable the complete swept frequency characterization of RF components with a single connection. The internal synthesized source is a fast (50 ms/sweep) and stable (1 Hz resolution) stimulus for testing narrowband devices. The HP 8711A's sensitive receivers have both narrowband and broadband detection, which makes the instrument ideal for testing linear and non-linear components that make up RF systems. Broadband detection allows characterization of frequency translation devices, while narrowband detection provides greater than 90 dB of dynamic range for testing high rejection, narrowband devices.

Optional HP Instrument BASIC (IBASIC) puts computer automation capabilities inside the instrument, simplifying measurement setups and testing. A built-in LIF/DOS format 3.5 inch floppy disk drive allows unlimited storage of instrument states, measurement and calibration data, and IBASIC programs.

Integrated source, receiver, test set, display, and disk drive result in a network analyzer that is easy to use, ideal for manufacturing, incoming inspection, and maintenance applications.

Designed for Manufacturing

Simplicity, ease of use, and automated functions save device test time. The time saving features of the HP 8711A were designed with high volume manufacturing in mind.

The HP 8711A is capable of displaying multiple measurement parameters simultaneously on the CRT, such as insertion loss and return loss characteristics. Nine internal save/recall registers are available to speed device testing. Storing and recalling complete instrument states internally saves time and reduces operating errors.

Powerful marker functions speed the final test of components by calculating and displaying specified device characteristics (maximum, minimum, 3 dB bandwidth and marker search) in real time, along with measurement data.

Limit testing allows comparison of measured data to user defined test limits and displaying the results on the instrument's display. This feature ensures your devices are aligned and tested to the same specifications at all production test stations.

HP Instrument BASIC and built-in disk drive simplify measurement automation and reduce system cost. IBASIC's unique keystroke recording capability enables automation of manual measurements without the need for any programming. The HP 8711A is PC compatible, use an IBM compatible personal computer and the analyzer's DOS disk format to control your measurement system and transfer data directly to popular MS-DOS programs. Peripherals are supported (printers and plotters) through serial, parallel, and HP-IB interfaces.

Specifications Summary

Source Characteristics
- **Frequency**
  - **Range:** 300 kHz to 1300 MHz
  - **Resolution:** 1 Hz
  - **Accuracy:** < 5 ppm
- **Output**
  - **Power range:** 0 to 16 dBm
    w/ attenuator −60 to 13 dBm
    75 Ω reduces output by 3 dB
  - **Resolution**
  - **Port flatness:** +/−1.0 dB
    w/attenuator +/−2.0 dB
    w/meter correction +/−0.3 dB
  - **Signal purity**
    - **Harmonics:** < −30 dBc
    - **Spurious:** < 30 dBc
    - **Phase noise:** < 67 dBc/Hz, at 10 kHz (typical)

Receiver Characteristics
- **Frequency range**
  - **Narrowband:** 300 kHz to 1300 MHz
  - **Broadband:** 10 MHz to 1300 MHz
- **Dynamic range**
  - **50 Ω Narrowband:** > 90 dB
    Broadband: > 66 dB
  - **75 Ω Narrowband:** > 87 dB
    Broadband: > 63 dB
- **Maximum input (0.1 dB compression)**
  - **Narrowband:** 10 dBm
  - **Broadband:** 16 dBm
- **Input damage level:** 20 dBm

Test Set Characteristics
- **Test port match:** 20 dB
- **System directivity:** 40 dB

RF Connectors
- **Test Ports:** 50 Ω Type N(f)
  75 Ω Type N(f)

Physical Characteristics
- **Size:** 180 mm H × 430 mm W × 480 mm D (7 in × 17 in × 18.75 in)
- **Weight:** Net, 20.5 kg (45 lbs); shipping, 25 kg (55 lbs)

Detectors/Bridges

External detectors (50 and 75 Ω) and bridge are available for remote device measurements. An unmodulated dc detection mode measures the microwave power directly without using modulation techniques.

HP 86200A 50 Ω Scalar Detector
An external scalar detector for use when measuring external 50 Ω devices.

HP 86201A 75 Ω Scalar Detector
An external scalar detector for use when measuring external 75 Ω devices.

HP 86205A 50 Ω Bridge
An external directional bridge which offers high directivity and excellent port match designed for 50 Ω device measurements.

HP 86207A 75 Ω Bridge
An external directional bridge which offers high directivity and excellent port match designed for 75 Ω device measurements.

Upgrade Kits

The following upgrade kits add optional measurement capability to existing HP 8711A network analyzers.

HP 86223A Attenuator Upgrade Kit
Provides the necessary components to retrofit an HP 8711A with a 60 dB step attenuator (Option 1E1). Includes installation at an HP service center. Also available as HP p/n 08711-60060.

HP 86224A IBASIC Upgrade Kit
Provides the necessary components to retrofit an HP 8711A with IBASIC capabilities (Option 1C2). Includes installation at an HP service center. Also available as HP p/n 08711-60061.

HP C1405A/ABA DIN Keyboard
PC keyboard to enhance editing capability (Option 1CL).

Calibration Kits

Accuracy enhancement characterizes the systematic errors by measuring known devices (standards) over the frequency range of interest. Kits for the HP 8711A contains standards to characterize these errors.

HP 85032E 50 Ω Calibration Kit
Contains 50 Ω Type N standards used to calibrate the HP 8711A for measurements of devices with 50 Ω Type N connectors. Standards include fixed termination, open circuit and short circuit.

HP 85036E 75 Ω Calibration Kit
Contains 75 Ω Type N standards used to calibrate the HP 8711A for measurements of devices with 75 Ω Type N connectors. Standards include fixed termination, open circuit, and short circuit.

Accessories

HP 11852B 50/75 Ω Minimum Loss Pad
A low SWR minimum loss pad required when measurements are made on 75 Ω devices using a 50 Ω measurement system.

HP 11853A Type N Accessory Kit
Accessory kit which provides the RF components required for measuring devices having 50 Ω Type N connectors.

HP 11854A BNC Accessory Kit
Accessory kit which provides the RF components required for measuring devices having 50 Ω BNC connectors.

HP 11855A Type N Accessory Kit
Accessory kit which provides the RF components required for measuring devices having 75 Ω Type N connectors.

HP 11856A BNC Accessory Kit
Accessory kit which provides the RF components required for measuring devices having 75 Ω BNC connectors.

HP 86211A Type N/Type F Adapter Kit
Adapter kit which provides Type N to Type F adapters necessary when measuring Type F devices on a network analyzer with Type N ports.

HP 86212A Type N/TNC Adapter Kit
Adapter kit which provides Type N to TNC adapters necessary when measuring TNC devices on a network analyzer with Type N ports.

Test Port Cables
Replacement test port cables are available as HP part numbers. The analyzer ships with the 50 Ω BNC cable as standard.

HP 8120-1839 BNC Test Port Cable, 50 Ω
HP 5063-0061 BNC Test Port Cable, 75 Ω
HP 8120-4781 Type N Cable, 50 Ω
HP 8120-2408 Type N Cable, 75 Ω

Ordering Information

	Price
HP 8711A Network Analyzer	$13,500
Opt 1EC 75 System Impedance	$0
Opt 1E1 60 dB Attenuator	$800
Opt 1C2 IBASIC Capability	$1,350
Opt 1CL DIN Keyboard	$210
Opt 1CF Soft Carrying Case	$250
Opt 1CM Rack Mount	$75
HP 86223A Attenuator Upgrade Kit	$1,150
HP 86224A IBASIC Upgrade Kit	$1,550
HP C1405A DIN Keyboard	$150
HP 85032E 50 Ω Calibration Kit	$650
HP 85036E 75 Ω Calibration Kit	$650
HP 11853A Type N Accessory Kit	$500
HP 11854A BNC Accessory Kit	$500
HP 11855A Type N Accessory Kit	$500
HP 11856A BNC Accessory Kit	$500
HP 86200A 50 Ω Scalar Detector	$600
HP 86201A 75 Ω Scalar Detector	$600
HP 86205A 50 Ω Bridge	$1,300
HP 86207A 75 Ω Bridge	$1,300
HP 86211A Type N/Type F Adapter Kit	$300
HP 86212A Type N/TNC Adapter Kit	$700
HP 8120-1839 BNC Test Port Cable, 50 Ω	$20
HP 5063-0061 BNC Test Port Cable, 75 Ω	$75
HP 8120-4781 Type N Cable, 50 Ω	$280
HP 8120-2408 Type N Cable, 75 Ω	$800

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

NETWORK ANALYZERS

RF Network Analyzer, 300 kHz to 3 GHz

HP 8752A/B

- 300 kHz to 1.3 or 3 GHz
- Integrated 1 Hz resolution synthesized source
- Integrated transmission/reflection test set
- 50 Ω or 75 Ω system impedance
- Direct save/recall to an external disk drive
- Execute complex test procedures with the test sequence function
- 100 dB of dynamic range
- Group delay and deviation from linear phase
- Superb uncorrected performance

HP 8752A

DESIGNED FOR HP-IB SYSTEMS

HP 8752A/B RF Network Analyzers

The HP 8752A/B RF network analyzers provide simple and complete vector network measurements in a compact and fully integrated RF network analyzer. Characterize your RF components and networks accurately and economically with the HP 8752A/B RF network analyzers in the 300 kHz to 1.3 or 3 GHz frequency range. Integration of the swept synthesized source, test set, and receiver results in a network analyzer that is easy to set up and use, which is ideal for service, incoming inspection, production, and final test measurements.

The integrated synthesized source provides measurement port power level of +5 to −20 dBm with linear, log, list, power, and CW sweep types. The sensitive tuned receivers provide 100 dB of dynamic range.

With two independent display channels available, you can simultaneously measure the reflection and transmission characteristics of the device under test on the crisp color display. Data can be displayed in log magnitude, linear magnitude, SWR, phase, group delay, polar, real, or Smith chart formats. The easy-to-use softkey measurement functions allow you to quickly measure the desired characteristic of your device under test.

Designed for Manufacturing

The productivity features of the HP 8752A/B increase your throughput in production. The test sequence function provides rapid and consistent execution of complex, repetitive tests with a single keystroke. In sequencing mode, you make the measurement once from the front panel and the instrument automatically saves the keystrokes without an external computer.

The HP 8752A/B offers excellent uncorrected performance, allowing simple and accurate measurements of your device under test without the need for measurement calibration. Other productivity enhancements include a plot/print buffer, limit testing, arbitrary frequency testing, and marker tracking functions. Up to four on-screen markers per channel are available for hardcopy outputs or for tuning at specific frequencies.

Time Domain Analysis

The HP 8752A/B with Option 010 has the capability of displaying the time domain response of a network, obtained by computing the inverse Fourier transform of the frequency domain response. Two time domain modes are offered with the HP 8752A/B. The low-pass mode provides traditional time domain reflector (TDR) measurement capability and gives the response of a mathematically simulated step or impulse response. The bandpass mode, which has only the impulse stimulus, provides the time domain response of frequency-selective devices such as SAW filters and antennas.

Specifications Summary

Source

Frequency characteristics

Range: 300 kHz to 1.3 GHz
(Opt 003: 300 kHz to 3 GHz)
Resolution: 1 Hz
Accuracy: ± 10 ppm

Output characteristics

Power range: −20 to +5 dBm
Resolution: 0.1 dB
Flatness: < 2 dB peak-to-peak
Level accuracy (50 MHz, −5 dBm): ± 0.5 dB
Level linearity (relative to −5 dBm):
−20 to −15 dBm: ± 0.5 dB
−15 to 0 dBm: ± 0.2 dB
0 to +5 dBm: ± 0.5 dB
Impedance: 50 Ω (HP 8752A), 75 Ω (HP 8752B)

Receiver

Frequency range: 300 kHz to 1.3 GHz
(Opt 003: 300 kHz to 3 GHz)
Noise level: Reflection −85 dBm (typical), Transmission −110 dBm (typical) @ 10 Hz bandwidth
Maximum input level: 0 dBm
Impedance: 50 Ω (HP 8752A), 75 Ω (HP 8752B)
Crosstalk: (300 kHz to 1.3 GHz) 100 dB
(1.3 to 3 GHz) 90 dB
Dynamic accuracy: ± 0.05 dB, ±0.3° over a 50 dB input range

Delay characteristics

Range: ½* (minimum aperture)
Aperture (selectable): frequency span/(# points −1) to 20% of the frequency span
Accuracy: (phase accuracy)/(360* aperture in Hz)

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

RF Connectors
Test Ports: 50 Ω Type N (female) (HP 8752A)
75 Ω Type N (female) (HP 8752B)
Physical Characteristics
Size: 178 mm H × 425 mm W × 498 mm D (7.0 in × 16.75 in × 20.0 in)
Weight: Net, 25 kg (56 lb); shipping, 28 kg (63 lb)

Upgrade Kits

The following upgrade kits add optional measurement capability to existing HP 8752A/B network analyzers.

HP 11885A 3 GHz Frequency Upgrade Kit

The HP 11885A upgrade kit extends the operating frequency range (Option 003) of the HP 8752A/B from 1.3 GHz to 3 GHz. Installation at an HP service center is included.

HP 85019C Time Domain Upgrade Kit

The HP 85019C upgrade kit adds time domain analysis capability (Option 010) to an existing HP 8752A/B network analyzer. This kit is user installable.

Accessories

HP 11878A 3.5 mm Adapter Kit

The HP 11878A Adapter Kit provides the RF components generally required when an SMA or 3.5 mm device needs to be measured with the HP 8752A standard Type N configuration. The kit includes four Type N to 3.5mm adapters to accommodate both male and female connectors.

HP 11853A 50 Ω Type N Accessory Kit

The HP 11853A Accessory Kit furnishes the RF components required for measurement of devices with 50 Ω Type N connectors.

HP 11854A 50 Ω BNC Accessory Kit

The HP 11854A Accessory Kit furnishes the RF components required for measurement of devices with 50 Ω BNC connectors.

HP 11855A 75 Ω Type N Accessory Kit

The HP 11855A Accessory Kit furnishes the RF components required for measurement of devices with 75 Ω Type N connectors.

HP 11856A 75 Ω BNC Accessory Kit

The HP 11856A Accessory Kit furnishes the RF components required for measurement of devices with 75 Ω BNC connectors.

Test Port cables

Hewlett-Packard supplies test port cables with each HP 8752A/B. Additional or replacement cables can be ordered separately:
HP Part Number 8120-4781 Type N 50 Ω - HP 8752A
HP Part Number 8120-2408 Type N 75 Ω - HP 8752B

HP 11852B 50 Ω/75 Ω Minimum Loss Pad

The HP 11852B is a low SWR minimum loss pad required when measurements are made on 75 Ω devices with the HP 8752A network analyzer. Measurements on two port devices require two HP 11852B pads and one 50 Ω Type N barrel.
Frequency range: dc to 2.0 GHz
Insertion loss: 5.7 dB
Return loss: 75 Ω typically > 30 dB, 50 Ω typically > 26 dB
Connectors: 50 Ω Type N (female) and 75 Ω Type N (male)

Calibration Kits

Accuracy enhancement procedures characterize the systematic errors of the measurement system by measuring known devices (standards) on the system over the frequency range of interest. The calibration kits in the HP 8752A/B family contain precision standards with which to characterize the systematic errors of an HP 8752A/B measurement system.

HP 85032B 50 Ω Type N Calibration Kit

Contains precision 50 Ω Type N standards used to calibrate the HP 8752A for measurements of devices with 50 Ω Type N connectors. This kit can also be used to perform system verification. Option 001 removes the precision phase-matched 7mm to Type N adapters. Standards include fixed terminations, open circuits, and short circuits.

HP 85036B 75 Ω Type N Calibration Kit

Contains precision 75 Ω Type N standards used to calibrate the HP 8752B for measurements of devices with 75 Ω Type N connectors. This kit can also be used to perform system verification. Standards include fixed terminations, open circuits, and short circuits.

HP 85033C 3.5 mm Calibration Kit

Contains precision 3.5 mm standards used to calibrate the HP8752A network analyzer for measurements of devices with 3.5 mm or SMA connectors. Option 001 removes the precision phase-matched 7mm to 3.5mm adapters. Standards include fixed terminations, open circuits, and short circuits.

Ordering Information

	Price
HP 8752A/B Network Analyzer	$23,000
Opt 003 3 GHz Frequency Extension	+$4,000
Opt 010 Time Domain Capability	+$5,300
Opt 802 Add Dual Disk Drive and Cable	+$1,745
Opt 908 Rack Mount Kit (w/o handles 5062-3978)	+$35
Opt 910 Extra Manual (08752-90001)	+$150
Opt 913 Rack Mount Kit (w/handles 5062-4072)	+$40
HP 11885A 3 GHz Frequency Upgrade	$4,500
HP 85019C Time Domain Upgrade	$5,300
HP 85032B 50 Ω Type N Calibration Kit	$1,600
Opt 001 Deletes 7mm to Type N adapters	−$500
HP 85036B 75 Ω Type N Calibration Kit	$2,000
HP 85033C 3.5 mm Calibration Kit	$2,500
Opt 001 Deletes 7mm to 3.5 mm adapters	−$500
HP 11878A 3.5 mm Adapter Kit	$550
HP 11853A 50 Ω Type N Accessory Kit	$400
HP 11854A 50 Ω BNC Accessory Kit	$400
HP 11855A 75 Ω Type N Accessory Kit	$500
HP 11856A 75 Ω BNC Accessory Kit	$500
HP 11852B 50 Ω/75 Ω Minimum Loss Pad	$400
HP 8120-4781 50 Ω Type N Test Port Cable	$350
HP 8120-2408 75 Ω Type N Test Port Cable	$800
HP 85024A High Frequency Probe	$2,100

☎ For off-the-shelf shipment, call 800-452-4844.

HP 85024A High Frequency Probe

The HP 85024A High Frequency Probe makes it easy to perform in-circuit measurements. An input capacitance of only 0.7 pF shunted by 1 megohm of resistance permits high frequency probing without adversely loading the circuit under test. Excellent frequency response and unity gain guarantee high accuracy in swept measurements with this probe. High probe sensitivity and low distortion levels allow measurements to be made while taking advantage of the full dynamic range of HP RF analyzers. Spectrum analyzers that supply probe power from the front panel include the HP 8568B, 8590B, 8591A, 8560A, 8561B, 8562A/B, and 71100A. RF network analyzers such as the HP 8753C, 8752A, 8751A, 3577A, and 4195A are also directly compatible. You can use the HP 85024A with other instruments by using the HP 1122A Probe Power Supply or any dual ± 15V, 130 mA supply.

HP 85024A

Specifications Summary

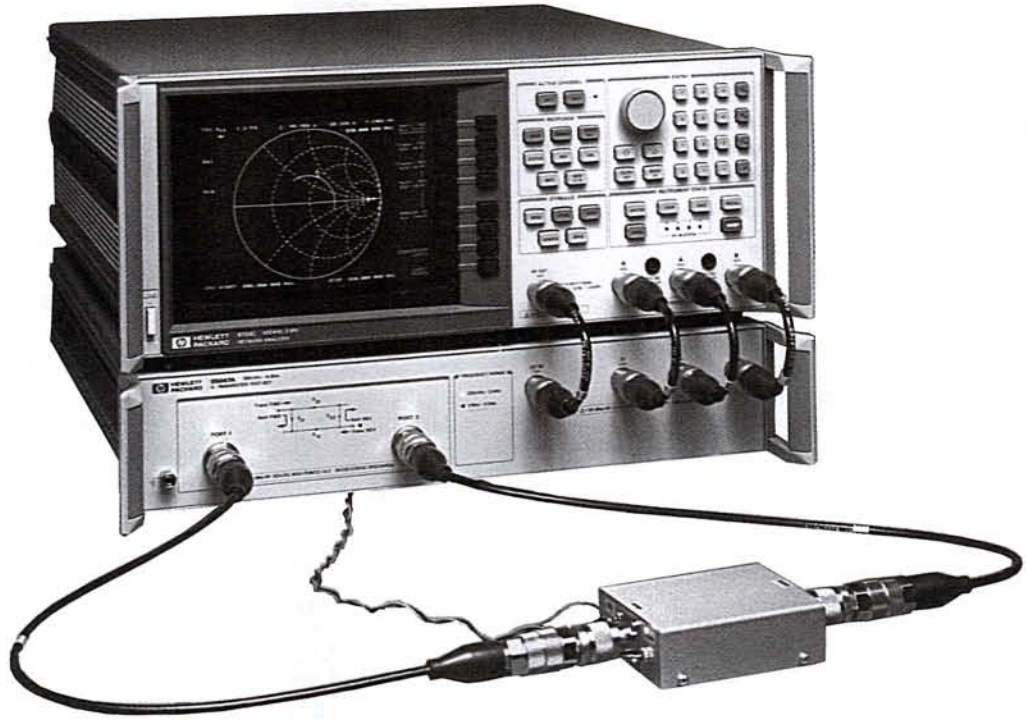
Input Capacitance (@ 500 MHz): <0.7 pF (nominal)
Input Resistance: 1 MΩ (nominal)
Bandwidth: 300 kHz to 3 GHz
Gain (@ 500 MHz): 0 dB ± 1 dB
Average Noise Level (10 Hz to 10 MHz): <1 mV
Frequency Response: ± 1.25 dB (300 kHz to 1 GHz)
+ 2, −3 dB (1 GHz to 3 GHz)
Input Voltage for 1 dB Compression: 0.3 V
Maximum Safe RF Voltage: 1.5V peak (with 10:1 divider 15V peak)
Noise Figure: <50 dB (<100 MHz)
<24 dB (100 MHz to 3 GHz)
Distortion (@ 0.3 V): < −30 dBc
Includes: Type N male adapter, 10:1 divider, spare probe tips, 2.5-in ground lead, hook tip, spanner tip, and probe tip nut driver.

NETWORK ANALYZERS

RF Network Analyzer, 300 kHz to 6 GHz

HP 8753C

- 300 kHz to 6 GHz
- Integrated 1 Hz resolution synthesized source
- Direct save/recall to an external disk drive
- Time domain analysis
- Execute complex test procedures with the test sequence function
- 100 dB of dynamic range
- Group delay and deviation from linear phase
- 0.001 dB, 0.01 deg, 0.01 nanosec marker resolution
- Built-in accuracy enhancement
- Swept harmonic measurements



HP 8753C with HP 85047A

DESIGNED FOR HP-IB SYSTEMS

HP 8753C Network Analyzer

The HP 8753C network analyzer provides excellent RF network measurements for lab and production test areas. When combined with a test set, it provides a complete solution for characterizing linear behavior of either active or passive networks, devices, or components from 300 kHz to 6 GHz. With two independent display channels available, you can simultaneously measure and view the reflection and transmission characteristics of the device under test in overlay or split-screen format on the crisp color display. The easy-to-use softkey selection of measurement functions allows you to measure the magnitude, phase, or group delay characteristics of your device under test.

The test sequence function allows rapid and consistent execution of complex repetitive tests with a single keystroke. In sequencing mode, you make the measurement once from the front panel, and the instrument stores the keystrokes so that no additional programming expertise is required. You can even set other HP-IB instruments with a test sequence. Other productivity enhancements include a plot/print buffer, limit testing, arbitrary frequency testing, and marker tracking functions. Segmented calibration and interpolative error correction allow you to apply vector accuracy enhancement over a subset of the frequency range that you initially calibrated the HP 8753C.

The integrated synthesized source provides >100 mW of output power, 1 Hz frequency resolution, and linear, log, list, power, and CW sweep types. Three tuned, 300 kHz to 3 GHz (Option 006 extends to 6 GHz) receivers allow versatile independent power measurements or simultaneous ratio measurements over a 100 dB dynamic range. By using the HP 85047A Test Set with the HP 8753C, the reflection and transmission characteristics of the device under test can be investigated from 300 kHz to 3 GHz or from 3 MHz to 6 GHz with the test set's frequency doubler enabled.

Non-Linear Device Testing

Non-linear device characterization is possible with the HP 8753C. Swept second- and third-harmonic levels of an amplifier can be displayed directly or relative to the fundamental carrier (dBc) when employing the optional harmonic measurement capability (Option 002). Amplifier harmonics up to 40 dBc can be measured quickly and conveniently on a swept-frequency basis for fundamental signals as low as 16 MHz, using the same test configuration used to measure gain. Power meter calibration provides leveled absolute power to devices that are sensitive to absolute input or output levels. The HP 8753C automatically controls an HP 436A, 437B, or 438A Power Meter to set the power anywhere in the test configuration with power meter accuracy.

The HP 8753C has the capability to perform mixer tracking and conversion loss measurements. These are possible because the tuned receiver can be offset from its synthesized source by the LO frequency of the mixer. Both fixed and swept IF measurements can be made.

Time Domain Analysis

Time domain responses can be displayed by the HP 8753C with Option 010. The instrument computes the inverse Fourier transform of the frequency domain data to display the reflection or transmission coefficient versus time. The HP 8753C offers two time domain modes. The low-pass mode provides the traditional Time Domain Reflectometer (TDR) measurement capability and gives the response of the network to a mathematically simulated step or impulse response. This mode gives information of the type of impedance (R, L, C) at the discontinuity. The bandpass time domain mode, which has only the impulse stimulus, has no frequency restrictions and provides the time domain response of frequency selective devices such as SAW filters or antennas. Gating may be used to selectively isolate a single response to view the frequency domain response of individual portions of a component without disturbing the circuit itself.

Specifications Summary

Source
Frequency Characteristics
Frequency range: 300 kHz to 3 GHz
Frequency resolution: 1 Hz
Frequency accuracy: ±10 ppm
Output Characteristics
Power range: −5 to +20 dBm
Power accuracy: (50 MHz, +10 dBm) ±0.5 dB
Power linearity (relative to +10 dBm):
0.5 to 0 dBm: ±0.5 dB
0 to +15 dBm: ±0.2 dB
+15 to +20 dBm: ±0.5 dB
Impedance: 50 Ω
Harmonics: ≤ −25 dBc (20 dBm output level)
≤ −50 dBc (0 dBm output level)
Nonharmonics:
Mixer-related: ≤ −32 dBc (20 dBm output level)
≤ −55 dBc (0 dBm output level)
Other spurious:
f<135 MHz: −60 dBc
f≥135 MHz: −60 dBc + 20*log (f/135 MHz) dBc
Phase noise (10 kHz offset in 1 Hz BW):
f<135 MHz: −90 dBc
f≥135 MHz: −90 dBc + 20*log(f/135 MHz) dBc

Receiver
Frequency Range: 300 kHz to 6 GHz
Inputs:
A, B 100 dB dynamic range <3 GHz
95 dB dynamic range 3 to 6 GHz
Sensitivity (noise level):
3 kHz BW: −90 dBm <3 GHz, −85 dBm 3 to 6 GHz
10 Hz BW: −100 dBm <3 GHz, −95 dBm 3 to 6 GHz
Maximum Input Level: 0 dBm
Impedance: 50 Ω
Input Crosstalk:
300 kHz to 1 GHz: −100 dB
1 GHz to 3 GHz: −90 dB
3 GHz to 4.5 GHz: −85 dB
4.5 GHz to 6 GHz: −75 dB
Dynamic Accuracy: ±0.05 dB, ±0.3° over a 50 dB input range
Delay Characteristics
Range: ½* (1/minimum aperture)
Aperture (selectable): frequency span/(# points −1) to 20% of the frequency span
Resolution: 27.8/(aperture in Hz)
typically 0.01 nanoseconds
Accuracy: (phase accuracy)/(360*aperture in Hz)
RF Connectors: 50 Ω Type N (female)
Physical Characteristics
Size: 178 mm H × 425 mm W × 498 mm D, (7.0 in × 16.75 in × 20.0 in)
Weight: Net, 22 kg (48 lb); shipping, 25 kg (55 lb)

Upgrade Kits

The following upgrade kits retrofit the latest operating systems or add optional measurement capability to existing HP 8753A/B/C network analyzers.

HP 11882A Upgrade Kit for the HP 8753A

This kit upgrades an HP 8753A to an HP 8753B with revision 3.0 firmware. New measurement capabilities include mixer measurements, support of 6 GHz and solid-state test sets, interpolative error correction, and the test sequencing function (for built-in automatic measurements). Options for 6 GHz receiver and harmonic measurements can also be added to an HP 8753A after the HP 11882A kit has been installed. This kit includes installation at an HP service center.

HP 11883A Harmonic Measurements Upgrade

This upgrade kit adds harmonic measurement capability (Option 002) to an HP 8753B/C network analyzer. This kit includes installation at an HP service center.

HP 11884A 6 GHz Receiver Upgrade

This kit extends the operating frequency range of the HP 8753B/C receiver from 3 GHz to 6 GHz. To make transmission/reflection measurements above 3 GHz, the HP 85047A S-parameter test set is required. This kit includes installation at an HP service center.

HP 85019A Time Domain Upgrade Kit

This upgrade kit adds time domain analysis capability (Option 010) to an existing HP 8753A network analyzer. This kit is user installable.

HP 85019B Time Domain Upgrade Kit

This upgrade kit adds time domain analysis capability (Option 010) to an existing HP 8753B/C network analyzer. This kit is user installable.

HP 86387A Mixer Measurement Upgrade for HP 8753B

This upgrade adds mixer measurement capability to an existing HP 8753B. Phase lock hardware and firmware revision 3.0 is included. This kit includes installation at an HP service center.

HP 86387B Mixer Measurement Upgrade for HP 8753C

This upgrade adds mixer measurement capability to an existing HP 8753C. Phase lock hardware and firmware revision 4.1 is included. This kit includes installation at an HP service center. Not required for HP 8753Cs at revision 4.02 or higher.

HP 86388A Upgrade Kit for the HP 8753B

This kit adds the latest firmware revision to an existing HP 8753B. Significant enhancements include diskfile compatibility with HP 8753C network analyzers and support of solid-state switching test sets. This kit is user installable.

Transmission/Reflection Test Sets

The transmission/reflection test sets provide the capability to simultaneously measure the reflection and transmission characteristics of two port devices. The device must be physically turned around to measure its reverse direction characteristics.

HP 85044A/B Transmission/Reflection Test Sets

The HP 85044A/B test sets provide the capability to measure the reflection and transmission characteristics of 50 Ω and 75 Ω devices, respectively.

Specifications Summary

	HP 85044A	HP 85044B
Impedance:	50 Ω	75 Ω
Frequency Range:	300 kHz to 3 GHz	300 kHz to 2 GHz
Directivity[3]:	35 dB to 1.3 GHz	35 dB to 1.3 GHz
	30 dB to 3.0 GHz	30 dB to 2.0 GHz
Typical Tracking		
Transmission magnitude, phase[1,2,3]:		
0.3 MHz to 2.0 MHz	±1.5 dB, ±10°	±1.5 dB, ±10°
2.0 MHz to F_{max}	±1.5 dB, ±10°	±1.5 dB, ±10°
Reflection magnitude, phase[1,2,3]:		
0.3 MHz to 2.0 MHz	±1.5 dB, ±25°	±1.5 dB, ±25°
2.0 MHz to F_{max}	±1.5 dB, ±10°	±1.5 dB, ±10°
Effective source match[2,3] (test ports):		
0.3 MHz to 2.0 MHz	14 dB	14 dB
2.0 MHz to 1.3 GHz	20 dB	17 dB
1.3 GHz to F_{max}	16 dB	16 dB
RF Connectors		
Test ports:	Precision 7 mm	75 Ω Type N (female)
All others:	50 Ω Type N (female)	50 Ω Type N (female)
Physical Characteristics		
Size: 615 mm H × 101 mm W × 204 mm D (2.44 in × 7.5 in × 8.0 in)		
Weight: Net, 1.7 kg (3.8 lb); shipping, 2.0 kg (4.4 lb)		

[1]Degrees, specified as deviation from linear phase.
[2]F_{max} is the upper frequency limit of the associated test set.
[3]Can be improved through accuracy enhancement.

NETWORK ANALYZERS
S-Parameter Test Sets
HP 8753C Series

S-Parameter Test Sets

The S-parameter test sets provide the capability to measure reflection and transmission characteristics (including S-parameters) of two port devices in either direction with a single connection. The test sets are controlled from the HP 8753C and include programmable step attenuators.

HP 85046A/B S-Parameter Test Sets

The HP 85046A/B test sets provide the capability to simultaneously measure the transmission and reflection characteristics of 50 Ω and 75 Ω devices, respectively.

Specifications Summary

	HP 85046A	HP 85046B
Impedance:	50 Ω	75 Ω
Frequency Range:	300 kHz to 3 GHz	300 kHz to 2 GHz
Directivity:	35 dB to 1.3 GHz	35 dB to 1.3 GHz
	30 dB to 3.0 GHz	30 dB to 2.0 GHz
Typical Tracking		
Transmission magnitude, phase[1,2,3]:		
0.3 MHz to 2.0 MHz	±1.5 dB, ±20°	±1.5 dB, ±20°
2.0 MHz to F_{max}	±1.5 dB, ±10°	±1.5 dB, ±10°
Reflection magnitude, phase[1,2,3]:		
0.3 MHz to 2.0 MHz	±1.5 dB, ±25°	±1.5 dB, ±25°
2.0 MHz to F_{max}	±1.5 dB, ±10°	±1.5 dB, ±10°
Effective source match[3] (test ports):		
0.3 MHz to 2.0 MHz	14 dB	14 dB
2.0 MHz to 1.3 GHz	20 dB	17 dB
1.3 GHz to F_{max}	16 dB	16 dB
RF Connectors		
Test ports:	Precision 7 mm	75 Ω Type N (female)
All others:	50 Ω Type N (female)	50 Ω Type N (female)

Includes: Four 190 mm (7.5 in) cables with Type N (male) connectors for connection to the HP 8753C. One HP 8753C test set interconnect cable.

Physical Characteristics
Size: 90 mm H × 426 mm W × 553 mm D (3.5 in × 16.75 in × 21.5 in)
Weight: Net, 9.1 kg (20 lb); shipping, 10 kg (22 lb).

HP 85047A S-Parameter Test Set

The HP 85047A test set includes a frequency doubler that can be switched in to measure 3 MHz to 6 GHz in a single sweep or switched out to measure 300 kHz to 3 GHz in a single sweep. The HP 8753C controls the frequency doubler. HP 8753C Option 006 (6 GHz receiver) is required to activate the HP 85047A.

Specifications Summary

Impedance: 50 Ω
Frequency Ranges: 300 kHz to 3 GHz
3 MHz to 6 GHz
Directivity: 300 kHz to 1.3 GHz: 35 dB
1.3 GHz to 3 GHz: 30 dB
3 GHz to 6 GHz: 25 dB
Typical Tracking
Transmission magnitude, phase:
300 kHz to 3 GHz: ±1.5 dB, ±10°
3 GHz to 6 GHz: +0.5, −2.5 dB, ±20°
Reflection magnitude, phase:
300 kHz to 3 GHz: ±1.5 dB, ±10°
3 GHz to 6 GHz: ±1.5 dB, ±20°
Effective Source Match:
300 kHz to 1.3 GHz: 20 dB
1.3 GHz to 3 GHz: 16 dB
3 GHz to 6 GHz: 14 dB
RF Connectors
Test ports: Precision 7 mm
All others: 50 Ω type N (female)
Includes: Four 190 mm (7.5 in) cables with Type N (male) connectors for connection to the HP 8753C, one HP 8753C test set interconnect cable
Physical Characteristics
Size: 90 mm H × 426 mm W × 533 mm D (3.5 in × 16.75 in × 21.5 in)
Weight: Net, 10 kg (22 lb); shipping, 11.5 kg (25.3 lb)

[1]Degrees, specified as deviation from linear phase.
[2]F_{max} is the upper frequency limit of the associated test set.
[3]Can be improved through accuracy enhancement.

Solid-State Switching

Solid-state switching allows for simultaneous measurement of forward and reverse parameters and continuous update of all 4 S-parameters as required for 2-port error correction (used to achieve best possible measurement accuracy). Option 009 replaces the standard solid-state RF test port switch with a mechanical RF switch. HP 8753 systems specifications for standard and Option 009 test sets are identical. Nominal insertion loss of the solid-state switch is less than 2 dB (at 3 GHz) or 3dB (at 6 GHz), relative to a mechanical switch.

The solid-state switch can be retrofitted into any existing HP 85046A/B or 85047A test set using the HP 86389A or 86389B solid-state switch upgrade kit. Solid-state switching test sets are supported on HP 8753C and HP 8753B network analyzers with firmware revision 3.0 or higher. For HP 8753A/B network analyzers with firmware revision 2.01 or lower, upgrade kits are available, which add support for solid-state test switching test sets.

HP 86389A/B Solid-State Switch Upgrade Kits

The HP 86389A/B kits retrofit any existing HP 85046A/B and HP 85047A S-parameter test set by replacing the mechanical RF test port switch with a solid-state RF switch. This solid-state switch allows for simultaneous measurement of forward and reverse parameters and continuous measurement of all 4 S-parameters (required for 2-port error correction).

The HP 86389A retrofits HP 85046A/B test sets, and the HP 86389B retrofits HP 85047A test sets. HP 8753B/C network analyzers with firmware revision 3.0 or higher support solid-state test sets. HP 8753A/B network analyzers with firmware revision 2.01 or lower must be upgraded (HP 11882A for the HP 8753A, HP 86388A for the HP 8753B). These kits include installation at an HP service center.

HP 86205A/86207A

Accessories

HP 86205A/86207A RF Bridges

The HP 86205A/86207A high directivity RF bridges offer unparalleled performance in a variety of general-purpose applications. They are ideal for accurate reflection measurements and signal leveling applications.

Specifications Summary

	HP 86205A	HP 86207A
Impedance:	50 Ω	75 Ω
Frequency Range:	300 kHz to 6 GHz	300 kHz to 3 GHz
Directivity:	30 dB, 0.3 MHz to 5 MHz	30 dB, 0.3 MHz to 5 MHz
	40 dB, 5 MHz to 2 GHz	40 dB, 5 MHz to 1.3 GHz
	30 dB, 2 GHz to 3 GHz	35 dB, 1.3 GHz to 2 GHz
(typical)	20 dB, 3 GHz to 5 GHz	30 dB, 2 GHz to 3 GHz
(typical)	16 dB, 5 GHz to 6 GHz	
Coupling Factor:	(<3 GHz) 16.0 dB, +0.15 dB/GHz	
	(>3 GHz) 16.5 dB, −0.20 dB/GHz	
Insertion Loss:	1.5 dB, +0.1 dB/GHz	
Maximum Input:	25 dBm	
RF Connectors:	50 Ω Type-N (female)	75 Ω Type-N (female)

Physical Characteristics
Size: 93 mm H × 160 mm W × 23 mm D (3.7 in × 6.3 in × 1 in)
Weight: Net, 0.57 kg (1.3 lbs); shipping, 1.8 kg (4 lbs)

HP 11850C/D Three-Way Power Splitters Specifications Summary

	HP 11850C	HP 11850D
Impedance:	50 Ω	75 Ω
Frequency Range:	dc to 3 GHz	dc to 2 GHz
Tracking:	±.25 dB, ±3°	±.2 dB, ±2.5°
Equivalent Source Match (ratio or leveling):	30 dB @ 1.3 GHz 20 dB @ 3 GHz	30 dB @ 1.3 GHz 20 dB @ 3 GHz
Nominal Insertion Loss:	9.5 dB +1 dB/GHz	7.8 dB
Input Port Match:		
dc to 1.3 GHz	20 dB	20 dB
1.3 GHz to F_{max}	10 dB	10 dB
RF Connectors		
RF input:	50 Ω Type N (female)	50 Ω Type N (female)
All others:	50 Ω Type N (female)	75 Ω Type N (female)

HP 11851B RF Cable Kit
This kit includes three 610 mm (24 in) 50 Ω cables phase matched to 4° at 1.3 GHz and one cable 860 mm (34 in). Connectors are Type N (male). Recommended for use with HP 85044A/B Transmission/Reflection Test Set and HP 11850C/D Power Splitter.

HP 11852B 50 Ω/75 Ω Minimum Loss Pad
The HP 11852B is a low SWR minimum loss pad required for measurements on 75 Ω devices with the HP 8753C receiver.
Frequency Range: dc to 2.0 GHz
Insertion Loss: 5.7 dB
Return Loss: 75 Ω typically ≥30 dB, 50 Ω typically ≥26 dB
Maximum Input Power: 250 mW (+24 dBm)
RF Connectors: 50 Ω Type N (female) and 75 Ω Type N (male)

Type N Accessory Kits

Each kit contains a Type N (female) short, a Type N (male) short, two Type N (male) barrels, two Type N (female) barrels, and a storage case.

HP 11853A 50 Ω Type N Accessory Kit
The HP 11853A accessory kit furnishes the RF components required for measurement of devices with 50 Ω Type N connectors using the HP 11850C, 85044A, 85046A, or 85047A.

HP 11855A 75 Ω Type N Accessory Kit
The HP 11855A accessory kit furnishes the RF components required for measurement of devices with 75 Ω Type N connectors using the HP 11850D or 85044B. This kit also contains a 75 Ω Type N (male) termination.

[1] F_{max} is the upper frequency limit of the associated power splitter.

BNC Accessory Kits

The BNC accessory kit contains two Type N (male) to BNC (female) adapters, two Type N (male) to BNC (male) adapters, two Type N (female) to BNC (female) adapters, two Type N (female) to BNC (male) adapters, a BNC (male) short, and a storage case.

HP 11854A 50 Ω BNC Accessory Kit
The HP 11854A accessory kit furnishes the RF components required for measurement of devices with 50 Ω BNC connectors using the HP 11850C, 85044A, 85046A, or 85047A.

HP 11856A 75 Ω BNC Accessory Kit
The HP 11856A furnishes RF components required for measurement of devices with 75 Ω BNC connectors using the HP 11850D, 85044B, or 85046B. This kit also contains a 75 Ω BNC (male) termination.

Test Port Cables

HP 11857D 50 Ω APC-7 Test Port Cables
The HP 11857D includes two precision 61 cm (24 in) cables, phase matched to 2° at 1.3 GHz for use with the HP 85046A S-parameter test set. Connectors are 50 Ω APC-7.

HP 11857B 75 Ω Type N Test Port Cables
The HP 11857B includes two precision 61 cm (24 in) cables, phase matched to 2° at 1.3 GHz for use with the HP 85046B S-parameter test set. One cable has 75 Ω Type N (male) connectors on both ends; the other has one Type N (male) and one Type N (female) connector.

Transistor Fixtures

Function: Mounts on front of HP 85046A and 85047A S-Parameter Test Sets, holds devices for S-parameter measurements in a 50 Ω, coax circuit.
Transistor Base Patterns
Model 11600B: Accepts TO-18/TO-72 packages
Model 11602B: Accepts TO-5/TO-12 packages
Calibration References: short circuit termination and a 50 Ω through-section
Frequency Range: dc to 2 GHz
Impedance: 50 Ω nominal
Reflection Coefficient: <0.05, 100 MHz to 1.0 GHz: <0.09, 1.0 to 2 GHz
Connectors: Hybrid APC-7; Option 001, Type N (female)

HP 11858A Transistor Fixture Adapter
The HP 11858A adapts the HP 11600B and 11602B transistor fixtures (vertical test port configuration) to the HP 85046A or 85047A S-parameter test set. Connectors are APC-7.

Systems Cabinet

The HP 85043B systems cabinet has been ergonomically designed specifically for the HP 8753C and the HP 85046A/B or 85047A S-parameter test sets. The 122 cm (48 in) system cabinet includes a bookcase, a drawer, and a convenient work surface.

Calibration Kits

Accuracy enhancement procedures characterize the systematic errors of the measurement system by measuring known devices (standards) on the system over the frequency range of interest. The calibration kits in the HP 8753C family contain precision standards with which to characterize the systematic errors of an HP 8753C measurement system.

HP 85031B 7 mm Calibration Kit
The HP 85031B Calibration Kit contains a set of precision 7 mm fixed terminations, an open circuit, and a short circuit used to calibrate the HP 8753C and its 50 Ω test sets for measurement of devices with precision 7 mm connectors.

NETWORK ANALYZERS
Accessories (cont'd)
HP 8753C Series

HP 85032B 50 Ω Type N Calibration Kit
The HP 85032B Calibration Kit contains precision 50 Ω Type N standards used to calibrate the HP 8753C and its 50 Ω test sets for measurement of devices with 50 Ω Type N connectors. Precision phase-matched 7 mm to 50 Ω Type N adapters are included for accurate measurements of non-insertable devices. Standards include fixed terminations, open circuits, and short circuits.

Option 001 is intended solely for use with the HP8752A network analyzer. Option 001 removes the precision phase-matched 7 mm to Type N adapters.

HP 85033C 3.5 mm Calibration Kit
The HP 85033C Calibration Kit contains precision 3.5 mm standards used to calibrate the HP 8753C and its 50 Ω test sets for measurement of devices with 3.5 mm and SMA connectors. Standards include fixed terminations, open circuits, and short circuits. Precision 7 mm to 3.5 mm adapters are included for accurate measurements of non-insertable devices.

Option 001 is intended solely for use with the HP 8752A network analyzer. Option 001 removes the precision phase-matched 7 mm to 3.5 mm adapters.

HP 85036B 75 Ω Type N Calibration Kit
The HP 85036B Calibration Kit contains precision 75 Ω Type N standards used to calibrate the HP 8753C and its 75 Ω test sets for measurement of devices with 75 Ω Type N connectors. Standards include fixed terminations, open circuits, and short circuits. Precision phase-matched adapters are included for accurate measurements of non-insertable devices.

Verification Kits
Measuring known devices, other than the calibration standards, is a convenient way of verifying that the HP 8753C measurement system is operating properly.

HP 85029B 7 mm Verification Kit
The HP 85029B Verification Kit contains a set of precision 7 mm devices, with data traceable to NIST, used to verify the calibrated performance of an HP 8753C measurement system. The devices have precision 7 mm connectors and include a 20 dB pad, a 50 dB pad, and a mismatch attenuator. The verification process requires only an HP 85031B calibration kit, an HP 85029B verification kit, and an external 3.5-inch disk drive connected to the HP 8753C.

Option 001 is intended solely for use with the HP 8702B Lightwave Component Analyzer. Option 001 adds verification data that is compatible with the HP 8702B.

Software
Software operates with a BASIC operating system, using an HP Series 300/400 computer (2 MB of memory required).

HP 85160A Measurement Automation Software
Measurement automation software simplifies device measurements by providing guided measurements, limit testing, sequencing to test all four S-parameters, data formatting flexibility (data files can be formatted to be compatible with Touchstone* linear circuit simulation programs), and complete save/recall capability to a floppy disk. After it is configured, you simply recall a test file and calibration data, connect the device under test, and output the results.

HP 8753MX Mixer Measurement System
Increase your production and R&D measurement efficiency with the HP 8753MX Mixer Measurement System. This RF analyzer system will characterize your frequency translator's performance with a single RF connection, eliminating configuration changes between tests for increased throughput. The system can measure:

- Conversion loss
- Compression
- RF and IF port SWR
- LO feedthrough (LO to RF and LO to IF)
- Isolation (RF to IF and IF to RF)
- Group delay
- Output power
- Amplitude/phase tracking

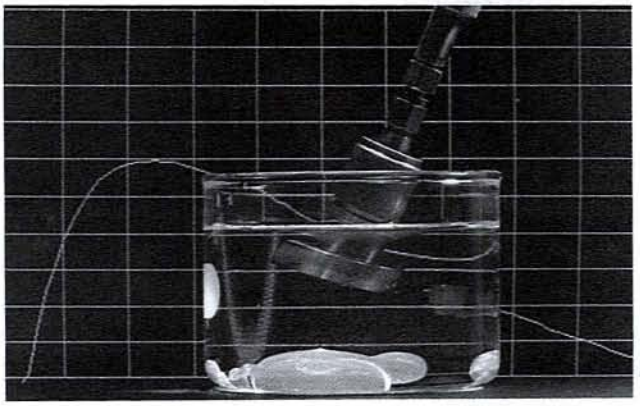
Included with the system is the HP 86370A Mixer Measurement Software, which provides a guided user interface for the system. The software, written in HP BASIC, is delivered unsecured to enable customization of the code. Measurement parameters are entered, modified, and displayed from the guided setup menu. Guided procedures are available for calibrations of reflection, transmission, and power meter measurements.

In addition to operating as a dedicated mixer measurement system, the HP 8753MX can also be used as a standard, two-port S-parameter measurement system. This unique combination of two- and three-port measurement capability makes the HP 8753MX an excellent choice for general purpose RF component test applications.

Ordering Information	Price
HP 8753C Network Analyzer	$26,500
Opt 002 Harmonic Measurement Capability	+$3,500
Opt 006 6 GHz Receiver Option	+$3,500
Opt 010 Time Domain Capability	+$5,300
Opt 802 Add Dual Disk Drive and Cable	+$1,745
Opt 908 Rack Mount Kit (w/o handles 5062-3978)	+$35
Opt 910 Extra Manual (08753-90153)	+$150
Opt 913 Rack Mount Kit (w/handles 5062-4072)	+$40
HP 85047A 50 Ω S-Parameter Test Set—6 GHz	$10,800
Opt 009 Mechanical Test Port Switch	−$1,000
Opt 913 Rack Mount Kit (5062-4069)	+$40
HP 85046A 50 Ω S-Parameter Test Set—3 GHz	$9,000
Opt 009 Mechanical Test Port Switch	−$1,000
Opt 913 Rack Mount Kit (5062-4069)	+$40
HP 85046B 75 Ω S-Parameter Test Set—3 GHz	$9,000
Opt 009 Mechanical Test Port Switch	−$1,000
Opt 913 Rack Mount Kit (5062-4069)	+$40
HP 85044A 50 Ω Transmission/Reflection Test Set	$3,200
HP 85044B 75 Ω Transmission/Reflection Test Set	$3,700
HP 85029B Precision 7 mm Verification Kit	$1,600
Opt 001 Data for HP 8702B	$0
HP 85031B Precision 7 mm Calibration Kit	$1,200
HP 85032B 50 Ω Type N Calibration Kit	$1,600
Opt 001 Deletes 7 mm to Type N adapters	−$500
HP 85033C Precision 3.5 mm Calibration Kit	+$2,500
Opt 001 Deletes 7 mm to 3.5 mm adapters	−$500
HP 85036B 75 Ω Type Calibration Kit	$2,000
HP 85043B Systems Rack	$3,200
HP 85160A Measurement Automation Software	$1,550
HP 11882A Upgrade Kit for HP 8753A	$3,400
HP 11883A Harmonic Measurements (Opt 002) Upgrade	$3,500
HP 11884A 6 GHz Receiver (Opt 006) Upgrade	$3,500
HP 85019A Time Domain (Opt 010) Upgrade (HP 8753A)	$5,300
HP 85019B Time Domain (Opt 010) Upgrade (HP8753B/C)	$5,300
HP 86388A Upgrade Kit for HP 8753B (Rev. 3.00)	$300
HP 86389A Solid-State Switch Upgrade Kit (for HP 85046A/B Test Sets)	$1,500
HP 86389B Solid-State Switch Upgrade Kit (for HP 85047A Test Sets)	$1,500
HP 86205A 50 Ω Bridge	$1,300
HP 86207A 75 Ω Bridge	$1,300
HP 11850C 50 Ω Power Splitter	$950
HP 11850D 75 Ω Power Splitter	$1,500
HP 11851B 50 Ω/Type N RF Cable Kit	$950
HP 11852B 50 Ω/75 Ω Minimum Loss Pad	$400
HP 11853A 50 Ω Type N Accessory Kit	$400
HP 11854A 50 Ω BNC Accessory Kit	$400
HP 11855A 75 Ω Type N Accessory Kit	$500
HP 11856A 75 Ω BNC Accessory Kit	$500
HP 11857B 75 Ω Type N Test Port Extension Cables	$1,455
HP 11857D 50 Ω APC-7 Test Port Extension Cables	$1,050
HP 11600B/11602B Transistor Fixtures	$1,800
HP 11858A Transistor Fixture Adapter	$980
HP 8753MX Mixer Measurement System	$78,900

☎ For off-the-shelf shipment, call 800-452-4844.

- Two accessories to complete turnkey systems for characterizing the dielectric properties of materials
- Fast, convenient, wide frequency range
- Compatible with the HP 8752, 8753, 8719, 8720 and 8510 network analyzers
- Software runs on HP Vectra (MS-DOS) or HP 9000 Series 300 (HP BASIC) controllers



Materials Measurements

Materials have two properties that determine how they interact with electromagnetic fields:

- Permittivity (ε) or dielectric constant—electric
- Permeability (μ)—magnetic

Permittivity ($\varepsilon^* = \varepsilon' - j\,\varepsilon''$) and permeability ($\mu^* = \mu' - j\mu''$) are complex values. The real part (ε' or μ') is a measure of how much energy is stored in a material. The imaginary part (ε'' or μ'') is a measure of how much energy is lost in a material. These properties are not constant and may change with frequency or temperature, for example.

Accurate measurements of these material properties during characterization or inspection help to achieve the best performance for a given application while shortening design cycles and minimizing scrap.

A materials measurement system consists of an instrument, a fixture to hold the material, and software to calculate ε^* or μ^*. Network analyzers from HP cover the frequency range of 300 kHz to 110 GHz. HP also offers accessories based on the open-ended coaxial probe and transmission line measurement techniques.

HP 85070S Dielectric Probe System

Measure the dielectric properties of materials quickly and conveniently with the HP 85070M dielectric probe measurement system. This system is based on the HP 85070B high-temperature dielectric probe, which features a hermetic glass-to-stainless steel seal to resist most corrosive chemicals and withstand temperatures from −70° C to +250° C.

This measurement is nondestructive and requires no sample preparation—saving you time, trouble, and material. The dielectric probe is well suited for measurements of liquid or semi-solid materials. Simply immerse the probe into the material; there is no need for special fixtures. The dielectric probe is not recommended for thin (substrates) or low loss (resonators) materials.

Knowledge of the dielectric loss of food, rubber, plastic, and ceramic products can assist researchers in the design and optimization of materials in microwave heating processes. Dielectric properties also correlate directly with other material properties—such as moisture content, phase transitions, molecular structure, polarizability, and relaxation constants. For example, this information has been useful in the development of microwaveable prepared foods.

A measurement system based on the HP 85070B yields permittivity (dielectric constant), loss factor, loss tangent, or Cole-Cole diagrams—versus frequency—from 200 MHz to 20 GHz (depending on the network analyzer and material). Measurement accuracy for the dielectric probe is typically five percent.

The HP 85070M is a fully configured materials measurement system consisting of the HP 85070B dielectric probe kit, network analyzer, cables, probe stand, and pre-configured HP Vectra PC. The probe kit contains both the dielectric probe and software.

HP 85071B Materials Measurement Software

Calculate the permittivity and permeability of material samples loaded into sections of coaxial airline or rectangular waveguide using HP 85071B software. This measurement technique works well for solid materials that can be machined to fit precisely inside a transmission line.

A dielectric measurement can provide critical design parameter information for materials used in state-of-the-art RF and microwave electronic component applications. The loss of a cable or the impedance of a substrate can be related to its dielectric properties. This information is also useful for improving ferrite, radome, absorber, and packaging designs.

There are a variety of different measurement models to choose from in the HP 85071B software. A complete system requires the addition of a fixture (coaxial or waveguide transmission line), network analyzer, and controller. Measurement accuracies of one percent to two percent are typical from 500 MHz to 110 GHz (depending on the material, fixture, and network analyzer).

Other Solutions

Other measurement techniques based on RF or microwave network analyzers exist and offer their own unique advantages. For example, free-space methods are noncontacting and suitable to temperature extremes. Resonator or cavity methods provide the highest accuracy and sensitivity to low-loss materials.

Below 30 MHz, the HP 16451B dielectric test fixture (coupled with an LCR meter or impedance analyzer) provides accurate low-frequency measurement of materials.

Ordering Information	Price
HP 85070M Dielectric Probe Measurement System	
Opt 003 3 GHz System	Contact HP
Opt 020 20 GHz System	Contact HP
HP 85070B Dielectric Probe Kit	$5,750
Opt 300 Substitute HP BASIC Software	$0
HP 85071B Materials Measurement Software	$4,800
Opt 300 Substitute HP BASIC Software	$0

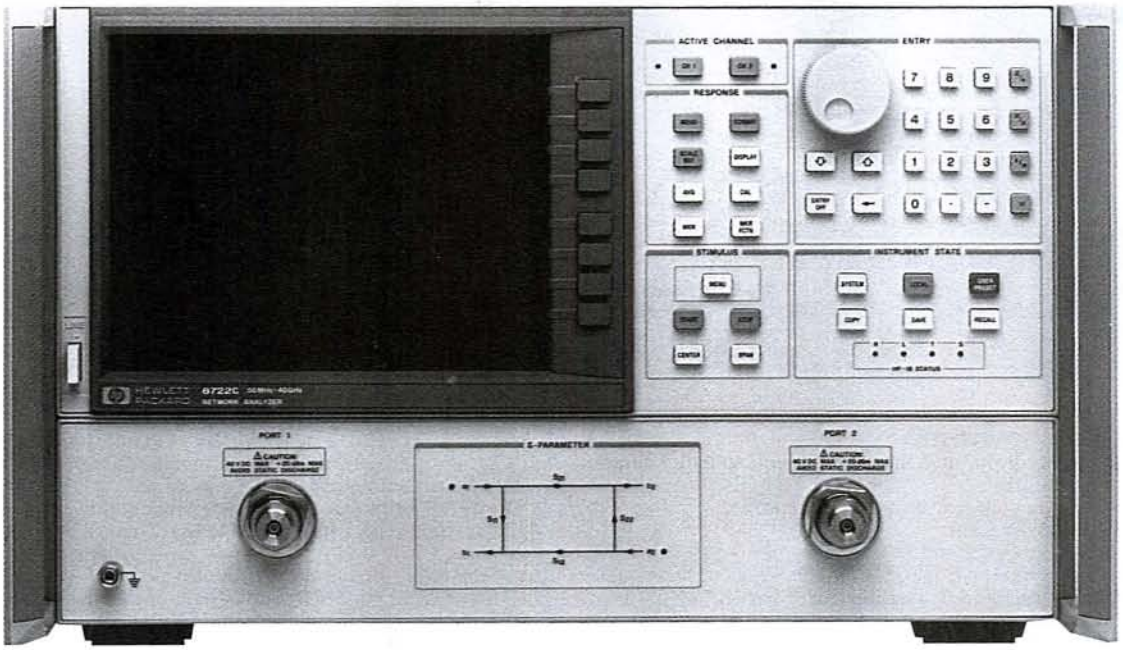
For the most current prices and product information, contact your local Hewlett-Packard sales office.

NETWORK ANALYZERS

Microwave Network Analyzers, 50 MHz to 40 GHz

HP 8719C, 8720C, 8722C, 85014C, 85162A

- 50 MHz to 13.5, 20, or 40 GHz frequency range
- Fast-sweeping synthesized source built in
- Integrated switching S-parameter test set
- Vector receiver, error correction, time domain
- Direct save/recall to an external disk drive
- Up to 103 dB dynamic range



HP 8722C

DESIGNED FOR HP-IB SYSTEMS

HP 8720 Series Network Analyzers

The HP 8719C, 8720C, and 8722C vector network analyzers characterize RF/microwave components down to 50 MHz and up to 40 GHz. These network analyzers include a fast-sweeping source, S-parameter test set, tuned receiver, and large color display in a single package. Their integrated design makes the HP 8720 series compact, economical, and easy to use. They are ideal choices for cost- or space-conscious engineers in research and development, manufacturing, incoming inspection, or quality assurance.

Affordable Analyzers with Excellent Performance

Despite their affordable price, the HP 8720 series network analyzers offer remarkable performance. The integral source is fully synthesized, even while sweeping, and provides stability and accuracy within 10 ppm (typical). Yet the sweep rate is extremely fast: measurement update times are typically about 1 ms per point. Frequency resolution is 100 kHz standard; Option 001 provides 1 Hz resolution for narrow-band or long-delay devices.

The tuned receivers with variable-bandwidth IF filters provide up to 103 dB of dynamic range. A built-in switching test set measures all 4 S-parameters (both forward and reverse) with a single connection.

Two independent channels can simultaneously display two measurements, such as reflection and transmission responses. The receiver detects both magnitude and phase, and displays results in a variety of useful formats, including group delay, deviation from linear phase, complex impedance, and SWR—on rectangular, polar, or Smith charts.

Built-in vector accuracy enhancement provides excellent error-corrected accuracy in all common coaxial connectors. A user kit supports user-defined standards, and allows calibration in waveguide (including effects of dispersion). Choose from a simple response normalization to full 2-port error correction. Or use TRL* to measure non-coaxial devices (e.g. microstrip) in a fixture. In addition, the frequency subset feature lets you zoom in on a response without recalibrating.

Powerful Features for Active Devices

With +10 dBm at their test ports, the HP 8719C and 8720C have plenty of power for testing amplifiers. For sensitive small-signal devices, the built-in step attenuator can cut power back to −65 dBm. Absolute power levels can be set accurately anywhere in the system, using the power meter calibration feature. Power sweep capability and power resolution of 0.1 dB make it easy to test the gain-compression characteristics of active components. In addition, there are 2 internal tees for biasing transistors through the test ports.

In-Fixture Device Characterization

Use TRL* calibration to minimize fixture errors, which would otherwise dominate the measurement of non-coaxial devices (such as microstrip). Or combine the network analyzer with a wafer-probing station, to measure devices while still on the wafer. Electronic port extensions and gating are also available to enhance accuracy.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

Time Domain and Fault Location

Time domain capability (Option 010) computes and displays the response versus time or distance (instead of frequency) of the device under test (DUT). Use time domain to locate and quantify individual faults or discontinuities in a network. Apply the gating feature to remove the effects of unwanted reflections (separated in time), then view the DUT's true response versus frequency.

Time-Saving Productivity Features

Limit test capability makes pass/fail decisions quantitative and decisive. Define up to 22 test limits per channel, based on the specifications of your components. Tuning is faster, and testing is more consistent.

To document results without a computer, the copy feature sends the entire display to a compatible plotter or printer. A built-in buffer controls the peripheral while you continue with the next measurement.

Annotate specific trace features with markers — up to 5 per channel, all displayed at once. Advanced marker functions track a maximum or minimum point (while tuning), or compute the delta between 2 markers. For bandpass filters, markers automatically calculate center frequency, bandwidth, and Q.

With save/recall capability, an experienced user can define and save test configurations for each DUT. Other users can recall identical conditions later, and align or test each DUT consistently. Use 5 internal non-volatile memory registers, or save/recall directly to an external CS80 disk drive.

Flexible Configuration for Systems

Option 011 deletes the couplers and transfer switch, providing direct access to the source output and 3 inputs. Build your own test set or switch matrix for high power, tracking, or multi-port devices. Or create an economical system with excellent sensitivity for RCS and near-field antenna test. Use the external TTL trigger to acquire over 200 points per second with precise timing.

Accessories

Configure a complete measurement system with test port cables, calibration kits, verification kits, and adapters. Waveguide calibration kits are available in X, P (Ku), K, and R (Ka) bands, covering 8.2 to 40 GHz. The HP 8720 family network analyzers use the same precision calibration standards and rugged flexible cables as the industry-standard HP 8510.

Software Enhances Measurement Capability

Automate these network analyzers with a desktop computer via HP-IB. The HP 85162A measurement automation software guides you through measurements and simplifies test configurations. With the HP 85014C active device measurement software, you can measure transistors quickly and completely. This software includes models to de-embed the HP 85041A transistor fixture, and also controls the bias supply.

Measure the dielectric properties of materials quickly and nondestructively with the HP 85070A dielectric probe kit (including software). For greater accuracy and flexibility, use the HP 85071A materials measurement software, for samples loaded into waveguide or coaxial fixtures.

Specifications Summary

Data applies at 23° ± 3° C. See product literature for total measurement uncertainty after error correction.

	HP 8719C	HP 8720C	HP 8722A
Minimum frequency	50 MHz	50 MHz	50 MHz
Maximum frequency	13.5 GHz	20 GHz	40 GHz
Frequency resolution (std)	100 kHz	100 kHz	100 kHz
With Opt 001	1 Hz	1 Hz	1 Hz
Frequency accuracy	10 ppm	10 ppm	10 ppm
Maximum power	+10 dBm	+10 dBm	−5 dBm
Minimum power	−65 dBm	−65 dBm	−65 dBm
Power resolution	0.1 dB	0.1 dB	0.1 dB
Power flatness	±2.0 dB	±2.0 dB	±3.0 dB
Power sweep range	20 dB	20 dB	10 dB
Receiver sensitivity (>2 GHz)	−93 dBm	−93 dBm	−91 dBm
With Opt 011	−113 dBm	−113 dBm	−113 dBm
System dynamic range (>2 GHz)	103 dB	103 dB	85 dB
Test port connector	3.5 mm	3.5 mm	2.4 mm

Measurement Rate (typical, 201-point sweep): <2 ms/point (1-port) to <5 ms/point (full 2-port)
HP-IB Functions: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0, C1, C10, E2
Size: 267 mm H × 425 mm W × 533 mm D (10.5 in × 16.75 in × 19.75 in), excluding connectors
Weight: Net, 34 kg (75 lb); shipping, 40 kg (88 lb)

Ordering Information

	Price
HP 8719C Network Analyzer (50 MHz to 13.5 GHz)	$45,500
HP 8720C Network Analyzer (50 MHz to 20 GHz)	$57,000
HP 8722C Network Analyzer (50 MHz to 40 GHz)	$75,000
The following options apply to all three network analyzers:	
Opt 001 1 Hz Frequency Resolution	+$9,500
Opt 010 Time Domain Capability	+$9,000
Opt 011 Direct-Access Receiver Configuration	−$4,000
Opt 802 Add HP 9122C Dual Disk Drive	+$1,545
Opt 913 Rack Mount Kit (#5062−4071)	+$40
Opt W30 Extended Repair Service (see page 636)	
Opt W31 On-Site Repair Service (see page 636)	
Opt W32 Calibration Service (see page 636)	
HP 85014C Active Device Measurement Software (see page 307)	
HP 85162A Measurement Automation Software	$1,550

NETWORK ANALYZERS

Microwave Network Analyzers, 45 MHz to 110 GHz

HP 8510 Series

- 45 MHz to 110 GHz frequency range
- Real-time error-corrected measurements
- 60 dB effective directivity and source match
- 80 dB to 100 dB dynamic range
- 0.001 dB, 0.01 degree, 0.01 nanosecond measurement resolution
- Time domain analysis

DESIGNED FOR HP-IB SYSTEMS

HP 8510C

HP 8510 Series Microwave Network Analyzers

The HP 8510 series microwave vector network analyzers provide a complete solution for characterizing the linear behavior of either active or passive networks over the 45 MHz to 50 GHz frequency range. A complete system comprises the HP 8510C network analyzer, an S-parameter test set, and a compatible RF source. For millimeter-wave measurement needs, complete systems operating to 110 GHz can be configured. For compatible lightwave measurement products, see page 567.

Measurement results can be displayed on a large, color CRT on one of two independent, yet identical, channels. The channels may be displayed individually, or simultaneously, with results presented in either log/linear magnitude, phase, or group delay format on rectangular or polar coordinates. Direct measurement of impedance is possible with the Smith chart format. The value and frequency of the data can be read with one of five independent markers. The CRT display can be copied directly to a plotter, such as the HP 7440A, 7475A, or 7550A. For increased productivity a plotter buffer is available. Also, a list of measurement data can be sent to an external printer such as the HP 2225A.

Powerful measurement enhancement functions are also available. Data averaging can be employed to narrow the effective receiver IF bandwidth, extending dynamic range and increasing signal-to-noise ratio. Trace smoothing aids in the interpretation of measurement results and is used to control the aperture of group delay measurements. Electrical length measurements are accomplished with the electrical delay function.

Built-in storage provides the capability to save and recall up to eight different front-panel states, eight separate calibrations, and eight separate measurements in nonvolatile memory. Extension of the internal storage capacity is possible via the built-in 3½-inch disc drive or an external disc drive.

High Performance

Along with the capability to completely characterize a microwave network with a single connection over the extremely broad 45 MHz to 50 GHz frequency range, the HP 8510 system offers wide dynamic range. Depending on the test set used, 80 dB to 100 dB of dynamic range is available. The precision IF processing and detection system contributes as little as ±0.05 dB and ±0.5 degree measurement uncertainty at a level of 50 dB below the reference. Meaningful resolutions of 0.001 dB, 0.01 degree, and 0.01 nanosecond are easily available.

Real-Time Error Correction

The HP 8510's built-in, high speed computer provides the capability to characterize and effectively remove the impact of systematic errors through accuracy enhancement techniques. Effective directivity and source match can be improved to as much as 60 dB. The data processing speed of the system is such that a fully error-corrected, 401 point trace of data is updated in under one second. This virtual "real-time" display of error-corrected data means that you can easily adjust your test device while it's being measured, with the assurance that you are viewing the data at the highest possible accuracy.

Time Domain Analysis

The HP 8510 (with Option 010) has the capability of displaying the time domain response of a network, obtained by computing the Inverse Fourier Transform of the frequency domain response. The time domain response displays the reflection coefficient of the network versus time, which displays the magnitude and location of each individual discontinuity, or else the transmission coefficient versus time, which displays each individual transmission path.

Pulsed-RF Measurement Capability.

For the measurement of pulsed-RF devices the HP 8510C can be equipped with wideband IF detectors (Option 008). When configured with a compatible test set (HP 85110A), the system can measure pulse widths as narrow as 1 usec on devices with output power up to 20 W (CW). Measurement formats include magnitude and phase versus frequency or time (pulse profile).

RF Sources

The recommended system source for the HP 8510C is the HP 8360 synthesized sweeper. It provides 1 Hz frequency resolution, phase-locked narrowband sweeps, and fully synthesized start frequencies for broadband ramp sweeps. All HP 8360-series synthesized sweepers are compatible with the HP 8510C. However, the HP 83621A (20 GHz), 83631A (26 GHz), and 83651A (50 GHz) models are optimized for HP 8510C system operation. Both the HP 8340-series synthesized sweeper and HP 8350B-series sweep oscillators are also compatible with the HP 8510C.

System Rack

HP 85043A System Rack Kit

The HP 85043A system rack stands 128 cm (50.5 in) high, 60 cm (23.6 in) wide, and 80 cm (31.5 in) deep. Complete with support rails and ac power distribution (suitable for 50 to 60 Hz, and 110 to 240 Vac), it includes rack mounting hardware for all instruments. Thermal design is such that no rack fan is needed.

System Software

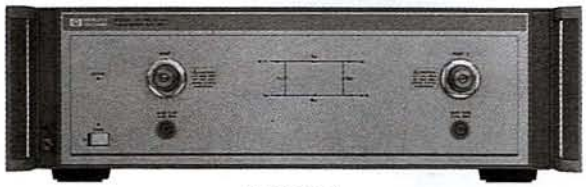
HP 85161B measurement automation software

The HP 85161B measurement automation software provides a more simplified and flexible user interface to the HP 8510C system. The program leads the operator through the measurement sequence one step at a time, from system setup and calibration, to device measurement and hardcopy output. Complete measurement configurations can be saved to disc for later recall. Also, data printout formats can be customized by the operator.

The HP 85161B software is designed for use with HP 9000 Series 200 or 300 computers and the BASIC operating system (5.0 or later).

Ordering Information

	Price
HP 8510C Network Analyzer	$36,500
Opt 008 Pulsed-RF Measurement Capability	+$10,800
Opt 010 Time Domain Capability	+$10,500
Opt W31 On-Site Repair Service (see page 636)	+$1,150
HP 85043A System Rack Kit	$3,500
HP 85161B Measurement Automation Software	$1,550



HP 8517A

HP 8511B

S-Parameter Test Sets

Several S-parameter test sets are available for the HP 8510C network analyzer for broadband coaxial measurements from 45 MHz to 50 GHz. The HP 8514B, 8515A, and 8517A test sets have an architecture that develops a separate reference channel for each incident port. RF switching is done with a built-in electronic switch. For active device measurements, the test sets include the ability to apply dc bias (external) to the test port center conductors. Also available are two 90 dB step attenuators (60 dB in the HP 8517A) which allow control of the port 1 and port 2 signal levels.

Pulsed-RF Measurement Test Set

The HP 85110A test set is specially configured for operation in pulsed-RF measurement systems (HP 85108). Four 90 dB step attenuators protect each input of the fundamentally-mixed down converter to allow measurement of test devices with output power of 20 watts CW.

Test Set General Information

	HP 8514B	HP 8515A	HP 8517A	HP 85110A
Frequency range (GHz)	0.045 to 20	0.045 to 26.5	0.045 to 50	2 to 20
Test ports (port 1 or 2): Nominal Operating Power Level (dBm)	0 to −5	−5 to −25	+3 to −13	0 to −3
Test Port Connector Type	3.5 mm (M)		2.4 mm (M)	3.5 mm (M)
Impedance dc Bias	50 Ω nominal 500 mA, 40 Vdc maximum			
Attenuation Range (incident signal)	0 to 90 dB, in 10 dB steps (0 to 60 dB for HP 8517A)			

Frequency Converters

With the HP 8511A (26.5 GHz) and 8511B (50 GHz) frequency converters, the HP 8510 becomes a general-purpose four-channel magnitude/phase receiver. Add your own power splitters for transmission measurements, and bridges or directional couplers for reflection measurements. Since one input is used for system phase-lock, the other three inputs are available for measurements of multi-port devices, subsystems, and antennas. All four inputs have precision 3.5 mm (HP 8511A) or 2.4 mm (8511B) connectors.

Multiple Test Set Operation

A single HP 8510C system may be configured with two test sets. In this configuration the test sets have different addresses, and the user may select between them from the front panel of the HP 8510 without reconnections. This capability is useful, for example, when combining a microwave coaxial test set with a millimeter-wave test set in the same HP 8510 system.

IF switching (Option 001): In the multiple test set configuration, the 20 MHz IF signal is daisy-chained from the test sets to the HP 8510. This capability requires test set Option 001 in one of the two test sets.

The RF signal must be routed to the desired test set using a coaxial RF switch and an HP 11713A switch driver. The switch driver is controlled automatically by the HP 8510C over the 8510 system interface bus.

Ordering Information

	Price
HP 8511A Frequency Converter	$20,500
Opt 001 Add IF Switching	+ $2,600
Opt W31 On-Site Repair Service (see page 636)	+$1,150
HP 8511B Frequency Converter	$25,000
Opt 001 Add IF Switching	$2,600
Opt W31 On-Site Repair Service (see page 636)	+$860
HP 8514B S-Parameter Test Set	$30,000
Opt 001 Add IF Switching	+ $2,600
Opt 002 Delete Step Attenuators and Bias Tees	− $6,500
Opt 003 High Forward Dynamic Range	$0
Opt W31 On-Site Repair Service (see page 636)	+$1,270
HP 8515A S-Parameter Test Set	$41,400
Opt 001 Add IF Switching	+ $2,600
Opt 002 Delete Step Attenuators and Bias Tees	− $7,000
Opt W31 On-Site Repair Service (see page 636)	+ $1,595
HP 8517A S-Parameter Test Set	$42,600
Opt 001 Add IF Switching	+ $2,600
Opt 002 Delete Step Attenuators and Bias Tees	− $7,500
Opt W31 On-Site Repair Service (see page 636)	+ $1,350
HP 85110A Pulsed-RF S-Parameter Test Set	$58,000
Opt 001 Add IF Switching	+ $2,600
Opt W31 On-Site Repair Service (see page 636)	+ $1,935

NETWORK ANALYZERS

Millimeter-Wave and Lightwave Test Sets Measurement System

HP 8510 Series

The HP 8510C system can easily be configured for making measurements at millimeter-wave frequencies. Hewlett-Packard offers hardware for configuring systems in the 33 to 50 GHz, 40 to 60 GHz, 50 to 75 GHz, and 75 to 110 GHz waveguide bands. These S-parameter configurations allow both forward and reverse measurements to be made with a single connection to the device under test. The greatest convenience and highest accuracy is assured through the TRL (Through-Reflect-Line) calibration technique.

HP 85106C Millimeter-Wave Network Analyzer Subsystem

The HP 85106C millimeter-wave network analyzer subsystem includes an HP 8510C network analyzer, an HP 85105A millimeter-wave controller, an HP 83621A synthesized source, and an HP 8350B/83540A source (LO), all mounted in a single bay rack with extendable worksurface. The system setup disk makes the retrieval of system states fast and easy. System installation at your facility and one year of on-site service are included with the HP 85106C at no additional cost. Two HP 85104A series test set modules are required to complete the system. Precision calibration kits and verification kits are also available for these waveguide bands.

The HP 85106C can be configured as a combination microwave/millimeter-wave S-parameter system with Option 001. This option adds an HP 8517A microwave test set, 50 GHz source (83651A), HP 85133F test port return cable set, HP 85056A calibration kit, and appropriate cabling for convenient switching between millimeter-wave operation and microwave operation with no re-connections required.

The HP 8510C's external phase-locked control allows the use of the economical HP 8350B sweep oscillator as the local oscillator (LO) source. However, a synthesizer can also be used as the LO source when faster measurement speeds are desired. Option 002 substitutes an HP 83621A synthesized source for the HP 8350B/83540A source as the LO.

Option 010 adds time domain capability to the HP 8510C for transferring frequency domain data to the time domain for observing the effects of impedance discontinuities as a function of distance or time.

HP 85104A Series Test Set Modules

An HP Q/U/V/W 85104A test set module contains all of the necessary waveguide hardware (frequency multiplier, isolators, directional couplers, and harmonic mixers) compactly integrated into one box. Any pair of the test set modules can be connected to the HP 85105A millimeter-wave controller for S-parameter millimeter-wave measurement capability. These modules are easy to maneuver and make the system extremely simple to set up.

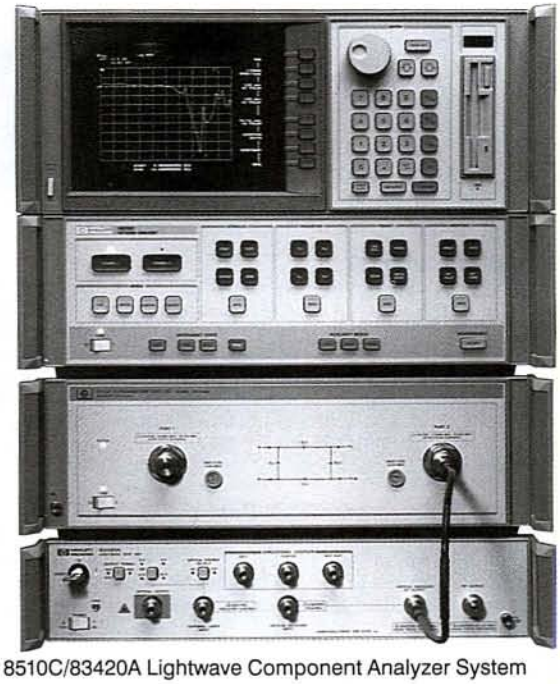
HP 11644A Series Calibration Kits

Each HP Q/U/V/W 11644A precision calibration kit contains two straight waveguide test port sections with precision flanges, a flush short circuit, a precision quarter-wavelength shim, and a sliding or fixed load termination. In addition to providing the "offset" for the offset short and offset load, the shim is also used as the "line" standard for a TRL calibration. The standards in the kit allow you to take full advantage of the built-in accuracy enhancement and data processing features of the HP 8510C.

HP 11645A Series Verification Kits

Each HP Q/U/V/W 11645A verification kit contains a standard section, a mismatch section, and a 20 dB and 50 dB attenuator. The devices in the kit are shipped with nominal data and uncertainties traceable to the US National Institute of Standards and Technology (NIST).

Ordering Information	Price
HP 85106C Millimeter-Wave Network Analyzer Subsystem	$125,500
Opt 001 Add Microwave Test Set (HP 8517A), 50 GHz Source (83651A), and 2.4 mm Accessories	+$73,530
Opt 002 Synthesized LO (HP 83621A) for the fastest measurement speed	+$19,000
Opt 010 Add Time Domain Capability to the HP 8510C	+$10,500



HP 8510C/83420A Lightwave Component Analyzer System

Test Set Modules (order 2 each)	
HP Q85104A WR-22 (33 to 50 GHz) Test Set Module	$30,000
HP U85104A WR-19 (40 to 60 GHz) Test Set Module	$31,000
HP V85104A WR-15 (50 to 75 GHz) Test Set Module	$34,000
HP W85104A WR-10 (75 to 110 GHz) Test Set Module	$37,000

Calibration Kits	
HP Q11644A WR-22 (33 to 50 GHz) Calibration Kit	$4,100
HP U11644A WR-19 (40 to 60 GHz) Calibration Kit	$4,450
HP V11644A WR-15 (50 to 75 GHz) Calibration Kit	$4,450
HP W11644A WR-10 (75 to 110 GHz) Calibration Kit	$4,650

Verification Kits	
HP Q11645A WR-22 (33 to 50 GHz) Verification Kit	$5,000
HP U11645A WR-19 (40 to 60 GHz) Verification Kit	$5,000
HP V11645A WR-15 (50 to 75 GHz) Verification Kit	$5,000
HP W11645A WR-10 (75 to 110 GHz) Verification Kit	$5,000

HP 83420A Lightwave Test Set

The HP 8510 microwave network analyzer can be extended to calibrated, lightwave measurements using the 20 GHz HP 83420A lightwave test set.

The HP 83420A contains a 1300 nm or 1550 nm lightwave source (Fabre Perot or DFB laser), receiver and lightwave directional coupler (for reflection measurements). It combines with existing HP 8510 analyzers for swept 130 MHz to 20 GHz optical and electrical testing of small-signal-sinusoidal transmission and reflection characteristics. Lightwave devices like lasers, photodiodes, optical modulators and optical amplifiers can be tested for modulation bandwidth, optical return loss and differential phase response. Data can be displayed in appropriate frequency and distance-time domain formats.

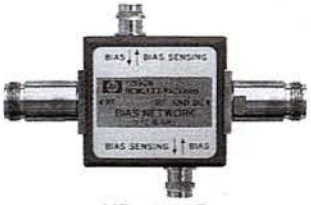
The HP 8510/83420 system is easy to operate since step-by-step measurement instructions can be provided when the HP 83420A test set program is run on an appropriate computer.

Ordering Information	Price
HP 83420A Lightwave Test Set	$49,500
Opt 01X Select Optical Connector	$0
Opt 100 External Lightwave Source Input	$2,800
Opt 210 1550 nm DFB Laser	$15,000
Opt 220 1300 nm DFB Laser	$10,500

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.


HP 85041A


HP 83040A



HP 11590B

HP 11612A

Active Device Test

Hewlett-Packard offers an extensive array of accessories designed for the needs of active device test and measurement, including fixtures, bias supplies, bias networks, and application software.

HP 85041A Transistor Test Fixture Kit

The HP 85041A transistor test fixture (TTF) kit is a comprehensive measurement system for testing and characterizing stripline packaged microwave transistors. It is useful only when used with the HP 85014BC active device measurement software.

Frequency Range: dc to 18 GHz
Transistor Package Inserts: 70 mil and 100 mil
Verification Devices: Short and through circuits
Connectors: Precision 7 mm
Accessories Supplied: Fixture stand, torque tool, tweezers, and lid opening tool

HP 83040 Series Modular Microcircuit Package

The new HP 83040 system bridges the gap between custom microcircuit packages and precision test fixtures. This versatile design tool provides a flexible, modular platform for breadboard design and test. Characterize and store circuit modules for easy integration into CAE models. Immediate availability eliminates mechanical design and fab queues, streamlining design cycle times.

- Compatible with many vector network analyzer calibration methods
- 0.254-mm (0.010-in) and 0.635-mm (0.025-in) substrates
- Excellent performance to 26.5 GHz (0.254-mm substrates)

(See page 383 for complete description and ordering information.)

HP 11608A Transistor Fixture

Function: Provides the capability of completely characterizing stripline transistors. A through-line microstrip and bolt-in grounding structure, machineable by customer, is included.
Frequency Range: dB to 12.4 GHz
Reflection Coefficient: <0.05, dc to 4 GHz; <0.07, 4.0 to 8.0 GHz; >0.15, 8 to 12.4 GHz
Package Styles:
Opt 003: 0.205-in diameter packages
Calibration References: Opt 003 only, short circuit termination and a 5-Ω through-section
Connectors: APC-7 hybrid
Weight: Net, 0.9 kg (2 lb); shipping, 1.4 kg (3 lb)
Size: 25 mm H × 143 mm W × 89 mm D (1 in × 5.63 in × 3.5 in)

Bias Networks

Bias networks are available for applying dc bias to the center conductor of a coaxial line which can be connected to a device under test. The bias network also provides a dc block to the RF input port.

Bias Network	HP 11590B	HP 11590B Opt 001	HP 11612A	HP 11612B
Frequency Range (GHz)	0.1 to 12.4	0.1 to 18	0.045 to 26.5	0.045 to 50
Connectors RF Input RF Output dc Bias	 Type N (f) Type N (f) BNC (f)	 7 mm 7 mm BNC (f)	 3.5 mm (f) 3.5 mm (m) SMB snap-on (m)*	 2.4 mm (f) 2.4 mm (f) SMB snap-on (m)*
Insertion Loss (max)	0.8 dB	0.8 dB, 0.1 to 12.4 GHz 1.2 dB, 12.4 to 18 GHz	0.8 dB, .045 to 12.4 GHz 1.3 dB, 12.4 to 26.5 GHz	0.8 dB, .045 to 12.4 GHz 1.3 dB, 12.4 to 26.5 GHz 26.5 to 50 GHz
Return Loss (min)	19 dB	19 dB, 0.1 to 12.4 GHz 14 dB, 12.4 to 18 GHz	20 dB, 0.045 to 8 GHz 18 dB, 8 to 18 GHz 14 dB, 18 to 26.5 GHz	20 dB, 0.045 to 8 GHz 18 dB, 8 to 18 GHz 14 dB, 18 to 26.5 GHz 10 dB, 26.5 to 50 GHz
Bias Current (max)	500 mA	500 mA	500 mA**	500 mA
Bias Voltage (max)	100 V	100 V	40 V	40 V

* Cable included, SMB(f) to BNC(m).
**Option 001 provides for 2 amps maximum bias current over the 400 MHz to 26.5 GHz frequency range. Higher bias currents may be applied with pulsed operation.

HP 11635A Bias Decoupling Network

The HP 11635A bias decoupling network is a recommended accessory for prevention of bias oscillations when biasing microwave bipolar transistors with any HP bias network or S-parameter test set. Installing the HP 11635A between the bias supply and the base bias network prevents low-frequency oscillations.

Application Software

Hewlett-Packard offers application software packages that compliment these network analyzer systems provide automated calibration and measurement capability. Software is available for HP Series 200/300 desktop computers using BASIC 2.0, 3.0, 4.0, or 5.0 operating systems on both 3½-inch and 5¼-inch disc media.

HP 85014B/C Active Device Measurement Application Pacs

The HP 85014B/C software pacs provide the capability for measurement of RF and microwave transistors (HP 85014B for the HP 8510C and HP 85014C for the HP 8719C/8720C/8722C). Features include automated device biasing with the HP 6626A precision power supply, system calibration, and de-embedding of S-parameters when using the HP 85041A transistor test fixture. They are also usable with other HP transistor fixtures as well as with user-designed fixtures. Plotted and listed output of device S, H, Y, and Z parameters, as well as the device amplifier summary and termination summary, are provided. Also available is the capability to store and retrieve S-parameter data in formats suitable for computer-aided-design applications.

Ordering Information	Price
HP 85041A Transistor Test Fixture	$6,500
HP 11590B Bias Network	$900
HP 11612A Bias Network	$1,000
Opt 001 2 Amps Maximum Bias Current	+$175
HP 11612B Bias Network	$1,200
HP 11635A Bias Decoupling Network	$450
HP 85014B/C Active Device Measurement Software	$3,400
HP 11608A Transistor Fixture, Customer-Machineable	$2,500
Opt 003 0.205-in Diameter Package Style	+$500

For the most current prices and product information, contact your local Hewlett-Packard sales office. See page 383.

NETWORK ANALYZERS

Microwave Network Analyzer Accessories (cont'd)

HP 8510, 8720 Series

HP 85050C

HP 85053B

Microwave Network Analyzer Accessories

A wide range of accessories is available for both the HP 8720C and the HP 8510C series network analyzers, including calibration kits, verification kits, cables, and adapters for 7 mm, 3.5 mm, Type N, and 2.4 mm connector interfaces. The standards used in the 3.5 mm, Type N, and 2.4 mm connectors use precision slotless connectors (PSC-3.5, PSC-N, and PSC-2.4).

Calibration Kits

Error-correction procedures require that the systematic errors in the measurement system be characterized by measuring known devices (standards) on the system over the frequency range of interest. All network analyzer calibration kits contain precision standard devices to characterize the systematic errors of the HP 8720C or 8510C network analyzer system.

Each calibration kit also contains adapters to change the sex of the test port, connector gages for verifying and maintaining the connector interface, and a torque wrench for proper connection. Each kit contains standards definitions on disk for the HP 8510C. (These definitions are already included in the HP 8720C.)

Verification Kits

Measuring known devices, other than the calibration standards, is a straightforward way of verifying that the network analyzer system is operating properly. Hewlett-Packard offers verification kits that include precision airlines, mismatch airlines, and precision fixed attenuators. Traceable measurement data for all devices is shipped with each kit on disk.

Verification kits may be recertified by Hewlett-Packard. This recertification includes a new measurement of all standards, as well as new data and uncertainties. Certification in compliance with MIL-STD 45662A is also available.

Verification Kit Summary

Verification Kit	Connector Type	Frequency Range (GHz)	Price
85051B	7 mm	0.045 to 18	$4,000
85053B	3.5 mm	0.045 to 26.5	$4,000
85055A	Type N	0.045 to 18	$4,000
85057B	2.4 mm	0.045 to 50	$4,600
R11645A	WR-28	26.5 to 40	$5,000

Calibration Kit Summary

Calibration Kit	Connector Type	Frequency Range (GHz)	Performance Summary Directivity/Source Match at Fmax w/8720C	w/8510C	Description	Price
85050B	7 mm	0.045 to 18	45/30	52/41	Contains open and short circuits and fixed and sliding terminations.	$5,500
85050C	7 mm	0.045 to 18	n/a	60/60	Contains standards for TRL calibration on HP 8510B, including precision airline. Also contains open and short circuit and fixed termination.	$6,000
85050D	7 mm	0.045 to 18	36/30	40/35	Economy kit. Contains open and short circuits and precision-fixed termination. No gages included.	$2,150
85052B	3.5 mm	0.045 to 26.5	40/30	44/31	Contains open and short circuits (m and f) and fixed and sliding terminations (m and f), and in-series adapters.	$8,090
85052C	3.5 mm	0.045 to 26.5	n/a	50/50	Contains standards for TRL calibration on HP 8510, including precision airlines. Also contains open and short circuits and fixed terminations. No gages included (see HP 11752D).	$8,930
85052D	3.5 mm	0.045 to 26.5	36/29	36/30	Economy kit. Contains open and short circuits (m and f) and precision fixed termination (m and f), and in-series adapters. No gages included.	$4,310
85054B	Type N	0.045 to 18	40/30	42/32	Contains open and short circuits (m and f) and fixed and sliding terminations (m and f), in-series adapters, and 7 mm to type N (m and f) adapters.	$8,900
85054D	Type N	0.045 to 18	34/28	34/28	Contains open and short ciurcuits (m and f) and broadband fixed terminations, in-series adapters, and 7-mm-to-type-N (m and f) adapters.	$5,400
85056A	2.4 mm	0.045 to 50	38/33	38/33	Contains open and short circuits (m and f) and fixed and sliding terminations (m and f), in-series adapters, and 7-mm-to-type-N (m and f) adapters.	$9,480
85056D	2.4 mm	0.045 to 50	26/24	26/24	Contains open and short circuits, broadband terminations, and in-series adapters. No gages included.	$5,250
85056K	2.92 mm (K-connector)	0.045 to 40	22/19 (typical)	22/19	Contains 2.4 mm open and short circuits, fixed terminations and 2.4 mm to 2.92 mm adapters	$7,000
Option 001			27/24 (typical)	27/24	Adds 2.4 mm sliding loads and gages	+$4,500
K11644A	WR-42	18.0 to 26.5	50/45	50/50	Contain flush short circuit, a precision shim, and a sliding (R) or fixed (X/P/K) termination.	$4,300
X11644A	WR-90	8.2 to 12.4	50/45	50/50		$4,300
P11644A	WR-62	12.4 to 18.0	50/45	50/50		$4,300
R11644A	WR-28	26.5 to 40	50/45	50/50		$3,850

Test Port Return Cables and Adapters

Test port cables and adapter sets are available for various connector types. The cable/adapter configurations are described below. All cables are designed with one end that connects directly to the special ruggedized ports of the network analyzer test set, and one end that connects to the device under test.

Special test port adapter sets are also available to convert the ruggedized ports of the network analyzer test set to the desired connector interface. Each kit contains two adapters, one male and one female.

Both the cables and the special adapters have one special female connector which is designed to connect directly to the 3.5 mm test port (2.4 mm for HP 8517A and 8722C). This side of the cable or adapter can only be connected to the test set port, and cannot be mated to a standard 3.5 mm (or 2.4 mm) male connector. The male test set ports, however, can be mated to a standard 3.5 mm (or 2.4 mm) female connector.

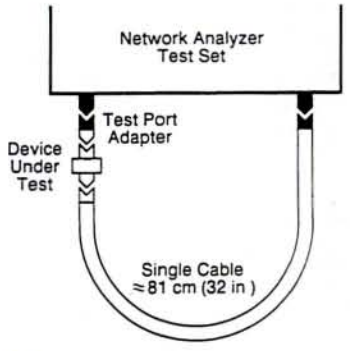
Choose one of the configurations shown.

Configuration A. This cable arrangement is for applications where the device under test is connected directly to the test set port. This setup offers the best mechanical rigidity for device connection. To adapt the test set port (port 1) to the device under test, choose the appropriate special adapter set. Besides converting the test port to the desired interface, these adapters also function as "test port savers" which protect the test set from damage and wear due to heavy use.

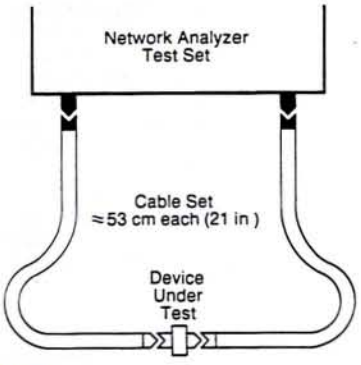
Configuration B. This cable arrangement is for applications where the device under test is connected between cable ends. This setup offers more flexibility when connecting to the device under test. Choose semi-rigid or flexible cables

The cables for 3.5 mm and 7 mm devices are available as semi-rigid cables, offering excellent performance and suitable for applications where the connectors of the device under test are in-line, or as super-flexible cables which are more rugged and have a tighter bending radius, ideal for manufacturing environments. The semi-rigid cables carry a 90-day warranty, whereas the flexible cables are warranted for one full year.

Configuration A



Configuration B



Configuration A
For HP 8719C/8720C Network Analyzer or HP 8514B/8515A Test Sets (3.5 mm test port)

	Cables/Adapters	Connector Type (on device side of cable/adapter)	Price
For 3.5 mm devices	HP 85131C Semi-rigid Cable or HP 85131E Flexible Cable	3.5 mm (f) 3.5 mm (f)	$750 $2,100
	HP 85130D Adapter Set[a]	3.5 mm (m or f)	$1,090
For 7 mm devices	HP 85132C Semi-rigid Cable or HP 85132E Flexible Cable	7 mm	$650 $1,900
	HP 85130B Adapter Set	7 mm	$1,090
For Type N devices	Use 7 mm cables and the 7 mm to N adapters included in the HP 85054B/D calibration kit.		–
	HP 85130C Adapter Set	Type N (m or f)	$1,090

[a] Recommended but not required

Configuration A
For HP 8722C Network Analyzer or HP 8517A Test Set (2.4 mm test port)

	Cables/Adapters	Connector Type (on device side of cable/adapter)	Price
For 2.4 mm devices	HP 85133C Semi-rigid Cable or HP 85133E Flexible Cable Set	2.4 mm (f)	$950 $2,750
	HP 85130G Adapter Set[a]	2.4 mm (m or f)	$1,090
For 3.5 mm devices	HP 85134C Semi-rigid Cable or HP 85134E Flexible Cable	3.5 mm (f) 3.5 mm (f)	$750 $2,100
	HP 85130F Adapter Set	3.5 mm (m or f)	$1,090
For 7 mm devices	HP 85135C Semi-rigid Cable or HP 85135E Flexible Cable	7 mm 7 mm	$650 $1,900
	HP 85130E Adapter Set	7 mm	$1,090

[a] Recommended but not required

Configuration B
For HP 8719C/8720C Network Analyzer or HP 8514B/8515A Test Sets (3.5 mm test port)

	Cable Set	Connector Type (on device side of cable/adapter)	Price
For 3.5 mm devices	HP 85131D Semi-rigid Cable Set or HP 85131F Flexible Cable Set	3.5 mm (one male, one female) 3.5 mm (one male, one female)	$1,300 $3,150
For 7 mm devices	HP 85132D Semi-rigid Cable Set or HP 85132F Flexible Cable Set	7 mm 7 mm	$1,100 $2,900
For Type N devices	Use 7 mm cables and the 7 mm to N adapters in the HP 85054B/D calibration kit.		–

Configuration B
For HP 8722C Network Analyzer or HP 8517A Test Set (2.4 mm test port)

	Cable Set	Connector Type (on device side of cable/adapter)	Price
For 2.4 mm devices	HP 85133D Semi-rigid Cable Set or HP 85133F Flexible Cable Set	2.4 mm (one male, one female)	$1,700 $4,250
For 3.5 mm devices	HP 85134D Semi-rigid Cable Set or HP 85134F Flexible Cable Set	3.5 mm (one male, one female) 3.5 mm (one male, one female)	$1,300 $3,150
For 7 mm devices	HP 85135D Semi-rigid Cable Set or HP 85135F Flexible Cable Set	7 mm 7 mm	$1,100 $2,950

NETWORK ANALYZERS

Pulsed-RF Network Analyzer

HP 85108A

HP 85108

Magnitude and Phase Characterization

The HP 8510 has become a standard measurement tool for the microwave design engineer. It provides a highly accurate, easy-to-use way to completely characterize the S-parameters of microwave components. This same tool now makes the characterization of pulsed-RF devices as simple as the press of a button. This dynamic characterization allows you to evaluate the magnitude and phase response at a specific point in a pulse across frequency.

HP 85108A Pulsed-RF Network Analyzer System

The HP 85108A is a factory-integrated system that provides the entire instrument configuration required to make pulsed-RF measurements. Simply add the desired measurement accessories for a complete system.

The system is built around the HP 8510C with the pulsed-RF measurement capability option (Option 008) already installed. The system also includes the HP 85110A S-parameter test set. An HP 83622A and an HP 83624A synthesized sweeper provide, respectively, the RF and LO signals needed to operate the fundamentally mixed test set.

HP 85108L Pulsed-RF Network Analyzer System

The HP 85108L and, the newest in the family of pulsed-RF test sets, the HP 85110L, provide improvements to pulsed-RF network analysis in many areas, but they specifically extend the frequency coverage down to 45 MHz and up to 2.3 GHz. The HP 85110L has excellent pulsed-RF and CW performance with system dynamic range greater than 70 dB when using the wideband detectors and better than 95 dB when using the standard narrowband detectors. Both detectors are included in the HP 85108 systems.

The HP 85108L system is built around the same HP 8510C and includes two 83620A option H80 synthesizers. The system is optimized for component testing in applications such as cellular, direct broadcast satellite, and VHF/UHF.

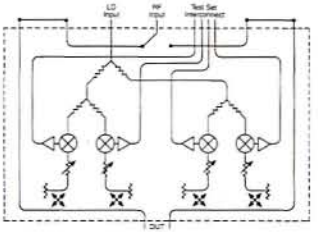
These systems also include on-site installation, and a one-year on-site warranty insures that the systems remain up and running.

HP 8510C Option 008

The HP 8510C pulsed-RF measurement capability option (Option 008) consists of an additional receiver subsystem for the HP 8510. This pulsed-RF measurement capability, which exists in parallel with the standard HP 8510C operation, provides you with the ability to measure and display the relative magnitude and phase shift of the component as a function of time with an equivalent bandwidth of 1.5 MHz. This allows the evaluation of the dynamic pulsed-RF characteristics for pulse widths down to 1 microsecond. Using the repetitive sampling method, point-to-point display resolution of 100 nanoseconds is available.

HP 85110A S-Parameter Test Set

The HP 85110A S-parameter test set is a required system component for the HP 8510C pulsed-RF measurement capability. The figure below shows a simplified block diagram of this test set.



Key to the performance of the test set are the fundamental mixers used to provide the low noise IF necessary to make accurate, pulsed-RF measurements with the pulsed-RF receiver subsystem. Two external synthesizers act as the RF and LO sources for the four-channel downconverter. This approach eliminates the need to dedicate one channel for phase-lock, making full two-port, pulsed-RF S-parameter measurements available. Also, the internal pulse modulator of the RF synthesizer can be used to pulse the device-under-test.

The block diagram also provides some distinct advantages, whether using the HP 8510C for pulsed-RF or standard S-parameter measurements. Because of the coupler-based measurement path and attenuators, the test set can handle high powers, up to 20 W. And the connections available on the rear panel provide access to the measurement path, making it easy to configure test systems that use a single measurement connection. Special versions of the HP 85110A test set are available for even higher power applications or other frequency ranges.

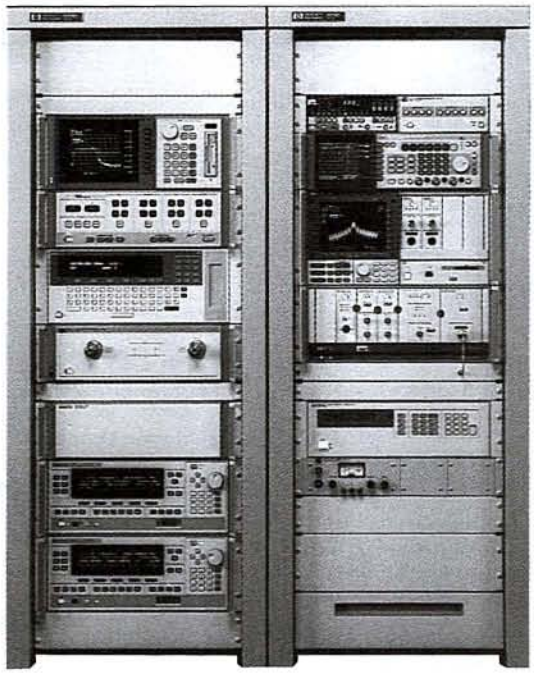
Ordering Information

	Price
HP 85108A Pulsed-RF Network Analyzer System	$194,500
The HP 85108A Pulsed-RF Network Analyzer system is a factory-integrated system that includes the instruments required to make dynamic pulsed-RF measurements. Installation and one-year, on-site warranty included.	
This system consists of: HP 8510C Network Analyzer with Option 008 Pulsed-RF Measurement Capability	
HP 83622A Synthesized Sweeper with Options: 001 Add Step Attenuator, 003 Delete Front Panel Keyboard/Display, 004 Rear Panel RF Output and 008 1 Hz Frequency Resolution.	
HP 83624A Synthesized Sweeper with Options: 003 Delete Front Panel Keyboard/Display, 004 Rear Panel RF Output and 008 1 Hz Frequency Resolution.	
HP 85110A S-Parameter Test Set	
System Rack	
HP 85110A S-Parameter Test Set	$58,000
Requires one HP 83622A 2 to 20 GHz synthesized sweeper and one HP 83624A 2 to 20 GHz (high power) synthesized sweeper for system operation.	
The HP 85110A is a 2 to 20 GHz S-Parameter Test Set that provides the low noise IF required by the HP 8510C Option 008 Pulsed-RF Measurement Capability.	
HP 85108L Pulsed-RF Network Analyzer System	$149,500
HP 85110L S-Parameter Test Set	$39,500

To upgrade an existing HP 8510C System for Pulsed-RF Measurements

Your existing HP 8510 system can also be upgraded to perform pulsed-RF measurements. This upgrade can be performed on-site or integrated into a full system at the factory.

- Hardware
- Software
- Support



HP 85108A F56

Test Systems for MMICs, Hybrids, or Modules

Hewlett-Packard can design and integrate customized test systems for your microwave component and sub-system testing application. By employing the single connection multiple measurement (SCMM) approach facilitated by open-architecture S-parameter test sets such as the HP 85110A, a variety of stimulus/response measurements are possible, all through a single RF connection to the device under test. Your existing HP 8510 and related hardware can be integrated into these types of systems.

With your HP test system, you will be able to measure the entire range of performance specifications required by MMIC chips or hybrids such as amplifiers, oscillators, mixers, attenuators, switches, or a combination of these—all with a single touchdown of the wafer probes or a single fixture insertion. Also, be assured that your HP system will provide the optimum in test performance and accuracy, and will be backed by the best service support in the industry.

Benefits of Integrated Test Systems

Examples of applications that can benefit from the SCMM approach are high-volume T/R module test, on-wafer MMICs, packaged hybrid devices, or even multi-port subsystems.

Lower Your Test Time

Integrated systems reduce test times by at least a factor of 2 over the same testing with multiple wafer passes or fixture insertions on separate test systems.

Increase Your Test Accuracy

Complete test data, taken at the same time under the same dc bias and temperature conditions, provides for the highest accuracy and consistency in product characterization.

Increase Your Product Yield

Reduced handling decreases wafer breakage, and yields increase due to reduced pad or connector damage.

Increase Your Product Reliability

Reduced pad damage results in better bonding, and single-pass testing decreases the chances of ESD damage.

Maximize Your System Up-Time

You get responsive, single vendor support from HP, worldwide.

Added together, these benefits will mean a substantial reduction to your microwave component costs!

System Integration and Support

Each system is fully integrated at HP, then installed at your facility. Integration can include customized system functional test software, acceptance test procedures, and system specifications (at additional cost). This frees your resources for more effective product development and manufacturing. Once your system is installed, local systems support from HP assures that it will continue to perform.

Experience Counts

Numerous test systems similar to the one shown above have already been supplied to customers around the world to cover a variety of MMIC, T/R module, and TWT testing applications. In producing these integrated systems, HP has combined 50 years of experience in producing the very best in test instrumentation and computation tools with over 15 years of experience designing, fabricating, and testing our own world-class GaAs devices, MMICs and hybrid assemblies. When you choose HP you get a test system supplier that can understand and relate to your testing needs.

If the capabilities of a completely integrated approach to component test interest you, contact your nearest local HP sales representative for more information on how such a system can be configured and delivered to you.

NETWORK ANALYZERS
On-Wafer Network Analyzer System
HP 85109B

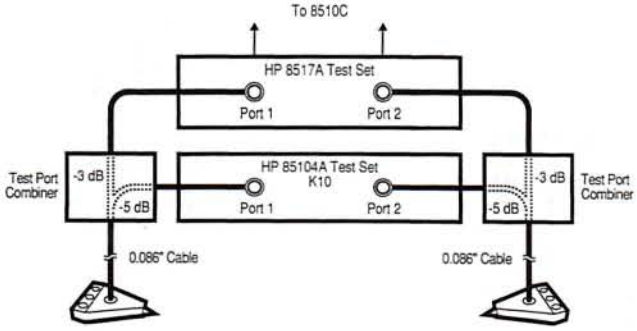
HP 85109B Network Analyzer System

Superior On-Wafer Measurements to 62.5 GHz

The HP 85109B Network Analyzer System allows you to make fully calibrated measurements on-wafer from 45 MHz to 62.5 GHz. By building on the HP 8510C network analyzer, the HP 85109B provides the highest measurement performance in frequency coverage, dynamic range, and measurement accuracy. Whether you order a full system or a special upgrade, all systems are fully integrated, tested, and verified at the factory prior to shipment and installation. This means you can begin making quality measurements right after installation. And every system comes with a one-year on-site warranty.

Single RF Connection to 62.5 GHz

To achieve superior dynamic range and still provide a single connection, the HP 85109B employs a specially designed low loss test port combiner. It couples the RF output of two test sets into a single 1.85 mm coaxial interface to wafer probes or a coaxial device. The combiners also provide a dc path to the probes, allowing convenient biasing of devices with the bias tees internal to the HP 8517A test set.



Broadband Calibration and Bias Control

The HP 85109B System Software enables performance of a single on-wafer or coaxial calibration from 45 MHz to 62.5 GHz. To do this, the software automatically switches test set bands and combines data from each test set. Error-corrected measurements to 62.5 GHz are then displayed on the HP 8510C. The system software can also be used to set up and control device bias using an HP 4142B, 4145A, or 6626A transistor bias supply.

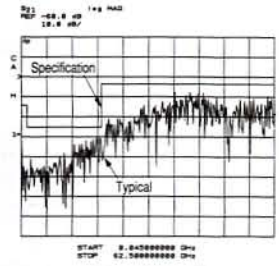
High Dynamic Range Ensures Accurate Calibration

The system combiners enable the HP 85109B to leverage the high power available with the HP U85104A K10 test set operating in the 40 to 62.5 GHz band. The more than 63dB of on-wafer dynamic range at 62.5 GHz enables longer-lasting calibrations. As an example, consistent device measurements typically can be made for up to twenty hours after LRM calibration (assuming a stable ±1° C temperature environment and that the semi-rigid cables are not stressed during calibration measurement).

Cost-Effective Upgrades

Through flexible upgrade paths, the HP 85109B offers the most cost-effective solution for you to make on-wafer measurements to 62.5 GHz. If you are already making measurements with an HP 8510 system, you are closer to making 62.5 GHz measurements than you think. System upgrades start at $110,000.

System Performance



Frequency Ranges: 0.045 to 62.5 GHz

Dynamic Range (typical):[1]

Note that the performance is shown at the probe tip. Two Cascade Microtech WPH-405-150 probes contact to coplanar devices and standards. 50.8 cm (20 in) of 0.086 in diameter cables are used to connect each probe to the system.

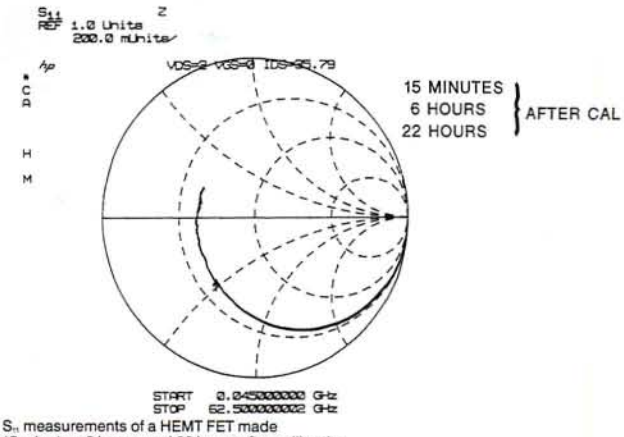
	Frequency Range (GHz)			
	0.045 to 2	2 to 2	20 to 40	40 to 62.5
Reference power at probe tip (dBm)	+1	−9	−24	−12
Minimum power at probe tip (dBm)	−75	−95	−87	−75
On-wafer dynamic range (dB)	76	86	63	63

[1]Limited by compression level and system noise floor. Noise floor is measured with full two-port error correction, 1024 averages (see figure above).

Calibration Types: LRM, TRL, SOLT

Typical Measurement Results

HP 85109B MEASUREMENT STABILITIY



S_{11} measurements of a HEMT FET made 15 minutes, 6 hours, and 22 hours after calibration.

Ordering Information

	Price
HP 85109B Network Analyzer System	$210,000

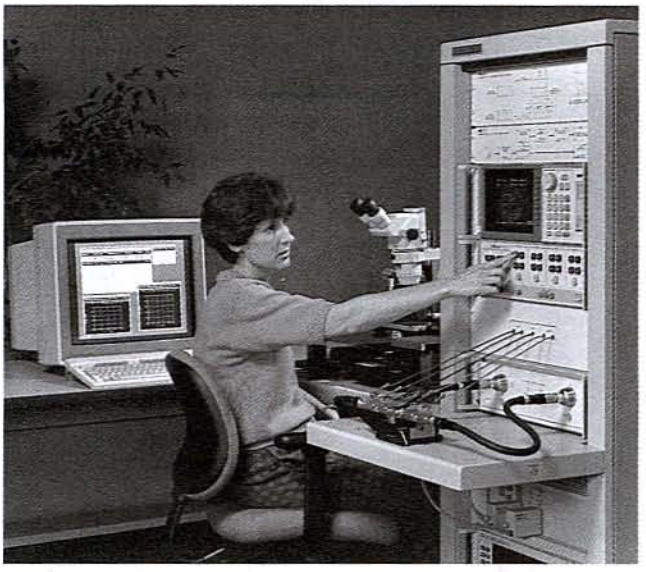
The system consists of the following:

- **HP 8510C Network Analyzer**
- **HP 8517A** S-Parameter Test Set
- **HP U85104A Opt K10** U-Band Test Set
- **HP 85105A** Millimeter-Wave Test Set Controller
  - **Opt 054** Rear-Panel Connectors and 50 GHz RF Switch
- **HP 83651A** 45 MHz to 50.0 GHz Synthesizer
- **HP 8350B/83540A Opt 004** Sweep Oscillator
- **HP U281A** WR-19-to 1.85-mm Adapters (2)
- **HP 92214B** System Table (to support probe station)
- **HP 85043A** System Cabinet
- 1.85-mm Test Port Combiners (2)
- RF Cables
- System Software

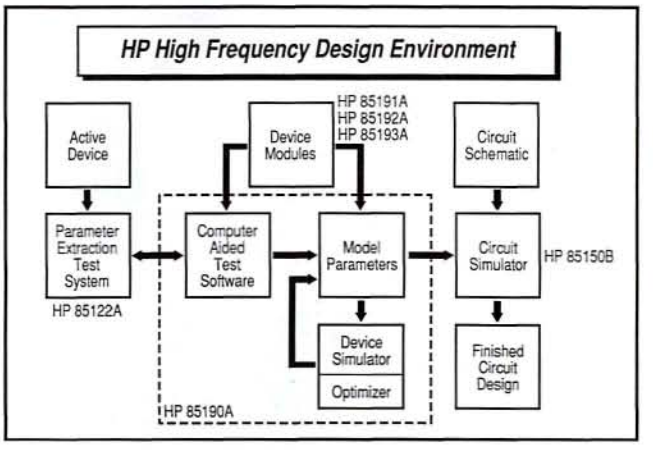
Opt 002 Delete HP 8350B/83540A Sweep Oscillator and add HP 83621A Synthesizer as LO source	+ $18,775
Opt 010 Add time domain capability to HP 8510C	+ $10,000
Opt E75 Combines single connection .045 to 62.5 GHz with on-wafer 50 to 75 GHz measurements	+ $30,000

Written in BASIC, the system software runs on HP 9000 series 300 Controllers with BASIC 5.0 or higher operating systems. The software's major subroutines can be integrated with custom software as a callable subroutine. An HP 9000 Series 200 or 300 computer with at least 2 MB of memory is required for installation and service.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.



NEW



High-Frequency Modeling System

The High-Frequency Modeling System is the first total system specifically dedicated to active device modeling. It combines the HP 85122A Parameter Extraction Test System and the HP 85190A High-Frequency ICCAP test and modeling software. Also available is a series of FET and BJT device models for RF and microwave nonlinear device modeling. The system supplies:

- **The highest measurement accuracy:** The system uses the HP 8510C or HP 8753C network analyzer for all S-parameter measurements and the HP 4142B dc source/monitor for all precision dc measurements.
- **Total software compatibility:** The HF ICCAP software is designed for compatibility with measurement instruments and circuit simulators such as HP's Microwave Design System.
- **A complete modeling solution:** The system—hardware and software—can be delivered to you fully configured and integrated, and includes installation and one year of on-site service.
- **An easy connection to wafer probes and fixtures:** The system is fully compatible with wafer probes from Cascade Microtech or test fixtures from Intercontinental Microwave.
- **User training and software support:** Instrument and software training courses are included with the base system, and on-line software phone support is available.

Test System Hardware

The HP 85122A Parameter Extraction Test System consists of the following:

- HP 8510C Network Analyzer
- HP 8514B .045 to 20 GHz Test Set
- HP 83621A .045 to 20 GHz Synthesized Sweeper
- HP 4142B dc Source/Monitor with HP 41420A and HP 41421B Modules and Accessories
- HP 11612A Opt K10 (port 1) and Opt K20 (port 2) Bias Networks
- HP 85131F 3.5 mm Test Port Cable Set
- 1600 mm System Cabinet

Custom configurations are also available upon request

Test and Modeling Software

HP 85190A High-Frequency ICCAP

This software provides the total framework environment from which standard, modified, or custom device models may be extracted or generated.

HP 85191A HP Root FET Model Generator

Designed for modeling both MESFET and HEMT devices, this new nonlinear database model addresses the growing need for the highest accuracy models in circuit simulation software. Model terminal characteristics are generated directly from measured S-parameter and dc bias data collected adaptively over the I-V plane, thus accurately accounting for large signal effects. The model incorporates scaling rules for multifingered devices and accounts for frequency dispersion effects in the device output conductance. Model data files in HF ICCAP may be read directly into HP's Microwave Nonlinear Simulator.

HP 85192A High-Frequency FET Models

This module includes three industry standard FET models: the Curtice quadratic and cubic, and the Statz (Raytheon) models. New extraction methods and numerous consistency checks are employed to achieve accurate device models reliably and efficiently.

HP 85193A High-Frequency BJT Models

This module includes both three and four terminal versions of the Gummel-Poon BJT model. For high-frequency devices, the model capacitances are extracted from S-parameter measurements. Other updated extraction methods and self checks provide BJT models of the highest accuracy.

Computer Platforms

The HP 85190 series of software is designed to work with the following workstation platforms and requirements:

- HP 9000 Series Models 300, 400, and 700 running HP-UX
- Sun SparcStation 1+ and 2 running Open Windows
- At least 32 MB of RAM
- At least a 300 MB hard disk
- At least one tape drive (1/4 in or DDS) for installation and updates

HP-IB is required for instrument control

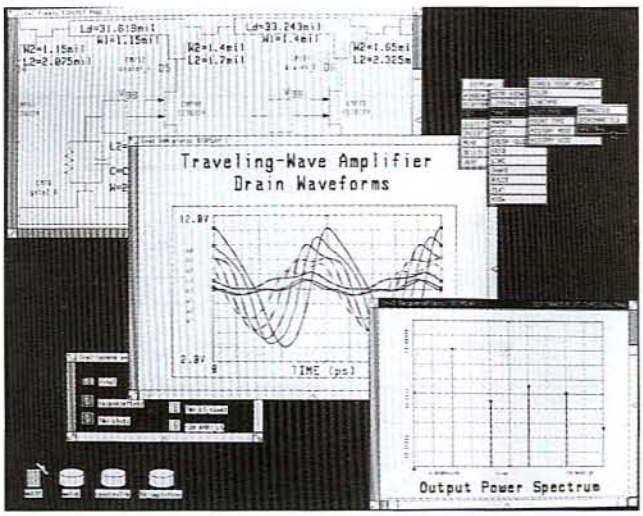
Ordering Information

	Price
HP 85122A Parameter Extracton System	$145,000
HP 85190A High-Frequency ICCAP	$31,000
Opt 001 Delete Simulator/Optimizer (Simulator/ optimizer not required if used with Root model only)	−$15,000
HP 85191A HP Root FET Model Generator	$12,000
HP 85192A High-Frequency FET Models	$9,000
HP 85193A High-Frequency BJT Models	$9,000

A complete line of update/phone software support products is also available. Please call your HP sales representative for more details.

HIGH-FREQUENCY CAE

Circuit Simulator, Electromagnetic Simulator



The HP Microwave Design System integrates system design, schematic capture, circuit simulation, artwork generation, and documentation to speed the high-frequency design process.

HP Microwave Design System

- Available on HP, Apollo, Sun, DEC, IBM, and 386/486 workstations
- Interacts with schematic, simulation, artwork, and documentation simultaneously
- Minimizes prototyping with advanced system, linear, nonlinear and time domain simulators
- Eases documentation chores with automatic links to schematics, layout and simulation results
- Generates artwork from the schematic automatically

Integrated Solution for High Frequency Design

The HP Microwave Design System is an integrated CAE package for RF and microwave engineers. It provides extensive modeling, analysis, and layout capabilities to take a design from its conception to physical representation. It is particularly well suited for developing monolithic microwave integrated circuits (MMICs), hybrid microwave and RF circuits, and RF and microwave subsystems.

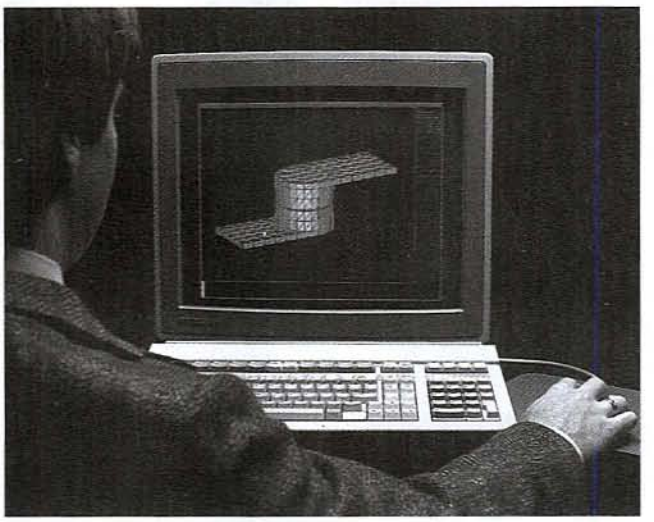
The HP Microwave Design System integrates the design capture system, the microwave linear simulator, the microwave nonlinear simulator, the high-frequency transient simulator, and the microwave artwork generator, with an exceptionally convenient documentation facility. Switching from one application to another is as easy as clicking a mouse button.

With the design capture system, you can enter circuit schematics as easily and intuitively as you would draw them on paper. These schematics are used by the microwave linear or nonlinear simulator, or the high-frequency transient simulator for analysis, optimization, or manual tuning. When satisfied with the circuit performance, you invoke the microwave artwork generator to generate the mask layouts automatically.

The information you create with the microwave design system is easily consolidated for immediate documentation. Generate engineering notebooks, reports, proposals, and production forms with minimum overhead. By preserving and leveraging the knowledge of the R&D environment, you can design circuits of increasing complexity.

Ordering Information	Price
HP Microwave Design System solutions	start at $18,000

(Please call your local HP sales representative for more detailed information.)



The HP High Frequency Structure Simulator creates S-parameters and electromagnetic field plots for passive structures, such as machined components and circuit models.

HP High Frequency Structure Simulator

- Available on HP, Apollo, Sun, and DEC workstations
- Calculates S-parameters for multiport structures
- Unrestricted geometries with unlimited number of dielectrics and conductors
- Conductor and dielectric loss
- Analysis is based solely on Maxwell's equations and includes dispersion
- Complete solution for electric and magnetic fields, energy densities, and more

Electromagnetic Field Solutions

The HP High Frequency Structure Simulator computes S-parameters for passive, three-dimensional structures. Although the simulator performs complete electromagnetic solutions, users need only minimal background in electromagnetic field theory to operate it. It requires only geometric and material parameters.

The high-frequency structure simulator has many applications, including: microwave machined component design; microwave, RF, and high-speed digital circuit modeling; and production refinement. Machined component designers can simulate complex designs before investing in a custom-machined prototype. High-frequency circuit designers can create model libraries of transmission line structures and other circuit elements for use with their circuit simulators. Production engineers can use the high-frequency structure simulator to study the effect of tolerance variations on quality and manufacturing yield.

Links to other systems enhance design productivity. Mechanical descriptions of components can be transferred from HP ME Series 30 mechanical design software. S-parameters computed by the high-frequency structure simulator can be used in the HP Microwave-Design System or in other circuit simulators.

Ordering Information	Price
HP 85180A High-Frequency Structure Simulator	$41,000

(Please call your local HP sales representative for more detailed information.)

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP family of logic analyzers: HP 1660 Series, HP 1650 Series, and HP 16500 Series

DESIGNED FOR HP-IB SYSTEMS

NEW

The HP Family of Logic Analyzers

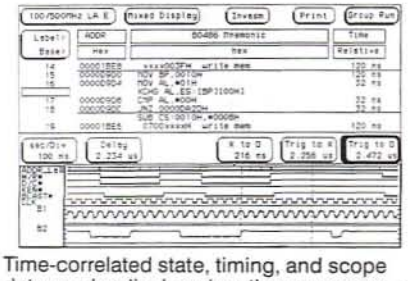
Hewlett-Packard logic analyzers support such diverse applications as hardware troubleshooting, hardware/software integration, software performance analysis, hardware characterization, prototype verification, low-volume manufacturing test, and failure analysis.

You can choose exactly the performance you need in the form factor you want from HP's complete line of logic analyzer models.

HP 16500 Series Modular Logic Analyzers

The HP 16500 Series provides you with everything you need to solve your toughest measurement problems, including troubleshooting and characterizing your digital designs. The HP 16500 Series consists of a modular mainframe with five slots which is expandable to nine slots.

Choose from high-performance state and timing modules, deep memory modules, digitizing oscilloscope modules, and pattern generator modules to match your measurement needs today. HP's demonstrated commitment to the platform ensures the HP 16500 Series will continue to solve your toughest measurement problems in the future.



Time-correlated state, timing, and scope data can be displayed on the same screen.

Portable Logic Analyzers

HP 1660 Series

The new HP 1660 Series portable logic analyzers were designed to give you measurement confidence. A carefully redesigned human interface and true high-performance specifications let you focus on solving your digital design and test problems quickly.

Developed using HP's second-generation logic analyzer-on-a-chip technology, the HP 1660 Series logic analyzers deliver high-performance measurements at a very affordable price.

HP 1650 Series

The HP 1650 Series portable logic analyzers provide an economical solution for 8-bit up to 16-bit microprocessor systems.

Unparalleled Ease of Use

All HP logic analyzers have menu-driven interfaces, and can be automatically configured from files on a built-in disk drive. You can easily set up HP 16500A measurements using its color touch screen. To change a parameter, simply point to the field you need to change and then enter the value using the onscreen pop-up keypad or knob.

Extensive usability testing on the HP 1660 Series refined its front panel interface so that it is easier to use than previous HP portable logic analyzers.

For added convenience, a mouse, trackball, and keyboard are available as options for the HP 16500 Series and the HP 1660 Series analyzers.

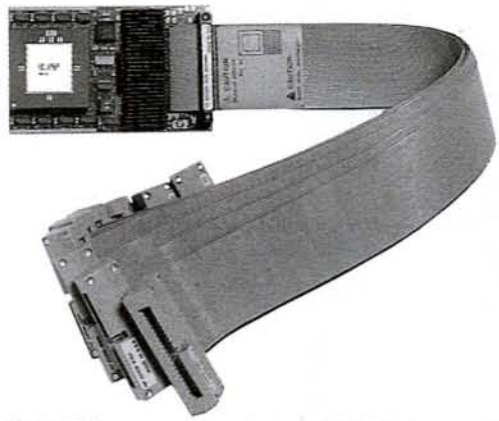
Solve Tough Problems by Combining Measurement Modules

When you capture symptoms but have not yet identified the underlying problem, the intermodule bus (IMB) lets you trigger other measurement modules in connection with the module where the symptom appears. For example, you might find a glitch using the timing analyzer, but not know what is causing it. By triggering an integrated oscilloscope module from the timing analyzer, you can quickly identify whether the cause was ringing, crosstalk, or some other analog problem.

See Analog Phenomena with a Built-In Digitizing Oscilloscope

HP logic analyzers offer digitizing oscilloscopes with the performance you need to solve the toughest measurement problems. Now you can get full 250-MHz analog bandwidth with a 1 GSa/s, 8-bit digitizing oscilloscope in the HP 16500A mainframe. Or, get 100-MHz analog bandwidth, 400 MSa/s, 6-bit digitizing oscilloscope in either the HP 1650 Series or the HP 16500 Series.

All HP oscilloscope modules have the digitizing advantages of waveform storage and recall, automatic measurements and markers, and powerful triggering. Plus, the oscilloscope can be cross-triggered by the logic analyzer and their measurements can be displayed time-correlated on the same screen for capturing and viewing the most elusive events.



The HP E2438A, R4000PC preprocessor, designed in HP's low-profile architecture

Logic Analyzer Section Highlights

HP Quality and Reliability

In addition to their measurement value, HP logic analyzers offer our traditional quality and reliability. HP operates a worldwide support network to provide the assistance you need to get the most out of your logic analyzer investment.

Option W30 adds to the product warranty by providing three years of customer-return repair service. If you purchase Option W30, HP provides all labor, parts, and materials necessary to maintain your HP logic analyzer in good operating condition.

Accessories Extend the Capabilities of Logic Analyzers

HP offers many accessories for use with both the mainframe and portable logic analyzers. For microprocessor-based development a wide range of solutions is offered. Preprocessors allow you to easily connect a logic analyzer to your target system with a hardware interface. Also included with the preprocessors is software that configures the analyzer for your particular microprocessor and displays trace data in microprocessor mnemonics.

If you are using surface-mounted microprocessors, HP offers different types of adapters for probing these devices. Additionally, several independent third-party vendors design and manufacture preprocessors that work with HP logic analyzers. Between HP and the third parties over 150 solutions are available to you.

In addition to the microprocessor solutions, HP offers accessories ranging from oscilloscope probes to test mobiles. All are designed to increase the functionality of your HP logic analyzer.

Unmatched Compatibility Protects Your Investment

Compatibility protects your investment because accessories you buy for one HP logic analyzer will work with another. Most preprocessors are compatible with every HP logic analyzer, as are setup and data files. With the new HP 16550A and HP 1660 Series, the operating software automatically converts setup files from earlier models.

All HP logic analyzers use the same user interface concepts. If you are familiar with one instrument, you will be able to operate another quickly.

Also, all HP state and timing analyzers use the same probing scheme. Compatibility between platforms and modules lets users already familiar with HP logic analyzers start making measurements on a new HP analyzer right away—without having to refixture, reprobe, or relearn a new logic analyzer.

Lightweight, Flexible Probes Mean Easy, Reliable Connection

HP's passive probes make connection to your target system easier than ever. There are no heavy active pods to dislodge the probing scheme at the wrong time. Cooling is not a problem because the passive probes do not generate heat.

Passive probing provides excellent impedance over a wide frequency range. And the low-capacitance loading means that critical edges are not affected by probing. HP's complete general-purpose probing solution comes standard with each analyzer. See page 333 for information on connectors that make it easy to interface to your design.

Quickly Store or Recall Setups and Data to Built-In Disk Drive

Store measurements and setups to the built-in 3½-in disk drive(s). The autoload feature lets you recall a specific configuration when turning on the instrument. You can use the disk to store information captured from a remote location, then examine the data in more detail on another HP logic analyzer in your lab.

HP-IB and RS-232 Standard on Every HP Logic Analyzer

Both HP-IB and RS-232 are standard on each instrument. You can program any analyzer from either interface while using the other interface to control a printer.

Every Analyzer is Fully Programmable

Use the built-in programming command for creating automated test sequences. Or, upload measurement data acquired by the logic analyzer into a computer for additional processing.

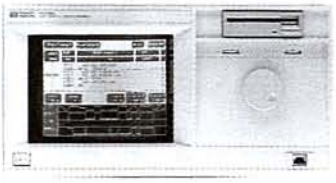
Instant Documentation Lets You Create Professional-Quality Reports

With the push of a button, you can document results professionally with the standard hard-copy features. Or, using HP's ScopeLink software, you can import your screen images directly into word processor documents on your PC. Full-color printouts are available using the HP PaintJet printer with your HP 16500A.

Links to Simulation and Manufacturing Test

Transfer and translate simulation vectors to the HP 16500A pattern generator and state analyzers to perform functional prototype analysis. Capture data from known good boards and transfer that information to board testers, or transfer the information back to the simulator.

HP Logic Analyzer Applications Selection Guide



	HP 16500 Series Modular Logic Analysis System pages 318 – 324	HP 1660 Series Portable Logic Analyzers pages 326 – 327 (NEW)	HP 1650 Series Portable Logic Analyzers page 325
Timing analysis			
1 GHz	HP 16515A, 16516A page 322		
500 MHz	HP 16550A (NEW) page 320	HP 1660A, 1661A, 1662A, 1663A (NEW) pages 326 –327	
100 MHz	HP 16540A/D, 16541A/D page 320 HP 16542A (NEW) page 322 HP 16510B, 16511B page 321		HP 1650B, 1651B, 1652B, 1653B, 1654B page 325
State analysis			
100 MHz	HP 16550A (NEW) page 320 HP 16540A/D, 16541A/D page 320 HP 16542A (NEW) page 322	HP 1660A, 1661A, 1662A, 1663A (NEW) pages 326 –327	
35 MHz	HP 16510B, 16511B page 321		HP 1650B, 1651B, 1652B, 1653B, 1654B page 325
Deep memory state and timing analysis			
1 M – 10 M	HP 16542A (NEW) page 322		
16 K	HP 16540D, 16541D page 320		
Digitizing oscilloscopes			
1 GSa/s	HP 16532A page 323		
400 MSa/s	HP 16530A, 16531A page 323		HP 1652B, 1653B page 325
Pattern generation			
50 MBit/s	HP 16520A, 16521A page 324		
State-to-Pattern Generator Link	HP 10392A page 324		HP 10392A page 325
CAE links	TSSI third-party support page 324		
System performance analysis	HP 10390A Opt 002 – 004 page 321		HP 10390A Opt 001 page 321

LOGIC ANALYZERS

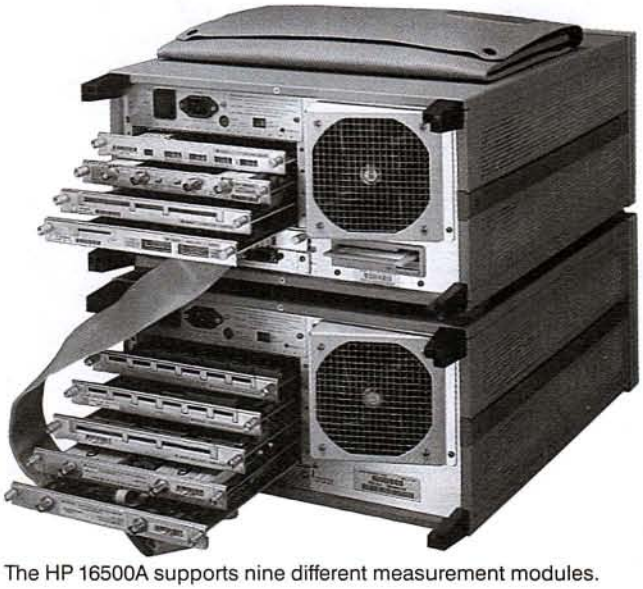
Logic Analysis Systems

HP 16500A and Measurement Modules

- Modular, configurable logic analysis system
- Expandable, up to nine different measurement modules
- Powerful cross-module triggering
- 100-MHz state analysis
- Support for most microprocessors
- 1-GHz timing and pattern generation modules

HP 16500A shown with HP 16501A

DESIGNED FOR HP-IB SYSTEMS



The HP 16500A supports nine different measurement modules.

HP 16500A Modular Logic Analysis System

The HP 16500A logic analysis system can be configured for a wide range of measurement tasks, including microprocessor debug, hardware design verification and debug, software performance analysis, characterization, and functional pass/fail testing. Start with a focused system, then expand as your needs evolve.

The HP 16500A's five card slots accept nine different measurement modules. With the HP 16500A, you can do the following:

- Customize your own system by adding cards to the five card slots.
- Make time-correlated measurements between modules using the intermodule bus.
- Compare hardware measurement data with design simulation data.
- Program the HP 16500A with easily understood commands through HP-IB or RS-232C built-in interfaces.
- Store setups and measurement results in either of two built-in disk drives for fast recall or permanent record.
- Generate report-quality documentation with pushbutton ease.

HP 16501A Logic Analysis System Expansion Frame

The expansion frame provides an additional four* slots to your HP 16500A logic analysis system, giving you control of up to nine measurement modules from your HP 16500A's interface. With the expansion frame you can now cross-trigger up to nine measurement modules and then view your results on the same screen with 10 ns time correlation.

Configure Your System

The HP 16500A logic analysis system can be configured for your debug, characterization, systems integration, or pass/fail testing applications. Start with a focused system, then expand it as your needs evolve. For example, start with a 102-channel logic analyzer and a 2-channel oscilloscope, then add more capability as needed.

Color Touchscreen, Mouse, and Keyboard

Save time and reduce errors with the HP 16500A color touch screen. Simply point to the field you want to change; the touchscreen eliminates the need to search a front panel for the right button. Pop-up menus offer all choices at a glance, and the software does not allow you to make an incorrect choice. Front-panel operations can also be executed via mouse and/or keyboard providing complete user-interface flexibility.

Color discriminates between overlapped traces and emphasizes important points. In addition, you can customize for personal preference and environmental considerations. Even infrequent users spend less time making measurements and more time analyzing the results.

Data display areas are not touch-sensitive, so there is no need to worry about losing your latest acquisition.

Store Setups and Data Quickly

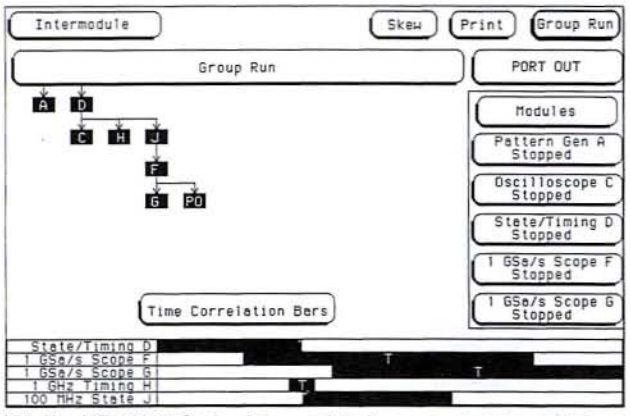
It is easy to store and retrieve measurement results and setups with the two built-in 3½-in disk drives. Use the back disk drive for the operating system, leaving the front disk free for measurement files.

*The HP 16501A interfaces with the HP 16500A via an expansion frame interface card that occupies one of the HP 16500A's five module slots. The expansion frame has five slots, providing a total of nine measurement module slots when combined with the HP 16500A.

HP 16500A Intermodule Bus (IMB)

IMB Lets You Make Measurements Never Before Possible with One Instrument

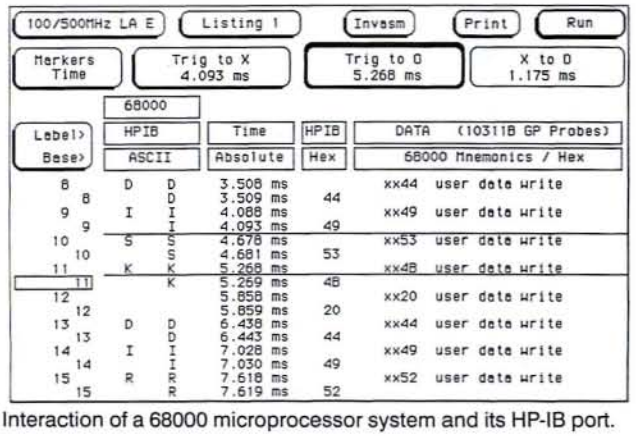
Run HP 16500 Series modules independently or combine their capabilities and correlate their acquisitions with 10-ns resolution to make measurements that previously required several instruments. The intermodule menu graphically communicates complex arming sequences in an easy-to-understand format. Use the time correlation bars for a quick overview of the measurements performed.



With the HP 16500 Series intermodule bus, you can arm or trigger one measurement module from another.

Analyze Systems with Multiple Microprocessors

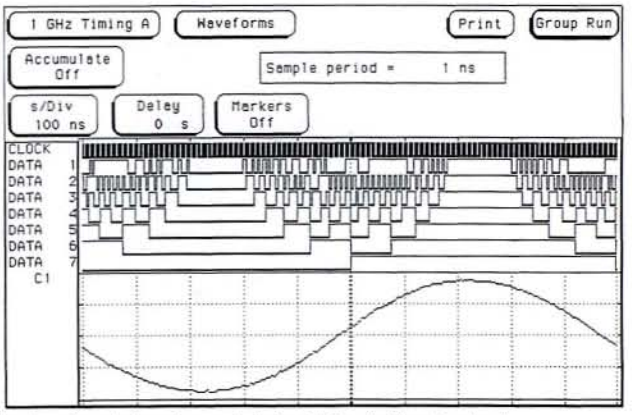
Capture states from separately clocked systems, such as multiple microprocessors or a microprocessor and its communications interface. Then analyze data flows between the systems with interleaved, time-correlated state displays.



Interaction of a 68000 microprocessor system and its HP-IB port.

Verify Mixed-Signal System Behavior

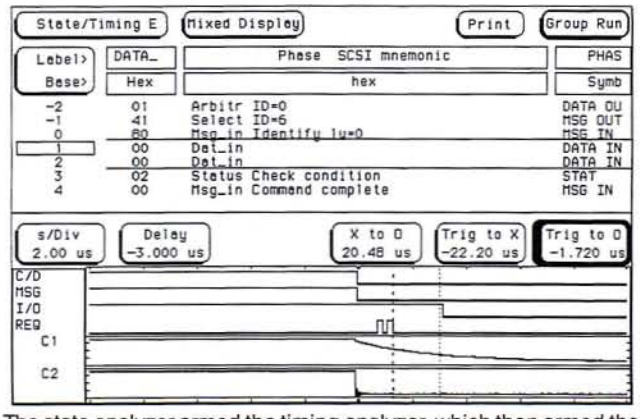
View the digital activity with up to 1-ns resolution in your mixed-signal system. Then display the time-correlated analog input signals captured with the built-in, 250-MHz digitizing oscilloscope to verify results.



Analog input signal correlated with its digitized output.

The Most Powerful Scope Trigger

Use the state analyzer to identify a problem sequence. Arm the timing analyzer with the state analyzer to trigger on a wide pattern. Then arm the oscilloscope with the timing analyzer to capture a signal's parametric behavior at the exact time.



The state analyzer armed the timing analyzer, which then armed the built-in scope to capture a hard-to-find fall-time violation.

LOGIC ANALYZERS

State and Timing Analysis Modules

HP 16550A, 16540A/D, 16541A/D, 16510B, and 16511B

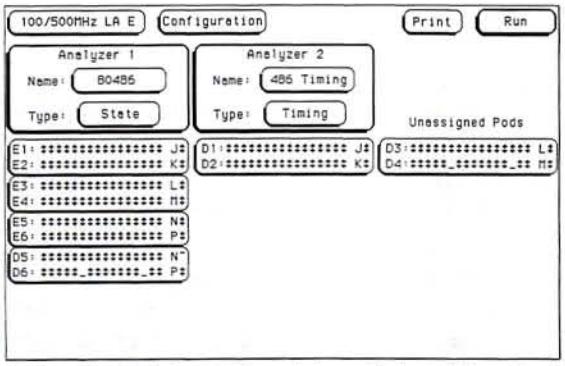
Key Specifications and Characteristics

	HP 16550A[1]	HP 16540A,D/16541A,D[2]	HP 16510B and 16511B[3]
Timing analysis rate	Conventional: 250/500 MHz* Transitional: 125/250 MHz* Glitch: 125 MHz	Conventional: 100 MHz	Transitional: 100 MHz Glitch: 50 MHz
State analysis rate	100 MHz	100 MHz	35 MHz
Channels/card	102/51*	16 (HP 16540A,D master cards) 48 (HP 16541A,D expansion cards)	80 (HP 16510B) 160 (80 max in timing, HP 16511B)
Clock channels	6 (of the 102 above)	2	5
Memory depth/channel	4 K/8 K*	4 K (A versions), 16 K (D versions)	1 K
Setup/hold time	3.5/0 ns to 0/3.5 ns adj. in 500 ps steps	4/0 ns, 2/2 ns, or 0/4 ns selectable	10/0 ns fixed
Minimum detectable glitch	3.5 ns	N/A	5 ns
Probe input R and C	100 kΩ and ~8 pF	100 kΩ and ~8 pF	100 kΩ and ~8 pF
Trigger terms	Patterns: 10 Ranges: 2 Edge and glitch: 2 Timers: 2	Patterns: 4 Ranges: 1	Patterns: 8 Ranges: 1 Edge: 1 Glitch: 1
Trigger sequence levels	12 in state and 10 in timing	4 in state and 4 in timing	8 in state and 2 in timing
Labels	126	126	20
Symbols	1000	500	200

State and Timing Analysis Modules

Capture State or Timing Data on All Channels

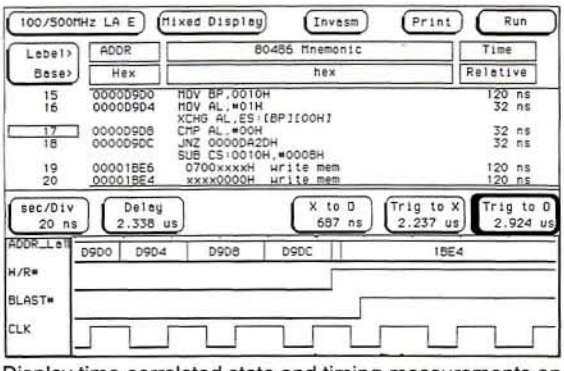
No need to connect special probes to view timing activity. All channels on HP state and timing analysis modules perform either state or timing (except the HP 16511B where 80 channels perform only state analysis). Set up your HP 16550A, 16510B, or 16511B analyzer to perform simultaneous state analysis on some channels and timing analysis on the rest.



Assign channels to capture state or timing data without moving probes.

Find Whether the Problem is in Software or Hardware

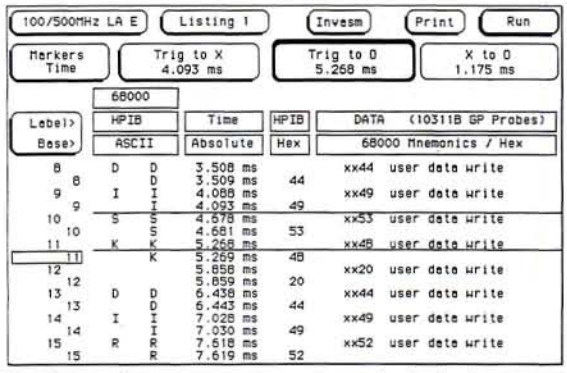
Arm the timing analyzer with the state analyzer to capture system behavior between states. Display both measurements on one screen and use time-correlated markers to identify the cause of problem states.



Display time-correlated state and timing measurements on the same screen.

Track Problems in Multiprocessor Systems or Between the Processor and its Interface Bus

Configure your HP 16550A, 16510B, or 16511B as two independent state analyzers that sample data using separate clocks. Time tagging of states lets you time-correlate and view the state listings interleaved on the same screen.



View interactions between two separately clocked systems.

Debug High-Performance Systems with Full Support for Your CISC or RISC Microprocessors

Today's high-performance processors already operate at bus rates in excess of 66 MHz. Because clock rates are one of the fastest ways to improve processor performance, you can expect bus rates to continue to increase. With up to 100 MHz state on the HP 16550A and the 16540A,D/16541A,D, modules, you can feel confident that you have the margin necessary for today's and tomorrow's systems.

In addition, HP state and timing analyzers bring you the broadest processor and bus support available (see pages 329-331). Supported processors include:

- Intel80186, 80286, 80386**, 80486**, 80860, 80960
- Motorola 68000, 68010, 68020, 68030, 68040, 88000
- MIPS R2000, R3000, R4000
- AMD AM29000
- TI TMS 320C30/31, 320C50
- SPARC 64901

Supported buses include: SCSI 1, 2, and 3; FutureBus+; MIL-STD 1553; EISA; MCA; IEEE-488 (HP-IB); RS-232; FDDI; VME; and VXI.

* Half-channel mode doubles memory depth, doubles maximum conventional timing speed, and doubles maximum transitional timing speed.

** Intel80386, 80486 are U.S. trademarks of Intel Corporation.

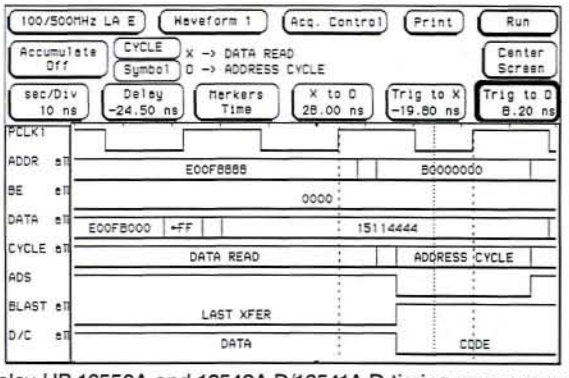
[1] Two HP 16550A boards may be connected together for 204-channel operation.

[2] HP 16541D expansion card requires HP 16540D master card. HP 16541A expansion card requires HP 16540A master card. Up to four HP 16541A,D cards are supported by each HP 16540A,D card respectively.

[3] HP 16511B requires two HP 16510B cards for 160-channel state analysis.

Analyze Distant Timing Events with Transitional Timing

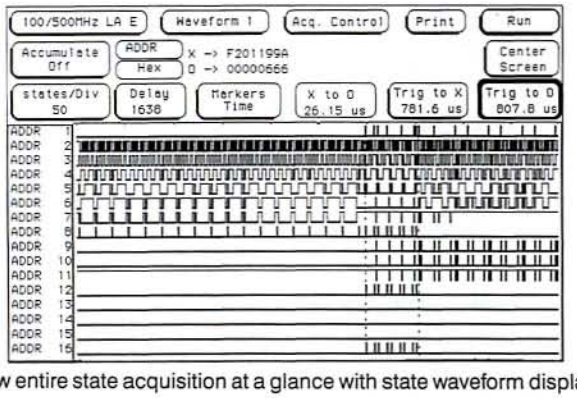
Capture events that are seconds apart maintaining up to 4-ns resolution with the HP 16550A, or 10-ns resolution with the HP 16510B. Transitional timing samples at full speed but only stores data when a transition occurs. This technique effectively extends the total time captured by the acquisition memory while maintaining high time resolution.



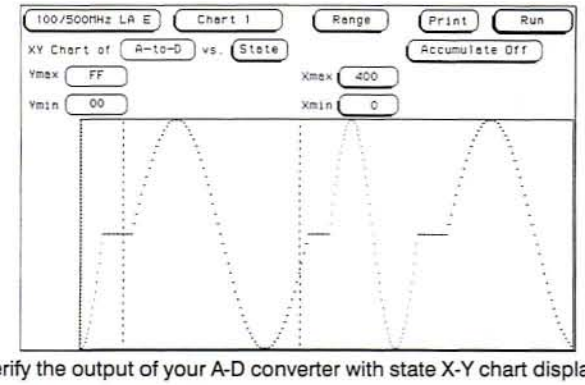
Display HP 16550A and 16540A,D/16541A,D timing measurements with bus values overlaid in the waveforms.

Enhance Troubleshooting with Flexible Display Modes

All state and timing analyzers let you display state measurements in listings, X-Y chart, or state waveforms. In addition to the waveform display, the HP 16550A and 16540A,D/16541A,D allow you to display timing information as a listing. Markers placed on one display are automatically updated in other display modes.



View entire state acquisition at a glance with state waveform display.



Verify the output of your A-D converter with state X-Y chart display.

Find Intermittent Errors Using Postprocessing

In state, set up compare mode to "run until compare not equal" to capture intermittent errors. Use compare for quick go/no-go testing of your product in manufacturing. State compare shows you the effects of system changes by comparing each sample in the current measurement to each sample in a previous measurement.

In timing, capture intermittent setup and hold violations using the specify-stop-measurement feature to repetitively acquire data until the time interval between two patterns violates a specified condition.

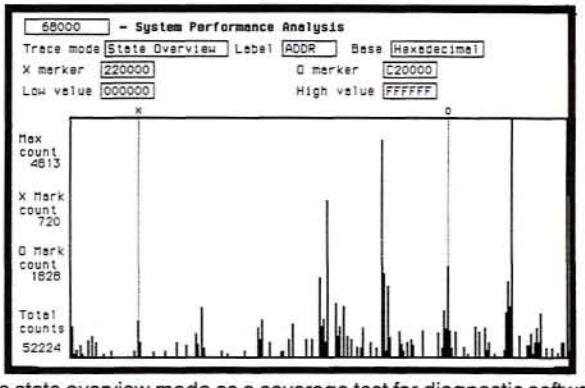
HP 10390A System Performance Analysis Software (HP 16550A, 16540A/D, 16510B, and 1650 Series)

Optimize Your System's Performance

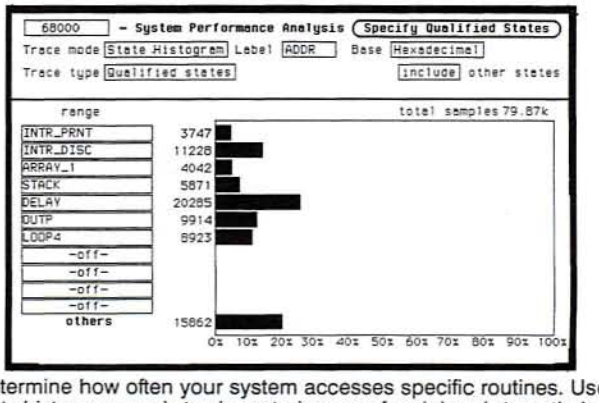
See an overall picture of your system to find the routines that are slowing performance. Find routines that are called most often, identify inefficient use of disks and peripherals, and find processes that use too much CPU time.

The HP 10390A system performance analysis software (SPA) converts your HP state analyzer into a powerful tool for finding bottlenecks in your system. SPA uses the state analyzer to sample your target system repetitively. The data captured is sorted into ranges before a new measurement is started after a random delay. The random delay ensures that the measurement will not sync on only a small portion of your system's code. After each acquisition, the captured information is translated into histograms and bar charts to present an accurate picture of your system's operation.

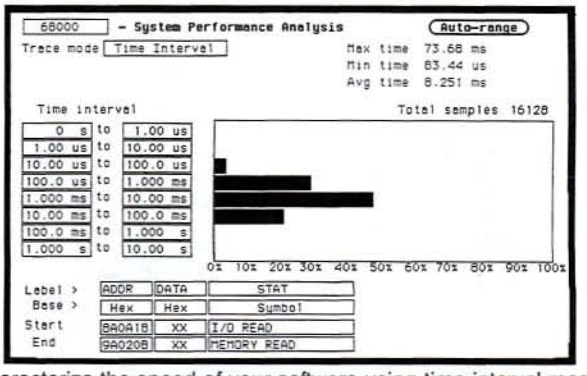
SPA performs three kinds of measurements: state overview, state histogram, and time interval measurements.



Use state overview mode as a coverage test for diagnostic software or to verify there are no accesses to protected memory segments.



Determine how often your system accesses specific routines. Use state histogram mode to characterize use of peripherals to optimize your system.



Characterize the speed of your software using time interval measurements. Find I/O routines that reduce system performance and measure their average, minimum, and maximum execution times.

LOGIC ANALYZERS

Deep Memory Module and High-Speed Timing Module

HP 16542A and HP 16515A, 16516A

NEW

HP 16542A Deep Memory State and Timing Module

Collect and Analyze Large Streams of Data

The HP 16542A module provides high-speed, configurable, deep memory logic analysis for your HP 16500 Series system. Debug systems that process and transfer large streams of data, such as image processing systems, radar or other imaging systems, DSP systems, and telecommunications systems. Find the cause of intermittent system crashes by capturing up to 1 M of inverse-assembled states in your computer system. Perform benchmark testing and system performance analysis by acquiring up to 10 MB of data per run.

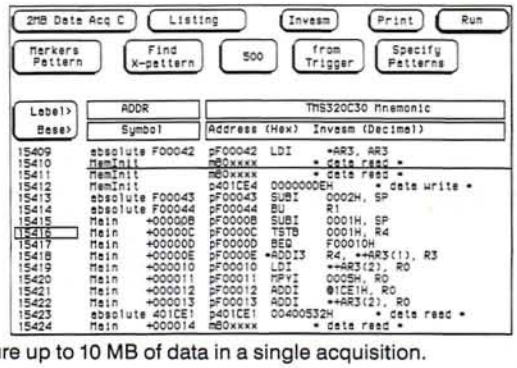
Key Specifications and Characteristics

	HP 16542A
Channels/card	16
Memory depth/channel/card	1 Mb/channels × 16 channels or 2 Mb/channels × 8 channels
Maximum memory depth/channel	1 Mb/channels × 80 channels 2 Mb/channels × 40 channels 5 Mb/channels × 16 channels* 10 Mb/channels × 8 channels*
Maximum state input clock rate	100 MHz
Timing analysis rate	100 MHz, fixed

*Requires HP E2430A memory expansion interface for multicard configurations.

Capture Entire Frames of Image Data

Capture and analyze image data from image processing systems, such as HDTVs, scanners, facsimiles, laser printers, and color photocopiers.



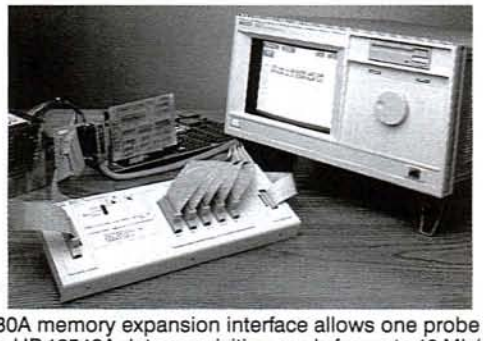
Capture up to 10 MB of data in a single acquisition.

Debug Digital Signal Processor Systems

Combine the HP 16542A with other HP 16500 Series modules for full DSP analysis in a single, easy-to-use mainframe. Use the HP 16550A 100-MHz state/timing analyzer to monitor code flow; the HP 16542A for memory-intensive data stream capture; and the HP 16532A 1-GSa/s oscilloscope for viewing parametric anomalies on the analog I/O streams.

Capture Data Bursts with Multirecord Mode

Use multirecord mode to specify a recurring trigger pattern and data stream length so that multiple data bursts or occurrences of real-time events may be captured in a single acquisition. Only data within these boundaries are stored, thereby using acquisition memory more effectively.



HP E2430A memory expansion interface allows one probe to drive up to five HP 16542A data acquisition cards for up to 10 Mb/channel memory depth.

HP 16515A/16516A High-Speed Timing Module

Measure Precise Time Relationships with 1-ns Resolution

Make time-interval measurements or view the order of events in your high-speed system with 1 ns single-shot resolution on every HP 16515A/16516A channel. Up to 80 channels in one HP 16500A mainframe lets you avoid having to move probes to find the problem.

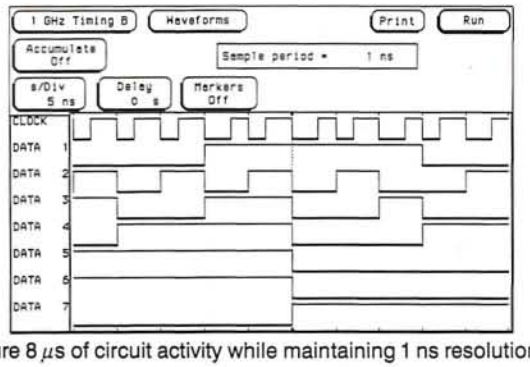
Key Specifications and Characteristics

	HP 16515A/16516A
Maximum sample rate	1 GHz
Channels/card**	16/16
Memory depth/channel	8 K
Time-interval accuracy	± [sample period + 0.01% of time interval reading + 1 ns + (0.5 ns if across pods)]
Input dynamic range	±7 V
Probe input resistance	10 kΩ ±2%
Probe input capacitance	~3 pF

**HP 16516A expansion card requires HP 16515A master card. Only one HP 16516A expansion card is supported by each HP 16515A.

Find the Cause of Elusive Problems

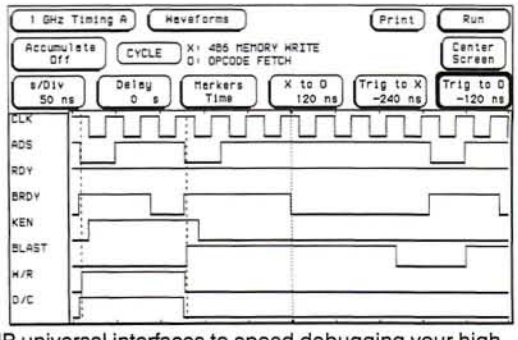
Find and analyze events that occur up to 8 μs before or after the trigger event. Capture data over many clock cycles while retaining precise edge placement information. Use the 8 K memory depth to find problems when you are not sure exactly where to trigger.



Capture 8 μs of circuit activity while maintaining 1 ns resolution.

Debug High-Performance Microprocessors

Speed up connection to microprocessors using HP's universal interfaces. A 1-GHz termination adapter and configuration software simplify connection of the HP 16515A/16516A timing analyzer to high-performance microprocessors such as the Motorola 68040 and others.



Use HP universal interfaces to speed debugging your high performance microprocessor.

HP 16532A and HP 16530A/16531A Digitizing Oscilloscopes

Built-In, Full-Featured Digitizing Oscilloscopes

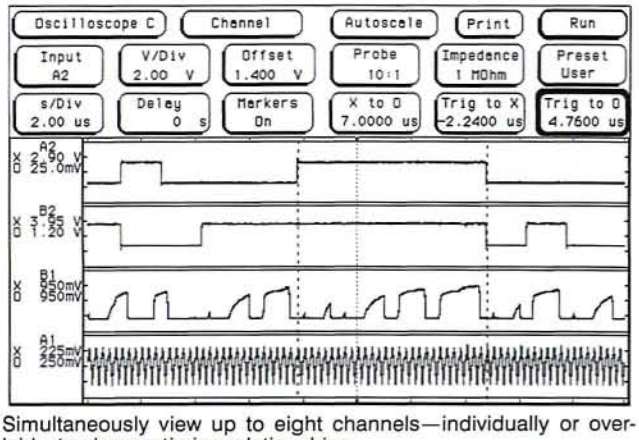
The HP 16532A and HP 16530A/16531A offer the advantages of a full-featured digitizing oscilloscope integrated into your logic analyzer. You can choose from either the 250-MHz bandwidth HP 16532A or the 100-MHz bandwidth HP 16530A/16531A modules. Both offer digitizing advantages such as autoscale, automatic measurements, powerful triggering, and negative time viewing.

Key Specifications and Characteristics

	HP 16532A	HP 16530A/16531A
Sample rate	1 GSa/s	400 MSa/s
Bandwidth*	250 MHz	100 MHz
Rise time**	1.4 ns	3.5 ns
Time interval accuracy	±150 ps	±1 ns
ADC resolution	8 bits	6 bits
Waveform record length	8000	4096
Channels per card***	2	0/2
Max. single time base channels	8	8
Max. channels per system	18	14

Use as a Standalone Scope with Many Channels

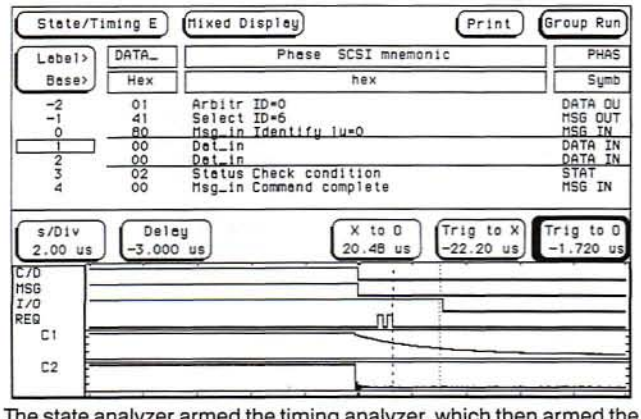
You can capture up to eight analog channels simultaneously (single time base) with either model. You can measure slow and fast events by adding additional oscilloscope modules to create a multiple time base digitizing oscilloscope. For large channel count measurements, you can configure as many as 18 HP 16532A scope channels in a single system.



Simultaneously view up to eight channels—individually or overlaid—to observe timing relationships.

Combine Scope with Other Logic Analysis Modules

You can arm or trigger the oscilloscope from any other module in the HP 16500 Series to capture and display the analog events that affect your digital system.



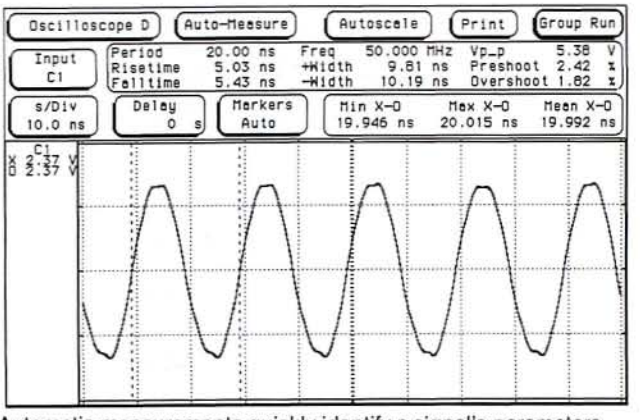
The state analyzer armed the timing analyzer, which then armed the built-in scope to capture a hard-to-find fall-time violation.

Automatic Setup, Measurements, and Time Markers Save You Time

Select Autoscale and the scope scales the time, voltage, and trigger levels instantly for a stable display of your waveforms. Use automatic measurements to analyze a signal's behavior easily. Markers can be used to measure voltage and timing relationships. Plus, automatic marker placement and statistics allow you to characterize a circuit quickly.

Automatic measurements display:

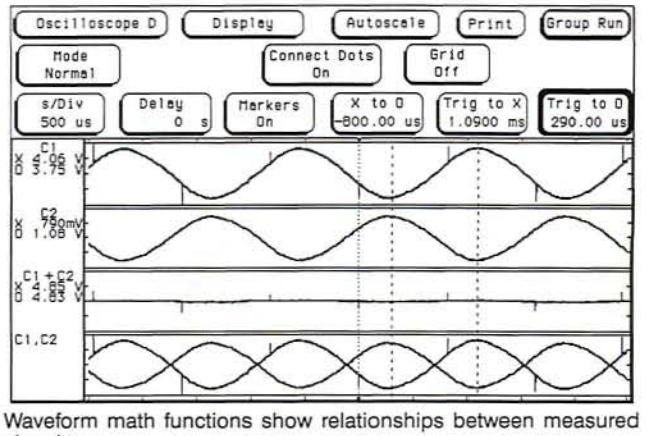
Frequency	Period
Rise time	Fall time
+Pulse width	−Pulse width
Overshoot	Preshoot
Peak-to-peak voltage	



Automatic measurements quickly identify a signal's parameters.

Flexible Display Modes Help You Find Signal Problems

Capture random signal variations or metastable states with the accumulate mode. Filter out noise with the average mode. Show true single-shot events with the single mode. Scan many periods of the waveform easily with the connect-the-dots feature. Analyze differential waveforms with the A-B mode.



Waveform math functions show relationships between measured signals.

*Specifications
**Rise time is calculated from: Rise time = 0.35/bandwidth
***HP 16531A acquisition cards require HP 16530A time base card. Up to four HP 16531A cards are supported by each HP 16530A. HP 16532A cards have a time base plus two acquisition channels on each card.

LOGIC ANALYZERS

Pattern Generator Modules and CAE Links

HP 16520A, 16521A

HP 16520A/16521A Pattern Generator Module

Functionally Test Your Designs

The HP 16520A and HP 16521A digital pattern generator module is the perfect tool for functional testing of your digital design. Use standard connectors to connect to your DUT and avoid the need to design custom fixtures. Correlate data captured with other HP 16500 Series modules to verify correct operation. Use in automated test environments to pass or fail products quickly, using only one instrument. Save time normally spent developing custom test hardware used for stimulus.

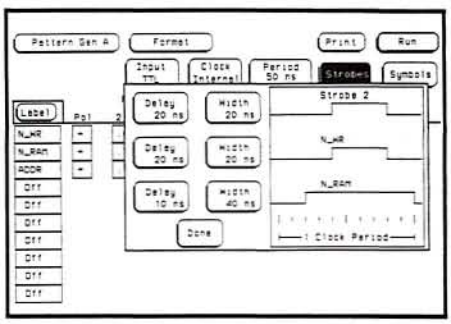
Key Specifications and Characteristics

	HP 16520A/16521A
Max data rate	50 Mb/s
Channels/card[1]	12 NRZ, 3 RZ/48 NRZ
Max channels/system	366
Memory depth/channel	4095 bits
Output levels	ECL, TTL, CMOS[2]

[1]HP 16521A expansion cards require HP 16520A master card. Up to four HP 16521A cards are supported by each HP 16520A.
[2]CMOS voltage levels require an HP 10348A CMOS buffer pod.

Continue Your Designs without Having to Wait

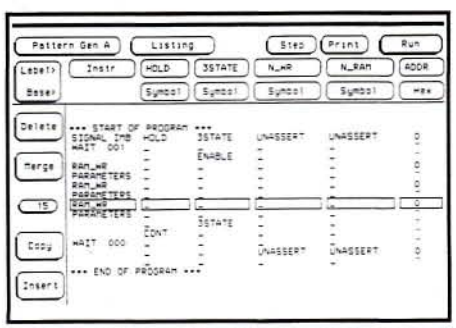
Use the HP 16520A/16521A as a substitute for missing boards, ICs, or buses. Instead of waiting for the missing pieces, you can continue to test and verify your design.



Three return-to-zero (RZ) channels can be used to simulate clock signals.

Debug Digital Circuits Easily

Quickly generate the patterns necessary to put your circuit in a desired state, or single-step your circuit through a series of states. Conveniently enter patterns in hex, octal, binary, decimal, or symbol bases. Easily edit data with Delete, Insert, Copy, and Merge functions. Use macros to specify repeating patterns, without re-entering them.



Symbols can be used to display data in your system's mnemonics, making debugging and documentation easier.

Create Stimulus Patterns Automatically

Automatically convert state data acquired with your HP 16510B or HP 1650 Series logic analyzer into pattern generator programs, using the HP 10392A state-to-pattern generator link. The HP 10392A software runs in the HP 16500A logic analysis system mainframe and does not require an external computer.

CAE Link Software

Verify Your Hardware by Using Simulation Vectors

Perform functional verification of your simulated design by transferring and translating simulation vectors to your HP 16500 system. Compare actual circuit behavior with simulation results to detect and isolate design faults. Using simulation vectors as the basis for your prototype verification, you can develop just the tests you need to verify that your design works.

CAE link between an HP 16500A and a workstation running TSSI software.

Save Time with Links Between Simulation and Prototype Tests

For functional prototype verification, you can quickly and easily transfer and translate just the test vectors you need. CAE links eliminate manual re-entry of test vectors and make the development of test suites easy.

Transfer Prototype Test Vectors to Manufacturing Tests

You can develop a core set of test vectors, make sure they fully test your product's functionality in the lab, then hand the completed design and test vectors to manufacturing. Plus, you can correlate the behavior of your DUT with simulated behavior by using HP 16500 Series modules. These permit you to monitor behavior of the device while it is in the test fixture. Captured data can then be compared to simulated data to determine if the test, tester, or design is at fault.

Begin Your ASIC Design Cycle with Real-World Test Vectors

Capture test vectors from the systems that your new ASIC will be designed to replace. Use HP 16500 Series acquisition modules to capture real data from key points in the system. Then transfer the test vectors back to the simulation environment for use as behavioral test data. This process lets you verify that your ASIC design behaves properly in your system before you send it to the foundry.

HP and TSSI: Working Together to Improve Your Productivity

The HP 16500 Series is supported by Test Systems Strategies, Inc. (TSSI) of Beaverton, Oregon (USA). TSSI markets software that links design and testing. TSSI supports most simulators in addition to supporting many popular ASIC verification, IC, and board testers.

TSSI supports HP 16500 Series pattern generator modules and all HP state and timing analyzers. You can capture system behavior with any of these analyzers and then transfer that information into TSSI's proprietary waveform database, where it can then be transferred to testers or simulators.

TSSI also supports the Compare mode found in all HP state analyzers. This means you can compare simulation results with acquisitions to detect system faults.

TSSI software runs on DEC VAX, HP workstations, Sun 3/Series, PCs, and other computer systems.

For more information about TSSI, contact your HP sales representative.

Full-featured low-cost logic analyzers:

- All state and timing features of the HP 16510B
- Built-in scope on HP 1652B and 1653B models
- Compact and portable
- Built-in 3½-in floppy disk
- HP-IB and RS-232 ports standard
- Fully programmable
- Lightweight, flexible passive probing included
- Compatible with HP analyzers and accessories

HP 1650 Series Portable Logic Analyzers
Key Specifications and Characteristics

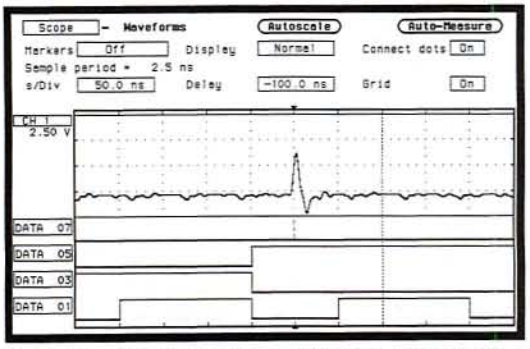
	HP 1650B	HP 1651B	HP 1652B	HP 1653B	HP 1654B
Timing analysis	100 MHz transitional on all channels; 50 MHz glitch on all channels				
State analysis	35 MHz on all channels				
State and timing channels	80	32	80	32	64
State and timing memory	1 Kbit/channel				
Scope channels			2	2	
Scope ADC sample rate			400 MSa/s, 6-bits	400 MSa/s, 6-bits	
Scope bandwidth			100 MHz	100 MHz	
Scope memory			2 K	2 K	

Debug 8-Bit and 16-Bit Microprocessor Systems

The HP 1650 Series portable logic analyzers provide low-cost logic analysis for your 8-bit and 16-bit microprocessor-based designs. Each analyzer can be configured as a single state or timing analyzer, two state analyzers, or a state and timing analyzer together. Most popular microprocessors are supported by the HP 1650 Series. Refer to pages 329-331 for a complete support list.

View Analog Behavior of Digital Signals with Built-in Scope

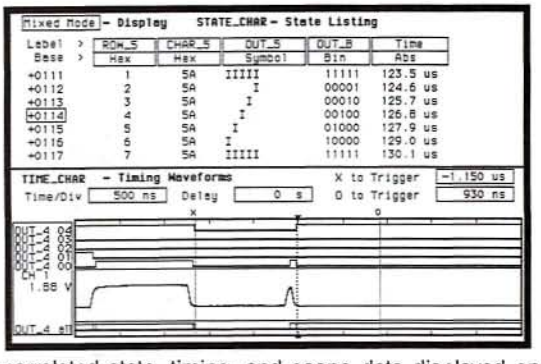
The HP 1652B and HP 1653B add two 400 MSa/s (100 MHz bandwidth) digitizing scope channels for viewing the analog behavior of your signals. Both channels capture nonrepeating events simultaneously with a full 2 K samples per channel. Characterize critical timing parameters with time interval measurements of better than 1 ns accuracy, or examine glitches in your system to determine if noise or loading is a problem.



Quickly analyze the cause of a glitch by viewing its analog parameters.

Enhance Troubleshooting with Full Analysis Features

All the state and timing features found in the HP 16510B (page 321) are standard in HP 1650 Series analyzers. On the HP 1652B and HP 1653B, diagnose problems using scope features such as precision voltage and time-interval measurements, auto-scale, waveform math, auto-calibration, infinite persistence and averaging display modes, and automatic pulse parameter measurements.



Time-correlated state, timing, and scope data displayed on one screen.

Display Time-Correlated State, Timing, and Oscilloscope Measurements to Solve Tough Problems

View the interaction between hardware and software to determine if there is a problem caused by a software bug or a hardware glitch. Trigger the scope on elusive events using the logic analyzer's powerful triggering capabilities. For example, use the timing analyzer's trigger to find a glitch, then cross-trigger the scope to view the glitch's analog behavior.

Service Equipment At Your Test Site

Compact and portable, HP 1650 Series logic analyzers are easy to carry to your test site. Their small size and light weight (22 lbs/10 kg or 24 lbs/11 kg with built-in scope) make them ideal for service applications. With the built-in scope, you have two complete test instruments in one small package.

Save Time by Transferring Configurations or Measurements Made with One Instrument to Another

Make measurements in the field with confidence that the setups and data can be reproduced later in the lab. Use the built-in 3½-in disk to transfer data from one HP 1650 Series analyzer to another, or to the HP 16510B. Duplicate failure modes in your lab using the HP 10392A state-to-pattern generator link to reproduce activity captured on-site to the HP 16520A/16521A pattern generator.

LOGIC ANALYZERS

HP 1660 Series Portable Logic Analyzers

HP 1660A, 1661A, 1662A, and 1663A

HP 1660A 136-Channel Portable Logic Analyzer

Full-featured portable logic analyzers:

- Breakthrough price: performance value
- All state and timing features of the HP 16550A
- Easy-to-use keypad interface
- Compact and portable
- Built-in DOS-format 3½-in floppy disk
- HP-IB and RS-232 ports standard
- Fully programmable
- Lightweight, flexible passive probing included
- Compatible with HP analyzers and accessories
- Supports keyboard, mouse, or trackball

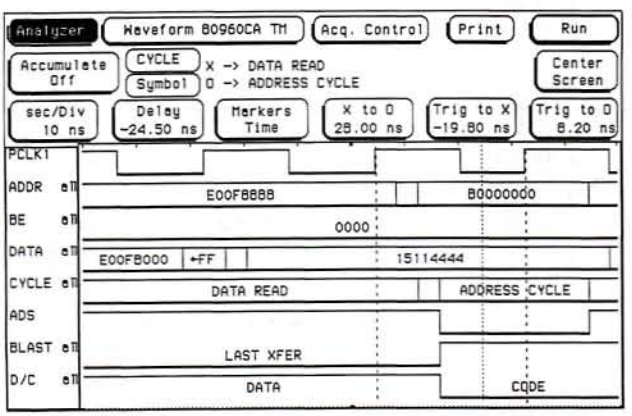
NEW

DESIGNED FOR HP-IB SYSTEMS

HP 1660 Series Logic Analyzer

Confidently Solve Tough Problems

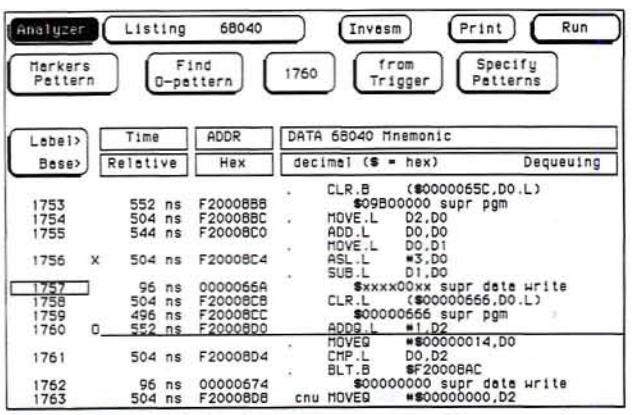
HP 1660 Series portable logic analyzers have been carefully crafted to help you solve tough digital design problems. No other portable logic analyzer packs as much measurement power into such a compact package. Whether in your lab, in manufacturing, or in the field, the small footprint (43 × 38 cm, or 17 × 15 in) and light weight (11.8 kg, or 26 lb) will be appreciated. Plus, the high-performance 100-MHz state and 500-MHz timing specifications give you the headroom for today's and tomorrow's leading-edge designs.



Make timing measurements with up to 2-ns resolution. Display bus values inside the waveforms, using any base (including Symbols.)

Debug a Wide Range of Microprocessor-Based Systems Ranging from 8-Bit Controllers to 32-Bit Workstations

Choose the HP 1660 Series model with the right number of channels for your application. Select from over 150 solutions to connect to your target system. HP 1660 Series logic analyzers are compatible with most HP preprocessors and inverse assemblers (see pages 329 through 331). State data can be displayed in processor-specific mnemonics to make debugging system problems easier.



View your system's behavior in processor-specific mnemonics, using HP preprocessors and inverse assemblers.

Key Specifications and Characteristics

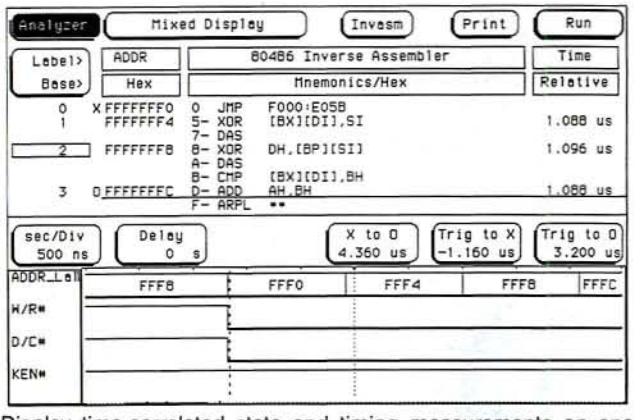
	HP 1660A	HP 1661A	HP 1662A	HP 1663A
Timing analysis	Conventional: 250 MHz all channels, 500 MHz half channels Transitional: 125 MHz all channels, 250 MHz half channels Glitch: 125 MHz half channels			
State analysis	100 MHz in all Modes			
State and timing channels	136	102	68	34
Clock channels	6 (of the 136 above)	6 (of the 102 above)	4 (of the 68 above)	2 (of the 34 above)
Memory depth/channel	4 K/channel, 8 K in half-channel modes			
Setup/hold time	3.5/0 ns to 0/3.5 ns adjustable in 500-ps increments			
State time tag resolution	8 ns			
Min detectable glitch	3.5 ns			
Probe input R & C	100 kΩ and ~8 pF			
Trigger terms	Patterns: 10 Ranges: 2 Edge and glitch: 2 Timers: 2			
Trigger sequence levels	12 in state and 10 in timing			
Labels	126			
Symbols	1000			

Enhance Troubleshooting with Full Analysis Features

As with all HP logic analyzers, the HP 1660 Series packs in numerous features designed to make debugging your system easier. You can view timing measurements in either waveform or listing formats. State measurements can be viewed in listing, compare listing, waveform, and X-Y chart displays. Both state and timing displays can be time-correlated on one screen.

Powerful triggering features help you capture elusive events. Start, Center, End, HW Delay, and User-Defined settings let you quickly specify the trigger position in memory. In state, use storage qualification to capture only the data you need to see, thereby using acquisition memory more efficiently. Use Timers to trigger when a timeout or a data overrun condition occurs. Cross-trigger the timing analyzer with the state analyzer to view the activity of control signals between states.

Find intermittent failures with postprocessing. In state, set up Compare mode to "Run Until Compare Not Equal" to capture an intermittent deviation from a reference measurement. In timing, capture setup and hold violations by using the Specify-Stop-Measurement feature to report when the time interval between two patterns violates a specified condition.



Display time-correlated state and timing measurements on one screen.

Easily Access All of the Analyzer's Capability

Controls and menus have been carefully designed and tested to make your HP 1660 Series analyzer easy to use. The intuitive interface means you can access all the measurement features quickly whether you use the instrument frequently or only occasionally. In addition to the new front-panel keypad interface, HP 1660 Series logic analyzers can be operated by a keyboard, mouse, or trackball.

Operate your HP 1660 Series analyzer from the front panel or with the optional keyboard, mouse, or trackball.

Conveniently Upload Measurements to Your Computer

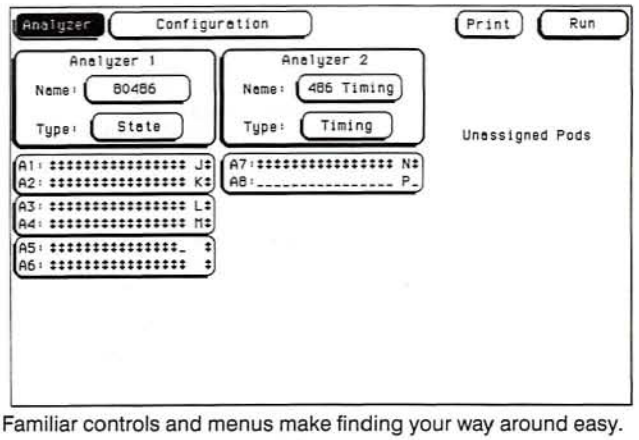
The built-in 3½-in DOS disk makes it easy to transfer measurement data into your computer. Unlike other logic analyzers, in which uploaded data is difficult to interpret, the Print-to-Disk feature automatically saves the data in easy-to-use ASCII format.

Full programmability lets you control all logic analyzer functions from a computer. Data and setup commands let you upload or download instrument configurations and measurement data.

Take Advantage of Your Investment in HP Logic Analyzers

HP 1660 Series logic analyzers are upgradable as your needs change. HP's traditional reliability means you can expect your HP 1660 Series logic analyzer to continue solving tough problems in the future.

Compatibility with previous HP logic analyzers lets you start using your HP 1660 Series logic analyzer without having to spend time refixturing, reconfiguring, or relearning a new device. HP 1660 Series logic analyzers use the same probe connectors, preprocessors, and inverse assemblers as current HP logic analyzers. The analyzers automatically translate configuration files from the HP 16510A/B, 16511B, 16540A/D, 16541A/D, and HP 1650 Series logic analyzers.



Familiar controls and menus make finding your way around easy.

Service Equipment at Your Test Site

Compact and portable, HP 1660 Series logic analyzers are easy to carry to your test site. Their small size and light weight (11.8 kg, or 26 lbs), along with a newly designed carrying handle and accessory pouch, make HP 1660 Series logic analyzers ideal for field-service applications.

Compact size lets you debug problems away from the bench.

Transfer Configurations or Measurements Made with One Instrument to Another

Make measurements in the field with confidence that the setups and data can be reproduced later in the lab. Use the built-in 3½-in disk to transfer data from one HP 1660 Series analyzer to another or to the HP 16550A.

Stop Waiting for Your Logic Analyzer to Boot Up

HP 1660 Series logic analyzers let you start making measurements as soon as the CRT lights up. The standard flash EEPROM is preprogrammed with the operating system to speed up booting time. In addition to allowing convenient firmware upgrades, storing the operating system in flash memory eliminates the need to switch between system and data disks when saving configuration files.

LOGIC ANALYZERS
Microprocessor and Bus Support

Easy Connection between a Logic Analyzer and the Target System

Preprocessor interface hardware provides an easy way to connect a Hewlett-Packard logic analyzer to your target system. The interface provides a clean electrical and mechanical connection, eliminating the need to probe individual lines. Additionally, clock signals are generated by the preprocessor to ensure that data is captured at the correct time. Many preprocessors for the more complex microprocessors have the ability to track address pipelines and properly align address and data in the trace listing.

Software Eases Setup and Interpretation of Data

Software that automatically configures the logic analyzer for your specific microprocessor or bus is included. For microprocessor support, address, data and status lines are labeled. When a trace is taken, the disassembler translates logic levels captured by the logic analyzer into microprocessor mnemonics. The resulting display can easily be compared to the original assembly code listings to track down software defects. So that you know exactly what instructions are executing in your target system, most disassemblers mark, in the trace display, instructions that are pre-fetched but never executed.

HP Support for New Preprocessors

Hewlett-Packard has the resources and commitment to support the latest microprocessors. HP works with semiconductor vendors to ensure that a development solution is available as new processors are introduced. If the processor you are interested in is not listed in the table on page 329, contact your HP sales representative to determine its support status.

Backplane and Bus Interfaces

Several backplane and bus preprocessor interfaces are offered. HP preprocessors passively monitor the activity on the bus, providing critical timing information as well as listing bus commands (if applicable) in the trace display. Support includes SCSI 1, 2, 3; VME/VXI; RS-232; as well as many other popular buses.

Third-Party Support

Hewlett-Packard has teamed up with a number of third-party hardware and software vendors to provide complete solutions for your microprocessor and bus analysis needs. Call your local HP sales representative for information on how to contact any of the independent vendors. Here is a list of some of the solutions offered by third parties. For a complete list refer to the Microprocessor and Bus Support Matrix on page 329.

- Boundary Scan (JTAG)
- Motorola 56156 DSP
- FDDI
- Future Bus
- I squared C

Design Your Own Preprocessor with the HP 10320C

The HP 10320C user-definable interface allows you to build a custom preprocessor. Use the HP 10320C when you need any of the following:

- An interface for analyzing custom or proprietary devices with your logic analyzer
- A semi-custom test fixture for using your logic analyzer in a manufacturing test environment
- A link for ribbon cables or connections to your logic analyzer

The HP 10320C provides a breadboard that fits inside the HP 10269C general-purpose probe interface. In addition, the kit includes mechanical hardware to mount the breadboard in place and connectors for sending your signals to the HP 10269C. The accompanying manual discusses the interface design process, including what to look for in your target system, how to design so that setup and hold requirements are met, and tips on power supply distribution.

Custom Inverse Assemblers

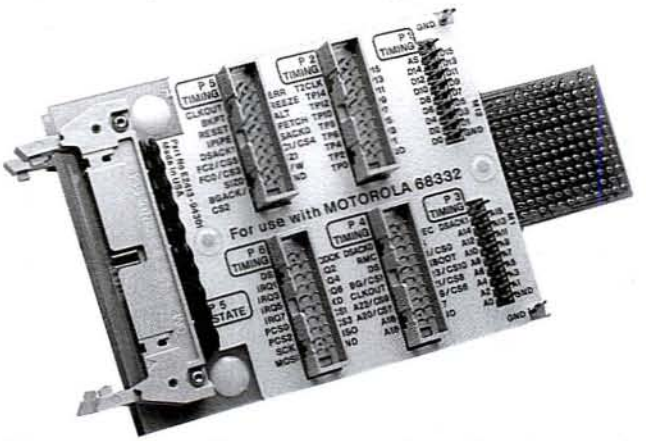
If your target-system microprocessor is not supported by HP or an independent third-party vendor, you can write your own disassembler with the HP 10391B. This software package allows you to create software that displays your system operation in familiar mnemonics. The physical connection to your target system can be made by using the HP 10320C to design a custom preprocessor or by simply placing connectors on a target system that accommodates the logic analyzer pods.

Equipment Required

The HP 10391B requires the following equipment:

- An HP Vectra personal computer based on an Intel 80386* (most Intel 80486* machines are also supported—contact your local HP sales representative for details) or an IBM PC or PC compatible with a minimum of 256 K of memory and MS-DOS* version 2.1 or later.
- One floppy disk drive and an internal hard disk (recommended configuration) for the PC, or two floppy disk drives.
- RS-232-C port and cable. Recommended card: HP 24540B Serial/Parallel card or HP 24541B Dual Serial card. For 25-pin ports, use HP 13242G cable or equivalent. For 9-pin ports, use HP 24542G cable.
- HP 1650A/B, 1651A/B, 1652B, 1653B, 1660 Series portable logic analyzers. Or HP 16500A mainframe logic analyzer with an HP 16510B, 16511B, 16540A/D, 16541A/D, or 16550A installed.

*Intel 80386 and 80486 are U.S. trademarks of Intel Corporation.
*MS-DOS is a U.S. registered trademark of Microsoft Corporation.



This preprocessor architecture is commonly used for microcontrollers. State, timing, and parametric measurements are available.

Selection Guide

Device	Package [7]	Analyzers supported (165x)	CLK [8]	Style [1]	Order no.	Price
Actel FPGA						
ACT1010,1020	PGA	50,52,510,511,540/41,550	50	U-B	*	$950
ACT1010,1020	PLCC	50,52,510,511,540/41,550	50	U-B	*	$950
ACT1010,1020	JQCC	50,52,510,511,540/41,550	50	U-B	*	$950
A1280	PGA	50,52,510,511,540/41,550	50	U-B	*	$950
Altera EPLD						
EPM5064	JLCC	50,52,510,511,540/41,550	35	U-B	*	$950
EPM5128	PLCC/JLCC	50,52,510,511,540/41,550	35	U-B	*	$950
EPM5128	PGA	50,52,510,511,540/41,550	35	U-B	*	$950
EPM5192	PLCC/JLCC	50,52,510,511,540/41,550	35	U-B	*	$950
EPM5192	PGA	50,52,510,511,540/41,550	35	U-B	*	$950
AMD						
29000/50	PGA	50,52,510,511,540/41,550	50	PT-B	*	$1,950
29030	PGA	50,52,510,511,540/41,550		P-B	*	$2,950
29200	PQFP	50,52,510,511,540/41,550		PT-B	*	$3,150
Analog Devices						
ADSP 2100	[2]	50,52,510		N/A	Factory	Free
ADSP 2101/2111	[2]	50,52,510		N/A	Factory	Free
Cypress						
7CY601 (Sparc)	PGA	50,52,510	All	P-B	*	$1,500
Fujitsu						
MB86901 (Sparc)	PGA	50,52,510	25	P-B	*	
GTE						
65816	[2]	50,52,510	All	N/A	Factory	Free
Hitachi						
6301/03	DIP	50,54,510	All	PT-B	10335G	$700
64180	DIP	50,52,510	All	PT-B	10336G	$700
64180	PLCC	50,52,510	All	PT-B	10336H	$1,300
IDT						
79R3051	[2]	50,52,510		N/A	*	
79R3051/2	PLCC	50,52,510,511,540/41,550	50	PT	*	$2,950
79R3081	PLCC	50,52,510,511,540/41,550	50	PT	*	$2,950
INMOS Transputer						
T212,222,225	[2]	50,52,510	33	N/A	Factory	Free
T400,414,425	[2]	50,52,510	33	N/A	Factory	Free
T800,801,805	[2]	50,52,510	33	N/A	Factory	Free
Intel						
8080	[2]	50-54,510	All	N/A	Factory	Free
8085	DIP	50-54,510,550	12	P-A	10304B	$1,100
MCS-51[3]	DIP	50-54,510,511,540,550	16	P-A	E2415A	$1,500
8031/51	DIP/PLCC	50,52,510,511,540/41,550	16	PT-B	*	$235 to $285
8031/51	PQFP		16	PT-B	*	$885
MCS-96[4]	PGA	50,52,510,540/41,550	12	PT-A	E2416A	$850
Adapter	PLCC				*	$160
8086/88	DIP	50-54,510,540/41,550	10	P-A	10305B	$1,400
Adapter	PLCC/LCC				*	$335 to $385
80186XL/EA	PGA/PLCC	50,52,510,540/41,550	20	PT-B	E2434A	$800
C186/XL [9]	QFP			AA	E2434A #1CC	$750
80186EB	PGA/PLCC	50,52,510,540/41,550	16	PT-B	E2434B	$800
Adpt. Soldered	QFP			AA	E2434B #1CC	$800
80186EC	PGA	50,52,510,540/41,550	20	PT-B	E2434C	$800
80186/188	PGA	50,52,54,510,550	25	PT-B	*	$335
80186/88	PLCC/LCC	50-54,510,550	25	PT-B	*	$335 to $385
80C196KA/KB	PGA	50,52,510	All	P-B	*	$335
80286	PGA	50,52,510,511,540/41,550	25	PT-A	E2409B	$1,700
Adapter	PLCC/LCC				#1CB/#1CA	$300 to $700
80386DX	PGA	50,52,510,540/41,550	33	P-A	10314D	$2,200
80386SX	PQFP	510,511,540/41		PT-B	*	$1,085
80486	PGA	50,52,510,511,540/41,550	33	U-B	E2403A	$1,400
80486	PGA	50,52,510,511,540/41,550	50	P-C	E2411B	$2,400
P5	PGA	550,540/41	66	PT-D	E2443A	$5,000
80860XR	PGA	511,540/41	40	P-C	E2435A	$2,400
80860XP	PGA	540/1,550	50	P-C	E2412A	$5,300
80960CA	PGA	50,52,510,511,540/41,550	40	P-C	E2432A	$3,000
80960KA	PGA	50,52,510,511,540/41,550	50	PT-B	*	$2,385
80960KA/KB/MC	PGA	50,52,510,511,540/41,550	50	U-B	*	$1,395
80960CA	PGA	50,52,510,511,540/41,550	50	U-B	*	$1,550
80960XR	PGA	50,52,510,511,540/41,550	50	U-B	*	$1,895

For current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

LOGIC ANALYZERS
Microprocessor and Bus Support Matrix (cont'd)

Selection Guide (continued)

Device	Package [7]	Analyzers supported (165x)	CLK [8]	Style [1]	Order no.	Price
LSI Logic						
LR33000	PGA	50,52,510	50	P-B	*	$2,950
LR33020	PGA	550	50	PT-B	*	$3,450
L64801 (Sparc)	PGA	50,52,510	25	P-B	*	
MIPS						
R3000	PGA	540/1,550	33	P-C	E2401A	$3,500
R3051	[2]	510			*	
R4000PC	PGA	550,540/41	50	P-C	E2438A	$3,500
Motorola						
146805E2	[2]	50-54,510	All	N/A	Factory	Free
56000/01	[2]	50-54,510	All	N/A	Factory	Free
56156/116	[2]	50-54,510,511,540/41,550	50	N/A	*	$1,750
6800/6802	DIP	50-54,510,550	2	P-A	10307B	$1,100
6803	[2]	50-54,510	All	N/A	Factory	Free
6809	DIP	50-54,510,550	2	P-A	10308B	$1,100
68000/10	DIP	50,52,510,511,540/41,550	12.5	P-A	10311B	$1,600
68000/10	DIP	50,52,54,510,550	12.5	PT-B	*	$420
68000/10	PGA	50,52,510,511,540/41,550	12.5	PT-B	10311G	$600
68000/10	PLCC	50,52,54,510,550	12.5	PT-B	*	$385 to $435
68000/10	SDIP	50,52,54,510,550	12.5	PT-B	*	$420
68EC000	PLCC	50,52,54,510,550	12.5	PT-B	*	$385 to $485
68008	DIP	50,52,510		PT-B	*	$643
68020	PGA	50,52,510,511,540/41,550	33	P-C	E2426A	$1,400
Adpt. Soldered	PQFP			LPA	#1CC	$1,300
68020	PQFP	50,52,510,550	33	PT-B	*	$1,050 to $1,150
68EC020	PGA	50,52,510,511,540/41,550		P-C	E2424B	$2,250
Adpt. Soldered	PQFP			AA	#1CC	$850
68EC020	PGA	50,52,510,550	33	PT-B	*	$360
68EC020	PQFP	50,52,510,550	33	PT-B	*	$950
68030	PGA	50,52,510,511,540,550		PT-B	10316G	$875
68030	PGA	50,52,510,511,540,550	50	PT-C	E2406A	$2,000
Adpt. Soldered	PQFP			LPA	#1CC	$1,300
68030	PQFP	50,52,510,550	33	PT-C	*	$1,050 to $1,150
68EC030 [6]	PGA	50,52,510,511,550	50	PT-C	E2406A	$2,000
68040	PGA	50,52,510,511,540/41,550	25	PT-C	E2420A	$3,000
68EC040	PGA	50,52,510,511,540/41,550	25	PT-C	E2420A	$3,000
68HC001	PGA	50,52,54,510,550		PT-B	*	$385
68HC001	PLCC	50,52,54,510,550		PT-B	*	$385
68HC11	DIP	50,52,510,550	8.4	PT-B	10315G	$900
68HC11	PLCC	50,52,510,550	8.4	PT-B	10315H	$1,800
68302	PGA	50,52,510,511,540/41,550	20	PT-B	E2414B	$750
Adpt. Soldered	PQFP			LPA	#1CC	$1,300
68302	PGA	50,52,54,510,550	20	PT-B	*	$360
Socketed	PQFP	50,52,54,510,550	20		*	$1,050
68330	QFP	50,52,54,510,550	16	PT-B	*	$950
68331/2 Soldered	PQFP	50,52,510,511,540/41,550		PT-B	E2413B	$2,400
68332	PQFP	50,52,54,510,550	16	PT-B	*	$1,050 to $1,150
64340	PGA	50,52,510,511,540/41,550		PT-B	E2424B	$875
Adpt. Soldered	PQFP			AA	#1CC	$1,100
68340 Socketed	PQFP	50,52,54,510,550		PT-B	*	$950
68HC16Z1	PQFP	50,52,510,511,540/41,550	16.7	PT-B	E2419A	$2,400
88100	PGA	50,52,510,540/41,550	50	PT	*	$1,795
88200	PGA	50,52,510,540/41,550	50	PT	*	$2,195
88110	PGA	550	50	PT	*	$3,500
National						
NS32016	[2]	50,52,510	All	N/A	Factory	Free
HPC16003/4/64	[2]	50,52,510	All	N/A	Factory	Free
HPC16100		50,52,510	All		*	$1,050
HPC46K	PLCC	50,52,54,510,550		PT-B	*	$750 to $800
HPC46K	PQFP	50,52,54,510,550		PT-B	*	$1,500 to $1,600
DP8344BCP		50,52,510		P-B	*	
NEC						
7810/11	[2]	50,52,510	All	N/A	Factory	Free
V20/30	DIP	50,52,510	10	PT-A	10337B	$1,785
V25	PLCC	50,52,54,510,550	16	PT-B	*	$795 to $835
V40/50	DIP	50,52,510	10	PT-A	10338B	$2,670
V60	PGA	50,52,510	16	PT-B	10339G	$1,200
V70	PGA	50,52,510	20	P-B	E2407A	$1,300

Selection Guide (continued)

Device	Package [7]	Analyzers supported (165x)	CLK [8]	Style [1]	Order no.	Price
Performance						
3400	PGA	540/1,550	33	P-C	E2401A	$3,500
Pace 1750	PGA	50,52,510	40	P-B	*	$2,950
Rockwell						
6502	[2]	50,52,510	All	N/A	Factory	Free
Siemans						
80515	PLCC	50-54,510,550	16	PT-B	*	$335 to $435
80C166	PQFP	50-54,510,550	All	PT-B	*	$1,050
Texas Instruments						
34010	[2]	50,52,510	All	N/A	Factory	Free
32020/C25	PGA	50,52,510,511,540/41,550	50	PT-B	E2418A	$1,000
320C30	PGA	50,52,510,511,540/41,550	40	PT-B	E2431A	$2,400
320C31	PQFP			LPA	#1CC	$1,300
370C050	[2]	50-54,510	20	N/A	Factory	Free
320C10/14	[2]	50-54,510	20	N/A	Factory	Free
320C50/51	PGA	50,52,510,511,540/41,550	28.5	PT-D	E2442A	$2,400
Xilinx LCA						
XC2018	PGA/PLCC	50,52,510,511,540/41,550	35	U-B	*	$950
XC2064	PGA/PLCC	50,52,510,511,540/41,550	35	U-B	*	$950
XC3020	PGA/PLCC	50,52,510,511,540/41,550	35	U-B	*	$950
XC3030	PGA/PLCC	50,52,510,511,540/41,550	35	U-B	*	$950
XC3042	PGA/PLCC	50,52,510,511,540/41,550	35	U-B	*	$950
XC3064	PGA/PLCC	50,52,510,511,540/41,550	35	U-B	*	$950
XC3090	PGA/PLCC	50,52,510,511,540/41,550	35	U-B	*	$950
XC4003	PGA/PLCC	50,52,510,511,540/41,550	75	U-B	*	$950
Zilog						
Z8	DIP	50-54,510		E-B	Zilog	$1,000
Z80	DIP	50-54,510,511,550		P-A	10300B	$1,200
Z80	DIP	50-54,510,550	16	PT-B	*	$285
Z80	PLCC	50-54,510,550	16	PT-B	*	$285 to $340
Z180	DIP	50,52,510		PT-B	10336G	$700
Z180	PLCC	50,52,510		PT-B	10336H	$1,300
Z180	PLCC	50-54,510,550	16	PT-B	*	$320 to $360
Z8001/2	[2]	50,52,510	All	N/A	Factory	Free
Buses						
HPIB/RS232	N/A	50,52,510,511,550		PT-A	10342B	$1,550
HPIB	N/A	50,52,510,511,550		PT-A	10342G	$600
SCSI 1,2,3	N/A	50B,52,510,511,540/41,550		PT-E	E2423A	$1,700
MILSTD 1553A/B		50,52,510,511,550		P-A	10341B	$4,500
VME VXI	B-C size	50,52,510		PT-E	E2441B	$1,300
IBM PC AT/XT		50,52,510		PT-E	*	$1,950
EISA		50,52,510		PT	*	
IBM MCA		50,52,510		PT	*	
FDDI Lan		50,52,510		P-E	*	
Future+		510,511,540/1		P-E	*	
I Squared C		50,52,510,511,540/41		P-E	*	
JTAG 1149.1		50,52,510,511,540/41,550		PT	*	$1,450
JTAG 1149.5		50,52,510,511,540/41,550	50	PT	*	$2,250
IBM MCA		16515,516		T-E	*	

Notes: Contact your Hewlett-Packard sales representative if the microprocessor you are interested in is not listed.

*Available through third party; contact your Hewlett-Packard sales representative for more information.

[1] Hardware style
P: Preprocessor interface. Includes disassembler. Used primarily for state analysis as signals are buffered.
PT: Preprocessor interface. Includes disassembler. Also provides unbuffered signals for timing analysis.
U: Universal interface. Signals not buffered. No disassembler. Used for timing analysis.
A: Requires 10269C to operate.
B: Interface board with connectors for termination adapters.
C: Low-profile probe with cables for termination modules.
D: Low-profile probe with terminations on probe.
E: Special bus interface hardware.
N/A: Not applicable. No hardware is provided.

LPA: Low-profile adapter. This adapter clamps onto a soldered on QFP part.
AA: Adapter assembly. This adapter replaces the microprocessor. It has the same footprint as the QFP part.

[2] Inverse assembly only; no interface hardware is provided.
[3] Includes 8031/33, 8051/8052, and CMOS versions.
[4] Includes 8096/7-90, -AH, -BH, 80C196KA-KB.
[5] Requires an evaluation board available from processor vendor.
[6] Adapter from a 68030 to a 68EC030 may be required.
[7] "Package A - Package B" indicates multiple packages supported by one product. "Package A/Package B" indicates separate products must be ordered.
[8] Maximum rate of preprocessor. Clock speed also depends on speed of the analyzer.
[9] Adapter supports 80C186/88 and 80C186/88XL. 80C186/88EA QFP is not supported.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

LOGIC ANALYZERS
Accessories and Upgrade Kits

Probing Surface-Mounted Microprocessors

Two types of solutions are available for probing surface-mounted microprocessors. The first solution, called a low-profile adapter, allows you to clamp directly onto a 132-pin, 25-mil, QFP package. This type of adapter allows you to use your logic analyzer in a production test environment. Also, you no longer need to lay out a special prototype board, using through-hole technology or a socket, to accommodate your development tools!

The second solution is called a surface-mounted adapter assembly. This solution replaces the microprocessor in your target system with an assembly that has the microprocessor's QFP footprint. The logic analyzer is plugged into the adapter assembly for analysis.

Flexible Extension Cables

Several slim, flexible PGA-to-PGA extension cables are available. These cables allow you to plug into physically constraining target systems.

HP's low-profile adapter for probing soldered-on, surface-mounted microprocessors.

Target processor	HP Preprocessor	Preprocessor interface	Adapter	Type[2]	Comments	Price
68302	E2414B	132-pin PGA	E2414B #1CC	LPA	PGA to 132 QFP	$1,300
68331, 68332	E2413B	132-pin QFP	5081-7736	LPA	Supplied with E2413B[1]	$1,300
68020	E2426A	114-pin PGA	E2426A #1CC	LPA	PGA to 132 PQFP	$1,300
68020	E2426A	114-pin PGA	64748-61604	EC	PGA to PGA	$825
68EC020	E2426B	114-pin PGA	64748-87602		68020 PGA to 68EC020 PGA. Supplied with E2426B[1]	$290
68EC020	E2426B	114-pin PGA	E2426B #1CC	AA	68020 PGA to 100-pin QFP	$850
68030, 68EC030	E2406A or 10316G	128-pin PGA	E2406A #1CC	LPA	PGA to 132 QFP	$1,300
68030, 68EC030	E2406A or 10316G	128-pin PGA	64747-61601	EC	PGA to PGA	$825
68340	E2424B	145-pin PGA	E2424B #1CC	AA	PGA to 144 QFP	$1,100
68HC16Z1	E2419A	132-pin QFP	5081-7736	LPA	Supplied with E2419A[1]	$1,300
80286	E2409B	68-pin PGA	E2409B #1CA		PGA to LCC	$685
80286	E2409B	68-pin PGA	E2409B #1CB		PGA to PLCC	$285
TMS320C31	E2431A	181-pin PGA	E2431A #1CC		PGA to 132 QFP	$1,300

[1] Order as replacement parts only. Shipped with product.

[2] AA Adapter assembly.
EC 4½-in, slim, flexible extension cable.
LPA Low-profile adapter.

An example of surface mount adapter assembly.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

General-Purpose Probes and Grabbers

All HP logic analyzers come with probes consisting of leadsets and grabbers.

For a more permanent connection to your target system, you can use termination adapters (TAs) that connect to your target system via a flexible 3M connector. The connection to your device under test consists of a 2 × 10, 0.1-in–center female header. Any 3M-type connector can be used as the interface to your system. For the HP 16515A or 16516A high-speed timing module, use TA part number HP 16515-63202. All other modules use TA part number HP 01650-63203.

If you want to have the termination closer to the active components on your board, you can use the HP 1810-1278 termination dip package or the HP 5062-7351 SIP package. These packages are designed to terminate eight and five channels, respectively, with one clock signal.

Oscilloscope Probes

Selecting the right probe for your particular measurement involves many choices. Though the oscilloscope modules in each analyzer come with probes that meet most measurement needs, you may require a probe with other characteristics.

The HP 1652B and HP 1653B are shipped with HP 10430A (1-MΩ, 6.5-pF) probes. The HP 16530A, 16531A, and 16532A oscilloscopes are shipped with HP 10433A (10-MΩ, 10-pF) mini-probes.

If you require more information on HP oscilloscope accessories, refer to Oscilloscope Probes and Accessories Data Sheet (HP p/n 5954-2678). This guide includes information on probe selection and lists other scope accessories.

HP Testmobiles and Carrying Cases

Make your logic-analysis system a portable one with the HP testmobile. Each testmobile is designed to withstand rugged use. Drawers for storing your accessories are included. The HP 1181A testmobile is designed for the HP 16500A mainframe logic-analysis system. For the HP 1650 and 1660 Series of logic analyzers, order the HP 1180A testmobile.

The HP 1650-1066 soft carrying case allows you to easily carry your HP 1650 or 1660 Series portable logic analyzer and its accessories to remote sites.

Pattern Generator Output Drivers

The HP 10345A 8-channel ECL differential output driver pod translates HP 16520A or HP 16521A ECL signals into ECL differential output levels. The HP 10346A eight-channel TTL tristate buffer pod allows you to tristate groups of pattern generator channels. The HP 10346A is useful when you are driving bidirectional buses such as backplane buses. The HP 10348A CMOS tristate buffer pod provides CMOS voltage levels and will allow you to tristate channels in the same manner as the HP 10346A.

For ordering information see page 334.

Logic Analyzer Upgrade Kits

Upgrade kits for logic analyzers include software, hardware, or both, to enhance the performance of your logic analyzer. The text below summarizes the upgrade options available for the HP logic analyzers listed. See page 334 for prices.

HP 1650A and 1651A Upgrades

You can upgrade the software capabilities of your HP 1650A or HP 1651A logic analyzer with the HP 10449A software upgrade kit. This kit includes RAM, ROM, software, and manual inserts to add the following features to the HP 1650A or HP 1651A:

- State compare mode
- State waveforms
- State chart mode

The HP 10449A upgrade kit does *not* include the HP-IB interface or 35-MHz state analysis features present on the HP 1650B. HP Service Center installation is highly recommended and is not included in the price.

HP 16500 Upgrades

The HP 16500-68713 upgrades your HP 16500A from 1 MB to 4 MB of operating system memory. You can install this kit yourself.

The HP 16500-68712 upgrades your 2.5-MB 16500A to 4 MB of operating system memory. HP Service Center installation is highly recommended and is not included in the price.

HP 1650B to HP 1652B and HP 1651B to HP 1653B Upgrades

The HP 10349B oscilloscope upgrade kit converts the HP 1650B or HP 1651B logic analyzer to a HP 1652B or HP 1653B, respectively. The upgrade kit includes the following:

- 2-channel 400 MSa/s digitizing oscilloscope board
- Software
- Manual inserts

HP Service Center installation is highly recommended and is not included in the price.

LOGIC ANALYZERS
Ordering Information

HP 16500 Series Modular Logic Analyzers	
HP 16500A Logic Analysis System Mainframe	$7,700
Opt 908 Rack Mount Kit (8¾-in EIA rackmount)	+$40
Opt 910 Extra Operating and Programming Manual	+$100
Opt W30 Three-Year Extended Repair Service	+$180
HP 16501A Logic Analysis System Expansion Frame	$4,750
Opt 908 Rack Mount Kit (8¾-in EIA rackmount)	+$40
Opt W30 Three-Year Extended Repair Service	+$115
HP 16510B 80-Channel 35-MHz State/100-MHz Timing	$6,300
Opt 910 Extra Operating and Programming Manual	+$100
Opt W30 Three-Year Extended Repair Service	+$130
HP 16511B 160-Channel Logic Analyzer 35-MHz State/100-MHz Timing Conversion Kit (2 HP 16510Bs needed)	$550
HP 16515A 16-Channel 1-GHz Timing Master Card	$9,000
Opt 910 Extra Operating and Programming Manual	+$75
Opt W30 Three-Year Extended Repair Service	+$190
HP 16516A 16-Channel 1-GHz Timing Expansion Card	$8,000
Opt W30 Three-Year Extended Repair Service	+$165
HP 16520A 12-Channel 50-Mb/s Pattern Generation Card	$4,600
Opt 910 Extra Operating and Programming Manual	+$100
Opt W30 Three-Year Extended Repair Service	+$95
HP 16521A Pattern Generator Expansion Card	$5,300
Opt W30 Three-Year Extended Repair Service	+$95
HP 16530A 400-MSa/s Oscilloscope Time-Base Card	$2,000
Opt 910 Extra Operating and Programing Manual	+$100
Opt W30 Three-Year Extended Repair Service	+$50
HP 16531A 2-Channel 400-Msa/s Scope Acquisition Card	$5,700
Opt W30 Three-Year Extended Repair Service	+$100
HP 16532A 2-Channel 1-GSa/s Oscilloscope Card	$9,000
Opt 910 Extra Operating and Programming Manual	+$100
Opt W30 Three-Year Extended Repair Service	+$225
Opt W32 Calibration Service	+$445
HP 16540A 16-Channel 100-MHz State/Timing Master Card	$7,000
Opt 910 Extra Operating and Programming Manual	+$100
Opt W30 Three-Year Extended Repair Service	+$165
Opt W32 Calibration service	+$445
HP 16541A 48-Channel 100-MHz State/Timing Expansion Card	$8,500
Opt W30 Three-Year Extended Repair Service	+$200
Opt W32 Extended Calibration Service	+$445
HP 16540D 100-MHz 16K Deep State/Timing Master Card	$8,400
Opt W30 Three-Year Extended Repair Service	+$210
Opt 32 Calibration Service	+$185
HP 16541D 100-MHz 16K Deep State/Timing Expansion Card	$9,900
Opt W30 Three-Year Extended Repair Service	+$250
Opt W32 Calibration Service	+$40
HP 16542A 16-Channel, 1 Mb/channel 100-MHz State and Timing	$8,500
Opt W30 Three-Year Extended Repair Service	+$215
Opt W32 Three-Year Return Calibration Service	+$235
Opt 910 Extra Operating and Programming Manuals	+$100
HP E2430A Memory Expansion Interface for HP 16542A	$2,200
HP 16550A 102-Channel 100-MHz State and 500-MHz Timing	$8,800
Opt W30 Three-Year Extended Repair Service	+$220
Opt 910 Extra Operating and Programming Manuals	+$100
Opt 110 1 MB to 4 MB CPU Upgrade for HP 16500A Mainframe	+$895
Opt 125 2.5 MB to 4 MB CPU Upgrade for HP 16500A Mainframe	+$295

HP 1660 Series Portable Logic Analyzers	
HP 1660A 136-Channel 100-MHz State and 500-MHz Timing	$13,500
Opt W30 Three-Year Extended Repair Service	+$340
Opt 910 Extra Operating and Programming Manuals	+$100
HP 1661A 102-Channel 100-MHz State and 500-MHz Timing	$10,900
Opt W30 Three-Year Extended Repair Service	+$275
Opt 910 Extra Operating and Programming Manuals	+100
HP 1662A 68-Channel 100-MHz State and 500-MHz Timing	$8,500
Opt W30 Three-Year Extended Repair Service	+$215
Opt 910 Extra Operating and Programming Manuals	+$100
HP 1663A 34-Channel 100-MHz State and 500-MHz Timing	$5,900
Opt W30 Three-Year Extended Repair Service	+$150
Opt 910 Extra Operating and Programming Manuals	+$100

HP 1650 Series Portable Logic Analyzers	Price
HP 1650B 80-Channel Log Analyzer	$8,400
Opt 908 Rack Mount Tray	+$300
Opt 910 Extra Operating and Programming Manual	+$100
Opt W30 Three-Year Extended Repair Service	+$190
HP 1651B 32-Channel Logic Analyzer	$4,500
Opt 908 Rack Mount Tray	+$300
Opt 910 Extra Operating and Programming Manual	+$100
Opt W30 Three-Year Extended Repair Service	+$100
HP 1652B 80-Channel Logic Analyzer with Oscilloscope	$12,000
Opt 908 Rack Mount Tray	+$300
Opt 910 Extra Operating and Programming Manual	+$100
Opt W30 Three-Year Extended Repair Service	+$285
HP 1653B 32-Channel Logic Analyzer with Oscilloscope	$8,400
Opt 908 Rack Mount Tray	+$300
Opt 910 Extra Operating and Programming Manual	+$100
Opt W30 Three-Year Extended Repair Service	+$185
HP 1654B 64-Channel Logic Analyzer	$7,500
Opt 908 Rack Mount Tray	+$300
Opt 910 Extra Operating and Programming Manual	+$100
Opt W30 Three-Year Extended Repair Service	+$165

Ordering Information	Price
Upgrade Kits	
HP 10449A Software Upgrade Kit for HP 1650A and 1651A	$550
HP 10349B Scope Upgrade Kit for HP 1650B and 1651B	$4,595
HP 16500-68715 Current Operating Software Version (HP 16500 Series)	$25
HP 01650-68706 Current Operating Software Version (HP 1650B, 1651B, 1654B)	$25
HP 01652-68704 Current Operating Software Version (HP 1652B, 1653B)	$25
HP 01660-68702 Current Operating Software (HP 1660 Series)	$25
HP 16500-68713 1 MB to 4 MB CPU Upgrade	$895
HP 16500-68712 2.5 MB to 4 MB CPU Upgrade	
Price for upgrade kits does not include installation.	
Accessory Software	
HP 10390A System Performance Analysis Software	
Opt 001 For the HP 1650 Series	$575
Opt 002 For the HP 16510A/B	$575
Opt 003 For the HP 16540A/41A	$575
Opt 004 For the HP 16550A	$575
HP 10391B Inverse Assembler Development Package	$1,050
HP 10392A State-to-Pattern Generator Link	$575
Probe Interface	
HP 10269C General-Purpose Probe Interface (required with many microprocessor support packages, see table "Microprocessor and Bus Support," page 329 and look for hardware style P-A).	$535
Interfaces for Microprocessors	
Please refer to the table on page 329.	
Probe Adapters	
Please refer to the table on page 332.	
User-Definable Interface Products	
HP 10320C User-Definable Interface	$300
HP 10321A Microprocessor Interface Parts Kit	$360
HP 10322A 40-Pin DIP Interface Cable	$480
HP 10323A 48-Pin DIP Interface Cable	$550
HP 10324A 64-Pin DIP interface cable	$670
HP 10391B Inverse Assembler Development Package	$1,050
Oscilloscope Accessories	
HP 10240B BNC-to-BNC Blocking Capacitor	$55
HP 10211A IC Probe Clip	$85
HP 10024A 16-Pin IC Test Clip	$45
Oscilloscope Probes	
HP 10020A 1:1-100, 50-500 Ω, <1 pF resistive divider probe set, 1.2m	$735
HP 10430A 10:1, 1 MΩ, 6.5 pF Mini-Probe, 1 m	$175
HP 10433A 10:1, 10 MΩ, 10 pF Mini-Probe, 2 m	$175
HP 10435A 10:1, 1 MΩ, 7.5 pF Mini-Probe, 1 m	$165
HP 10437A 1:1, 50 Ω Mini-Probe, 2 m	$125
HP 10438A 1:1, 1 MΩ, 40 pF Mini-Probe, 1 m	$100
HP 10439A 1:1, 1 MΩ, 64 pF Mini-Probe, 2 m	$105
HP 10440A 100:1, 10 MΩ, 2.5 pF Mini-Probe, 2 m	$175
State and Timing Analyzer Replacement Probes and Lead Sets	
HP 01650-61607 16-Channel Woven Probe Cable for 1650B, 1651B, 1652B, and 1653B	$130
HP 16510-61601 16-Channel Woven Probe Cable for HP 16510B	$165
HP 16510-61602 16-Channel Woven Probe Cable for HP 16510B	$160
HP 5959-9333 5 Probe Leads for HP 1650 Series	$25
HP 5959-9334 5 Short Ground Leads for HP 1650B, 1651B, 1652B, 1653B, and 16510B	$20
HP 5959-9335 5 Long Ground Leads for State and Timing Analyzers (except HP 16515A/16516A)	$20
HP 01650-61608 16-Channel Probe Lead Set for State and Timing Analyzers (except HP 16515A/16516A)	$185
HP 01650-63203 Termination Adaptor for State and Timing Analyzers (except HP 16515A/16516A)	$100
HP 1810-1278 9-Channel IC Termination Adaptor	$6.25
HP 5062-7351 Terminiation IC SIP	$3
HP 1251-8106 2 × 10, 0.1-in Center Header (similar to 3-M[1] p/n 3592-6002)	$6.25
HP 5090-4356 Surface-Mount Grabbers (package of 20)	$25
HP 5959-0288 Throughhole Grabbers (package of 20)	$20
HP 16515-61604 1-Channel Coax Probe Cable for HP 16515A/16516A	$75
HP 16515-69502 8 1-Channel Lead Set for HP 16515A/16516A	$150
HP 16515-68703 Grounding Kit for HP 16515A/16516A	$150
HP 16515-68705 Probe Pins for HP 16515A/16516A	$120
HP 16515-63202 1 GHz Timing Termination Adaptor for HP 16515A/16516A	$120
Pattern Generator Accessories; Replacement Probes and Lead Sets	
HP 10392A State-to-Pattern Generator Link	$575
HP 16520-61601 Input Qualifier Probe Cable	$120
HP 16520-69501 Input Qualifier Probe Kit	$185
HP 16520-61602 8-Channel Data Probe Cable	$205
HP 16520-61603 Clock/Strobe Probe Cable	$205
HP 10347A Pattern Generator Probe Lead Set	$225
HP 10345A 8-Channel ECL Differential Driver Pod	$130
HP 10346A 8-Channel TTL Tristate Buffer Pod	$130
HP 10348A 8-Channel CMOS Tristate Buffer Pod	$130
HP 5959-0288 Grabbers (package of 20)	$20
Other Accessories for HP Logic Analyzers	
HP 1180A Testmobile for HP 1650 Series and HP 1660 Series	$290
HP 1181A Testmobile for the HP 16500A	$950
HP 92199B Power Strip	$36
HP 1540-1066 Soft Carrying Case for HP 1650 Series	$135
HP 9211-2645 Transit Case for HP 1650 Series	$430
HP 9211-2658 Transit Case for HP 16500A	$520
HP 92192A Blank Double-Sided 3½-in diskettes (box of 10)	$19
HP 5061-6175 Rack Mount Kit for HP 1650B/1651B/1652B/1653B	$300
HP 5062-7379 Rack Mount Kit for HP 1660A (call your local HP sales representative for price information)	
HP 5061-9679 Rack Mount Kit for HP 16500A	$40
HP 1494-0015 Rack Mount Slide Tray for HP 1650 Series	$120
HP 5061-6183 Front Cover for HP 1650 Series	$40
HP E2427A Keyboard Kit HP 16500A, HP 1660 Series	$325
HP 46060A HP Mouse HP 16500A, HP 1660 Series	$179
HP M1309A Trackball HP 16500A, HP 1660 Series	$513

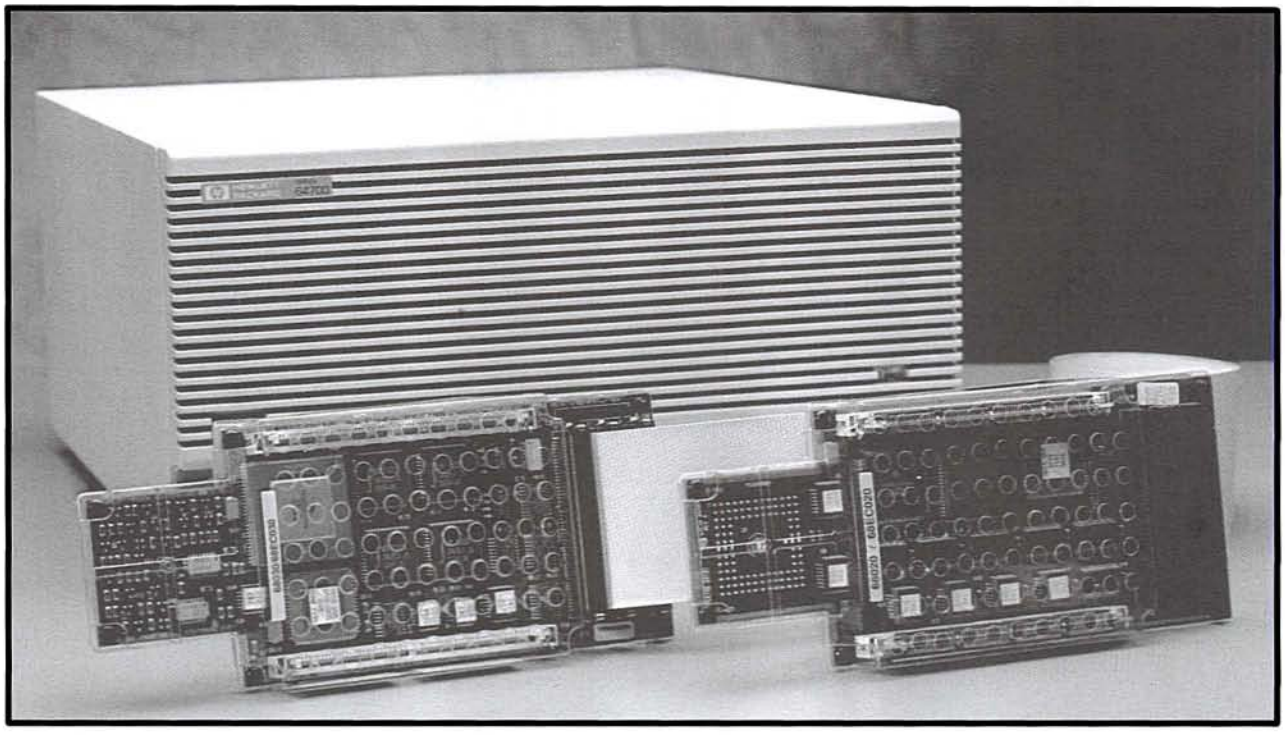
For off-the-shelf shipment, call 800-452-4844.

[1] 3-M is a registered trademark of Minnesota Mining and Manufacturing Corporation.

MICROPROCESSOR DEVELOPMENT SYSTEMS

Emulators, Analyzers, and Software Development

HP 64000 Series



HP 64700 Series Emulators/Analyzers

Real-Time, Transparent Emulation and Analysis

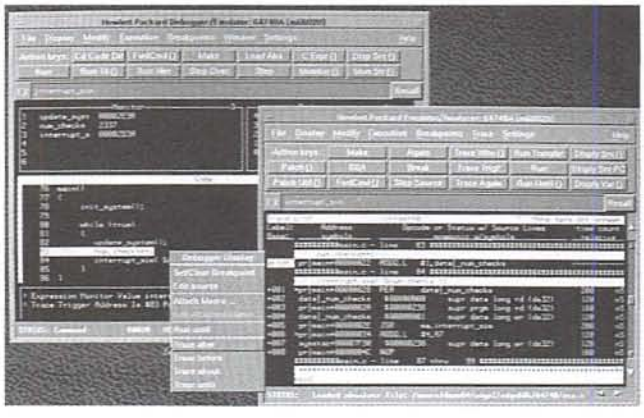
HP 64700 Series emulators/analyzers provide real-time, transparent emulation and analysis for popular microprocessors. The HP 64700 Series is made up of modular emulation and analysis tools that can be controlled from a terminal, an optional HP 9000 or Sun Motif–style interface, PC-hosted interface, or an optional LAN card for workstations. This choice of interfaces, plus high-speed program download, makes for efficient microprocessor-based system development.

High Performance

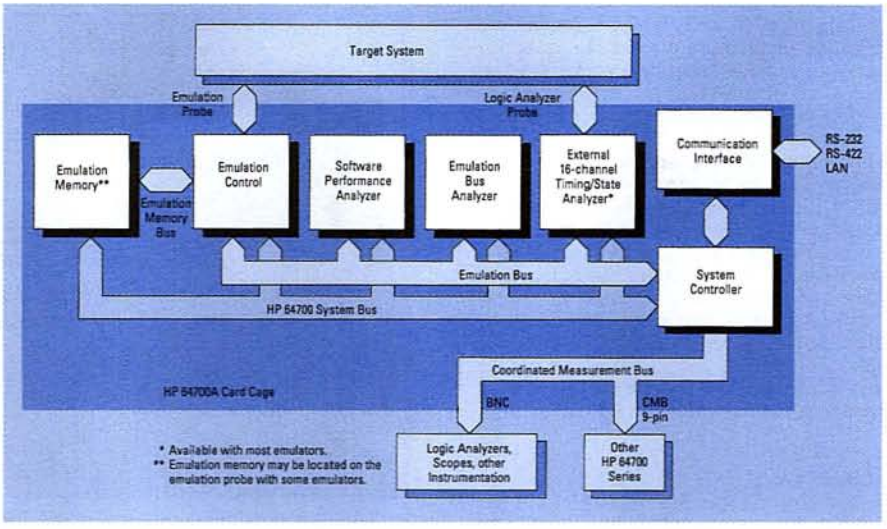
- Real-time, transparent emulation at full processor speeds
- Triggering capabilities in an emulation bus analyzer support eight-level sequencing, time tags, prestore analysis for establishing software interrelationships
- In a workstation environment a software performance analyzer card is available for evaluating and improving code performance and efficiency
- A 64-channel emulation bus analyzer card includes a 16-channel external analyzer that can function as an independent 100-MHz timing analyzer as well as a 25-MHz state analyzer
- Synchronized operation and cross-triggering between multiple emulators for multiple processor designs
- A high-speed RS-422 interface greatly improves emulator download and upload times when used with PCs
- LAN card available for fast download and host independence in a workstation environment
- Dual-bus architecture and dual-port emulation memory to ensure nonstop, real-time emulation
- Fully tested to rugged electrical, temperature, and shock standards to ensure continued reliability and performance
- Meets international requirements for RFI/EMI emissions

Choice of Design Environments

HP 64700 Series emulators/analyzers offer several flexible configuration options. These host-independent emulation and analysis vehicles can be controlled from a simple terminal, or the emulator can be hosted on an IBM PC compatible such as the HP Vectra PC. For large team-oriented or complex designs, the HP 64700 integration environment hosted on HP 9000 or Sun workstations offers powerful development solutions.



In a workstation environment, an X/Motif interface offers easy access to the HP 64700 Series development tools. Command entry is quick and accurate with a click of a mouse button. Multiple windows can be displayed simultaneously for comparing different fields.



HP 64700 Series emulators/analyzers have a dual-bus architecture with a foreground and/or background monitor to permit you to control the microprocessor emulation in the target system. This dual-bus architecture gives you maximum transparency by allowing traces to be executed and displayed without halting processor execution.

HP 64700A Cardcage

The HP 64700A cardcage is the basis for modular emulators and analyzers. It can be disassembled and reassembled easily for cost-saving reconfiguration to support other 8-, 16-, and 32-bit processors.

The cardcage has six and one-half card slots. One slot is dedicated to a cardcage host control card, one to an emulation bus analyzer card, and the one-half card slot is for a LAN card. The remaining four slots are available for emulator card sets, a flash EPROM card, a software performance analyzer card, and future products. The flash EPROM card offers easy software and firmware updates without the need to install new ROMs.

A host computer can communicate with the cardcage via LAN, RS-232-C, or RS-422, which allows the HP development tools to operate in a variety of design environments. The cardcage contains two independent RS-232-C serial ports, each with standard 25-pin female connectors. There is an RS-422 capability embedded in one of the ports, which can be programmed to operate at rates of up to 460 kB and is available for IBM PC compatibles.

When using these emulators with HP or Sun workstations, the LAN card is needed for connection to Ethernet networks via ThinLAN, ThickLAN, or StarLAN. TCP/IP protocols, LAN gateways, and ARPA/Berkeley standards are supported.

Terminal Mode Operation

A firmware-resident ASCII terminal interface is embedded in the emulator, supplying commands for all emulation and analysis features. Commands are ASCII strings; file transfers using industry-standard formats are accepted. Since a terminal can access these commands, host independence is realized. This interface is ideal for remote field applications, and for use of portable computers, field service, or other applications where a host is impractical or unavailable.

PC-Hosted Environment

A PC user interface for MS-DOS–based computers makes these emulation systems one of the easiest to use in the industry. Visually self-explanatory screens give you simplified access to best-of-class emulation and analysis features for any level of measurement complexity. Hierarchical command trees lead you quickly through your tasks.

A PC-based development environment provides the solution for the microprocessor software development and analysis needs of individual engineers and small design teams. High-performance tools include an IBM PC compatible, HP 64700 Series emulator, and windowed user interface, combined with software development tools. These tools constitute a development environment tailored for small design teams and those desiring personal development systems.

HP MS-DOS–based PC interface windows provide views of several areas of interest at once, eliminating time wasted in repeatedly switching contexts or running commands. The interface supports color and monochrome displays and uses directed syntax with menus and submenus for quick selection of commands.

Workstation Interface

Easy-to-use interfaces are available on HP and Sun workstations. These interfaces are Motif-style, including terminal window operation, 3-D look and feel, pull-down menus, point and click, cut and paste, and pop-up recall buffers and help screens. This interface makes it very easy to move about an emulation session with pop-up windows, recall commands, specifications, and file history, reducing the need to remember many commands or file names.

Emulation Memory

Dual-ported emulation memory in the HP 64700 Series emulators runs at maximum processor speeds with no wait states for accurate duplication of target system performance. The dual-port memory allows emulation displays and modifications of emulation memory without halting the processor during emulation. Memory can be mapped in 256-byte, 512-byte, or 1-Kbyte blocks, depending on the processor and can be configured as either emulation or target RAM, emulation or target ROM, or guarded memory. The emulator checks for writes to ROM or guarded memory.

Popular File Formats

Popular absolute file formats are accepted by the HP 64700 Series emulators, including Intel OMF-86, OMF-51, OMF-286, OMF-386, and IEEE-695.

MICROPROCESSOR DEVELOPMENT SYSTEMS

Emulators, Analyzers, and Software Development (cont'd)

HP 64000 Series

Advanced Probe Technologies

For quick, sure plug-in capability, 8- and 16-bit processors are probed with slim, flexible cables ending in a low-profile probe for accessing hard-to-reach targets without sacrificing signal fidelity. Signal fidelity is maintained at maximum-rated processor speeds so that you know your system analysis and processor control functions are accurate.

Multiple package types are supported where applicable. For example, both PGA and DIP packages for the Motorola 68000, along with QFP, LCC and PGA packages for the Intel 80186, are supported.

For 32-bit designs, HP uses active probes to maintain processor speeds. An active probe contains target CPU, memory, and high-speed circuitry for both functional and electrical transparency.

Probe interfaces and adapters are available to accommodate package configurations for the most popular processors supported by HP emulators and preprocessors—PGAs, LCCs, PQFPs/CQFPs. Low-profile, minimum width designs and special extenders ensure access to your target system. There's even a 114-mm (4.5 in) flexible extender to help you get around corners or into tight locations where the probe won't fit.

8-, 16-, and 32-Bit Emulation

High-quality, real-time emulators are the core from which HP has evolved support for the microprocessor software development process. Full-speed execution of microprocessor code can be traced and analyzed nonintrusively with or without functional prototype hardware. Emulation of multiple processors makes possible interactive measurements and coordinated execution starts of complex designs.

Emulators provide an essential link between the software development environment and the target system. Programs developed on the HP 64700 development environment are run on the emulation subsystem for real-time debug and analysis. The emulation bus analyzer provides the displays and triggering conditions for the emulator and is the access point for interactive emulation analysis. Processor run controls in the emulator allow you to single step, display, and modify memory. Modifications and improvements to software are made quickly in the early design phases; emulation gives you the flexibility to experiment before committing a product to firmware.

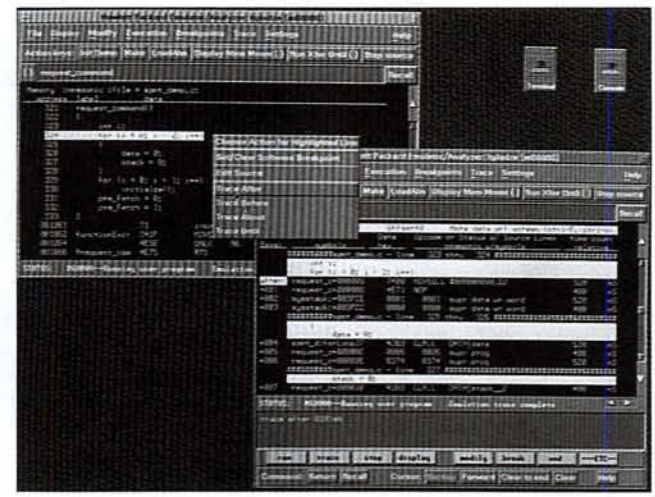
Comprehensive Logic Analysis

Emulation Bus Analysis

Each HP 64700 Series emulator includes an emulation bus analyzer for tracing microprocessor code flow. Based on the same "logic-analyzer-on-a-chip" used in the HP 1650A/1651A Logic Analyzers and the HP 16500A Logic Analysis System, the analyzer has abundant resources for solving the most complex system problems. Up to eight hardware resources, each consisting of address, data, and status event comparators, can be combined in several fashions. Those resources can be grouped to establish complex sequential trace specifications using "find A, followed by B . . . " constructs up to eight levels deep. A range comparator can be applied to address or data events at any one of the levels. Each event is tagged with an execution time for easy measurement of code execution times. A dual-bus architecture allows all traces to be set up and reviewed without breaking processor execution. A prestore function allows tracking of relationships between a given software element and one or more other software events that influence that element. For example, prestore helps pinpoint which of several different tasks accessing a variable is responsible for corrupting it.

Emulation bus analyzer features include:

- Eight levels of sequencing for complex program flow tracking
- Address, data, or status range resources
- Prestore queue for variable access tracking
- Time tagging for instruction execution measurements
- 1,024-state-deep memory (512 states with time tagging)
- Store qualification resources
- Code coverage memory for reliability metrics



Emulation and emulation bus analysis cards provide debug, run control, source-line referencing, and real-time trace capability.

Real-Time Operating System Measurements

HP 64700 Series emulators/analyzers for Motorola processors offer measurements in embedded designs that use real-time operating systems. Whether you are using pSOS+ from Integrated Systems Corp., VRTX32 from Ready Systems, or VxWorks from Windriver Systems, these real-time operating system tools help you understand the flow of operating system activity, track dynamic memory usage, isolate defects based on operating system level task qualifiers, and perform application task duration time profiling. These measurement tools make it very easy to debug real-time problems in a task-oriented application. If you are using a custom operating system, there is a user definable measurement tool that can be configured to your application. These tools are part of HP's X/Motif-based emulation and analysis tools for software and hardware integration currently available on HP 9000 Series 300/400/700 workstations and Sun SPARCstations.

Logic Analysis

The 64-channel emulation bus analyzer includes a 16-channel state/timing analyzer. The analyzer can be configured as a 100-MHz timing analyzer with 5-ns glitch detection or as a 25-MHz state analyzer. In state mode, the analyzer can be clocked by the microprocessor clock or by an independent synchronous source.

Based on the same logic analyzer chip as the emulation bus analyzer, the logic analyzer also has full triggering and qualification capabilities. The analyzer can serve as a standalone logic analyzer or can be coupled with the emulation bus analyzer for correlation of microprocessor activity with other target system activity. The two analyzers can cross-trigger or arm each other on the basis of hardware or software events that one analyzer detects. Target system probing is through a 1.4 meter cable with 18 probe leads (16 data channels and two clock channels). There are 36 miniature probe tips included for easy connection of both signal and ground lines of each lead to target system ICs or test points.

Software Performance Analysis

Software performance analysis verifies and benchmarks both high-level and assembly-level code, even when they are mixed. The software performance analyzer (SPA) can measure activity generated by your entire program (activity), find the most active modules and determine if they are being called too often, and measure how long any subroutine takes to execute (duration). These measurements show where your optimization effort will yield the greatest benefit.

An additional advantage of SPA is its ability to show convergence when measuring, for example, the duration of a process. SPA calculates a measurement error tolerance level each time additional data is acquired. Best of all, SPA lets you make software performance benchmarks and predictions before any costly hardware is produced.

SPA is closely coupled to the emulation/analysis environment by such features as cross-triggering and an enable/disable window. You can control when data is collected and filter out irrelevant activity.

The software performance analyzer provides overview measurements to aid in evaluating total system effectiveness of programs operating in real time. Global measurements let software designers determine where resources are being used in terms of execution times, memory usage, and interaction traffic. Software performance measurements aid in determining where to focus optimization efforts for maximum effect on system performance.

- Monitors up to 254 specified simultaneous events during activity measurements
- Monitors up to 84 simultaneous events in real time for duration measurements
- Supports 16- and 32-bit processors
- Graphical user interface that is compatible with X11/Motif
- Histogram or statistical data list displays
- Statistical data list includes mean, percentage, standard deviation, and maximum and minimum times by either state or time counts
- Automatically reads and loads symbols from the data base used by the emulator/analyzer
- Hosted on HP 9000 Series 300/400/700 workstations and Sun SPARCstations

Software Development

For C programmers, source code syntax is checked against draft ANSI standard C and compiled into highly space- and time-efficient executable code by HP's optimizing Advanced C Cross Compilers. Each microprocessor-specific compiler makes full use of the microprocessor's instruction set and address modes with features not available in most native compilers.

The quality and reliability of these compilers is ensured through a comprehensive process emphasizing object-oriented design and exhaustive testing with four independent test suites. Working tightly with corresponding assemblers and linkers, HP compilers generate symbolic code that is directly usable by debuggers and integration and test tools in the succeeding phases of the development cycle.

Software Integration

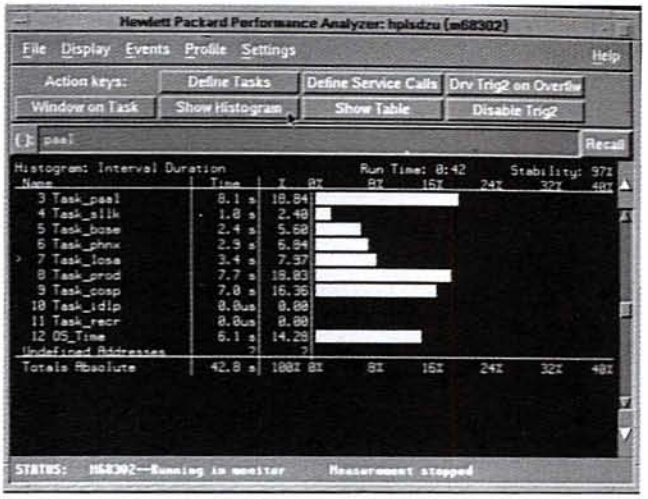
HP's Advanced Cross Debug System provides clear insight into microprocessor programs from the beginning of coding through system integration. C and assembly code can be debugged simultaneously. In either view of the program, the code, stack, and variables are displayed and updated at every step or break in execution.

Using the simulator, programs can be run and debugged without any hardware external to the host computer. When using the debugger with an emulator, your program runs full speed on the real microprocessor with real memory. With in-circuit emulation, prototype memory is also available.

A powerful software test environment can be built using command files to run the debugger (in background) and using a journaling feature to record all input and capture the resulting output.

HP Branch Validator

HP Branch Validator is a software verification tool that is easy to use in the software verification process. HP Branch Validator, working through HP SoftBench, provides a complete environment for branch analysis that supports rapid reiteration of the compile-test-analyze loop. Comprehensive reports provide detailed feedback on the thoroughness of test suites. There are native and embedded versions of HP Branch Validator that are hosted on HP 9000 and Sun workstations.



Optimize your code using the software performance analyzer and real-time, nonstatistical measurements. With this analyzer you can measure program activity, locate the most active modules and determine if they are being called too often, and measure how long any subroutine takes to execute. This analyzer operates in a workstation environment.

A mouse-driven OSF/Motif interface allows for a rapid learning curve with minimal reference to manuals. The HP SoftBench environment provides a user with familiarity, which contributes to efficient use of tools and programmer satisfaction in creating a custom environment for software test. The convenient use of menus and windows enables you to quickly focus the test suite on relevant sets of files and measure against the criteria for successful branch validation.

Native Development

As an integrated part of HP CASEdge, the native version of HP Branch Validator takes advantage of the HP SoftBench engineering environment to support development of HP-UX C language products. Both ANSI and non-ANSI versions of the HP-UX C compiler are supported.

Embedded Development

As an integrated part of the HP AxCASE environment, HP Branch Validator supports AxLS C language for embedded microprocessor development applications. HP Branch Validator can use the actual prototype hardware with an emulator, running the program under test, to produce test metrics. This tool can also be used with an emulator running out of circuit or with a debugger/simulator to develop software before the hardware is available.

Ordering Information

The HP 64700 modular analyzers/emulators are a dynamic family of software and hardware development tools for embedded microprocessor-based systems. With development support for over sixty 8-, 16-, and 32-bit microprocessors, there are many combinations of solutions available. It is recommended that an HP field engineer be contacted for a suggested system configuration that will fit your application. For a copy of our latest brochure, in the U.S. call 1-800-447-3282 (please call between 8:00 am and 5:00 pm mountain time). Outside the U.S., please call your local HP sales office.

MICROPROCESSOR DEVELOPMENT SYSTEMS

Emulators, Analyzers, and Software Development (cont'd)

HP 64000 Series

HP 64700 Modular Emulators/Analyzers

The following are examples of emulation/analyzer systems with PC interface software and the processors currently supported. These are basic systems that do not include the software performance analyzer, interfaces, or LAN card for HP 9000 and Sun workstations, or software available from VABs.

Microprocessor	Card cage HP 64700A	Emulator card model number	Emulation memory	Emulation memory model number	Emulation bus analyzer model number	PC interface software	Price
Advanced Micro Devices (AMD)							
Am29000	●	64774G	0		64704A	●	$40,490
Am29050		64774K	512 KB	64774Y			$44,140
			1 MB	64774Z			$47,790
AT&T							
AT&T DSP32C	●	64773G	64 KB		64704A	●	$32,660
Hitachi							
H8/510	●	64732A	128 KB	64726A	64703A	●	$22,690
			512 KB	64727A			$25,890
			1 MB	64728A			$27,440
H8/325	●	64734F	128 KB	64725A	64706A	●	$17,090
647180X	●	64735F	128 KB	64725A	64706A	●	$17,590
H8/330	●	64736F	128 KB	64725A	64706A	●	$17,090
H8/532	●	64737F	128 KB	64725A	64706A	●	$17,590
H8/520	●	64738F	128 KB	64725A	64706A	●	$17,390
H8/536	●	64739A	128 KB	64725A	64706A	●	$17,790
PA/10 PGA/QFP	●	64781A/B	256 KB		64704A	●	$30,490
Intel							
8086/8087	●	64762G	128 KB		64706A	●	$15,865
		64762H	512 KB				$21,990
8088/8087	●	64763G	128 KB		64706A	●	$15,865
80186EA/XL, 80C186EA/XL, 80188EA/XL (Emulation control card)	●	64767A (64748C)	1 MB		64706A	●	$20,190
80186EB/C186EB/188EB (Emulation control card)	●	64767B (64748C)	1 MB		64706A	●	$20,190
80186EC/C186EC/188EC (Emulation control card)	●	64767C (64748C)	1 MB		64706A	●	$20,190
80C286	●	64766H	128 KB		64704A	●	$25,985
80C196	●	64771G	64 KB		64704A	●	$18,305
80960KA/KB	●	64760G	0		64705A	●	$25,025
			256 KB	64171A			$26,225
			1 MB	64171B			$29,025
80960SA/SB	●	64761A	0		64704A	●	$17,490
			256 KB	64171A			$18,690
			1 MB	64171B			$21,490
8051, DIP	●	64788G	128 KB		64704A	●	$20,965
8051, PLCC	●	64788H	128 KB		64704A	●	$20,965
Mitsubishi							
MELPS 7700	●	64145F	128 KB	64726A	64706A	●	$19,190
			512 KB	64727A			$22,390
Motorola							
68000 DIP (Emulation control card)	●	64744B (64744A)	60 KB		64706A	●	$15,090
			256 KB	64171A			$16,290
			1 MB	64171B			$19,090
68000/HC001 PGA (Emulation control card)	●	64744C (64744A)	60 KB		64706A	●	$15,090
			256 KB	64171A			$16,290
			1 MB	64171B			$19,090
68000/HC001 PLCC (Emulation control card)	●	64744D (64744A)	60 KB		64706A	●	$15,090
			256 KB	64171A			$16,290
			1 MB	64171B			$19,090
68EC000 PLCC (Emulation control card)	●	64744E (64744A)	60 KB		64706A	●	$15,090
			256 KB	64171A			$16,290
			1 MB	64171B			$19,090
68302, PGA	●	64746G	128 KB		64703A	●	$23,540
		64746J	0				$23,090
			256 KB	64171A			$24,290
			1 MB	64171B			$27,090

Microprocessor	Card cage HP 64700A	Emulator card model number	Emulation memory	Emulation memory model number	Emulation bus analyzer model number	PC interface software	Price
Motorola *(continued)*							
68EC020/020 (Emulation control card)	●	64748B	0		64704A	●	$22,490
		(64748C)	256 KB	64171A			$23,690
			1 MB	64171B			$25,490
68EC030/030 (Emulation control card)	●	64747B	0		64704A	●	$25,490
		(64748C)	256 KB	64171A			$26,690
			1 MB	64171B			$29,490
68332	●	64749G	0		64703A	●	$23,790
	●	64749H	512 KB			●	$29,040
68331	●	64749J	512 KB		64703A	●	$29,040
68340 (Emulation control card)	●	64751A (64748C)	256 KB	64171A	64704A	●	$23,690
			1 MB	64171B			$26,490
68040	●	64750A	512 KB		64704A	●	$45,390
National Semiconductor							
NS32532/32GX32	●	64772G	512 KB		64704A	●	$29,100
NS32GX320	●	64778G	0		64704A	●	$35,990
NS32FX16	●	64779G	2 MB		64703A	●	$31,540
NS32CG16	●	64779H	2 MB		64703A	●	$31,540
NS32CG160	●	64779J	2 MB		64703A	●	$31,540
HPC16003/16083	●	64775G	128 KB		64706A	●	$23,490
HPC16004/16064	●	64775H	128 KB		64706A	●	$23,490
HPC16400E	●	64775J	128 KB		64706A	●	$23,490
NEC							
V25, PLCC	●	64731F	128 KB	64726A	64706A	●	$18,190
			512 KB	64727A			$21,390
V25+	●	64754F	128 KB	64726A	64706A	●	$18,190
			512 KB	64727A			$21,390
V35+	●	64755F	128 KB	64726A	64706A	●	$18,190
			512 KB	64727A			$21,390
V33	●	64756F	128 KB	64726A	64703A	●	$22,590
			512 KB	64727A			$25,790
			1 MB	64728A			$27,340
V40	●	64791A	128 KB	64726A	64703A	●	$22,390
			512 KB	64727A			$25,590
			1 MB	64728A			$27,140
V50	●	64792A	128 KB	64726A	64703A	●	$22,390
			512 KB	64727A			$25,590
			1 MB	64728A			$27,140
V53	●	64757F	128 KB	64726A	64703A	●	$23,290
			512 KB	64727A			$26,490
			1 MB	64728A			$28,040
V70 20 MHz	●	64758G	512 KB		64706A	●	$26,190
		64758H	1 MB				$31,490
782XX series	●	64759F	128 KB	64725A	64706A	●	
7821X probe cable	●	64759F/001					$18,970
7822X probe cable	●	64759F/002					$19,110
7823X probe cable	●	64759F/003					$19,110
Texas Instruments							
TMS320C25, PGA	●	64787G	128 KB		64706A	●	$19,240
Zilog							
Z80	●	64753G	64 KB		64706A	●	$14,350

For the most current prices and product information, contact your local Hewlett-Packard sales office.

DIGITAL CIRCUIT TESTERS

Signature Multimeter and Analyzer

HP 5005B, 5006A

- Digital and analog measurements
- Single-probe measurements of logic signals, voltage, frequency
- 25-MHz multiple logic family signature analysis
- Full at-speed testing of digital products
- Composite signatures
- Signatures compared with signature memory

HP 5005B

HP 5006A

HP 5006A and HP 5005B Digital Troubleshooting

Signature Analysis

Signature analysis is a fast and accurate method for troubleshooting digital circuits. Finding faults is reduced to tracing signal flow and comparing measured signatures to printouts or computer-stored signatures. A signature is a 16-bit cyclic redundancy code (CRC) generated for blocks of data. Instead of entire bit streams, only signatures are compared to detect errors.

HP's patented signature analysis technique enables the HP 5005B or HP 5006A to generate a compressed, four-digit "fingerprint" or signature of a digital data stream at a logic node. Any fault associated with a device connected to the node will force a change in the data stream and produce an erroneous signature.

The Technique

Troubleshoot with signature analysis by probing a circuit, reading the display, and comparing to the known-good signature. Reference signatures can be generated by probing an operational circuit, or by external stimulation.

Many features of the HP 5005B and HP 5006A simplify troubleshooting procedures:

- Compatibility with multiple logic families: preset threshold levels (TTL, CMOS, and ECL for the HP 5005B; TTL and CMOS for the HP 5006A) and adjustable thresholds (+12.5 V to −12.5 V) simplify use with a wide variety of logic devices
- 25-MHz clock frequency: signature analysis is possible for high-speed circuits such as CRT controllers
- Qualified signature mode: fault isolation in complex products can be done quickly by windowing the signature collection to specific modules or devices with no major test setup changes
- HP-IB programmability: every HP 5005B and HP 5006A measurement and control function can be programmed through HP-IB

Time Savers

Two features save time when troubleshooting without a computer-aided system: composite signatures, and signature memory. A composite signature is the binary sum of individual signatures. The HP 5005B and HP 5006A compute composite signatures for any grouping of digital signals (such as bus or IC). Only the composite signature need be compared to a documented reference signature if all signals for that group are good.

Signatures are stored in memory after the probe switch is pushed. The memory stores the last 32 readings. Signatures can be compared in groups, not after every probe, by reviewing memory in the RECALL mode.

HP 5005B Signature Multimeter

Total checkout of a digital system often requires characterizing both digital data activity and analog signal parameters. The HP 5005B Signature Multimeter offers, in a single instrument, a meaurement set optimized for digital troubleshooting applications. Digital multimeter functions for checking power supplies and circuit board integrity, universal counter features for measuring clock frequencies and time intervals between signals, and a means for verifying the analog integrity of active digital signals are all included in the HP 5005B Signature Multimeter.

Digital Multimeter

Certain digital problems result from analog circuit failures: a low power supply voltage, an open or shorted circuit path, a faulty A/D or D/A converter. Each may contribute to a system failure. The HP 5005B contains a 4 1/2-digit dc voltmeter, ohmmeter, and differential voltmeter. Performance is tuned for analog measurements necessary for digital troubleshooting.

Frequency Counter

The HP 5005B counter functions provide totalize and frequency measurements to 50 MHz and time interval measurements with 100 nanosecond resolution. Intended to extend digital troubleshooting capabilities, the counter functions can characterize one-shots and timers (time interval measurement), test interrupt lines, reset lines and RS-232 asynchronous interfaces (totalize), and verify clock and clock driver circuitry (frequency measurement).

Voltage Threshold

Logic level degredation is a common and troublesome malfunction in digital products. The HP 5005B's peak voltage measurement mode provides a simple, direct method for measuring the logic high and logic low voltages of active digital signals.

When in peak voltage measurement mode, the HP 5005B characterizes and displays either the greatest (positive peak) or lowest (negative peak) voltage probed. Selection of positive peak or negative peak modes displays the appropriate measured threshold for comparison against the specifications of the logic family.

Multifunction Probe

The HP 5005B multifunction probe automates access to the signature analyzer, multimeter, and counter functions through a single probe. Signal multiplexing to the appropriate function is internal to the HP 5005B. A switch located on the side of the probe allows the operator to trigger automatic measurement. The analog parameters and functional digital operation can be characterized by probing the same point.

HP 5005B and HP 5006A Specifications

Common Signature Specifications

Display: 4 digits. Characters 0-9, ACFHPU
Probe: Logic level lamps: high, low, open, pulsing; minimum pulse width: 10 ns
Fault Detection: 100% of single-bit errors; 99.998% of multiple-bit errors
Minimum Gate Length: 1 clock cycle (1 data bit) between START and STOP
Maximum Gate Length: No limit
Minimum Timing Between Gates: 1 clock cycle between STOP and START

Data Probe Timing
Setup time: 10 ns (data to be valid ≃10 ns before clock edge)
Hold time: 0 ns (data held until clock edge)

START, STOP, QUAL Timing
Setup time: 20 ns (signals valid ≃20 ns before clock edge)
Hold time: 0 ns (data held until clock edge)

CLOCK Timing
Maximum clock frequency: 25 MHz
Minimum pulse width: 15 ns in high or low state

HP 5006A Unique Specifications

Input Impedance
Probe: 50 k Ω to ground nominal
Pod: 100 K Ω to ground nominal

Overload Protection

Probe:	**Pod:**
±150 V continuous	±20 V continuous
±250 V intermittent	±140 V intermittent
250 Vac for 1 minute	±140 Vac for 1 minute

CMOS sense: 20 Vdc maximum

TTL Thresholds
Probe: Logic one: 2 V + .2 – .3; logic zero: 0.8 V + .3 – .2
Pod: 1.4 V ± .6

CMOS Thresholds
Logic one: 70% of sensed voltage
Logic zero: 30% of sensed voltage

Other
Lamps: Key status: recall, edit, signature latch, unstable latch, qualify mode, timing polarities. Programmable (Option 040): remote, talk, listen, SRQ. Status: composite signature, gate, unstable
Selectable power: 115 V + 10-25% ac line, 48-440 Hz. 230 V + 10-15% ac line, 48-66 Hz. 25 VA maximum
Operating environment: Temperature: 0-55° C. humidity: 95% RH at +40° C; altitude: 4600 m (15,000 ft)
Size: 89 mm H × 216 mm W × 279 mm D (3.5 in × 8.5 in × 11 in)
Weight: Net 2.4 kg (5.3 lb); shipping: 4.1 kg (9 lb)

HP 5005B Unique Signature Specifications

Qualify Mode: Data clock qualified by external signal. DATA probe input impedance ≃50 k Ω to the average value of "0" and "1" threshold settings (±6 V max.); 15 pF.
Front Panel Indicators: Flashing GATE light indicates detection of valid START, STOP, CLOCK conditions. Flashing UNSTABLE light indicates a difference between 2 successive signatures and possible intermittent faults.

Logic Thresholds
Preset thresholds: TTL, ECL, CMOS
Adjustable thresholds: Each threshold can be adjusted to ±12.5V in 50 mV steps, accuracy is ±.2 V.
Logic threshold circuitry: Operative during NORM, QUAL, kHz, TOTLZ and ms measurements.

HP 5005B Multimeter Specifications

Frequency
Display: 5 digits
Ranges: 100 kHz, 1 MHz, 10 MHz, 50 MHz, autoranged
Resolution: 1 LSD (1 Hz on 100 kHz range)
Accuracy: ±0.01% of reading ±1 count
Minimum pulse width ≃10 ns in high or low state
Gate time ≃1 s, fixed
Input impedance ≃50 k Ω to the average value of "0" and "1" threshold settings (±6 V max); 15 pF

Totalizing
Display: 5 digits
Range: 0 to 99, 999 counts
Resolution: 1 count
Maximum input frequency ≃50 MHz with a minimum pulse width of 10 ns and a minimum pulse separation of 10 ns
Minimum START/STOP pulse width ≃20 ns
DATA input impedance ≃50 k Ω to the average value of "0" and "1" threshold settings (+6 V max); 15 pF
START/STOP input impedance ≃100 k Ω; 15 pF

Time Interval
Display: 5 digits
Ranges: 10 ms, 100 ms, 1 s, 10 s, 100 s, autoranged
Resolution: 1 count (100 ns on 10 ms range)
Accuracy: ±0.01% of reading ±2 counts
Minimum START/STOP pulse width ≈20 ns
START, STOP input impedance ≃100 k Ω

Resistance
Display: 4 or 5 digits, depending on range
Ranges: 30 kΩ, 300 kΩ, 1 MΩ, 3 MΩ, 10 MΩ, autoranged
Accuracy: (at 15°C–30°C)

Range	Full Scale	Accuracy	Display Resolution
30 k Ω	29.999 k Ω	±1% of reading ±2 Ω	1 Ω
300 k Ω	299.99 k Ω	±1% of reading	10 Ω
1 M Ω	999.9 k Ω	±1% of reading	100 Ω
3 M Ω	2999. k Ω	±10% or reading	1 k Ω
10 M Ω	10000. k Ω	±10% of reading	10 k Ω
Input impedance ≃ 20 k Ω to ±2 V			

dc Voltage
Display: 4½ digits
Ranges: ±25 V, ±250 V, autoranged; referenced to earth ground
Accuracy: (at 15° C–30° C)

Range	Accuracy	Resolution
25 V	±0.1% of reading ±2 mV	1 mV
250 V (<100 V)	±0.25% of reading ±20 mV	10 mV
250 V (≥100 V)	±0.25% of reading ±20 mV	100 mV
Input impedance ≃ 10 M Ω		

Differential Voltage
Reading: reads voltage at probe; displays difference between reading and voltage at the time ΔV key was depressed.
Specifications: See dc Voltage. Range is determined by the larger of the two compared voltages.

Peak Voltage
Display: 3½ digits
Range: 0–±12 Vp
Resolution: 50 mV
Accuracy: ±2% of reading ±5% of p-p signal ±100 mV
Minimum peak duration ≃10 ns
Maximum time between peaks ≃50 ms
Input impedance ≃100 k Ω; 15 pF

Other
Data Probe Protection:
Continuous overload
dcV, ΔV, k Ω modes only: ±250 V ac/dc
All other modes: ±150 V ac/dc, 20 V rms at input frequencies >2 MHz
Intermittent overload: ±250 V ac/dc (up to 1 min), all modes
Timing Pod Protection:
Continuous overload: ±100 V ac/dc, 20 V rms (input frequencies > 2 MHz)
Intermittent overload: ±140 V ac/dc (up to 1 min)
Operating Temperature: 0° C to +55° C
Power: selectable 100 V, 120 V, 220 V or 240 V ac line (+5%–10%), 48-66 Hz, 35 VA maximum
Weight: Net: 5.5 kg (12.0 lb); shipping: 8.7 kg (19 lb)

Ordering Information

	Price
HP 5005B Signature Multimeter	$8,500
Opt 910 Additional Manual	+$130
HP 5006A Signature Analyzer	$3,000
Opt 40 HP-IB Interface	+$300
Opt 910 Additional Manual	+$16.50
HP 5060-0173 Half Rack Mount Kit, HP 5006A	$95 ☎

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For the most current prices and product information, contact your local Hewlett-Packard sales representative.

DIGITAL CIRCUIT TESTERS

Logic Troubleshooting Components

HP 545A, 546A, 547A, 548A

HP 545A TTL/CMOS Logic Probe

The HP 545A Logic Probe contains all the features built into other HP probes, plus switch-selectable, multi-family operation and built-in pulse memory. Employing straightforward one-lamp display, the HP 545A operates from 3 to 18 volts in CMOS applications or from 4.5 to 15 Vdc in the TTL mode while maintaining standard TTL thresholds.

The probe's independent, built-in pulse memory and LED display help you capture hard-to-see intermittent pulses. Connect the probe tip to a circuit point, reset the memory, and wait for the probe to catch hard-to-find glitches.

The hand-held HP 545A is light, rugged, overload protected, and very fast: 80 MHz in TTL, 40 MHz in CMOS. Handy power supply connectors easily hook up to supply voltage almost anywhere in the unit under test.

HP 545A Probe Specifications

Input Current: ≤15 μA (source or sink)
Input Capacitance: ≤15 pF
Logic Thresholds
*__TTL:__ Logic one 2.0 + 0.4, −0.2 V. Logic zero 0.8 + 0.2, −0.4 V
CMOS: 3−10 Vdc supply
Logic one: $0.7 \times V_{supply} \pm 0.5$ Vdc
Logic zero: $0.3 \times V_{supply} \pm 0.5$ Vdc
CMOS: ≥10−18 Vdc supply
Logic one: $0.7 \times V_{supply} \pm 1.0$ Vdc
Logic zero: $0.3 \times V_{supply} \pm 1.0$ Vdc
Input Minimum Pulse Width: 10 ns using ground lead (typically 20 ns without ground lead)
Input Maximum Pulse Repetition Frequency: TTL, 80 MHz; CMOS, 40 MHz
Input Overload Protection: ±120 V continuous (dc to 1 kHz); ±250 for 15 seconds (dc to 1 kHz)
Pulse Memory: Indicates first entry into valid logic level; also indicates return to initial valid level from bad level for pulse ≥1 μs wide
Power Requirements
TTL: 4.5 to 15 Vdc*
CMOS: 3 to 18 Vdc
Maximum current: 70 mA
Overload protection: ±25 Vdc for one minute
Accessory Included: Ground clip
* +5 ±10% Vdc power supply; usable to +15 Vdc with slightly increased logic low threshold.

HP 546A Logic Pulser

The Logic Pulser solves the problem of how to pulse IC's in digital circuits. Touch the Pulser to the circuit under test, press the pulse button and all circuits connected to the node (outputs as well as inputs) are briefly driven to their opposite state. No unsoldering of IC outputs is required. Pulse injection is automatic, high nodes are pulsed low and low nodes high each time the button is pressed.

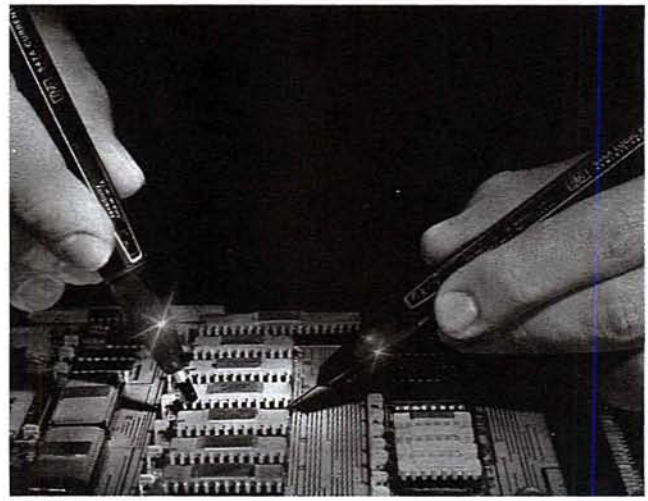
Several features of the HP 546A—automatic polarity pulse output, pulse width, and amplitude—simplify multi-family operation. To deliver a continual or specific-length pulse stream, the Pulser is programmable. Choose from several output patterns: single pulses; pulse streams of 1, 10, or 100 Hz; bursts of 10 or 100 Hz; or bursts of 10 or 100 pulses. Used with HP multi-family IC Troubleshooters, the HP 546A can be a voltage and current source for digital troubleshooting applications.

HP 546A Pulser Specifications

Output

			Typical Output Voltage	
Family	Output Current	Pulse Width	HIGH	LOW
TTL/DTL	≤650 mA	≥0.5 μs	≥3 Vdc	≤0.8 Vdc
CMOS	≤100 mA	≥5.0 μs	≥(V_{supply} − 1 Vdc)	≤0.5 Vdc

Power Supply Requirements: TTL; 4.5 to 5.5 Vdc at 35 mA, CMOS; 3 to 18 Vdc at 35 mA, protected to ±25 Vdc for 1 min



HP 547A/546A

HP 547A Digital Current Tracer

The HP 547A Current Tracer precisely locates low-impedance faults in digital circuits by locating current sources or sinks. On a bad node, the Tracer can verify that the driver is functioning and locate problems by tracing current flow to the source or sink causing the node to be stuck. The Tracer is designed to troubleshoot circuits carrying fast rise-time current pulses. The Tracer displays transitions, single pulses, and pulse trains using a simple one-light indicator. Because it is not voltage sensitive, the Tracer operates on all logic families having current pulses exceeding 1 mA, including CMOS where even lightly-loaded outputs can have up to 2 to 3 mA of instantaneous charging current.

HP 547A Current Tracer Specifications

Input
Sensitivity: 1 mA to 1 A
Frequency response: Light indicates single-step current transitions; single pulses ≥50 ns in width; pulse trains to 10 MHz (typically 20 MHz for current pulses ≥10 mA)
Risetime: Light indicates current transitions with risetime ≤200 ns at 1 mA
Power Supply Requirements
Voltage: 4.5 to 18 Vdc
Input current: ≤75 mA
Maximum ripple: ±500 mV above 5 Vdc
Overvoltage protection: ±25 Vdc for one minute

HP 548A Logic Clip

The HP 548A Logic Clip is an extremely handy service and design tool which clips onto dual-inline package (DIP) ICs and instantly displays the states of up to 16 pins simultaneously. The 16 LEDs independently follow level changes at the associated pins. Lit diodes are logic high; extinguished diodes are logic low. The Logic Clip needs no power connections and has its own gating logic for locating ground and V_{cc} pins. Buffered inputs reduce circuit loading.

HP 548A Specifications

Input Threshold: (≥0.4 ±0.06 × Supply Voltage) = Logic High
Input Impedance: 1 CMOS load per input
Input Protection: 30 Vdc for 1 minute
Supply Voltage: 4-18 Vdc across any two pins
Auxiliary Supply Input: 4.5 to 20 Vdc applied via connector. Supply must be ≥1.5 Vdc more positive than any pin of IC under test.
Supply Current: <55 mA

DIGITAL CIRCUIT TESTERS

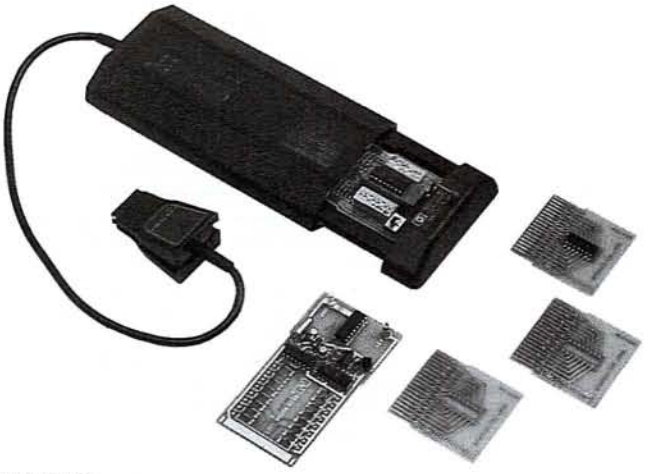
Logic Comparator and Troubleshooting Kits

HP 10529A, 5011T, 5021A, 5022A, 5023A, 5024A

- Stimulus-response capability
- In-circuit fault finding

HP 10529A

- Dynamic and static testing
- Multi-pin testing



HP 5022A

HP 10529A Logic Comparator

The HP 10529A Logic Comparator clips onto powered TTL or DTL ICs and detects functional failures. In-circuit ICs are compared with a known-good reference IC inserted in the Comparator. Pins are identified as output or input by setting 16 miniature switches. Any logic state difference between the test and reference ICs is indicated by a lighted LED. Intermittent errors as short as 300 ns are detected using the socket board and indicated visually. A test board is supplied to confirm correct operation of all Comparator circuitry, test leads, and display elements.

Additional blank reference boards are available separately (HP 10541A). Twenty pre-programmed reference boards are available (HP 10541B) to support testing for 7400, 7402, 7404, 7408, 7410, 7420, 7430, 7440, 7451, 7454, 7473, 7474, 7475, 7476, 7483, 7486, 7490, 7493, 74121, and 9601 ICs.

HP 10529A Specifications

Input Threshold: 1.4 V nominal (1.8 V nominal with socket board), TTL or DTL compatible

Test IC Loading: Outputs driving Test IC inputs are loaded by 5 low-power TTL loads plus input of Reference IC. Test IC outputs are loaded by 2 low-power TTL loads.

Input Protection: Voltages < -1 V or > 7 V must be current limited to 10 mA

Supply Voltage: 5 V $\pm 5\%$, at 300 mA

Supply Protection: Supply voltage must be limited to 7 V.

Maximum Current Consumption: 300 mA

Sensitivity

Error sensitivity: 200 ns with reference board or 300 ns with socket board. Errors greater than this are detected and stretched to at least 0.1 second

Delayed variation immunity: 50 ns. Errors shorter than this value are considered spurious and ignored

Frequency Range: Maximum operational frequency varies with duty cycle. An error existing for a full clock cycle will be detected if the cycle rate is less than 3 MHz.

Accessories Included: 1 test board; 10 blank reference boards; 1 programmable socket board; 1 carrying case

Logic Troubleshooting Kits

Each of HP's IC Troubleshooters provide their own unique and important troubleshooting function. Together they become invaluable stimulus-response testing partners that help pinpoint faults and ensure fast non-destructive repair of digital circuits.

HP has packaged the IC Troubleshooters into kits which offer ordering convenience and cost savings. Applications information is available, such as AN 163-2, "New Techniques of Digital Troubleshooting," to help users derive maximum benefit from these instruments.

Fault	Stimulus	Response	Test Method
Shorted Node[1]	Pulser[2]	Current Tracer	• Pulse shorted node • Follow current pulses to short
Stuck Data Bus	Pulser[2]	Current Tracer	• Pulse bus line(s) • Trace current to device holding the bus in a stuck condition
Internally Open IC	Pulser[2]	Probe	• Pulse device input(s) • Probe output for response

[1] A node is an interconnection between two or more IC's.
[2] Use the Pulser to provide stimulus or use normal circuit signals, whichever is most convenient.

Ordering Information	Price
HP 545A Logic Probe	$320
HP 546A Logic Pulser	$410
HP 547A Digital Current Tracer	$750
Accessories (HP 545A, 546A, 547A)	
HP 00545-60104 Tip Kit for HP 546A, 545A	$80
HP 10526-60002 Multi-Pin Stimulus Kit	$100
HP 1250-1948 Adapter, Coax Str.	$25
HP 548A Logic Clip	$380
HP 10529A Logic Comparator	$1,600
Accessories (HP 10529A)	
HP 10541A Twenty Blank Reference Boards	$320
HP 10541B Twenty Pre-Programmed Boards	$490

IC Troubleshooter Kits Selection and Ordering

HP Model	545A TTL/CMOS Probe	546A TTL/CMOS Pulser	547A TTL/CMOS Current Tracer	548A TTL/CMOS Clip	10529A TTL Comparator	Price
5011T Kit	X	X		X	X	$2,670
5021A Kit	X	X		X		$1,090
5022A Kit	X	X	X	X		$1,830
5023A Kit	X	X	X	X	X	$3,400
5024A Kit	X	X	X			$1,460

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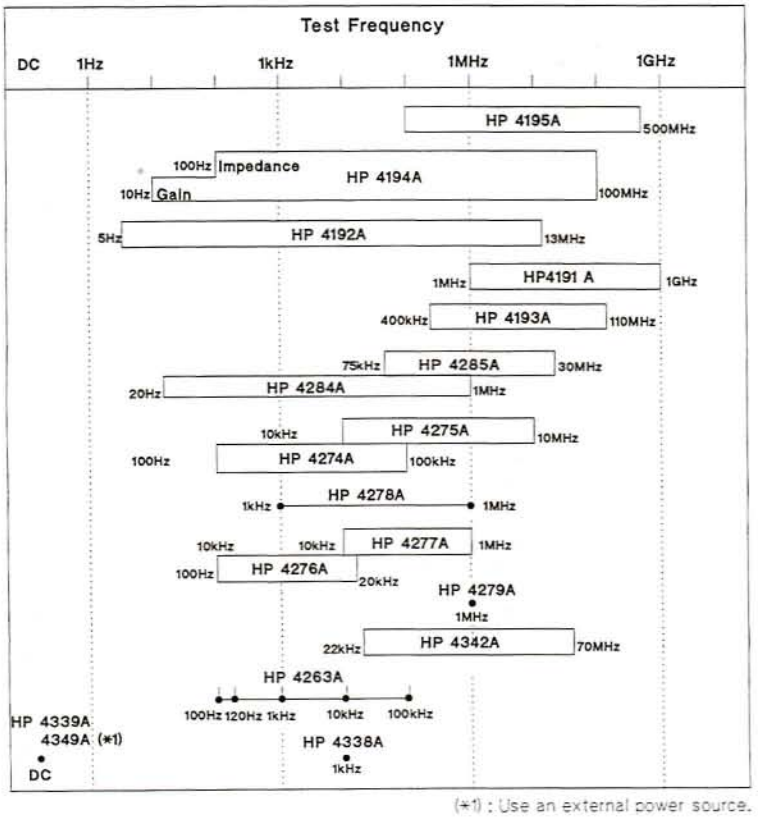
	Component/Material Manufacturer		Component User	
Application Area	R&D and QA	Production	Incoming Inspection	R&D
Major Requirements	Verify that device has sufficient performance	Perform GO/NO-GO testing based on MIL, IEC, etc.		Evaluate devices/circuits under actual working conditions
Required Measurement Functions	Multi-function/General Purpose Wide freq. range Auto freq. sweep Variable signal level & DC Bias Multi-parameter High accuracy and resolution	High Speed/Single Function High Speed Fixed frequency level & DC Bias Single parameter		Multi-funciton/General Purpose High frequency resolution Auto freq. sweep Variable signal level & DC Bias Multi-parameter High accuracy and resolution
HP 4195A				
HP 4194A				
HP 4192A				
HP 4191A				
HP 4193A				
HP 4284A/4285A				
HP 4274A/4275A				
HP 4278A				
HP 4276A/4277A				
HP 4279A				
HP 4263A				
HP 4342A				
HP 4338A				
HP 4339A/4349A				

Table 1. Component measurement applications and HP products



(*1) : Use an external power source.

Table 2. HP component measurement products versus test frequency

Note: Refer to page 285 for complete information of the HP 4195A

Component Measurement

An impedance-measuring instrument measures impedance characteristics of electronic components, materials, and circuits. HP impedance instruments provide:

- A broad product line, to fit each application.
- Full evaluation of impedance characteristics under conditions of varying frequency, test-signal level, and dc bias.
- High-precision, high-resolution impedance measurement, with error correction for test-lead or test-fixture effects.

Impedance-measuring instruments can be divided into two general categories: LCR meters and impedance analyzers. The LCR meter primarily measures the inductance, capacitance, and resistance of a test device. The impedance analyzer, in addition to all of the functions of the LCR meter, measures the impedance and phase of the test device, and makes detailed analysis of the impedance measurement.

The major applications of impedance-measurement instruments are in electronic-component materials manufacture and electronic equipment manufacture (electronic component users).

Table 1 shows the type of evaluation and the functions required according to instrument application.

Impedance measurements can be divided into two general categories:

- Tests of whether the test device functions properly under application conditions.
- Tests under conditions stipulated by MIL or IEC standards.

When type 1 measurements are conducted in a research and development department, the purpose is to shorten development time through careful evaluation. Therefore, a multi-function, general-purpose instrument for the measurement of many characteristics is required, such as an impedance analyzer or high-resolution LCR meter.

Type 2 measurements are conducted for go/no-go tests in manufacturing or incoming inspection. The measurement data are fed back to vendors or manufacturing processes for correction and improvement. Because of volume, test costs must be minimized. Therefore, a high-speed, single-function instrument may be used. Sorting and interpreting test results may be required, so an LCR meter with a comparator option can be used.

Table 2 shows Hewlett-Packard's line of instruments arranged according to measurement frequency and performance. Test frequencies of these instruments range from 5 Hz to 1 GHz, and some have fixed MIL/IEC standard frequencies between 1 kHz and 1 MHz.

Since Hewlett-Packard introduced the first digital LCR meter, the company has continued to create high-performance impedance-measurement instruments. Because of this effort, it is now possible for virtually anyone to make the most difficult impedance measurements with ease and great accuracy.

Variety of Available Test Fixtures and Cables

A variety of test fixtures and cables is available for the HP LCR meters for many applications. Figure 1 is a compatibility chart for the test fixtures and cables and HP's LCR meters. Refer to the individual LCR meter data sheet for details.

*1: Information given with cable length: Connector type, recommended frequency of use, maximum applicable dc voltage.

*2: Information given with recommended frequency of use: Maximum applicable dc voltage.

*3: Information given with cable length: Recommended frequency of use, maximum applicable dc voltage, (shape of UNKNOWN terminals).

*4: A cable with 7-mm connectors required

*5: HP 16034E, 16047A, 16089A/B/C/D, HP 16334A, and HP 16048A/B/D/E can be connected.

HP 16092A
with HP 16085B

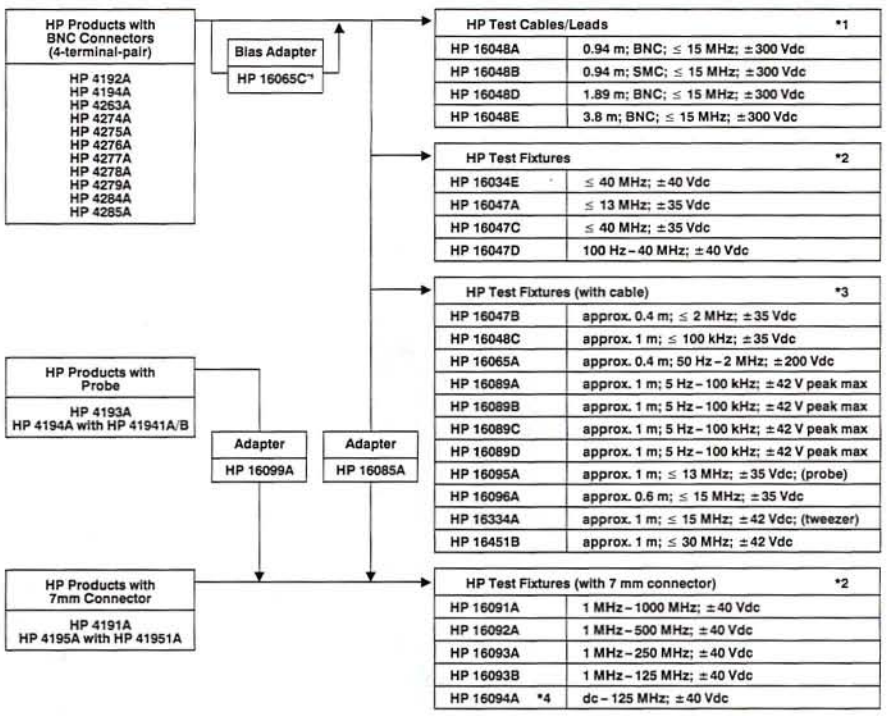


Figure 1. HP instruments versus accessories

HP 16047D

HP 16048A

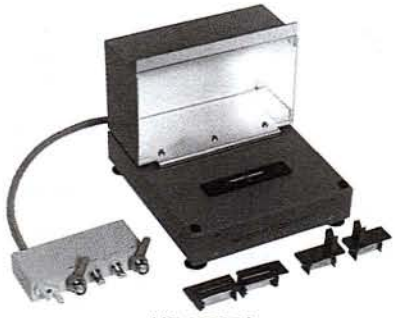
HP 16047C

HP 16034E

HP 16093A
with HP 16099A

Note: Refer to the sections of the HP 41941A/B and 41951A for more information.

HP 16334A



HP 16065A

HP 16451B

HP 16089B

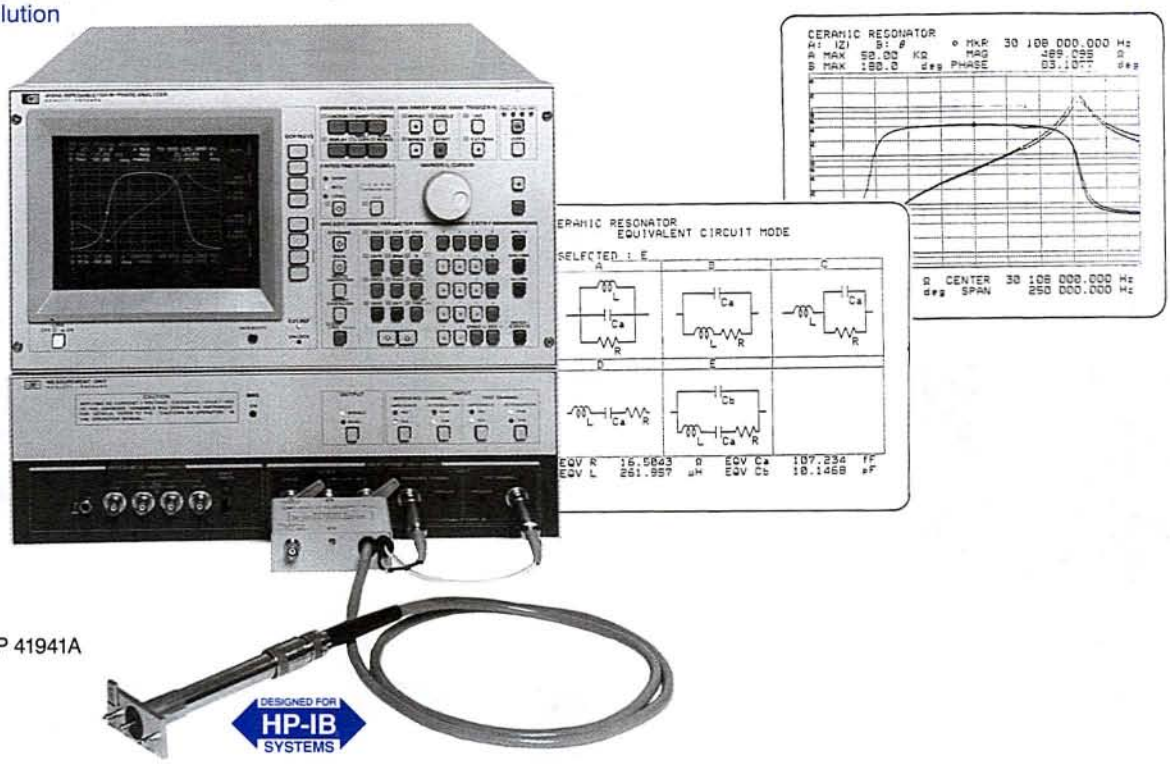
COMPONENT MEASUREMENT

Impedance/Gain-Phase Analyzer

HP 4194A

- High accuracy and wide range Impedance measurement:
  - 100 Hz to 40 MHz, 0.1 mΩ to 1.6 MΩ, 0.17%
  - 10 kHz to 100 MHz, 0.1 Ω to 1 MΩ, 1.5% when used with the HP 41941A/B

  Gain-phase measurement:
  - 10 Hz to 100 MHz, −107 dBm to +15 dBm, 0.1 dB resolution
- Flexible measurement, computation, and analysis capabilities on a color graphic display
- Fully programmable



HP 4194A with HP 41941A

HP 4194A Impedance/Gain-Phase Analyzer

The HP 4194A Impedance/Gain-Phase Analyzer is an integrated solution for efficient measurement and analysis or go/no-go testing of components and circuits. Detailed impedance and transmission characteristics, including secondary parameter derivations, can be simply and quickly evaluated or tested. The HP 4194A can contribute to improving engineering productivity and reducing test cost. The analyzer is flexible and has wide measurement capabilities in both impedance and transmission measurements. It is also fully programmable using Auto Sequence Programming (ASP). Desired measurements and computations, including graphics analysis, can be programmed simply by storing front-panel keystroke operations, allowing you to customize measurement, computation, and analysis functions. The HP 4194A also features high-accuracy and error elimination functions to ensure reliable measurements.

Wide Range Accurate Measurement

Featuring a wide test frequency range—100 Hz to 40 MHz for impedance measurements (10 kHz to 100 MHz when using the HP 41941A/B Impedance Probe Kit) and 10 Hz to 100 MHz for gain-phase measurements—the HP 4194A satisfies a wide spectrum of needs. Realistic device characteristics can be analyzed under actual operating conditions by varying the test frequency, test signal level, and dc bias. The HP 4194A's high degree of measurement accuracy—0.17 percent for impedance measurements (1.5 percent when using the HP 41941A/B) with an amplitude ratio of 0.1 dB—ensures that you'll improve the quality of your test devices.

Quick Analysis

The HP 4194A makes high-speed measurements, (approximately 3.7 ms per point), displays results on a color CRT, and performs parameter analysis of components and circuits quickly and efficiently, substantially reducing development and evaluation time. The analysis function not only provides you with impedance and transmission characteristics, but also allows you to determine secondary parameters. Using the marker and line cursor functions, you can obtain the resonating frequency of resonators and the pass band width of band pass filters quickly.

Equivalent Circuit Analysis Function

Using the HP 4194A's Equivalent Circuit Analysis Function, you can easily and quickly obtain those equivalent circuit constants that, until now, required a number of time-consuming, complicated calculations. By using measured values, this unique function can approximate the circuit constant values of five circuit models. For example, a resonator's equivalent circuit elements or a coil's self inductance, lead resistance, and stray capacitance can be easily obtained.

The Equivalent Circuit Analysis Function also simulates the frequency characteristics of components by using derived circuit values or values you specify. By using approximation and simulation, you can compare design values to measurement values, and thereby improve component design efficiency.

Auto Sequence Program (ASP)

The HP 4194A's ASP function, an internal programming feature, allows you to control all HP 4194A operations (measurement, display, and analysis) without the need for an external computer. By using ASP and actual measurement values, you can readily calculate many secondary parameters that you may need to evaluate. You can use the HP 4194A's powerful analysis functions to analyze these calculated parameters.

You can also use ASP to enhance such HP 4194A functions as alternate sweep, sweep timing control, and marker tracking. Because ASP eliminates the need for external controller, thereby eliminating data transfer time, the HP 4194A can quickly and efficiently perform production line go/no-go testing of components such as resonators and filters. All these features combine to increase your engineering and manufacturing productivity.

Increased Capabilities with the HP 41941A/B Impedance Probe Kit

When using the HP 4194A with the HP 41941A/B Impedance Probe Kit, you can perform reliable impedance evaluations up to 100 MHz. Measurement errors due to residual impedance and stray admittance are eliminated by using the calibration standards furnished with the HP 41941A/B and the HP 4194A's automatic calibration function. This makes it possible to make highly accurate measurements (basic measurement accuracy 1.5 to 3 percent) over a wide measurement range of 100 mΩ to 1 MΩ. Calibration accuracy is guaranteed to the tips of the HP 41941A (1.5 m) and HP 41941B (3 m) impedance probes.

The HP 41941A/B can be used as a grounded probe to evaluate the impedance of in-circuit components such as printed circuit patterns, and the input/output impedance of circuits. In addition, you can connect an external dc bias source directly to the HP 41941A/B to perform dc biased measurements up to ±150 V/0.5 A, to measure the dc characteristics of inductors, capacitors, materials, and semiconductors. To perform swept dc bias measurements, use the HP 4194A's ±40 V internal dc bias source.

Specifications

Impedance Measurements

Measurement Parameters: |Z|, |Y|, θ, R, X, G, B, L, C, D, Q. Twenty parameter combinations are available.
Test Frequency: 100 Hz to 40 MHz (Cable length: 0m), 100 Hz to 15 MHz (Cable length: 1 m), 1 mHz resolution.
OSC Level: 10 mV −1 Vrms (≤10 MHz), 10 mV −0.5 Vrms (>10 MHz) (UNKNOWN terminal open), 3-digit resolution
dc Bias: 0 to ±40 V, 10 mV resolution
Measurement Terminal: 4—terminal pair configuration
Measurement Range and Maximum Resolution:

Measurement parameter	Range	Max resolution
|Z|,R,X	10 mΩ to 100 MΩ	100 μΩ
|Y|,G,B	10 nS to 100 S	1 nS
θ	±180°	0.01°
L	1 nH to 100 kH	10 pH
C	10 fF to 0.1 F	0.1 fF
D	0.001 to 10	0.0001
Q	0.1 to 1000	0.1

Basic Measurement Accuracy: 0.17%
Level Monitor: 1 mV - 1 V rms, 1 μA −20 mA

Gain-Phase Measurements

Measurement Parameters: Tch/Rch (dB, Linear Ratio), Tch, Rch (V, dBm, dBV), θ(degree, rad), τ
Tch= Test Channel, Rch= Reference Channel, τ = Group Delay
Measurement Frequency: 10 Hz to 100 MHz, 1 mHz resolution
Aperture Frequency Range (Group Delay Measurements): 0.5% to 100% of frequency span
OSC Level: −65 dBm - +15 dBm, 0.1 dB resolution
Measurement Range:
Tch/Rch: 0 to ±120 dB, 0.001 dB resolution
Tch, Rch: −107 dBm - −5 dBm (0 dB Attenuator)
−87 dBm - +15 dBm (20 dB Attenuator)
0.001 dB resolution
θ: ±180° (can display phase continuously with the phase scale expansion function), 0.01° resolution
τ: 0.1 ns to 1 s, 0.1 ns resolution
Basic Measurement Accuracy
Tch/Rch: 0.1 dB, 0.5°
Tch, Rch: 0.35 dBm
Level Monitor: Monitor the input level of the reference and test channels in units of dBm, dBV and Volts.

Impedance Measurements Using the HP 41941A/B

The specifications listed below are for the HP 4194A when used with the HP 41941A/B.
Frequency Range: 10 kHz to 100 MHz, 1 mHz resolution
OSC Level: Opt 350: 10 mV to 1.28 V rms
Opt 375: 10 mV to 1.54 V rms
dc Bias: Internal: ±40 V, ±20 mA
External: ±150 V, ±500 mA, max 25 W
Measurement Range: 100 mΩ to 1 MΩ
Basic Measurement Accuracy:
±1.5% to 3% (≧ 100 kHz), ±3% to 6% (< 100 kHz)
Cable Length: HP 41941A: 1.5 m, HP 41941B: 3 m

Common Specifications

Trigger Mode: Internal, external, and manual
Sweep Capabilities
Sweep parameter: Frequency, OSC level, dc bias (impedance measurements only)
Entry: START/STOP or CENTER/SPAN
Sweep type: LIN, LOG, ZERO SPAN (dc Bias: LIN or ZERO SPAN only)
Number of measurement points: 2 to 401 points
Sweep functions: Partial sweep, expand markers sweep, program points measurement

Display

CRT: 7.5-in color CRT
Display Mode: Rectangular (X- A & B), rectangular (A - B), table
Display Control: Autoscale, superimpose, and storage

Analysis

Marker: Single, delta, double markers
Line-Cursor: Line-cursor, delta-line cursor
Equivalent Circuit Function: Approximation, simulation
Arithmetic Operation
Data register manipulation: Use arithmetic operations and functions to manipulate data registers
Go/no-go limits

Programming

Auto Sequence Program (ASP): Control the HP 4194A's operation with an internal program language. ASP can be entered using the front panel keys or downloaded from HP-IB.
Program Memory Size: 20 kB of nonvolatile memory
Copy: Dump, plot, print mode

General Specifications

Operating Temperature and Humidity: 0° C to 40° C
(HP 41941A/B: −20 to +65° C), ≤95% RH at 40° C
Storage Temperature: −30° C to +60° C
(HP 41941A/B: −40 to +65° C)
Safety: Based on IEC −348, UL −1244
Power: 100, 120, 220V ±10%, 240 V −10% + 5%, 48 to 66 Hz, 400 VA (max)
Size: 425 mm W × 375 mm H × 620 mm D (16.73 in × 14.76 in × 24.41 in)
Weight: Net, approximately 37 kg (81.4 lb)

Reference Data

Typical Measurement Speed
Impedance: Approximately 3.7 ms/point
Gain-phase: Approximately 3.5 ms/point
Impedance when used with the HP 41941A/B: Approximately 6 ms/point

Accessories Furnished

HP 16047D: Direct Coupled Test Fixture
HP 8120-1838: 30-cm BNC Cable (2 ea) (Opt 350)
HP 04194-61640: 30-cm BNC Cable (2 ea) (Opt 375)
HP 8120-1839: 60-cm NNC Cable (Opt 350)
HP 04194-61641: 60-cm NNC Cable (Opt 375)
HP 1250-0080: BNC Adapter

Accessories Available

Refer to page 347.

Ordering Information

	Price
HP 4194A Impedance/Gain-Phase Analyzer	$24,950
Opt 350* 50 Ω System	$0
Opt 375* 75 Ω System	$0
Opt W30 Extended Repair Service (see page 636)	+$455
Opt 001 High Stability Frequency Reference	+$850
HP 41941A* Impedance Probe Kit (1.5 m)	$1,770
HP 41941B* Impedance Probe Kit (3 m)	$1,770

*Must select either Opt 350 or 375

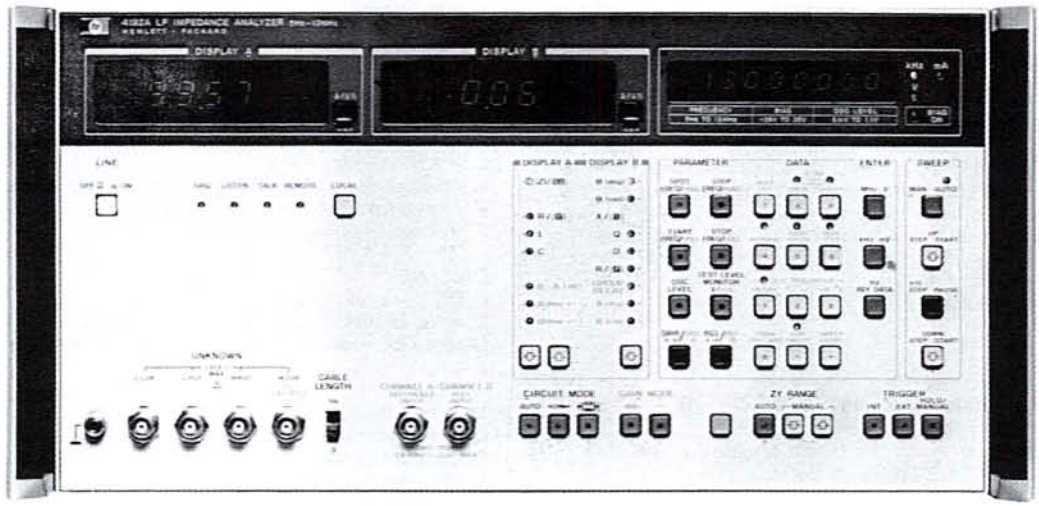
For the most current prices and product information, contact your local Hewlett-Packard sales office.

COMPONENT MEASUREMENT

LF Impedance Analyzer, 5 Hz to 13 MHz

HP 4192A

- 5 Hz to 13 MHz variable measuring frequency
- Gain-phase measurement: Amplitude, phase, group delay
- Floating or grounded devices
- Impedance measurement: |Z| • |Y| • θ • R • X • G • B • L • C • D • Q • Δ • Δ%
- Standard HP-IB



HP 4192A (shown with Option 907 handles)

DESIGNED FOR HP-IB SYSTEMS

HP 4192A LF Impedance Analyzer

The HP 4192A LF Impedance Analyzer performs both network analysis and impedance analysis on such devices such as telecommunication filters, audio/video electronic circuits, and basic electronic components. Both floating and grounded devices can be tested.

Automatic Swept Frequency Measurement of All Impedance Parameters

The HP 4192A can measure 11 impedance parameters (|Z|, |Y|, θ, R, X, G, B, L, C, D, Q) over a wide range |Z|: 0.1 mΩ to 1 MΩ; |Y|: 1 nS to 10 S).

The built-in frequency synthesizer can be set from 5 Hz to 13 MHz with a maximum resolution of 1 mHz. This feature allows accurate characterization of such high Q devices as crystals. Test signal level is variable from 5 mV to 1.1 V with 1 mV resolution. Also, an internal dc bias voltage source provides ±35 V at 10 mV increments. Thus, the HP 4192A can evaluate components and entire circuits at near actual operating conditions.

Specifications (Refer to data sheet for complete specifications.)

Measuring Signal (23 ±5° C)
- **Frequency range:** 5 Hz to 13 MHz
- **Frequency step:** 0.001 Hz (5 Hz to 10 kHz), 0.01 Hz (10 kHz to 100 kHz), 0.1 Hz (100 kHz to 1 MHz), 1 Hz (1 MHz to 13 MHz).
- **Frequency accuracy:** ±50 ppm
- **OSC level:** 5 mV to 1.1 V rms variable into 50 Ω (amplitude-phase measurement) or open circuit (impedance measurement).
- **OSC level step:** 1 mV (5 mV to 100 mV), 5 mV (100 mV to 1.1 V).
- **OSC level accuracy:** 5 Hz to 1 MHz: ±((5 + 10/f)% of setting +2 mV) where f is in Hz. 1 MHz to 13 MHz: ±((4 + 1.5 × F)% of setting + 2 mV) where F is in MHz.
- **Level monitor** (impedance measurement): Current through or voltage across sample can be monitored
- **Control:** Spot and sweep via front panel or HP-IB

Measuring Mode
- **Spot measurement:** At specific frequency (or dc bias)
- **Swept measurement:** Manual or automatic sweep from START to STOP frequency (or dc bias) at selected STEP frequency (or dc bias) rate
- **Sweep mode:** Linear or logarithmic (frequency only)

Recorder Outputs: Output dc voltage proportional to each measured value, and frequency or dc bias.
- **Maximum output voltage:** ±1 V
- **Output voltage accuracy:** ±(0.5% of voltage +20 mV)

Key Status Memory: Five sets of measuring conditions can be stored and recalled at any time.
HP-IB Data Output and Remote Control: Standard
Self-Test: Automatic introspective testing
Trigger: Internal, external, manual, or HP-IB

Amplitude-Phase Measurement

Parameter Measured: Relative amplitude B-A (dB) and phase θ (degrees or radians), B-A and group delay, absolute amplitude A (dBm or dBV) or B (dBm or dBV), and deviation (Δ, Δ%) of all parameters
Reference Amplitude: 0 dBV = 1 V rms, 0 dBm = 1 mW (with 50 Ω termination)
OSC Output Resistance: 50 Ω
Channels A and B: Input impedance: 1 MΩ ±2%, shunt capacitance: 25 pF ±5 pF
Display Range and Resolution
- **B-A:** 0 to ±100 dB, 0.001 dB (0 to ±20 dB), 0.01 dB (±20 to ±100 dB)
- **θ:** 0 to ±180°, 0.01°
- **Group delay:** 0.1 ns to 19 s, max. resolution 4½ digits
- **A or B:** +0.8 to −100 dBV, 0.001 dB (> −20 dB), 0.01 dB (≤ −20 dB), +13.8 to −87 dBm, 0.001 dB (> −20 dBm), 0.01 dB (≤ −20 dBm)

Measuring Accuracy (23 ±5° C): Specified at BNC unknown terminals after 30-minute warmup (test speed: normal or average)
B-A (relative amplitude) and θ (phase) Measurement: Determined by sum of channel A and B accuracies given below (accuracy of each channel changes according to absolute input level)

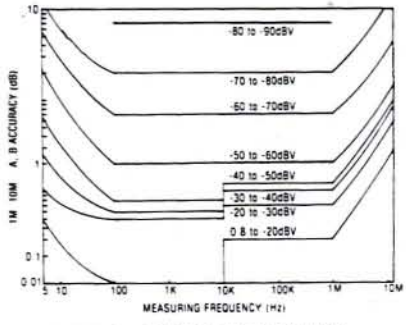


FIGURE 1 : GAIN MEASUREMENT ACCURACY

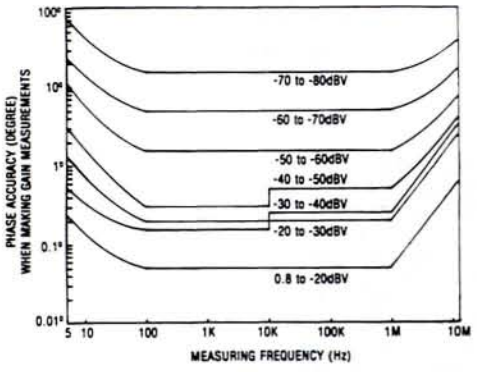


FIGURE 2 : PHASE ACCURACY WHEN MAKING GAIN MEASUREMENT

Impedance Measurement

Parameter Measured: $|Z| - \theta$, $|Y| - \theta$, R – X, G – B, L – D · Q · R · G, C – D · Q · R · G and deviation (Δ, $\Delta\%$) of all parameters
Display: 4½ digits, max. display 12999 counts, 19999 for L & C.
Circuit Mode: Series equivalent circuit (–∿∿–□–) and parallel equivalent circuit (–□–∿∿–). Automatic selection available.
Auto ZERO Adjustment: Automatic normalization of the readout offset due to residuals of the test fixture by pushbutton operation (at spot frequency)
Measuring Range and Accuracy (23 ±5° C)**:** Specified at BNC unknown terminals after 30 minute warmup when OSC level is more than 0.1 V and when auto ZERO adjust is performed (test speed: normal or average). Accuracy given below is only valid when the measured value is equal to full scale of each range.
|Z| – θ, R – X Measurement: Range: |Z|, R, X: 0.1 m Ω to 1.2999 M Ω; θ: −180.00° to +180.00°. Accuracy: R accuracy (D ≥ 10); X accuracy (D < 1)

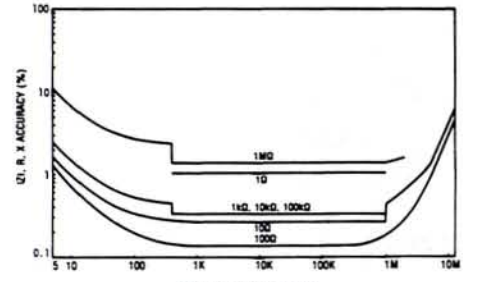


FIGURE 3 : |Z|, R, X ACCURACY

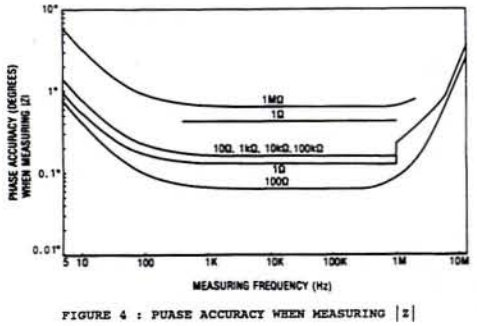


FIGURE 4 : PHASE ACCURACY WHEN MEASURING |Z|

|Y| – θ, G – B Measurement: Range: |Y|, G, B: 1 nS to 12.999 S; θ: −180.00° to +180.00°. Accuracy: G accuracy (D > 1); B accuracy (D ≤ 0.1).

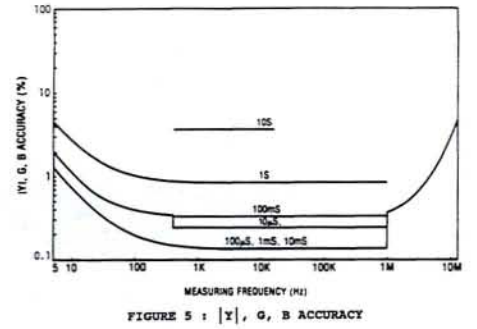


FIGURE 5 : |Y|, G, B ACCURACY

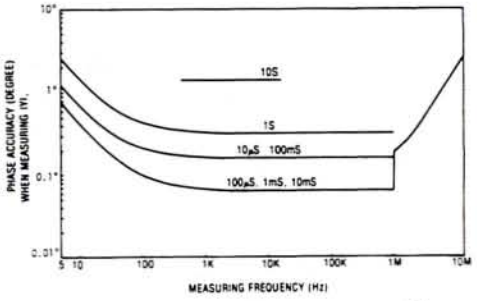


FIGURE 6 : PHASE ACCURACY WHEN MEASURING |Y|

L – D · Q, C – D · Q Measurement: (automatically calculated from measured Z/Y values)

Parameter	Measuring range*	Basic accuracy
L	0.01 nH to 1000 H	0.27%
C	0.1fF to 199** mF	0.15%
D(1/Q)	0.0001 to 19.999	0.001 (C-measurement) 0.003 (L-measurement)

*Varies with measuring frequency except for D(1/Q)
**Accuracy of C ranges over 100 mF is not specified

Internal dc Bias: Standard (impedance measurement only)
Voltage range: −35 V to +35 V, 10 mV step
Setting accuracy (23 ±5° C): 0.5% of setting +5 mV
Bias control: Spot and swept, using front panel controls or HP-IB

General Specifications

Measuring Time (high speed mode)
B-A and θ, A or B: 88 to 127 ms (≥ 400 Hz)
Impedance parameters: 58 to 91 ms (≥ 1 kHz)
Test Level Monitor Range (impedance measurement)
Voltage: 5 mV to 1.1 V
Current: 1 µA to 11 mA
Operating Temperature: 0 to 55° C, ≤ 95% RH at 40° C
Power: 100, 120, 220 V ±10%, 240 V + 5% to −10%, 48 to 66 Hz, 150 VA max.
Size: 425.5 mm W × 235 mm H × 615 mm D (16.75 in × 9 in × 22.6 in)
Weight: Approximately 19 kg (41.9 lb)
Furnished Accessories and Parts: HP 16047A test fixture, HP 11048C 50 Ω feed thru terminations (2 ea), power splitter, HP 11170A BNC cables (2 ea), BNC adapter

Ordering Information

	Price
HP 4192A LF Impedance Analyzer	$17,200

Accessories

HP 16095A Probe Fixture	$840
HP 16096A 2-Port Component Test Fixture	$1,570
HP 16097A Accessory Kit	$2,395
HP 16047C Test Fixture	$315
HP 16048A Test Leads (BNC connector)	$345
HP 16048C Test Leads with Alligator Clip	$440

Refer to page 347 for accessories.

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office. See page 345.

COMPONENT MEASUREMENT

RF Impedance Analyzer

HP 4191A

- 1 to 1000 MHz variable test frequency with sweep capability
- Direct reading of $|Z| - \theta$, $|Y| - \theta$, $|\Gamma| - \theta$; L • C – R • G • D • Q R – X, G – B, Γx – Γy
- High resolution—4½ digit max
- Wide measuring range—1 m–100 k (|Z|)
- Versatile, easy-to-use test fixtures

HP 4191A (Shown with Option 907 Handles)

DESIGNED FOR HP-IB SYSTEMS

HP 4191A RF Impedance Analyzer

The HP 4191A RF Impedance Analyzer measures 14 parameters with a maximum resolution of 4½ digits. The internal synthesizer provides variable frequencies from 1 MHz through 1000 MHz covering the UHF, VHF, and video bands with automatic sweep capability. An internal dc bias supply with auto sweep function covers the voltage range of ±40 V in 10 mV steps.

The HP 4191A permits reliable measurements over a wide measuring range. Its outstanding repeatability, frequency response, and accuracy are made possible by a unique error-correction capability and specially designed test fixtures. These features allow the HP 4191A to be used in evaluating electronic materials, components, and circuitry.

The internal synthesizer provides a maximum resolution of 100 Hz (Option 002) with an accuracy of 3 ppm, allowing small changes in the resonant frequency of the device under test to be easily detected. The swept frequency capability aids in the analysis of frequency characteristics of the device.

Two complete front-panel settings (parameter selection and the sweep control) can be stored in a non-volatile memory and recalled at any time with a single key operation. This, together with the standard HP-IB interface, makes the HP 4191A extremely efficient as either a standalone or a systems instrument.

These unique features permit very wide applications in: (1) semiconductor testing such as surface state evaluation at high frequencies (C-V/G-V and conductance (G/ω-ω) characteristics), and the input/output impedance evaulation of diodes and transistors, (2) resonator, filter, and magnetic and dielectric materials testing, (3) evaluation of LCR components such as high-frequency chip and leaded components, and (4) testing of communications-related components such as cables, connectors, etc.

Specifications (Refer to data sheet for complete specifications.)

Parameter Measured: $|Z| - \theta$, $|Y| - \theta$, $|\Gamma| - \theta$, R – X, G – B, Γx – Γy L–R • G • D • Q, C–R • G • D • Q

Display: 4½ digit, max display 19999 counts

Deviation Measurement (deviation from stored reference)
Δ: −19999 to +19999 counts Δ%: −1999.9 to +19999.9%

Measuring Signal (23 ±5° C)
Frequency range: 1 MHz to 1000 MHz
Frequency step:
Standard: 100 kHz, 1 to 500 MHz 200 kHz, 500 to 1000 MHz
Opt 002: 100 Hz, 1 to 500 MHz 200 Hz, 500 to 1000 MHz
Frequency accuracy: ±3 ppm
Signal level (into 50 Ω): −20 ±3 dBm
Frequency control: Spot and swept

Measuring Mode
Spot measurement: At specific frequency (or dc bias)
Swept measurement: Manual or automatic sweep from start to stop frequency (or dc bias) at step frequency (or dc bias) rate in linear or logarithmic form

Auto Calibration: Automatic error compensation referenced to connected terminations (0 Ω, 50 Ω, 0 S), 51 frequencies including start and stop frequencies

Electrical Length Compensation: Automatic compensation for electrical length of test fixtures (range: 0 to 99.99 cm)

Internal dc Bias: Voltage range: −40 to +40 V, 10 mV step
Setting accuracy: 0.1% of setting +10 mV
Bias control: spot and swept

External dc Bias: Voltage range: −40 to +40 V
Max allowable current: 100 mA

Key Status Memory: Two sets of measuring conditions can be stored and recalled at any time. These conditions are kept in storage even when LINE is turned off.

Ranging: Auto/Range hold

Trigger: Internal, External, or Manual

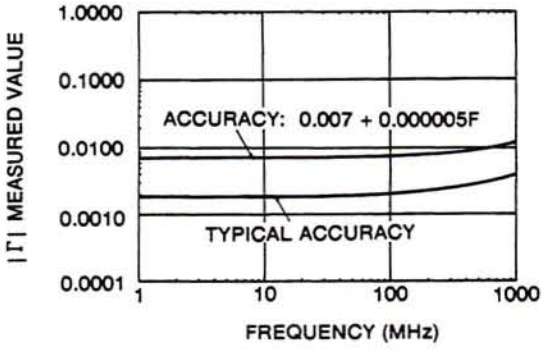
Self-Test: Automatic internal program test

HP-IB Data Output and Remote Control: Standard

$|\Gamma|-\theta/\Gamma x$-Γy Measurement
Measuring range: $|\Gamma|$, Γx, Γy: 0.0001 to 1.0000
θ: 0° to ±180.00° (0 to ± πrad.)
$|\Gamma|$,Γx,Γy resolution: 0.0001

Reference Data (Not Specified)

Temperature Coefficient For $|\Gamma|$: 0.0001/° C (23 ±5° C)
Measuring Time: <800 ms or <250 ms (high speed mode)
Frequency Switching Time: ≤ 200 ms



General Specifications

Temperature: 0 - 55° C, <95% RH
Power: 100, 120, 220 V ± 10%, 240 V + 5% – 10%, 48 – 66 Hz, 150 VA max
Size: 425.5 mm W × 230 H × 574 mm D (16.75 in × 9 in × 22.6 in)
Weight: Approximately 24 kg (52.8 lb)
Accessories Furnished: Accessory case (with reference terminations included)

Accessories Available	Price
HP 16091A Coaxial Test Fixture	$570
HP 16092A Spring Clip Test Fixture	$555
HP 16093A Binding Post Test Fixture	$225
HP 16093B Binding Post Test Fixture	$250
HP 16094A Probe Fixture	$218

Refer to page 347 for accessories.

Ordering Information

HP 4191A RF Impedance Analyzer	$21,450
Opt W30 Extended Repair Service (see page 636)	+$465
Opt 002 100 Hz/200 Hz Resolution Synthesizer	+$2,190
Opt 004 Recorder Outputs	+$560

- 400 kHz to 110 MHz spot or swept frequency
- Measure impedance magnitude (10 mΩ to 120 kΩ) and phase (−180.0° to +180.0°)
- Test components in-circuit and out-of-circuit
- Fixtures include low-grounded probe, spring clip fixture, and binding post fixture
- Standard HP-IB and analog outputs

HP 4193A Vector Impedance Meter

The HP 4193A Vector Impedance Meter measures impedance magnitude and phase. An internal oscillator provides test signals from 400 kHz to 110.0 MHz. The test signal is a constant current between 10 μA and 100 μA, depending on |Z| range.

Reliable and Accurate Impedance Measurement

The HP 4193A can measure and display impedance magnitudes from 10 mΩ to 120 kΩ. Impedance phase is displayed from +180.0° to −180.0°. Accuracy is as good as 3.0 percent of reading (magnitude) and 3.2° (phase).

Also, the HP 4193A's 3½-digit resolution makes it easy to see small changes in measurement results during adjustment procedures.

Frequency Sweep for Complex Component Testing

When you're testing complex components such as ceramic resonators, it's useful to sweep frequency to get the big picture, and to identify such critical impedance points as the series resonant point. This requires both swept measurement and measurements at individual "spot" frequencies. The HP 4193A can do both.

The HP 4193A can be tuned to any individual frequency from 400 kHz to 110.0 MHz with a maximum resolution of 1 kHz. If a greater frequency resolution is required, it can be provided by connecting an external synthesized source such as the HP 3335A or HP 8656B to the HP 4193A EXT OSC input.

Flexible internal frequency sweep is an exciting HP 4193A feature. Frequency can be swept linearly over any portion of the HP 4193A frequency range or swept logarithmically over the entire 400 kHz to 110.0 MHz range.

Test In-Circuit and Out-of-Circuit Components

Several test fixtures help adapt the HP 4193A to your device under test. For example, the handy L-ground probe is useful for in-circuit testing. The HP 16099A Test Fixture Adapter and three associated fixtures help connect to out-of-circuit devices of various sizes and shapes.

Specifications (Refer to data sheet for complete specifications.)

Test Signal Output Specifications
Test signal is output from the furnished low-ground probe.
Frequency Range: 400 kHz to 110.0 MHz
Frequency Resolution
400 kHz to 9.999 MHz: 1 kHz resolution
10.00 MHz to 99.99 MHz: 10 kHz resolution
100.0 MHz to 110.0 MHz: 100 kHz resolution
Frequency Accuracy: ±0.01% of setting after calibration
Frequency Stability: ±100 ppm per month (0 to 55° C)
Frequency Control
Spot: Spot frequency is set using coarse, medium and fine controls
Full sweep: Logarithmic sweep at 43 points over full range of 400 kHz to 110 MHz
Partial Sweep: Linear sweep from selected START to STOP frequency. Number of steps is selected as 100, 1000 or "HIGH RESOLN." When "HIGH RESOLN" steps are selected, the operator must also select "coarse," "medium," or "fine" resolution.
EXT OSC: Increase frequency resolution by connecting an external frequency synthesizer

Impedance Measurement Specifications

Input Configuration: Low-grounded probe (furnished)
Digital Display of Impedance: 3½ digits
|Z|: 0 to 1999 counts (0 to 120 counts on 100 kΩ range)
θ: −1800 to +1800 counts (−180 to +180 counts on 100 kΩ range)
Measurement Trigger: Internal, external, and manual
Measurement Range Control: Auto, hold, and manual
Measurement Range
|Z|: Five decade ranges: 10 Ω, 100 Ω, 1 kΩ, 10 kΩ, 100 kΩ
minimum |Z| (sensitivity): 10 mΩ
maximum |Z|: 120 kΩ
θ: **One range:** −180.0° to +180.0°

Reference Data

Test Signal Output

Frequency Settling Time: 5 ms to 400 ms. Best case is when (Δf/f)% is less than 10% (below 10 MHz) and less than 1% (above 10 MHz).
Signal Purity
Spurious: −60 dBc (dBc is dB below carrier)
Harmonics: −30 dBc
Residual FM: Measured in a 100 Hz band centered on the carrier
1 MHz to 110 MHz: 100 Hz p-pFM
Test Level: Constant current source

Impedance Measurement

Residual Impedance of Probe (at probe tip)
Resistance: ≤0.55 Ω
Inductance: ≤(4.9 + 10/f) nH where f is measuring frequency in MHz
Parallel capacitance: ≤0.11 pF
Measuring Speed: Assumes range is fixed; recorder output is OFF
HI SPEED: Approximately 150 ms per measurement
NORMAL: Approximately 1 s per measurement
Ranging Time: Approximately 1.2s
Temperature Coefficient at 23° C ± 5° C
|Z|: 2 m Ω/° C, θ: 0.02°/° C

General

Operating Temperature/Humidity: 0 to 55° C, ≤95% RH @ 40° C
Note that measurement error in 0° C to 55° C temperature range is typically double the error in the 23° C ± 5° C range.
Power: 100/120/220 V ±10%, 240 V −10% to +5%, 48 to 66 Hz, 150 VA max
Size: 426 mm W × 178 mm H × 498 mm D (16.75 in × 7 in × 19.6 in)
Weight: 18 kg (40 lb)
Accessories Furnished: The low-ground probe kit includes a probe, spare pins, spare clips, BNC adapter, component mounting adapter, probe socket, and accessory case.

Ordering Information

	Price
HP 4193A Vector Impedance Meter	$12,700
Accessories	
HP 16099A Test Fixture Adapter (used with HP 16092A and HP 16093A/B)	$535
HP 16092A Spring Clip Fixture (used with HP 16099A)	$555
HP 16093A Binding Post Fixture (used with HP 16099A)	$225
HP 16093B Binding Post Fixture (used with HP 16099A)	$250

Refer to page 347 for accessories.

For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office.

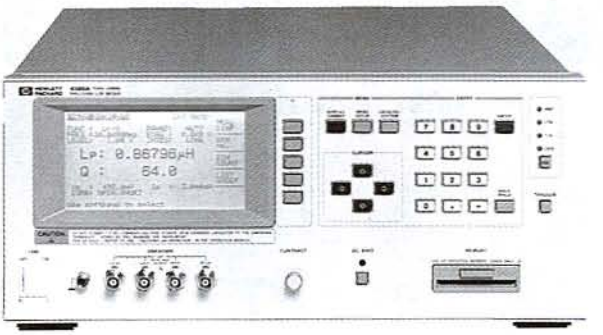
COMPONENT MEASUREMENT

Precision LCR Meters

HP 4284A, 4285A

- 20 Hz to 1 MHz, with over 8,600 test frequencies
- 0.05% basic accuracy, 6-digit resolution
- Test signal level (Option 001): 5 mV to 20 Vrms, 50 μA to 200 mArms
- 10-bin component sorting-comparator
- 75 kHz to 30 MHz in 100-Hz steps
- 0.1% basic accuracy
- High-speed measurements: 30 ms/meas
- List sweep measurement capability

HP 4284A



HP 4285A

DESIGNED FOR HP-IB SYSTEMS

Hewlett-Packard Instrument Drivers

HP 4284A, HP 4285A Precision LCR Meters

The HP 4284A and HP 4285A precision LCR meters are cost-effective solutions for component and material measurement. They can be used to improve component quality by providing an accurate, high-throughput test solution. The wide 20 Hz to 1 MHz test frequency range and superior test signal performance allow the HP 4284A to test components to the most commonly used test standards, such as IEC/MIL standards, and under conditions that simulate the intended application. For demanding RF component tests, the HP 4285A offers a higher test frequency range, from 75 kHz to 30 MHz. Whether in research and development, production, quality assurance, or incoming inspection, the HP 4284A and HP 4285A will meet all of your LCR meter test and measurement requirements.

Wide Range of Test Signal and dc Bias

The test signal (voltage/current) is variable from 5 mV rms to 2 V rms, and from 50 μA rms (100 μA rms on the HP 4285A) to 20 mA rms. The constant test signal level feature guarantees that the applied test signal level will remain constant for demanding tests. Option 001 of HP 4284A will allow you to vary the test signal level from 5 mV rms to 20 V rms and from 50 μA rms to 200 mA rms, offering a convenient method of testing components over a wide range of working conditions. The dc bias is selectable from ±1mV to ±40V with an accuracy of 0.1% for applications that require accurate bias control, such as measuring the C-V characteristics of semiconductors.

High Accuracy, Resolution, and Test Throughput

The HP 4284A's wide impedance measurement range covers from 1 Ω to 100 MΩ full scale with 0.01 mΩ minimum resolution and with an unmatched basic accuracy of 0.05% to 1 MHz. The HP 4285A covers a wide impedance range up to 10 MΩ with a basic accuracy of 0.1%, permitting more accurate component tests at RF frequencies than previously available LCR meters. Six full digits of resolution for all measurement parameters allow you to determine even the smallest differences in materials or component performance. A dissipation factor measurement resolution of 0.000001 is very useful when developing low loss capacitors and inductors used in high-performance electronic equipment. The measurement time needed to obtain the optimum accuracy is only 190 ms/meas. (1 kHz). A selectable integration time permits high-throughput testing with a measurement time of only 40 ms/meas (1 kHz) for a slight tradeoff in accuracy.

High Current Biasing for Power Inductor Evaluation

Combining the HP 4284A precision LCR meter, HP 42841A current source, and HP 42842A/B current fixture gives you a high-performance power inductor and transformer test system, which enables the testing of inductors up to 1MHz and at high dc current levels, up to 20 A (40 A with two HP 42841A and the HP 42842B) demanded for components used in advanced switching power supplies. To evaluate the inductors at higher frequencies, the HP 4285A precision LCR meter, HP 42841A current source, and HP 42842C current fixture make measurements up to 30 MHz and 10 A.

High Q Measurements of RF Components

The HP 4285A precision LCR meter together with the HP 42851A precision Q adapter permits fast and accurate Q factor measurements up to 999.999 with the resonant measurement method. The automatic tuning, 5-digit display, and variable test level allow you to measure Q factors of RF components and materials in a fraction of the time previously required.

Flexibility and Ease of System Integration

The HP 4284A's built-in comparator, advanced compensation, and optional handler and scanner interfaces permit easy integration with automatic component handling equipment. The 10-bin comparator allows for error-free Go/No-Go testing by comparing a component's measured value with user-selected test limits. The scanner interface provides control and compensation for up to 128 (HP 4284A) or 90 (HP 4285A) multiplexed measurement channels. The list sweep feature permits up to ten frequencies, test signal levels, or bias level points to be automatically measured. The high-speed HP-IB interface and SCPI programming language are excellent for data logging and system applications.

Simple Operation for Error-Free Measurement Setup

The large, easy-to-read LCD screen displays the instrument settings and the measurement results. The new softkey and cursor operation provides easy front-panel operation. The memory card allows storing and retrieving of up to ten entire instrument setups, including bin-limit information. It improves operator efficiency and minimizes setup errors.

Specifications (Refer to data sheet for complete specifications.)

Parameters Measured: |Z|-θ, |Y|-θ, R-X, G-B
C-D, Q, ESR, G, Rp
L-D, Q, ESR, G, Rp
Deviation and % deviation
Measurement Circuit Modes: Series and parallel
Ranging: Auto and manual
Trigger: Internal, external, and manual
Delay Time: 0 to 60.000s in 1 ms steps
Measurement Terminals: Four-terminal pair
Test Cable Length:
HP 4284A: Standard: 0 and 1 m
With Opt 006: 0, 1, 2 and 4 m
HP 4285A: 0, 1 and 2 m
Integration Time: Short, medium, and long
Averaging: 1 to 256, programmable
Test Signal:
HP 4284A: 20 Hz to 1 MHz ± 0.01%, 8610 Selectable frequencies
HP 4285A: 75 kHz to 30 MHz ± 0.01%, 100-Hz steps
Test Signal Modes:
Normal: Programs selected voltage or current at the measurement terminals open or shorted, respectively, and not at the device under test
Constant: Maintains selected voltage or current at the device under test independent of changes in the device's impedance

Test signal levels

HP 4284A Standard

		Range	Accuracy
Normal	V	5 mV rms to 2 V rms	±(10% + 1 mV rms)
	I	50 μA rms to 20 mA rms	±(10% + 10 μA rms)
Constant	V	10 mV rms to 1 V rms	±(6% + 1 mV rms)
	I	100 μA rms to 10 mA rms	±(6% + 10 μA rms)

HP 4284A with Option 001

		Range	Accuracy
Normal	V	5 mV rms to 20 V rms	±(10% + 1 mV rms)
	I	50 μA rms to 200 mA rms	±(10% + 10 μA rms)
Constant	V	10 mV rms to 10 V rms	±(10% + 1 mV rms)
	I	100 μA rms to 100 mA rms	+(10% + 10 μA rms)

HP 4285A

		Range	Accuracy
Normal	V	5 mV rms to 2 V rms	±(8% + 0.4 fm% + 1 mV rms)
	I	200 μA rms to 20 mA rms	±(8% + 1 fm% + 40 μA rms)
Constant	V	10 mV rms to 1 V rms	±(6% + 0.2 fm% + 1 mV rms)
	I	100 μA rms to 20 mA rms	±(6% + 0.2 fm% + 40 μA rms)

fm: test frequency (MHz)

dc bias

HP 4284A standard : 0V, 1.5V and 2V
HP 4284A/4285A Opt 001 : 0V to ±40V

Range	Resolution	Accuracy
±(0.000 to 4.000)V	1 mV	±(0.1% + 1 mV)
±(4.002 to 8.000)V	2 mV	±(0.1% + 2 mV)
±(8.005 to 20.000)V	5 mV	±(0.1% + 5 mV)
±(20.01 to 40.00)V	10 mV	±(0.1% + 10 mV)

Measurement Display Range

Parameter	Range
|Z|, R, X	0.01 m Ω to 99.9999 MΩ
|Y|, G, B	0.01 nS to 99.9999 S
C	HP 4284A: 0.01 fF to 9.9999 F HP 4285A: 0.01 fF to 999.999 μF
L	HP 4284A: 0.01 nH to 99.9999 kH HP 4285A: 0.001 nH to 99.9999 H
D	0.000001 to 9.99999
Q	0.01 to 99999.9
θ	−180.000° to 180.000°
Δ %	−999.999% to 999.999%

Display

LCD dot-matrix display: Displays measured values, control settings, comparator limits and decisions, list sweep tables, self-test messages, and annunciations.

Correction Function

Zero OPEN/SHORT: Eliminates measurement errors due to the test fixture's stray parasitic impedance
Load: Improves measurement accuracy by using a calibrated device as reference

List Sweep Function

A maximum of ten frequencies or test signal levels can be programmed. Single or sequential testing can be performed. When Opt 001 is installed, dc voltage bias testing can also be performed.

Comparator

Ten-bin sorting for the primary measurement parameter. IN/OUT for the secondary measurement parameter
Bin Count: 0 to 999999
List Sweep Comparator: HIGH/IN/LOW decision output for each measurement point in the list sweep table

Other Functions

STORE/LOAD: Ten instrument setups can be stored/ loaded from the internal non-volatile memory. Ten additional setups can also be stored/loaded from a memory card.
HP-IB: All instrument control settings, measured values, comparator limits, list sweep table, and self-test results. The memory buffer can store a maximum of 128 measurement results and output the data over HP-IB. ASCII and 64-bit binary data formats.

Options

Opt 001
HP 4284A: Increases the ac test signal to 20 V rms/200 mA rms. Variable ±40 Vdc bias
HP 4285A: Variable ±40 Vdc bias
Opt 002
HP 4284A: Allows the HP 4284A to control the HP 42841A bias current source
HP 4285A: Allows the HP 4285A to control the HP 42841A bias current source and the HP 42851A precision Q adapter
Opt 006 (HP 4284A only): Increases test cable length capability. Adds 2- and 4-m operation
Opt 109 Delete HP-IB Interface
Opt 201 Handler Interface
Opt 202 Handler Interface
Opt 301 Scanner Interface. Provides control interface for operation with a scanner. OPEN/SHORT/LOAD correction data for each scanner channel is stored in nonvolatile memory.
HP 4284A: 128 channels at three frequencies
HP 4285A: 90 channels at seven frequencies

COMPONENT MEASUREMENT
Precision LCR Meters
HP 4284A, 4285A

General Specifications
Power Requirements: 100/120/220 V ± 10%, 240 V +5%/−10%, 47 to 66Hz
Power Consumption: 200 VA max
Operating temperature and humidity: 0 to 55° C, ≤95% RH at 40° C
Size: 426 mm W × 177 mm H × 498 mm D (16.77 in × 6.97 in × 19.61 in)
Weight: Approximately 16 kg (35.2 lb)

HP 4284A Measurement Accuracy
The following measurement accuracy is specified when all of the following conditions are satisfied:
1. Warm-up time: ≧30 minutes
2. Ambient temperature: 23 ±5° C
3. Test signal voltage: 0.3 V rms to 1 V rms
4. Test cable length: 0 m
5. OPEN and SHORT corrections have been performed
6. D ≦ 0.1 for C, L, X, and B measurements
   Q ≦ 0.1 for R and G measurements

Accuracies are relative to calibrated standards. Absolute accuracies are given as: (HP 4284A's relative accuracy + calibration uncertainly of standards).
|Z|, C, L, and D accuracies are shown in Figure 1.
The accuracies are represented as:
|Z|, C, and L: ± (% of reading)
D: ± (D value)

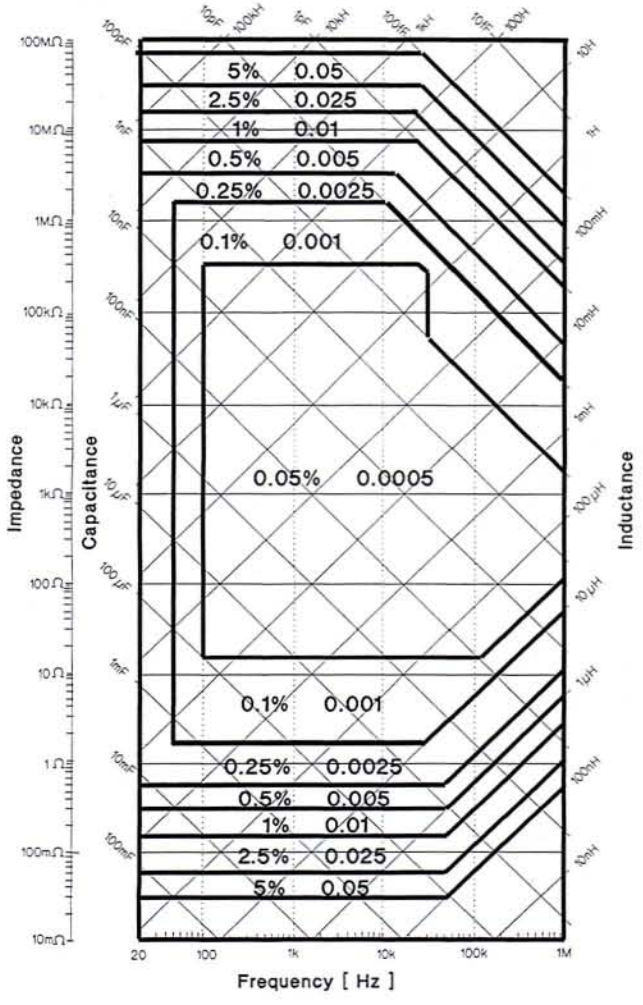


Figure 1. HP 4284A Measurement Accuracy

HP 4285A Measurement Accuracy
The following measurement accuracy is specified when all of the following conditions are satisfied:
1. Warm-up time: ≧30 minutes
2. Ambient temperature: 23 ±5° C
3. Test signal voltage: 0.2 V rms to 1 V rms
4. Test cable length: 0 m
5. OPEN and SHORT corrections have been performed
6. D ≦ 0.1 for C, L, X, and B measurements
   Q ≦ 0.1 for R and G measurements

|Z|, C, L, and D accuracies are shown in Figure 2.
The accuracies are represented as:
|Z|, C, and L: ± (% of reading)
D: ± (D value)

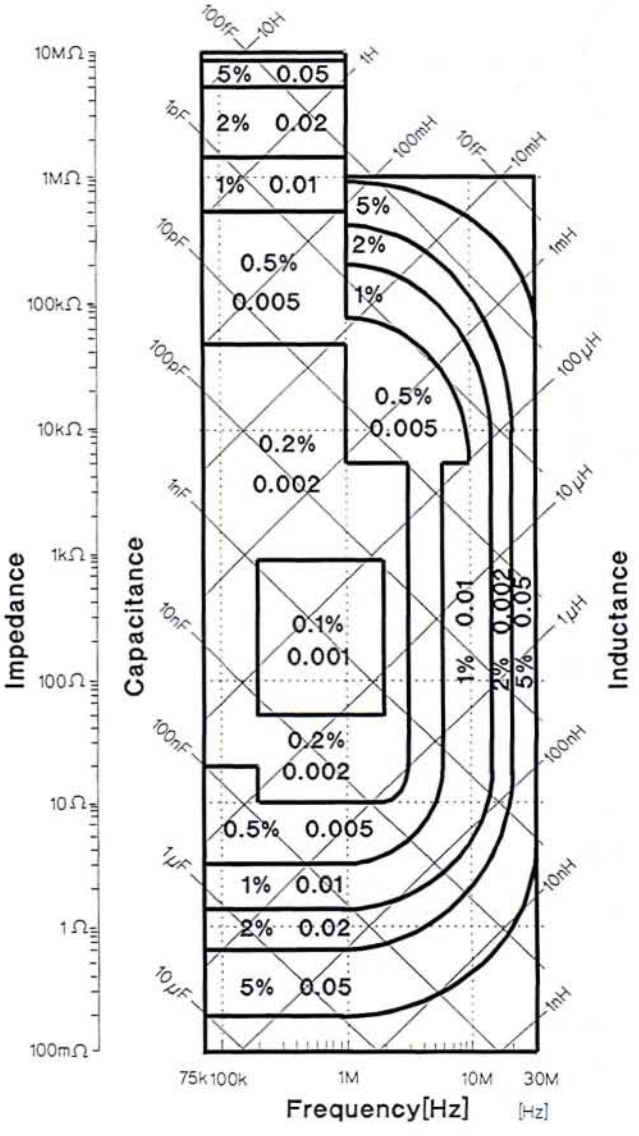


Figure 2. HP 4285A Measurement Accuracy

Supplemental Characteristics

Measurement Time: Typical measurement time from the trigger command to the end of measurement (EOM) output at the handler interface connector.

HP 4284A

	20 Hz	100 Hz	1 kHz	10 kHz to 1 MHz
SHORT	1,100 ms	270 ms	40 ms	30 ms
MEDIUM	1,320 ms	400 ms	190 ms	180 ms
LONG	1,320 ms	1,040 ms	830 ms	820 ms

HP 4285A

	75 kHz to 30 MHz
SHORT	30 ms
MEDIUM	65 ms
LONG	200 ms

Option 001 dc Bias Current Output: 100 mA max

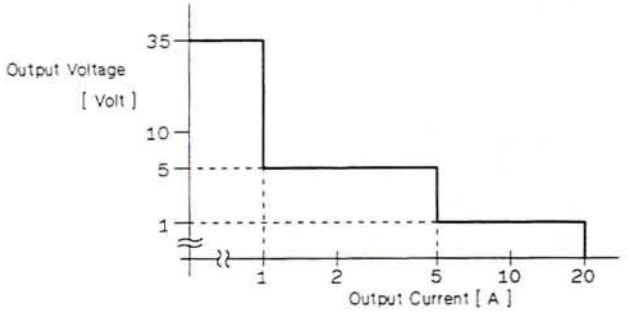
Accessories

HP 42841A Bias Current Source

Bias current output: (23 ±5° C)

Range	Resolution	Accuracy
0.00 A to 1.00 A	0.01 A	± (1% of setting + 5 mA)
1.1 A to 5.0 A	0.1 A	± (2% of setting)
5.1 A to 20.0 A	0.1 A	± (3% of setting)

Output Voltage



Basic impedance accuracy: 1% when used with the HP 4284A/4285A

Interface: Custom, directly controllable by the HP 4284A/4285A with Opt 002

HP 48242A/B Bias Current Test Fixture

Used with the HP 4284A and HP 42841A for high dc bias current measurements

HP 42842A: 20A max

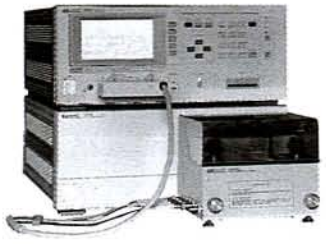
HP 42842B: 40A max

HP 42842C Bias Current Test Fixture

Used with the HP 4285A and HP 42841A for high dc bias current measurement. 10 A max

HP 42843A Bias Current Cable

Used with the HP 4284A, HP 42841A (2 units), and HP 42842B for 40 A maximum applications



HP 4284A with HP 42841A and HP 42842A

HP 42851A Precision Q Adapter

Used with the HP 4285A for resonant Q measurements

Parameters Measured: Q-L, Q-C

Q Measurement Range: 5.00 to 999.99

Basic Q Accuracy: 5%

Measurement Time: 75 ms to 1.5 s

Interface: Custom, directly controllable by the HP 4285A with Opt 002

Opt 001: SMD Text Fixture

SMD Test Fixture

HP 4285A with HP 42851A

Ordering Information

	Price
HP 4284A Precision LCR Meter	$11,000
HP 4285A Precision LCR Meter	$13,530
Opt 001 Power Amplifier/dc Bias (HP 4284A)	+$1,210
dc Bias (HP 4285A)	+$920
Opt 002 Bias Current Interface (HP 4284A)	+$280
Accessory Control Interface (HP 4285A)	+$280
Opt 006 2m/4m Cable Length Operation (HP 4284A only)	+$176
Opt 009 Delete Operation Manual	−$77
Opt 109 Delete HP-IB Interface	−$248
Opt 201 Handler Interface	+$280
Opt 202 Handler Interface	+$310
Opt 301 Scanner Interface	+$600
Opt W30 Extended Repair Service (see page 636)	
HP 4284A	+$190
HP 4285A	+$215
HP 42841A Bias Current Source	$6,970
HP 42842A Bias Current Test Fixture (20 A max)	$1,640
HP 42842B Bias Current Test Fixture (40 A max)	$2,050
HP 42842C Bias Current Test Fixture (10 A max)	$2,500
Opt 001 SMD Test Fixture (HP 42842C only)	+$430
HP 42843A Bias Current Cable	$1,000
HP 42851A Precision Q Adapter	$4,850
Opt 001 SMD Test Fixture	+$430

Refer to page 347 for accessories.

COMPONENT MEASUREMENT

1 kHz/1 MHz Capacitance Meter

HP 4278A

- Measurement speed: 6.5 ms/10 ms/21 ms
- Measurement parameters: C-D•Q•ESR•G
- C-D measurement accuracy:
  0.07%, 0.0005(1 kHz, 21 ms)
  0.05%, 0.0002(1 MHz, 21 ms)
- High resolution: 6 digit, D:0.00001
- Intelligent built-in comparator: 10-bin sorting

HP 4278A

DESIGNED FOR HP-IB SYSTEMS

HP 4278A Capacitance Meter

The HP 4278A 1 kHz/1 MHz Capacitance Meter is a high-speed, highly reliable, precision test instrument aimed at incoming/outgoing capacitor inspection applications on the production line and in quality control. The HP 4278A will improve test efficiency by performing comparative measurements of low to medium value capacitors (up to 200 μF—a range that covers most ceramic and film capacitors).

The HP 4278A's standard measurement frequencies and oscillator output levels are 1kHz/1MHz and from 0.1 V to 1 V in 0.1 V steps, respectively.

The built-in comparator function of the HP 4278A gives you the ability to sort parts into ten bins. A high-speed HP-IB interface and an optional handler interface are available for combining the HP 4278A with an automatic handler and an external computer, to build a total solution for automatic testing and data acquisition and analysis.

Specifications (Refer to data sheet for complete specifications.)

Measurement Parameters: C-D•Q•ESR•G
Display: Dot-matrix LCD. 4, 5, 6 digits, selectable
Measurement Circuit Modes: Parallel and series
Test signals
Frequency: 1 kHz and 1 MHz, ±0.02%
Signal level: 0.1 to 1 V rms, ±10% (C≤20 μF), in 0.1 V rms steps
Measurement Time Modes: SHORT, MEDIUM, and LONG
Measurement Times

Mode	SHORT	MEDIUM	LONG
Time*	6.5 ms	10 ms	21 ms

* Measurement time includes settling, integration (analog measurements), calculation, and comparison times.

Measurement Range

Measurement Parameter	1 KHz	1 MHz normal mode 1 MHz high accuracy
C	0.001 pF to 200.000 μF	0.00001 pF to 1280.00 pF 0.00001 pF to 2663.00 pF
DF	0.00001 to 9.99999	0.00001 to 9.99999 .000001 to .999999

1. 1 kHz normal mode: 7 decade ranges 100 pF to 100 μF full scale. 100% overranging on all ranges, (max. 200000 counts) when D ≦ 0.5.
2. 1 MHz normal mode: 11 binary ranges, 1 pF to 1024 pF full scale. 25% overranging on all ranges, when D ≦ 1.
3. 1 MHz high accuracy mode: Measurement range is ±30% of the user defined nominal value, maximum 2048 pF, when D ≦ 0.05.

Measurement Accuracy

It is specified at the UNKNOWN terminals and at the end of standard 1- or 2-m test leads under the following conditions.

1. Warmup time: ≧ 10 minutes
2. Ambient temperature is 23 ±5° C and variance is less than 0.2° C/minute
3. Test signal level is set to 1 V rms
4. Zero OPEN/SHORT compensation has been performed
5. D ≦ 0.05 for 1 MHz High Accuracy Mode,
   D ≦ 0.1 for 1 kHz and 1 MHz Normal Modes
6. Accuracies are only valid when the measured value is equal to the full scale of each range
7. Accuracy stated in the tables is given for LONG integration time
8. Accuracy equations are read as follows:
   C: ± (% of reading + % of full scale)
   D: ± (% of reading + absolute D value)
   (C: ± (% of reading + absolute C value) for Table 3)

Table 1: 1 kHz Measurement Accuracy

C range	C	D
100 μF	0.07% + 0.025%	0.065% + 0.0025
100 pF to 10 μF	0.05% + 0.025%	0.05% + 0.0005

Table 2: 1 MHz Normal Mode Measurement Accuracy

C range	C	D
256 to 1024 pF	0.1% + 0.02%	0.1% + 0.0005
4 to 128 pF	0.05% + 0.02%	0.1% + 0.0005
2 pF	0.05% + 0.03%	0.1% + 0.0005
1 pF	0.05% + 0.06%	0.1% + 0.001

Table 3: 1 MHz High Accuracy Mode Measurement Accuracy

Nominal C + Open Circuit C	C	D
1024 to 2048 pF	0.11%	0.0004
256 to 1024 pF	0.07%	0.0003
4 to 256 pF	0.05%	0.0002
2 to 4 pF	0.06% + 0.0004 pF	0.0003
0 to 2 pF	0.08% + 0.0004 pF	0.0006

Trigger Modes: Internal, external, or manual
Measurement Terminals: Four-terminal pair, guarded
Cable Length Compensation: 0, 1, or 2 m
Compensation Function: Zero OPEN/SHORT, standard, offset
Comparator: Ten-bin sorting for capacitance, and go/no-go testing for D, Q, ESR, and G
Self Test: Checks the HP 4278A's basic operation
Memory Card: External memory for storing and recalling control settings and comparator limits

General Specifications

Operating Temperature and Humidity: 0–55° C, 95% RH @ 40° C
Power: 100, 120, 220 Vac ±10%, 240VAC +5 −10%, 48 to 66 Hz, 200 VA max
Size: Approximately 426 mm W × 177 mm H × 498 mm D (16.77 in × 6.97 in × 19.61 in)
Weight: Approximately 10 kg (22 lb, standard)

Accessories Available

	Price
HP 16270A Memory Card Set	$315
HP 16334A Tweezer-Type Test Fixture for Chip Components	$450
HP 16047A Direct-Coupled Test Fixture	$275
HP 16047C Test Fixture	$315
HP 16048A Test Leads, BNC (1 m)	$345
HP 16048B Test Leads, SMC (1 m)	$330
HP 16048D Test Leads, BNC (2 m)	$440

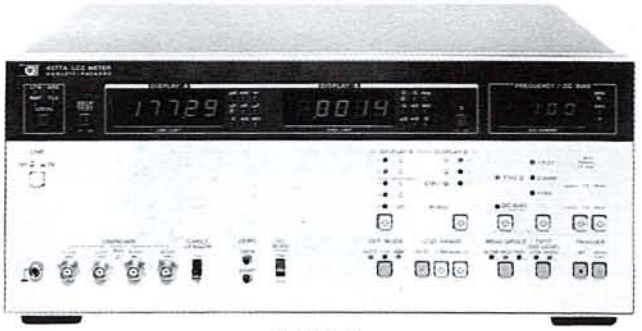
Ordering Information

HP 4278A 1 kHz/1 MHz Capacitance Meter	$8,640
Opt W30 Extended Repair Service (see page 636)	+$180
Opt 001 1 kHz Test Frequency Only	−$865
Opt 002 1 MHz Test Frequency Only	−$370
Opt 003 1% Frequency Shift: Prevents possible test signal interference when component test contacts are located close to those of other test units	$0
Opt 009 Delete Manual	−$28
Opt 101 HP-IB Compatibility	+$248
Opt 201 Handler Interface	+$280
Opt 202 Handler Interface	+$310
Opt 301 Scanner Interface	+$600

For off-the-shelf shipment, call 800-452-4844.

- 3-digit frequency setting:
  100 Hz to 20 kHz (801 spots)
  10 kHz to 1 MHz (701 spots)
- High-speed measurements
- Measure L/C-D/Q/ESR/G, |Z| – θ, high speed L/C
- 10-bin component sorting-comparator (Opt 002)
- 0.1% basic accuracy over impedance range of 100 mΩ to 10 MΩ (HP 4276A), 10 Ω to 1 MΩ (HP 4277A)

HP 4276A



HP 4277A

DESIGNED FOR HP-IB SYSTEMS

HP 4276A and 4277A LCZ Meters

HP's 4276A and 4277A LCZ Meters are general-purpose impedance-measuring instruments designed to measure circuit components such as capacitors and inductors using frequency and dc bias conditions identical to those of the intended application. Both HP 4276A and HP 4277A feature variable test frequency (100 Hz to 20 kHz and 10 kHz –1 MHz respectively), optional dc bias variable from 0 to ± 40 V, multiple parameters (L • C • |Z| • D • Q • ESR • G • θ) with fully automatic high speed measurements, and 4½ digit resolution. The HP 4276A has an impedance range of 100 mΩ to 10 MΩ and the HP 4277A 10 Ω to 1 MΩ.

Both instruments are ideal for production line, quality control, and circuit design applications, and are versatile enough for standalone use or systems use under HP-IB control (standard). An optional comparator for 10-bin sorting with measurement time of less than 100 ms makes the HP 4276A/4277A a good choice for production line testing of discrete components.

Specifications

(Refer to data sheet for complete specifications.)
Common to HP 4276A and HP 4277A:

Parameters Measured: C-D • Q • ESR • G • L-D • Q • ESR • G
high speed L, high speed C
|z|- Θ and Δ (deviation for any parameter)

Display: 4½ digits (max), maximum display 19999

Measurement Circuit Modes: Auto, Parallel, and Series

Frequency Control Modes: SPOT, COARSE (10 freq./decade), and FINE (max. freq. resolution)

Test Signal Level (Unknown terminal open)

	HIGH	LOW
HP 4276A	1 V rms ± 10% @ 1 kHz	50 mV ± 20% (CP only) @ 1 kHz
HP 4277A	1 V rms ± 10%	20 mV ± 15%

Test Frequencies:
HP 4276A: 100 Hz to 20 kHz ± 0.01% (801 points)
HP 4277A: 10 kHz to 1 MHz ± 0.01% (701 points)

Measurement Accuracy and Range: Specified at the front panel unknown connectors when all of the following conditions are satisfied:
(1) warmup time ≧ 30 min.
(2) test signal level is set to HIGH (1 V rms)
(3) measurement speed mode: MED or SLOW
(4) ambient temperature is 23° C ±5° C
(5) cable length switch is set to 0 m (HP 4277A)
(6) OPEN and SHORT adjustments have been made
(7) D ≦ 0.1

C Measurement Basic Accuracy:
HP 4276A: 0.1% + 17 counts to 3% + 2 counts
HP 4277A: 0.1% + 17 counts to 3% + 4 counts

dc Bias
Internal dc bias (opt.): 0 to ±40 V

Reference Data

Measurement Speed (typical): (Circuit mode: AUTO, test signal level: HIGH, display digit: 3 digits, FAST mode)

Measurements	HP 4276A @ 1 kHz	HP 4277A @ 1 MHz
C-D • ESR • G	65 ms	75 ms
L-D • ESR • G	75 ms	65 ms
Z-θ	80 ms	75 ms
High Speed C	35 ms	40 ms

General Specifications

Operating Temperature and Humidity: 0° to 55° C, ≤ 95% RH at 40° C
Power Requirements: 100/120/220 Vac ±10%, 240 V +5% –10%; 48 to 66 Hz
Power Consumption: 65 VA max (HP 4276A);
75 VA max (HP 4277A)
Size: 188 mm H × 426 mm W × 422 mm D (7⅜ in × 16¾ in × 16⅝ in)
Weight: Approx. 8.5 kg (18.7 lb)

Special Options

HP 4276A Opt H05: 1 kHz C-D measurement only (1V/100 mV)
HP 4276A Opt H06: 1 kHz C-D measurement only (1V/300 mV)
HP 4276A Opt H07: 1 kHz C-D measurement only (1V/500 mV)
HP 4277A Opt H03: Programmable dc bias for high speed C-V measurement (1V/20 mV, 1 MHz only)
HP 4277A Opt H04: Programmable dc bias for high speed C-V measurement (500 mV/20 mV, 1 MHz only)
HP 4277A Opt H07: High accuracy dc bias
Contact your nearest HP sales office for more information.

Accessories

Furnished Accessories: HP 16047A Direct Coupled Test Fixture
Accessories Available
HP 16064A: Retrofit Kit for Comparator (HP 4276A/HP 4277A, Opt 002)

Ordering Information

	Price
HP 4276A LCZ Meter	$6,230
HP 4277A LCZ Meter	$8,160
Opt 001 Internal dc bias, 0 to ±40 V	+$241
Opt 002 10-bin sorting for L/C/|Z| and go/no-go testing for D/Q, interfaceable with component handler	+$840
Opt W30 Extended Repair Service (HP 4276A). See page 636.	+$135
Opt W30 Extended Repair Service (HP 4277A). See page 636.	+$185

For the most current prices and product information, contact your local Hewlett-Packard sales office.

COMPONENT MEASUREMENT

LCR Meter

HP 4263A

- 0.1% basic accuracy
- 100 Hz, 120 Hz, 1 kHz, 10 kHz, 100 kHz test frequencies
- 50 m, 100 m, 250 m, 500 m, 1 V rms test levels
- High-speed measurement: 25 ms
- High-speed contact check
- Quick test recovery
- Wide capacitance test range
- Front-end protection
- Built-in comparator
- Transformer parameter measurements (optional)

HP4263A

DESIGNED FOR HP-IB SYSTEMS

HP 4263A LCR Meter

The HP 4263A LCR Meter is HP's most cost-effective low-end LCR meter, designed for both component evaluation on the production line and fundamental impedance testing for bench-top applications. The HP 4263A has five test frequencies that allow you to simulate testing under the correct conditions: 100 Hz, 120 Hz, 1 kHz, 10 kHz, and 100 kHz. An optional 20 kHz test frequency can be added to those five frequencies (Opt 002).

High-Speed Measurements

The HP 4263A can boost throughput with a measurement speed of 25 ms at any test frequency. This ability improves the throughput of electrolytic capacitor and transformer testing. The HP 4263A can check the contact condition between the test terminals and the device under test (DUT). This function ensures the reliability of PASS/FAIL testing with automatic handlers in production. The quick recovery system of the HP 4263A improves throughput. Normal operation is resumed the instant a faulty DUT is removed from the handler, so the handler can always be operated at its full speed.

Electrolytic Capacitor Measurements

The HP 4263A's accuracy and wide measurement range are the right tools to make precise measurements of electrolytic capacitors. Charged capacitors can discharge through the front end and destroy an instrument. The HP 4263A's front end is designed for protection and maintains test integrity.

Transformer Parameter Measurements

With the HP 4263A's ability to make turns ratio (N), mutal inductance (M), and dc resistance (DCR) measurements, data calculations and changing test setups are no longer time-consuming tasks. (Opt 001)

Specifications (Refer to data sheet for complete specifications.)

Measurement Functions

Measurement parameters: |Z|, |Y|, θ [°], R, X, G, B, L, C, Q, D, ESR

Opt 001: Add DCR (dc resistance), N (turns ratio), and M (mutual inductance) measurement

Measurement circuit mode: Series and parallel

Mathematical Functions: Deviation and percent deviation

Ranging: Auto and manual

Trigger: Internal, external, manual, and HP-IB

Delay Time: 0 to 9999 ms in 1 ms steps

Test Cable Lengths: 0 m, 1 m, 2 m, 4 m (freq = 100/120/1k Hz); 0 m, 1 m, 2 m (freq = 10k/20k Hz); 0 m, 1 m (freq = 100 kHz)

Measurement Time: Short, medium, and long

Averaging: 1 to 256

Test Signal Information

Test frequency: 100 Hz, 120 Hz, 1 kHz, 10 kHz, and 100 kHz

Opt 002: Add 20 kHz test frequency

Frequency accuracy: ±0.01% (freq = 100 Hz, 1 kHz, 10 kHz, (20 kHz), 100 kHz), ±1% (freq = 120 Hz)

Output impedance: 100 Ω ±10%, 25 Ω ±10% (≤ 1 Ω range)

ac test signal level: 50 mV, 100 mV, 250 mV, 500 mV, and 1 V rms

Accuracy: ±10% + 10 mV

Internal dc bias

Level: 1.5 and 2 V **Accuracy:** ± (5% + 2 mV)

External dc bias: 0 to +3 V

Measurement Range

Parameter	Measurement range
|Z|, R, X	1 mΩ to 100 MΩ
|Y|, G, B	10 nS to 1000 S
C	1 pF to 1 F
L	10 nH to 100 kH
D	0.0001 to 9.9999
Q	0.1 to 9999.9
θ	−180° to +180° C
DCR	1 mΩ to 100 MΩ
N	0.9 to 200 (unspecified)
L, M	1 μH to 100 H (unspecified)
Δ %	−999.99% to 999.99%

Measurement Accuracy: ±0.1% (basic) (for |Z|, R, X, |Y|, G, B, C, L)

Measurement Time

Mode	Time (typical)
Short	25 ms
Medium	65 ms
Long	500 ms

Front-End Protection: Internal circuit protection when a charged capacitor is connected to the input terminals. The maximum capacitor voltage is: Vmax = $\sqrt{(8/C)}$ typical @ Vmax ≤250 V; Vmax = $\sqrt{(2/C)}$ typical @ Vmax ≤1000 V C is in Farads

Display: 5 digits (max)

Correction Function

Zero OPEN/SHORT: Eliminates measurement errors due to stray parasitic impedances in the test fixtures.

Load: Improves measurement accuracy by using a calibrated device as a reference. Available only via HP-IB.

Comparator Function: HIGH/IN/LOW for each primary measurement parameter and secondary measurement parameter.

Contact Check Function: Contact failure between the test fixture and device can be detected. Additional time for contact check: 5 ms.

Other Functions

Save/recall: Ten instrument setups can be saved/recalled from the internal nonvolatile memory.

Continuous memory capability: If the instrument is turned off, or if a power failure occurs, instrument settings (except dc bias on/off) are automatically memorized (≥ 72 hours at 23° ±5° C).

HP-IB interface: All control settings, measured values, and comparator information.

Handler interface: All output signals are negative-logic, optically isolated open collectors. Output signals include: HIGH/IN/LOW, no contact, index, end of measurement, and alarm. Input signals include: keylock and external trigger.

General Specifications

Power Requirements: 90 to 132 V or 198 to 264 V, 47 to 66 Hz, 45 VA max.

Operating Temperature: 0 to 55° C

Size: 320 mm W × 100 mm H × 300 mm D (12.6 in × 3.94 in × 11.81 in)

Weight: 4.5 kg (9.9 lb)

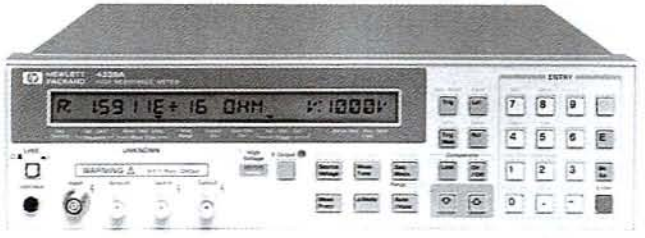
Ordering Information

	Price
HP 16060A Transformer Test Fixture	$540
HP 16065C External Bias Adapter (up to 40 Vdc)	$450
HP 16089A Kelvin Clip Leads (1 m, 2 large clips)	$490
HP 16089B Kelvin Clip Leads (1 m, 2 medium clips)	$480 ☎
HP 16089C Kelvin Clip Leads (1 m, 2 IC clips)	$580
HP 16089D Alligator Clip Leads (1 m, 4 medium)	$410 ☎
HP 16064B LED Display/Trigger Box (pass/fail display and trigger)	$330
HP 4263A LCR Meter	$3,800 ☎
Opt 001 Add N/M/DCR Measurement Function	$660
Opt 002 Add 20 kHz Test Frequency	+$250
Opt 009 Delete Operation Manual	−$54
Opt W30 Extended Repair Service (see page 636)	+$90

☎ For off-the-shelf shipment, call 800-452-4844.

- Wide measurement range: $1 \times 10^3\ \Omega$ to $1.6 \times 10^{16}\ \Omega$
- Stable test fixtures: Resistivity cell, component test fixture
- High-speed measurement: 10 ms
- Test sequence programming
- Resistivity calculations
- Grounded DUT measurement

DESIGNED FOR HP-IB SYSTEMS



HP 4339A

HP 4339A High-Resistance Meter

The HP 4339A high-resistance meter is HP's most advanced tool for making precision high-resistance measurements.

Precise and Stable Measurement

The measurement range is from $1 \times 10^3\ \Omega$ to $1.6 \times 10^{16}\ \Omega$, with a basic accuracy of 0.6%. This wide range allows accurate, high-resistance measurement of capacitors, relays, switches, connectors, materials, cables, and PC boards. The grounded device-under-test (DUT) measurement capability of the HP 4339A gives you the ability to evaluate cables and transformers under grounded conditions. The HP 16008B resistivity cell and the HP 16339A component test fixture are designed for stable and safe measurements of materials or components.

Ease of Use

The test sequence program function allows you to control a series of resistance measurements in a sequence (charge-measure-discharge). You can set the charge time, measurement interval time, and number of measurements in a sequence through the front panel. Surface resistivity (ρs) and volume resistivity (ρv) functions can be called to act upon measurement data. Calculated results are then automatically displayed, saving you time and effort.

High Test Throughput

The 10 ms measurement time, 2 ms high-speed contact check function, built-in comparator, and HP-IB/handler interfaces deliver high-speed test throughput for production environments.

Specifications

(Refer to data sheet for complete specifications.)
Measurement Parameters: R (dc resistance), I (dc current), ρs (surface resistivity), ρv (volume resistivity)
Mathematical Functions: Deviation and percent deviation
Ranging: Auto and manual
Trigger: Internal, external, manual, and HP-IB
Delay Time: 0 to 9999 ms in 1 ms steps
Test Cable Lengths: 2 m maximum
Measurement Time: Short, medium, and long
Averaging: 1 to 256
Test Voltage: 0.1 to 1000 Vdc, 0.1 V steps @ 0.1 to 200 V, 1 V steps @ 200 to 1000 V
Voltage Accuracy: (0.16% + 100 mV) @ ≤ 200 V,
(0.16% + 500 mV) @ > 200 V
Maximum Current: 10 mA @ ≤ 100 V, 5 mA @ ≤ 250 V,
2 mA @ ≤ 500 V, 1 mA @ ≤ 1 kV
Current Compliance setting: 0.5 mA, 1 mA, 2 mA, 5 mA, 10 mA
Output Resistance: 1 kΩ ±10%
Input Resistance: 1 kΩ ±10%

Measurement Range/Accuracy

Parameter	Measurement range	Basic accuracy
I	60 fA to 100 μA	±0.4%
R (Ω)	1×10^3 to 1.6×10^{16}	±0.6%

Measurement Time: Time interval from a trigger command to the end of measurement (EOM) signal output at the handler interface port (range: hold, display, off).

Mode	Time (typical)
Short	10 ms
Medium	30 ms
Long	390 ms

Display: 5 digits (max)
Correction Function
Zero OPEN: Eliminates measurement errors due to stray parasitic resistance in the test fixtures.
Test Sequence Program: Controls a series of resistance measurements. Charge time, measurement internal time, and measurement number can be programmed.
Comparator Function: HIGH/IN/LOW for the measurement parameter
Contact Check Function
Contact failure between the test fixture and device can be detected.
Available DUT type: Capacitive DUT's only
DUT capacitance: ≥0.5 pF + 5% of residual stray capacitance
Residual stray capacitance of the fixture: ≤50 pF
Additional measurement time for contact check: 2 ms
Other Functions
Save/recall: Ten instrument setups can be saved/recalled from the internal nonvolatile memory.
Continuous memory capability: If the instrument is turned off, or if a power failure occurs, instrument settings are automatically memorized (≥72 hours at 23 ±5° C).
HP-IB interface: All control settings, measured values, and comparator information
Handler interface: All output signals are negative-logic, optically isolated open collectors. Output signals include: HIGH/IN/LOW, no contact, index, end of measurement, and alarm. Input signals include: high voltage off, keylock, and external trigger.

General Specifications

Power Requirements: 90 to 132 V or 198 to 264 V, 47 to 66 Hz, 45 VA maximum
Operating Temperature: 0 to 55° C
Size: 320 mm W × 100 mm H × 450 mm D (12.6 in × 3.94 in × 17.72 in)
Weight: 6.5 kg (14.3 lb)

Furnished Accessories

Operation manual, shunt connector, power cable (test fixtures and/or test leads must be ordered separately.)

Ordering Information

	Price
HP 16339A Component Test Fixture	$1,960
HP 16008B Resistivity Cell (50 mm Diameter Electrode)	$2,280
Opt 001 Add 26/76 mm Diameter Electrodes	+$540
Opt 002 Add 26 mm Diameter Electrode	+$250
Opt 003 Add 76 mm Diameter Electrode	+$420
HP 16117B Low-Noise Test Leads (1 m, 2 clips)	$460
HP 16117C Low-Noise Test Leads (1 m, connectors)	$390
HP 16064B LED Display/Trigger Box	$330
HP 4339A High-Resistance Meter	$4,500
Opt 009 Delete Operation Manual	−$60
Opt W30 Extended Repair Service (see page 636)	+$105

For the most current prices and product information, contact your local Hewlett-Packard sales

COMPONENT MEASUREMENT

Four-Channel High-Resistance Meter

HP 4349A

- Designed for capacitor measurements
- Four-channel input
- High-speed measurement: 9 ms (typical)
- Fast settling time
- High-speed contact check
- Comparator function

HP 4349A

DESIGNED FOR HP-IB SYSTEMS

HP 4349A Four-Channel High-Resistance Meter

The HP 4349A four-channel high-resistance meter is HP's highest-throughput high-resistance meter for production testing capacitors.

High Throughput

To verify component reliability, capacitor manufacturers need to test capacitor insulation resistance at different voltages. The four-channel configuration permits simultaneous testing of four capacitors with different test voltages. This configuration reduces the investment cost when compared to a single-channel instrument. The HP 4349A's 11 ms four-channel simultaneous measurement improves the test throughput in a capacitor production line. For insulation resistance testing for capacitor manufacturers, capacitor charge time is a key factor in slowing down measurement time. The HP 4349A's front end has a 1 kΩ input impedance that allows the instrument to reduce the capacitor's charge time, and thus increases test throughput. The contact check function verifies that the signal path between the handler and the device under test (DUT) is optimal for a measurement. Contact checking maintains automatic handler/DUT integrity while keeping system throughput high.

System Integration

The built-in comparators for all four channels and the HP-IB/handler interface make system integration with automatic handlers and computers a fast and clean process.

Specifications (Refer to data sheet for complete specifications.)

Measurement Functions

Measurement Parameters: I (dc current), R (dc resistance)

Note: The HP 4349A has no test voltage source. It needs an external voltage source for resistance measurements. (The HP 4349A converts current measurement data into resistance with the test voltage data entered into memory.)

Number of Test Channels: 4 channels (Opt 001: 2 channels). Each channel measures simultaneously by the trigger.

Test Voltage Data Entry: 0.1000 to 1000.0 V (5 digits)

Ranging: Auto and manual

Trigger: Internal, external, manual, and HP-IB

Delay Time: 0 to 9999 ms in 1 ms steps

Test Cable Lengths: 2 m maximum

Measurement Time: Short and long

Averaging: 1 to 256

Input Resistance: 1 kΩ ±10%

Measurement Range/Accuracy

Parameter	Measurement range	Basic accuracy
I	1 pA to 100 μA	2%
R (in ohms)	1×10^{3} to 1×10^{15}	2% + voltage source accuracy

Measurement Time (Time interval from a trigger command to the end of measurement (EOM) signal output at the handler interface port): 9 ms, 28 ms, 98 ms, 396 ms (typical)

Display: 24 digits LCD display. Capable of displaying: measured values, control settings, comparator limits and decisions, self-test messages, and annunciations.

Correction Function

Zero OPEN: Eliminates measurement errors due to leakage current in the test fixture for each test channel.

Comparator Function: HIGH/IN/LOW for the measurement parameter of each test channel

Contact Check Function

Contact failure between the test fixture and device can be detected.

Available DUT type: Capacitive DUT only

Required condition

DUT capacitance: ≥0.5 pF + 5% of residual stray capacitance

Residual stray capacitance of the fixture: ≤50 pF

Additional time for contact check: 2 ms

Other Functions

Save/recall: Ten instrument setups can be saved/recalled from the internal nonvolatile memory.

Continuous memory capability: If the instrument is turned off, or if a power failure occurs, instrument settings (except dc bias) are automatically memorized (≥72 hours at 23 ±5° C).

HP-IB interface: All control settings, measured values, and comparator information

Handler interface: All output signals are negative-logic, optically isolated open collectors. Output signals include: HIGH/IN/LOW and no contact for each channel, index, end-of-measurement, and alarm. Input signals include keylock and external trigger.

General Specifications

Power Requirements: 90 to 132 V or 198 to 264 V, 47 to 66 Hz, 45 VA maximum

Operating Temperature: 0 to 55° C

Size: 320 mm W × 100 mm H × 450 mm D (12.6 in × 3.94 in × 17.72 in)

Weight: 6.5 kg (14.3 lb)

Furnished Accessories

Operation manual, power cable (not including test lead). HP 16117D is needed for each channel.

Ordering Information	Price
HP 16117D Low-Noise Test Lead (1 m, Triax Connector)	$146
HP 4349A Four-Channel High-Resistance Meter	$6,450
Opt 001 2 Test Channels	−$650
Opt 009 Delete Operation Manual	−$47
Opt W30 Extended Repair Service (see page 636)	+$150

- Low and selectable test signal current: 1 μA to 10 mA
- Wide measurement range: 10 μΩ to 100 kΩ
- 10 μΩ resolution
- 1 kHz ac measurement
- High-speed measurement: 34 ms
- Built-in comparator
- Auto-measurement mode

HP 4338A

DESIGNED FOR HP-IB SYSTEMS

HP 4338A Milliohmmeter

The HP 4338A milliohmmeter is a precise, reliable, high-speed test tool for measurements of low resistance.

Precise, Low-Resistance Measurement

Contact failure of electromechanical components in a low-current circuit is a key issue for component reliability. The HP 4338A offers selectable low ac test signals (1 μA to 10 mA). Users can now characterize low resistances of electromechanical components under low-current conditions. A high resolution of 10 μΩ allows you to determine the slightest differences in contact resistance testing of relays, switches, connectors, PC board traces and cables. The 1 kHz test signal eliminates potential errors introduced by thermoelectric effects on the device-under-test (DUT) contacts. The 1 kHz ac test signal is the best solution to evaluate the internal resistance of batteries, because it avoids dc energy consumption.

High-Speed Measurements

The high-speed (34 ms), built-in comparator and HP-IB/handler interfaces make it possible to construct a measurement system using an automatic handler and external computer to minimize production test time.

Auto-Measurement Mode

When performing gross continuity testing where the test signal level is not a significant factor in the test, the auto-measurement function allows the instrument to select an appropriate test signal and measurement range setting.

Specifications (Refer to data sheet for complete specifications.)

Measurement Function
Measurement parameters: R (ac resistance), X (reactance), L (inductance), |Z| (impedance), ϴ (phase [°])
Combinations: R, R-X, R-L, |Z|-ϴ (series mode only)
Mathematical Functions: Deviation and percent deviation
Ranging: Auto and manual
Trigger: Internal, external, manual, and HP-IB
Delay Time: 0 to 9999 ms in 1 ms steps
Measurement Time: Short, medium, and long
Averaging: 1 to 256
Test Signal Characteristics
Test frequency: 1 kHz
Frequency accuracy: ±0.1%
Test signal level: 1 μA, 10 μA, 100 μA, 1 mA, 10 mA rms
Level accuracy: ±10% + 0.2 μA
Maximum voltage across sample: 20 mV peak in any case
Measurement Range

Parameter	Measurement range
R	10 μΩ to 100 kΩ
X, |Z|	10 μΩ to 100 kΩ (typical)
L	10 nH to 10 H (typical)
ϴ	−180° to +180° C (typical)

Measurement Accuracy: ±0.4% Basic for R
Measurement Time: Time interval from a trigger command to the end of measurement (EOM) signal output at the handler interface port.

Mode	Time (typical)
Short	34 ms
Medium	70 ms
Long	900 ms

Display: 24 digits LCD display. Capable of displaying: measured values, control settings, comparator limits and decisions, self-test messages, and annunciations.
Correction Function
Zero SHORT: Eliminates measurement errors due to parasitic impedances in the test fixture.
Comparator Function
HIGH/IN/LOW for each primary measurement parameter and the secondary measurement parameter.
Other Functions
Superimposed dc: ±42 Vdc maximum may be present on measurement terminals.
Save/recall: Ten instrument setups can be saved/recalled from the internal nonvolatile memory.
Continuous memory capability: If the instrument is turned off, or if a power failure occurs, instrument settings are automatically memorized (≤72 hours at 23 ±5° C).
HP-IB interface: All control settings, measured values, and comparator information
Handler interface: All output signals are negative-logic, optically isolated open collectors.
Output signals include: HIGH/IN/LOW, index, end of measurement, and alarm. Input signalsare keylock and external trigger.

General Specifications

Power Requirements: 90 to 132 V or 198 to 264 V, 47 to 66 Hz, 45 VA max
Operating Temperature: 0° to 55° C
Size: 320 mm W × 100 mm H × 300 mm D (12.6 in × 3.94 in × 11.81 in)
Weight: 4.5 kg (9.9 lb)

Furnished Accessories

Operation manual, power cable (mating cable and test leads, or HP 16338A test lead set, must be ordered separately.)

Ordering Information

	Price
HP 16338A Test Lead Set	$770
HP 16143B Mating Cable (0.6 m)	$320
HP 16005B Kelvin Clip Lead (0.4 m, with large clip)	$100
HP 16005C Kelvin IC Clip Lead (0.4 m, with IC clip)	$140
HP 16006A Pin-Type Probe Lead (0.4 m)	$53
HP 16007A Alligator Clip Leads (0.4 m, with 2 red clips)	$25
HP 16007B Alligator Clip Leads (0.4 m, with 2 black clips)	$25
HP 16064B LED Display/Trigger Box	$330
HP 4338A Milliohmmeter	$3,450
Opt 009 Delete Operation Manual	−$54
Opt W30 Extended Repair Service (see page 636)	+$80

☎ For off-the-shelf shipment, call 800-452-4844.

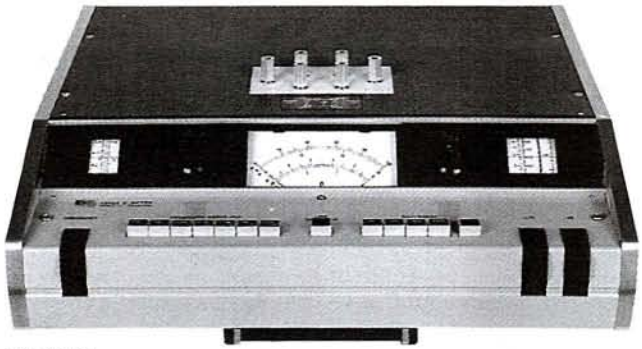
For the most current prices and product information, contact your local Hewlett-Packard sales

COMPONENT MEASUREMENT

Q Meter/1 MHz C-V Meter

HP 4342A, 4279A

- Frequency range: 22 kHz to 70 MHz
- Q range: 5 to 1000



HP 4342A

HP 4342A Q Meter

The direct-reading expanded scale of the HP 4342A permits measurement of Q from 5 to 1000 and reading of very small changes in Q resulting from variation in test parameters. The HP 4342A will measure the dissipation factor and dielectric constant of insulating materials. The Q meter can measure the coefficient of coupling, mutual inductance, and frequency response of transformers.

Specifications

Test Frequency

Range: 22 kHz to 70 MHz (**HP 4342A Opt 001:** 10 kHz to 32 MHz)
Accuracy: ±1.5% from 22 kHz to 22 MHz; ±2% from 22 MHz to 70 MHz; ±1% at "L" point on frequency dial (**HP 4342A Opt 001:** ±1.5% from 10 kHz to 10 MHz; ±2% from 10 MHz to 32 MHz; ±1% at "L" point on frequency dial)
Increments: Approximately 1% resolution

Q Measurement Characteristics

Q range: 5 to 1000 in 4 ranges
Q accuracy: % of indicated value: (@ 25° C)

Q	22 kHz to 30 MHz	30 MHz to 70 MHz
5 to 300	±7	±10
300 to 600	±10	±15
600 to 1000	±15	±20

Q increments: 1 from 20 to 100; 0.5 from 5 to 10
ΔQ range: 0 to 100 in 4 ranges: 0 to 3, 0 to 10, 0 to 30, 0 to 100
ΔQ accuracy: ±10% of full scale
ΔQ increments: 0.1 from 0 to 10; 0.05 from 0 to 3

Inductance Measurement Characteristics

L range: 0.09 μH to 1.2 H, direct reading at 7 specific frequencies
L accuracy: ±3% after substitution of residuals (approx. 10 nH)

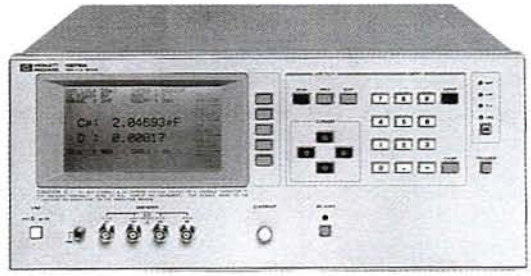
General

Temperature Range: 0° C to 50° C
Power: 115 or 230 V ±10%; 50 to 400 Hz; approx. 40 VA
Size: 138 mm H × 425 mm W × 414 mm D (5.4 in × 16.8 in × 16.3 in)
Weight: Net, 14 kg (31 lb); shipping, 18.45 kg (41 lb)

Ordering Information

	Price
HP 4342A Q Meter	$8,710
Opt 001 Frequency Range (10 kHz to 32 MHz)	+$360
HP 16014A Series Loss Test Adapter	$168
HP 16451A Dielectric Test Adapter	$795
HP 16462A Auxiliary Capacitor	$740
HP 16470A Reference Inductors, set of 20	$3,145
HP 16470B Stable Inductors, set of 4	$1,750
HP 16470C Complete set of 24 Inductors (HP 16470A + HP 16470B)	$4,920

- Built-in programmable dc bias sweep source with a voltage accuracy of 0.1%
- High-speed C-V measurements: 10 ms, 20 ms, and 30 ms/meas point
- 0.1% basic accuracy and six-digit resolution
- Automatic dc bias polarity control



HP 4279A

DESIGNED FOR HP-IB SYSTEMS

HP 4279A 1 MHz C-V Meter

The HP 4279A 1 MHz C-V meter offers the optimal solution for increasing quality and throughput when measuring the capacitance versus bias voltage characteristics of varactor diodes, MOS diodes, and the like. The HP 4279A measures capacitance over a range of 0.00001pF to 1280.00pF with a basic accuracy of 0.1% and a six-digit display resolution, while sweeping the accurate dc bias voltage. The automatic bias polarity control feature allows quick selection of the correct polarity bias voltage for the device under test.

Specifications

Parameters Measured: C-D,Q,ESR,G
Display: 4, 5, 6 digits, selectable, maximum display 999999
Measurement Frequency: 1 MHz ±0.02%
Test Signal Level: 20 mV, 50 mV, 100 mV, 200 mV, 500 mV, and 1 V rms
Measurement Terminals: 4-terminal pair
Test Cable Length Compensation: 0 m, 1 m and 2 m
Error-Correction: OPEN/SHORT/LOAD and temperature compensation
Measurement Time: 10ms/20ms/30ms selectable

Measurement Accuracy (@ 23° C ±5° C) and Range

Basic measurement accuracy: ±0.1% (@ D≤0.1)
Range: C:0.00001pF - 1280.00pF, D: 0.00001 - 9.99999
Internal dc Bias: 0 V to ±38 V, up to 51 sweep points are programmable via HP-IB

Bias voltage	Voltage step	Accuracy (at 23° C – 5° C)
± (0.000 to 4.000) V	1 mV	± (0.1% of setting + 1 mV)
± (4.002 to 8.000) V	2 mV	± (0.1% of setting ± 2 mV)
± (8.005 to 20.000) V	5 mV	± (0.1% of setting + 3 mV)
± (20.01-38.00) V	10 mV	± (0.1% of setting + 10 mV)

Bias Polarity Control: Automatically performed
External dc Bias: 0 V to ±100 V via rear panel connector

General

Operating Temperature and Humidity: 0° C to 55° C, ≤95% RH at 40° C
Power: 100/120/220 V ±10%, 240 V +5% –10%: 48 to 66 Hz; 200 VA max
Size: 177 mm H × 426 mm W × 498 mm D (7 in × 16.8 in × 19.6 in)
Weight: Approximately 15 kg (33 lb)
Accessories Available: Refer to page 347.

Ordering Information

	Price
HP 4279A 1 MHz C-V Meter	$10,700
Opt W30 Extended Repair Service (see page 636)	+$215
Opt 003 1% Frequency Shift	$0
Opt 009 Delete Manual	–$36

HP 16380A

HP 16380C

HP 4440B

HP 16380A and 16380C Standard Capacitor Sets

The HP 16380A and HP 16380C are precision standard capacitor sets that cover the range of 1 pF to 1 μF in decade steps. The HP 16380A consists of four discrete air-dielectric capacitors with nominal values of 1 pF, 10 pF, 100 pF, and 1000 pF. Similarly, the HP 16380C consists of four discrete capacitors, but with solid dielectrics and with nominal values of 0.01 μF, 0.1 μF, and 1 μF.

Both the HP 16380A and HP 16380C are furnished with test certification of 0.01% calibration accuracy. Capacitance stability with respect to time varies from capacitor to capacitor but is in the range of ±50 or ±300 ppm/year.

The HP 16380A and HP 16380C both have the four-terminal pair configuration to allow direct connection to any of Hewlett-Packard's many four-terminal pair impedance measuring instruments. The HP 16380A/C can be easily adapted to two-, three-, and five-terminal configurations.

HP 16380A, 16380C Specifications (valid at 1 kHz, 23 ± 5° C)

HP 16380A

Capacitance	1 pF	10 pF	100 pF	1000 pF
Nominal accuracy	±0.1%			
Calibration accuracy	±0.01%			
Stability	≤300 ppm/yr*			
Dissipation factor	≤0.0001			
Dimensions	112 mm H × 142 mm W × 88 mm D			
Weight	8.0 kg (includes case)			

*Supplemental performance characteristics.

HP 16380C

Capacitance	0.01 μF	0.1 μF	1 μF
Nominal accuracy	±0.1%		
Calibration accuracy	±0.01%		
Stability	≤50 ppm/yr		
Dissipation factor	≤0.0004	≤0.0005	≤0.0007
Dimensions	117 mm H × 142 mm W × 88 mm D		
Weight	6.3 kg (includes case)		

HP 4440B Decade Capacitor

The HP 4440B Decade Capacitor is a high-accuracy instrument providing usable capacitances from 40 pF to 1.2 μF. Its 0.25% accuracy makes it an ideal aid for circuit design or as a working standard.

The use of silvered-mica capacitors in all four decades provides higher accuracy, lower dissipation factor, and good temperature coefficient. An air capacitor vernier provides 100 pF (from 40 pF to 140 pF) with resolution of 1 pF. Capacitors are housed in a double shield in such a way that increased capacitance from two terminals to three terminals is held to 1 pF.

4440B Specifications

Capacitance: 40 pF to 1.2 μF in steps of 100 pF with a 40 pF to 140 pF variable air capacitor providing continuous adjustment to better than 2 pF between steps
Direct Reading Accuracy: ±(0.25% +3 pF) at 1 kHz for three-terminal connection
Resonant Frequency: Typical values of the resonant frequency are 450 kHz at 1 μF, 4 MHz at 0.01 μF, and 40 MHz at 100 pF.
Dissipation Factor: for C ≥1040 pF, 0.001 max at 1 kHz
for C < 1040 pF, 0.005 max at 1 kHz
Temperature Coefficient: < +70 ppm/° C
Insulation Resistance: 5 GΩ minimum, after 5 minutes at 500 V dc
Maximum Voltage: 42 V dc or 30 V rms
Weight: Net, 2.5 kg (5½ lb); shipping, 3.6 kg (8 lb)
Size: 76 mm H × 264 mm W × 152 mm D (3 in × 11 in × 6 in)

Ordering Information

	Price
HP 16380A Standard Capacitor Set (1 pF, 10 pF, 100 pF, 1000 pF)	$3,250
HP 16380C Standard Capacitor Set (0.01 μF, 0.1 μF, 1 μF)	$4,895
HP 4440B Decade Capacitor	$1,975

For the most current prices and product information, contact your local Hewlett-Packard sales

NOISE FIGURE METER

Automatic Noise Figure Meter

HP 8970B

- 10 to 1600 MHz (2047 MHz with Option 020)
- Accurate and simple, swept or CW measurements
- Second-stage correction
- Displays both noise figure and gain
- Calibrated display on oscilloscope, recorder, or plotter
- Powerful special function enhancements

HP 8970B

DESIGNED FOR HP-IB SYSTEMS

HP 8970B Noise Figure Meter

With the HP 8970B Noise Figure Meter, noise figure measurements are easy, accurate, and repeatable. Automatic second-stage correction makes accurate noise figure readings possible even for low-gain devices. The HP 8970B's dynamic range allows gain measurements of at least 40 dB (higher in some cases) or loss measurements to −20 dB, with no external attenuation or amplification. The HP 8970B can store up to 4 ENR (Excess Noise Ratio) noise source calibration tables. It also properly interpolates ENR values at each measurement frequency.

Microprocessor and Controller Functions

The HP 8970B takes the mystery out of noise figure measurements. It uses a microprocessor to make the calculations and corrections necessary for truly accurate, convenient, and flexible noise figure measurements. The meter also controls external local oscillators (such as the HP 8671/73 series synthesizers, the HP 8340 or HP 8360 series synthesized sweepers, or the HP 8350 sweep oscillator) and the HP 8971B Noise Figure Test Set. This makes accurate, broadband microwave measurements of amplifiers, mixers, and transistors as simple as RF measurements.

Virtually all of the HP 8970B's front panel keys and functions are accessible over HP-IB, Hewlett Packard's enhanced version of IEEE-488. The meter has an independent System Interface Bus (SIB) to control the HP 8971B and local oscillator. This additional bus frees you from having to write computer code to control an instrument on the SIB (such as the local oscillator) when used in an automated setup. Pass-through capability allows other instrument controllers to send messages through the meter to any other instrument on the SIB.

Simple Calibration and Second-Stage Correction

Noise figure measurement accuracy is enhanced because the meter measures its own noise figure (and that of the rest of the measurement system) at up to 181 points. It stores this information, interpolates where necessary, and corrects for it when displaying the device-under-test noise figure. It also measures the test device gain.

Display

The HP 8970B's front-panel LEDs display frequency, gain, and noise figure. Rear-panel BNC connectors allow swept display of noise figure and gain versus frequency on an oscilloscope or x-y recorder. You can also have the noise figure and gain vs. frequency display sent to a digital plotter over the HP 8970B's SIB. All display modes are easily and accurately scaled to the desired resolution from the meter's front panel. The swept oscilloscope display allows you to optimize your test device in real time for both noise figure and gain. You can easily change the noise figure display from noise figure to effective noise temperature (Te) or Y factor.

Front Panel and Special Functions

The HP 8970B front-panel keys control number entry, calibration, and measurement. STORE, RECALL, and SEQ keys allow up to 9 front panel settings to be stored and sequenced automatically or manually to save setup time. Smoothing INCREASE and DECREASE keys are used to average up to 512 readings before display. This increases accuracy and eliminates display flicker.

For those who need greater measurement power than that provided by the HP 8970B's simple front panel, more than 200 special functions can be selected by pressing a numerical code and special function key. Two examples are hot-cold measurements and automatic compensation for losses at the input of the test device. One of the special functions is a catalog that quickly shows you the current special functions being used. Three pull-out cards serve as a mini-reference manual for the instrument. They include most of the special functions, the HP-IB formats and codes, error messages, and typical measurement setups.

HP 8970B Partial Specifications

(See technical data sheet for complete specifications.)

Noise Figure (Gain) Measurement Range: 0 to 30 dB (−20 to at least 40 dB)
Noise Figure (Gain) Instrumentation Uncertainty: ±0.1 dB for 0° to 55° C (±.15 dB)
Noise Figure Resolution: 0.01 dB (0.001 dB over HP-IB)
Gain Resolution: 0.01 dB (0.001 dB over HP-IB)
Frequency Range: Tunable from 10 to 1600 MHz (2047 MHz with Option 020)
Tuning Accuracy (from 10° to 40° C): ± (1MHz + 1% of frequency), 6 MHz maximum
Frequency Resolution: 1 MHz
Noise Figure (for input power levels below −60 dBm): <7 dB + 0.003 dB/MHz
Maximum Operating Input Power: −10 dBm
Maximum Net External Gain: >65 dB between noise HP 8970B RF input
Noise Source Drive: 28.0 ± 0.1 V
Operating Temperature: 0° to 55° C
Storage Temperature: −55° to 75° C
Power: 100, 120, 220, or 240 V (+5%, −10%); 48–66 Hz; 150 VA maximum
Size: 425 mm W × 143 mm H × 476 mm D (16.75 in × 5.68 in × 18.38 in)
Weight: Net, 15.5 kg (34 lb); shipping, 18.5 kg (40 lb)

HP 8970S/V

DESIGNED FOR HP-IB SYSTEMS

- 10 MHz to 26.5 GHz
- Fully specified system
- Removes double-sideband inaccuracies
- As easy to operate as the HP 8970A or HP 8970B

HP 8971C

DESIGNED FOR HP-IB SYSTEMS

HP 8970S/V Microwave Noise Figure Measurement Systems

The HP 8970S/V remove the burden of designing, building, and supporting a microwave noise figure measurement system. You can now spend your time designing and building products, not test systems.

Each system consists of the HP 8970B noise figure meter, the HP 8971C noise figure test set, and a synthesized local oscillator. The HP 8970V system, which operates 10 MHz to 20 GHz, uses the new HP 83711A synthesized CW generator as its local oscillator. The HP 8970S, allows you to select the LO from the list below. Frequency operation depends on the LO selected, but can be configured to measure 10 MHz to 26.5 GHz. The HP 8971C with Option 001 is recommended for operation above 20 GHz.

The HP 8970B acts as the controller, so all system operation is transparent to the user. To ensure specified performance, the HP 8970S/V systems are given specifications just like an RF noise figure meter (i.e, the HP 8970B).

HP 8970S/V Partial Specifications

(See HP 8970S technical data sheet for complete specifications.)
Frequency Range: 10 MHz to 26.5 GHz (HP 8970S)
10 MHz to 20 GHz (HP 8970V)
Noise Figure Measurement Range: 0 to 30 dB
Noise Figure Instrumentation Uncertainty (for a 14 to 16 dB ENR noise source in a 10° to 40° C environment and for device under test noise figure plus gain greater than 10 dB):
10 MHz to 18 GHz: ±0.2 dB (plus typical drift of ±0.015 dB/° C)
18 to 26.5 GHz: ±0.4 dB (plus typical drift of ±0.08 dB/° C)
Gain Instrumentation Uncertainty: ±0.28 dB (plus typical drift of
±0.05 dB/° C, 10 MHz to 18 GHz
±0.07 dB/° C, 18 to 26.5 GHz
Noise Figure (max):
10 to 30 MHz: 18 dB
30 to 100 MHz: 13 dB
0.1 to 12 GHz: 10 dB
12 to 18 GHZ: 11.5 dB
18 to 26.5 GHz: 14 dB
Input SWR: 10 MHz to 18 GHz: 2.25
18 to 26.5 GHz: 2.7
Recommended Local Oscillators: HP 8671B, 8672A, 8673B/C/E/G, 8340B, 8341B, 83620A, 83622A, 83640A, 83630A, 83711A, 83712A, 83731A, and 83732A

HP 8971C Noise Figure Test Set

The HP 8971C Noise Figure Test Set brings the simplicity of double-sideband measurements and the accuracy of single-sideband measurements together in one package. Careful design and high performance components, including a stable YIG filter, allow broadband single-sideband measurements from 10 MHz to 26.5 GHz with a single calibration and sweep. A low-noise preamplifier built into the Noise Figure Test Set lowers the second-stage noise figure, thereby reducing a major source of measurement uncertainty.

Measurement modes in the HP 8970B allow for double down-conversion using the HP 8971C as the second down-converter. These modes can be used for millimeter-wave measurements of amplifiers and transistors and measurements of receivers and mixers with IFs above 1.6 GHz.

HP 8971C Partial Specifications

(See HP 8971C technical data sheet for complete specifications.)
Frequency Range: 10 MHz to 26.5 GHz
Input SWR:
10 MHz to 18 GHz: 2.25
18 to 26.5 GHz: 2.7
Image and Odd-Harmonic Rejection: 20 dB
Accessories Supplied:
1 LO-to-HP 8971B cable — SMA(female), 300 mm
1 HP 8971B-to-HP 8970B cable — N(male), 190 mm
1 N(male)-to-SMA(male) adapter
2 HP-IB cables — .5 m

NOISE FIGURE METER

Noise Sources

Models HP 346 A/B/C, R/Q347B

HP 346A, 346B, 346C

HP R/Q347B

HP 346A/B/C Broadband Noise Sources

The ideal companion to the HP's noise figure meter and systems is the HP 346 family of noise sources. Since they are broadband (10 MHz to either 18 or 26.5 GHz), they eliminate the necessity for several sources at different frequency bands. Each source has individually calibrated ENR values at specific frequencies. The calibration is printed on its label (see illustration) for easy loading into the HP 8970B. The low SWR of each noise source reduces a major source of measurement uncertainty—re-reflections of test signals. In addition, the variety of available connectors reduces the need for degrading accuracy with connector adapters.

The HP 346 family of noise sources are designed for a broad range of measurement applications. The HP 346C covers the broadest frequency range, 10 MHz to 26.5 GHz. The HP 346B's high ENR, low SWR, and variety of connectors make it a general-purpose noise source. The HP 346A is designed especially for accurate characterization of input-impedance–sensitive devices (like GaAsFETs and many UHF amplifiers). Its very small change in reflection coefficient (<0.01) from ON to OFF minimizes errors when measuring noise figure and gain as a function of input impedance.

HP 346A/B/C Partial Specifications

(See technical data sheet for complete specifications.)

Frequency Range: 10 MHz to 18 GHz for HP 346A/B; 10 MHz to 26.5 GHz for HP 346C.

Excess Noise Ratio (ENR) limits: HP 346A: 5 to 7 dB; HP 346B: 14 to 16 dB; HP 346C: 12 to 16 dB (10 MHz to 12 GHz) and 14 to 17 dB (12.0 to 26.5 GHz).

Maximum SWR (reflection coefficient) On and Off:

HP 346A/B: 10 to 30 MHz — 1.3 (0.13); 30 to 5000 MHz — 1.15 (0.07); 5 to 18 GHz — 1.25 (0.11).

HP 346C: 10 MHz to 18 GHz — 1.25 (0.11); 18 to 26.5 GHz — 1.35 (0.15).

Power Required: 28 ± 1 Vdc.

Size: 140 mm H × 21 mm W × 30 mm D (5.5 in × 0.8 in × 1.2 in)

Weight: Net, 0.108 kg (3.5 oz); shipping, 0.5 kg (1 lb)

Standard Connector: APC—3.5 (male)

HP 346C Option K01 Broadband Noise Source

This new coaxial noise source features coverage from 1 to 50 GHz with the 2.4 mm coaxial connector. ENR is nominally 20 dB at 1 GHz and 7dB at 50 GHz. Contact HP for technical specifications.

HP 346B Option H01 High ENR Noise Source

The HP 346B Option H01 has high ENR (21 dB typical), suitable for measuring high noise figure devices. Contact HP for technical specifications.

HP 346B Option H42 DBS Noise Source

The 346B Option H42 was developed especially to test low noise block converters (LNB) used for Direct Broadcast Satellite (DBS). WR75 waveguide output, 5 dB ENR, low ENR calibration uncertainty, and low SWR improve the noise figure measurement accuracy of DBS LNBs. Contact HP for technical specifications.

HP R & Q347B Noise Sources Partial Specifications

(See technical data sheet for complete specifications.)

Frequency Range: R347B: 26.5 to 40 GHz
Q347B: 33 to 50 GHz

Excess Noise Ratio (ENR) Range:
HP R347B: 10 to 13 dB
HP Q347B: 10 to 13 dB (33 to 42 GHz)
6 to 12.5 dB (42 to 50 GHz)

Max. SWR (reflection coefficient):
HP R347B: <1.42 (0.17)
HP Q347B: <1.57 (0.22)

Ordering Information

	Price
HP 8970B Noise Figure Meter	$ 13,500
Opt 020 Increases Upper Frequency from 1600 to 2047 MHz	+ $2,000
Opt 907 Front Panel Handle Kit (5061-9689)	+ $55 ?
Opt 908 Rackmounting Flange Kit (5061-9677)	+ $33 ?
Opt 909 Both Options 907 and 908 (5061-9683)	+ $80 ?
Opt 915 Service Manual (08970-90023)	$35 ?
Opt 916 Additional Operating Manual (08970-90048)	$30 ?
Opt 700 External Mate Translator	+ $7,055
Opt W30 Extended Repair Service	$140
Opt W32 Calibration Service	$525
HP 8971C Noise Figure Test Set	$22,000
Opt 001 Add L.O. Power Amplifier	+$5,500
Opt 002 Delete RF Preamplifier	−$3,000
Opt 907 Front Panel Handle Kit (5062-3988)	$43 ?
HP 8970S Noise Figure Measurement System	See HP 8970S Ordering Guide
HP 8970V Noise Figure Measurement System (10 MHz to 20 GHz)	$56,500
Opt W30 Extended Repair Service	$1,200
Opt W32 Calibration Service	$4,050
HP 346A Noise Source	$1,800 ?
Opt 001 Type N (male) Connector	$0
Opt 002 APC-7 Connector	$25
Opt 004 Type N (female) Connector	$0
Opt 910 Extra Operating Manual	$2
Opt W30 Extended Repair Service	$55
Opt W32 Calibration Service	$285
HP 346B Noise Source	$1,700 ?
Opt 001 Type N (male) Connector	$0
Opt 002 APC-7 Connector	$25
Opt 004 Type N (female) Connector	$0
Opt H01 High ENR	+$312
Opt H42 DBS Noise Source	+$2,250
Opt 910 Extra Operating Manual	$2
Opt W30 Extended Repair Service	$55
Opt W32 Calibration Service	$285
HP 346C Noise Source	$2,275 ?
Opt 910 Extra Operating Manual	$2
Opt W30 Extended Repair Service	$55
Opt W32 Calibration Service	$305
HP 346 Opt K01 Noise Source	$3,600
HP R347B Noise Source	$2,800
HP Q347B Noise Source	$3,400

☎ For off-the-shelf shipment, call 800-452-4844.

HP Microwave System Amplifiers

HP microwave system amplifiers provide up to 1 W of ultrabroadband output power to boost available power where you need it in microwave ATE systems. The ultra broad bandwidth allows system designers to replace several narrow band amplifiers with a single HP solution, eliminating the need for crossover networks or a multiple bias supplies. These amplifiers are fully integrated with a low-profile heat sink and mounting brackets that allow easy incorporation into a system. Place power where you need it with the remotely locatable dc power supply. The amplifier and power supply come with 2-m-long dc bias cables.

Use these amplifiers to increase output power from microwave sources and increase test system dynamic range. Drive a variety of narrow band travelling wave tubes with a single-driver solution that is highly reliable and low cost to maintain year after year. With excellent noise figure relative to its broad bandwidth and high gain, these amplifiers can make a significant improvement to system noise figure. By using feedback to an external source ALC input, system designers can level output power at the test port, negating the effects of post sweeper reflections and losses. The standard HP 83020A, 83018A, and 83017A include an internal GaAs directional detector for external levelling applications. As an option, the HP 83020A and 83018A are available without the coupler/detector providing slightly more power with reduced cost. The Microwave System Amplifiers utilize GaAs MMIC technology to offer ultrabroadband performance and very low part count for improved reliability.

Specifications (+20° to +30° C)

HP Model	Frequency (GHz)	Power out Psat (dBm)	Power out P1dBC (dBm)	Gain dB min)	VSWR In/out	Noise figure (dB typ)	Detected output	dc bias volt/amp	Price
83020A	2 to 26.5	+30 2 to 20 +26 20 to 26.5	+27 2 to 18 +23 18 to 26.5	30 2 to 20 27 20 to 26.5	3.0:1 in 4.5:1 2 to 10 2.2:1 10 to 26.5	10 2 to 20 13 20 to 26.5	Yes	+15 V @ 3.3A −15 V @ 50 mA	$18,500
83018A	2 to 26.5	+24 2 to 20 +21 20 to 26.5	+22 2 to 20 +17 20 to 26.5	27 2 to 20 23 20 to 26.5	3.0:1 in 4.5:1 2 to 10 2.2:1 10 to 26.5	10 2 to 20 13 20 to 26.5	Yes	+12 V @ 2A −12 V @ 50 mA	$11,500
83017A	0.5 to 26.5	+20 typ 0.5 to 20 +15 typ 20 to 26.5	+18 0.5 to 20 +13 20 to 26.5	25	2.6:1 in 2.6:1 out	8 0.5 to 18 13 18 to 26.5	Yes	+12 V @ 700 mA −12 V @ 50 mA	$4,950
83006A	0.01 to 26.5	+18 typ 0.01 to 10 +16 typ 10 to 20 +14 typ 20 to 26.5	+13 0.01 to 20 +10 20 to 26.5	20	2.6:1 in 2.8:1 0.01 to 18 3.2:1 18 to 26.5	13 0.01 to 0.1 8 0.1 to 18 13 18 to 26.5	No	+12 V @ 450 mA −12 V @ 50 mA	$3,950
87405A	0.01 to 3		+4	22–27 min/max	1.7:1 0.01 to 2 in 2.0:1 2 to 2.9 in 2.2:1 2.9 to 3 in 2.0:1 out	6.5 0.01 to 2 7.5 2 to 3	No	Probe power connector	$1,500
87415A	2 to 8		+23	25	2.0:1 in 3.6:1 2 to 2.5 2.6:1 2.5 to 8	13	No	+12 V @ 900 mA	$2,400
87400A	2 to 8		+23	25	2.0:1 in 3.6:1 2 to 2.5 2.6:1 2.5 to 8	13	No	+12 V @ 900 mA	$1,900

RF Connectors: 3.5 mm (f) on RF input and output (except HP 87405 type N(f) in, N(m) out); BNC (f) detector out

Weight: HP 83020A 3.4 kg (7½ lb), HP 83018A 1.8 kg (4 lb), HP 87405A 270 g (0.6 lb), HP 83017A, 83006A, 87415A 640 g (1½ lb)

Size:
HP 83020A: 202 mm W × 87 mm H × 275 mm D (8 in × 3.4 in × 10.8 in)
HP 83017A, 83006A, 87415A: 103 mm W × 45 mm H × 132 mm D (4 in × 1.8 in × 5.2 in)
HP 83018A: 114 mm W × 76 mm H × 212 mm D (4.5 in × 3 in × 8.3 in)
HP 87400A: 86 mm W × 44 mm H × 12 mm D (3.4 in × .5 in × 1.7 in)

Bias Cable: 2-m cable with a connector on one end and bare wires on the other, shipped with the amplifiers below.
HP 83020A: HP p/n 83020-60004
HP 83018A, 83017A, 83006A, 87415: HP p/n 83006-60004

HP power supply	dc output voltage/current	Output power	ac input voltage	Size (W,H,D)	Price
HP 87421A	+12V @ 2.0A, −12V @ 200mA	25 W max	100 to 240 VAC 50/60 Hz	114 mm, 57 mm, 176 mm 4.5 in, 2.3 in, 6.9 in	$395
HP 87422A	+15V @ 3.3A, −15V @ 50mA +12V @ 2.0A, −12V @ 200mA	70 W max	100 to 240 VAC 50/60 Hz	202 mm, 86 mm, 276 mm 8.0 in, 3.4 in, 10.9 in	$685

Bias Cable: 2-m cables to connect between amplifier and power supplies, shipped with power supplies below.
HP 87421A: HP p/n 83006-60005
HP 87422A: HP p/n 87422-60001, 83006-60005

MICROWAVE TEST ACCESSORIES

Transmission Reflection Test Sets, Power Splitters, Power Dividers

HP 8721A, 86205A, 11850C/D, 11667A/B/C, 11636A/B

HP 86205A

HP 8721A

HP 11850C

HP 11667B

HP 11636A

Description

Accurate broadband measurements of transmission and reflection parameters are highly dependent on the device used to separate signals for the measurement. Some devices separate the reflected and transmitted signals and some split power for ratio and comparison measurements.

HP 8721A Directional Bridge
HP 8721A Option 008 75 Ω Version

Frequency Range: 0.1 to 110 MHz
Directivity: >40 dB, 1 to 110 MHz, typically >30 dB, 0.1 to 1 MHz
Load Port Match: >30 dB (VSWR <1.07)
Transmission Arm: Nominal loss, 6 dB. Frequency response, <0.2 dB.
Coupling Arm: Nominal coupling, 6 dB. Frequency response, <0.6 dB.
Maximum Input Power: +20 dBm
Weight: Net, 0.55 kg (0.25 lb); shipping, 1.1 kg (0.5 lb)
Size: 59 mm H × 39 mm W × 123 mm D (1.5 in × 1 in × 3.13 in)

HP 86205A 50 Ω RF Bridge
HP 86207A 75 Ω RF Bridge

The HP 86205A and HP 86207A RF Bridges provide high directivity, low insertion loss, and an extremely flat coupling factor over 300 kHz to 6 GHz frequency range. This combination of characteristics makes these bridges ideal for general purpose reflection measurement and signal leveling applications. Detailed specifications on the HP 86205A and HP 86207A RF Bridges appear on page 299.

HP 11850C 50 Ω Power Splitter
HP 11850D 75 Ω Power Splitter

These three-way power splitters are designed for ratio measurements from dc to 3.0 GHz (11850C) or 2 GHz (11850D). One output port provides the reference and the other two output ports can be used for independent transmission measurements. They provide 0.25 dB tracking and >20 dB output match. Detailed specifications are on page 299.

HP 11667A Power Splitter (Type N)
HP 11667B Power Splitter (3.5 mm)
HP 11667C Power Splitter (2.4 mm)

These two-way, two-resistor splitters provide good input and output source match in ratio measurement and source leveling applications. The HP 11667A operates from dc to 18 GHz with output match >17 dB and tracking <0.25 dB. The HP 11667B operates from dc to 26.5 GHz and has output source match >18 dB and tracking <0.4 dB. The HP 11667C operates from dc to 50 GHz and has an output source match >12 dB and tracking <0.4 dB. Detailed specifications are on page 280.

HP 11636A/B Power Dividers/Combiners

The HP 11636A/B are two-way, three-resistor power dividers for nonratio measurements. They can also be used as power combiners for combining two independent signals. They are ideal for fault location measurements with HP 8757 and HP 85016B software.
Frequency Range: HP 11636A: dc to 18 GHz
HP 11636B: dc to 26.5 GHz.
Impedance: 50 Ω nominal
Insertion Loss: 6 dB nominal

	dc to 10 GHz	dc to 18 GHz	dc to 26.5 GHz
Input SWR			
HP 11636A	<1.25	<1.35	
HP 11636B	<1.22	<1.29	<1.29
Output SWR			
(nonratio measurements)			
HP 11636A	<1.25	<1.35	
HP 11636B	<1.22	<1.29	<1.29
Output Tracking			
(between output arms)			
HP 11636A	<0.4 dB	<0.5 dB	
HP 11636B	<0.25 dB	<0.25 dB	<0.5 dB
Typical Phase Tracking			
(between output arms)			
HP 11636A	2°	2°	
HP 11636B	2°	2.5°	3°

Maximum Input Power
HP 11636 A +30 dBm
HP 11636B +27 dBm
Connectors
HP 11636A: Type N male input port, female output ports
HP 11636B: APC-3.5 female on all ports
Size
HP 11636A: 42 mm H × 45 mm W × 18 mm D (1.64 in × 1.75 in × 0.69 in)
HP 11636B: 40 mm H × 47 mm W × 10 mm D (1.6 in × 1.9 in × 0.4 in)
Weight
HP 11636A: Net, 0.14 kg (0.31 lb); shipping, 0.45 kg (1 lb)
HP 11636B: Net, 0.06 kg (0.13 lb); shipping, 0.14 kg (0.3 lb)

Ordering Information

	Price
HP 8721 Directional Bridge	$400
Opt 008 75 Ω Version	+$50
HP 86205A 50 Ω RF Bridge	$1,300
HP 86207A 75 Ω RF Bridge	$1,300
HP 11850C 50 Ω Power Splitter	$950
HP 11850D 75 Ω Power Splitter	$1,700
HP 11667A Power Splitter (dc to 18 GHz)	$990 ?
Opt 001 Type N Male Input, Type N Female Outputs	$0
Opt 002 Type N Female Input, APC-7 On Outputs	+$75
HP 11667B Power Splitter (dc to 26.5 GHz)	$1,070 ?
HP 11667C Power Splitter (dc to 50 GHz)	$1,570 ?
HP 11636A Power Divider (dc to 18 GHz)	$600 ?
HP 11636B Power Divider (dc to 26.5 GHz)	$1,050 ?

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 8490D, 8491A/B, 8492A, 8493A/B/C Fixed Attenuators

Hewlett-Packard coaxial fixed attenuators provide precision attenuation, flat frequency response, low SWR over broad frequency ranges (dc to 50.0 GHz) at low prices. Attenuators are available in nominal attenuations of 3 dB and 6 dB, also 10 dB increments from 10 dB to 60 dB. These attenuators are swept-frequency tested to ensure they meet specifications at all frequencies. Calibration points are provided on a nameplate chart attached to each unit.

HP 8491C Economy Fixed Attenuators

The HP 8491C Series general-purpose fixed attenuators feature precision attenuation, flat frequency response, and low SWR from dc to 18 GHz. Available with precision Type-N connectors, the HP 8491C family is available in 3, 6, 10, 20, and 30 dB attenuation values. Please specify attenuation value (option) when ordering.

HP 11581A, 11582A, 11583A/C Attenuator Sets

A set of four Hewlett-Packard attenuators—3, 6, 10, and 20 dB—are furnished in a handsome walnut accessory case. The HP 11581A set consists of HP 8491A Attenuators; the HP 11582A set, HP 8491B Attenuators; the HP 11583A set, HP 8492A Attenuators; and the HP 11583C set, HP 8493C Attenuators. The set includes calibration reports certified traceable to the National Institute of Standards and Technology, containing both the attenuation and the reflection coefficients for each attenuator at the frequencies indicated under "Option 890" calibration data on the next page. Thus it is not required to specify Option 890.

These sets are ideal for calibration labs or where precise knowledge of attenuation and SWR is desired.

HP 8498A High Power Attenuator

The HP 8498A Option 030 is designed to meet the needs of high power attenuation applications in the RF and microwave frequency range. It is specified from dc to 18 GHz at 25 W average, 500 W peak, from dc to 5.8 GHz and 125 W peak from 5.8 to 18 GHz. Available only in a 30 dB model (Option 030), the unit offers low SWR (<1.30 at 18 GHz) and good accuracy (±1 dB at 18 GHz). The unit also features "human engineered" cooling fins that prevent operator burns even under continuous maximum input power conditions.

Option 890 Calibration Data

Extensive calibration data is available on HP attenuators at low cost. When Option 890 is specified for the fixed attenuators or microwave step attenuators, standardized calibration data in frequency steps no larger than 500 MHz is provided over the frequency range of the units. This data is generated from measurements made on an HP 8510 Automatic Network Analyzer and features excellent accuracy (traceable to NIST) and low cost. Data is given for attenuation and the SWR (reflection coefficient for the HP 8493C) of each port and is provided in a protective plastic envelope.

HP 11742A Blocking Capacitor

The HP 11742A is a high-performance outside blocking capacitor. It features broadband performance, low SWR (1.2 from .01 to 26.5 GHz) and low insertion loss (.6 dB from .01 to 26.5 GHz). The HP 11742A comes with 3.5 mm connectors. It is ideal for use with high-frequency oscilloscopes and in bias circuits for the attenuation of low frequencies and blocking dc voltages up to 50 V.

2.4-mm Instrument Grade Connectors

The 2.4-mm coaxial connector family allows mode-free operation from dc to 50 GHz in coax. Designed to offer a very repeatable, low return loss coaxial interface rugged enough for repeated connect-disconnect cycles, the 2.4 mm draws upon many years of connector development experience and incorporates the best features of many different designs. These precision-instrument-grade connectors and connector parts offer designers very repeatable, low return loss connectors for test equipment and demanding breadboard design applications.

Typical 2.4 mm Performance (return loss)

	dc to 18 GHz	18 to 26.5 GHz	26.5 to 50 GHz
Connector pair	30 dB	28 dB	22 dB
Launch connectors	28 dB	26 dB	20 dB

2.4 mm Male (plug) Connector Parts and Assemblies

HP model	Description	Price
33392A	Male outer conductor	$32*
33392B	Male center conductor	$15*
33392C	Snap ring	$4*
33392D	Coupling nut	$8*
33392E	Bead/ring assembly	$24*
33393A	Male barrel launch	$225
33392H	Cable end connector	$19*
33393C	Cable assy (0.086 dia)	$80

*Minimum order quantity 10 each

2.4 mm Female (jack) Connector Parts and Assemblies

33392F	Female outer conductor	$50*
33392G	Female center conductor	$15*
33392E	Bead/ring assembly	$24*
33393B	Female barrel launch	$225

*Minimum order quantity 10 each

HP 11970 Series Harmonic Mixers

Although designed for operation with HP spectrum analyzers, these broadband mixers also serve a wide variety of general-purpose uses for the frequency bands from 18 to 110 GHz. Such uses include down-conversion for noise figure and network analysis measurements.

As down-conversion mixers for test receivers, the HP 11970s offer flat response, low SWR, and low conversion loss without requiring bias. These mixers can also serve as harmonic generators with input signals from 2 to 6.1 GHz. Outputs are at the band specified, and each mixer is individually calibrated for conversion loss over its complete band.

HP 11970 Series Specifications

HP model	Frequency range (GHz)	Frequency response (dB)	Waveguide and equivalent flange	Price
11970K	18 to 26.5	±1.9 ±2.1	WR-42 UG-595/U	$2,100
11970A	26.5 to 40	±1.9 ±2.1	WR-28 UG-599/U	$2,200
11970Q	33 to 50	±1.9 ±2/3	WR-22 UG-383/U	$2,275
11970U	40 to 60	±1.9 ±2.3	WR-19 UG-383/U (mod)	$2,550
11970V	50 to 75	±2.1 ±2.5	WR-15 UG-385/U	$3,000
11970W	75 to 110	±3.0	WR-10 UG-385/U (mod)	$3,400

MICROWAVE TEST ACCESSORIES

Coaxial Fixed Attenuators

HP 8490 Series, 11581/2/3

HP 8490 Series


HP 8492 Series

HP 8493A/B/C Series

Ordering Example

Include appropriate frequency range/connector and attenuation designations from the ordering example below with every attenuator order.

8491B Option 010

Connectors and Frequency Range

0D: 2.4 mm (m,f), dc to 50.0 GHz
1A: Type N (m,f), dc to 12.4 GHz
1B: Type N (m,f), dc to 18 GHz
1C: Type N (m,f), dc to 18 GHz
2A: APC-7, dc to 18 GHz
3A: SMA (m,f), dc to 12.4 GHz
3B: SMA (m,f), dc to 18 GHz
3C: 3.5 mm (m,f), dc to 26.5 GHz
8A: Type N (m,f), dc to 18 GHz
8498 is available in a 30-dB model only

Attenuation

003: 3 dB
006: 6 dB
010: 10 dB
020: 20 dB
030: 30 dB
040: 40 dB*
050: 50 dB**
060: 60 dB**

*Not available for HP 8493A/B and 8491C
**Not available for HP 8493A/B/C, 8491C, and 8490D

Ordering Information

	Price
HP 11581A 3, 6, 10, 20 dB HP 8491A set	$600
HP 11582A 3, 6, 10, 20 dB HP 8491B set	$735
HP 11583A 3, 6, 10, 20 dB HP 8492A set	$1,325
HP 11583C 3, 6, 10, 20 dB HP 8493C set	$1,360

HP 8490D, 8491A/B/C, 8492A, 8493A/B/C, 8498A, Option 890 Specifications

Freq Range (GHz)	Conn (m,f)	HP Model	SWR (max)	Power		Attenuation Accuracy 3 dB Opt 003	6 dB Opt 006	10 dB Opt 010	20 dB Opt 020	30 dB Opt 030	40 dB Opt 040	50 dB Opt 050	60 dB Opt 060	Price
dc to 12.4			dc to 8 GHz: 1.2 8 to 12.4 GHz: 1.3	2 W avg 100 W peak	dc to 12.4	±0.3	±0.4	±0.6	±0.6	±1.0	±1.5	±1.5	±2	
	Type N	8491A				Opt 003	Opt 006	Opt 010	Opt 020	Opt 030				$125
	Type N	8491A									Opt 040	Opt 050	Opt 060	$175
	SMA	8493A				Opt 003	Opt 006	Opt 010	Opt 020	Opt 030				$135
dc to 18			dc to 8 GHz: 1.2 8 to 12.4 GHz: 1.3 12.4 to 18 GHz: 1.5	2 W avg 100 W peak	dc to 12.4 12.4 to 18	±0.3 ±0.4	±0.4 ±0.5	±0.6 ±0.6	±0.6 ±1.0	±1.0 ±1.0	±1.5 ±1.5	±1.5 ±1.5	±2 ±2	
	Type N	8491B				Opt 003	Opt 006	Opt 010	Opt 020	Opt 030				$150
	Type N	8491B									Opt 040	Opt 050	Opt 060	$210
	Type N	8491C				Opt 003	Opt 006	Opt 010	Opt 020	Opt 030				$95
	SMA	8493B				Opt 003	Opt 006	Opt 010	Opt 020	Opt 030				$165
	APC-7	8492A	dc to 8 GHz: 1.15			Opt 003	Opt 006	Opt 010	Opt 020	Opt 030				$300
	APC-7	8492A	8 to 12.4 GHz: 1.25 12.4 to 18 GHz: 1.35								Opt 040	Opt 050	Opt 060	$350
dc to 18 High Power	Type N	8498A Opt 030	dc to 8 GHz: 1.15 8 to 12.4 GHz: 1.25 12.4 to 18 GHz: 1.30	25 W avg 500 W peak (dc to 5.8 GHz) 125 W peak (5.8 to 18 GHz) 500 W μs max per pulse						Opt 030				$1,050
dc to 26.5			dc to 8 GHz: 1.1 8 to 12.4 GHz: 1.15 12.4 to 26.5 GHz: 1.25 1.27 (Opt 006 only)	2 W avg 100 W peak	dc to 18 18 to 26.5	±0.5 ±1.0	±0.6 ±0.6	±0.3 ±0.5	±0.5 ±0.6	±0.7 ±1.0	±1.0 ±1.3			
	3.5 mm	8493C				Opt 003	Opt 006	Opt 010	Opt 020	Opt 030	Opt 040			$250
dc to 50			dc to 26.5 GHz: 1.15 (1.08 Opt 040 only) 26.5 to 40 GHz: 1.25 (1.15 Opt 040 only) 40 to 50 GHz: 1.45 (1.25 Opt 040 only)	2 W avg 100 W peak	dc to 26.5 26.5 to 50	+0.9 −0.5 +1.8 −0.5	+0.9 −0.6 +1.8 −0.6	+0.09 −0.6 +1.3 −0.6	+1.3 −0.8 +1.7 −0.8	+1.3 −0.8 +1.7 −0.8	+1.5 −0.8 +2.5 −0.8			
	2.4 mm	8490D				Opt 003	Opt 006	Opt 010	Opt 020	Opt 030	Opt 040			$400

Opt 890 Calibration Data	HP Models	Calibration Frequencies (MHz)	Opt 890 Price
	8490D 8491A, 8493A	0.4 GHz to 50 GHz in 400 MHz steps 0.2 GHz to 12.4 GHz in 200 MHz steps	+$50 +$20
	8491B, 8492A, 8493B, 8498A	0.2 GHz to 18.0 GHz in 200 MHz steps	+$25
	8493C	1.5 GHz to 26.5 GHz in 250 MHz steps	+$40

☎ For off-the-shelf shipment, call 800-452-4844.

- Excellent repeatability
- Manual and programmable
- Calibration data available
- Five million cycles per section reliability

HP 8495D

HP 8495K

HP 11716A

DESIGNED FOR HP-IB SYSTEMS

dc to 1000 MHz Programmable and Manual Step Attenuators. HP 355C/D/E/F

- Precision attenuation from dc to 1000 MHz
- 355C/E provide 0 to 12 dB in 1 dB steps
- 355D/F provide 0 to 120 dB in 10 dB steps
- All standard models use standard BNC RF connectors
- Programmable models (E/F) use 7-pin connectors

dc to 4, 18, and 26.5 GHz Programmable and Manual Step Attenuators
HP 8494A/B/G/H (0 to 11 dB, 1 dB steps)
HP 8495A/B/D/G/H/K (0 to 70 dB, 10 dB steps)
HP 8496A/B/G/H (0 to 110 dB, 10 dB steps)
HP 8497K (0 to 90 dB, 10 dB steps)

Hewlett-Packard attenuators offer exceptional repeatability and reliability in a wide range of attenuation, frequency, and connector options.

- SMA (f), Type N (f), APC-7 and 3.5 mm RF connectors
- dc to 4 GHz, dc to 18 GHz, and dc to 26.5 GHz models
- Permanent magnet latching design and automatic dc current interrupts simplify programmable model drive circuit design

Each attenuator contains three or four cascaded attenuator sections; edge-line contacts insert and remove attenuator sections as needed. Precision gold-plated leaf springs ensure long life (over 5 million cycles) and very high attenuator repeatability (typically 0.01 dB). Programmable models (G, H, and K suffixes) feature fast-switching solenoids; attenuation programming is done through a 12-pin connector.

To improve measurement accuracy in manual and automated test systems, NIST traceable calibration data (SWR and attenuation) is available as Option 890. Generated on an HP 8510 network analyzer, this option offers swept data for each attenuator step in 250 MHz steps from 1500 MHz to 26.5 GHz (upper frequency varies by model).

To simplify connecting programmable attenuators to the drive circuit, each unit is supplied with a 5-ft cable assembly. With an HP 11713A Attenuator Driver, or an HP 70611 Driver for MMS-based systems, the attenuators are easily integrated into a Hewlett-Packard Interface Bus (HP-IB) automated system.

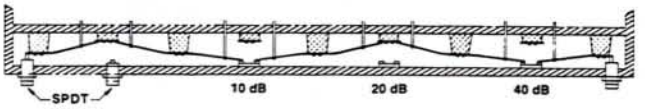


Figure 1. 70 dB plus SPDT.

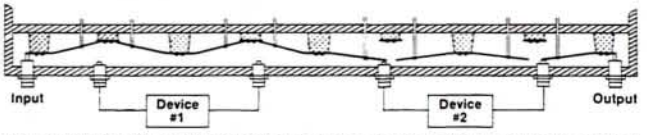


Figure 2. Dual transfer switch showing device #2 inserted in signal path.

Custom Attenuator and Switch Combinations

Custom step attenuator/switch combinations are possible with the HP 8494/5/6/7 attenuator family. Examples can be as simple as adding a SPDT switch section to a standard 70 dB attenuator (figure 1) or creating a dual transfer switch (figure 2). See the HP Microwave Test Accessories Catalog for more information.

HP 11716A/B Attenuator Interconnect Kits

Quickly and conveniently connect 1 dB step and 10 dB step attenuators together to achieve greater dynamic range with 1 dB steps. The 11716A/B interconnect kits contain a rigid RF cable, mounting bracket, and necessary hardware to connect any pair of HP 8494/5/6/7 attenuators in series (see photo above). Attenuators must be ordered separately.

Ordering Information	Price
HP 11716A Interconnect Kit (Type N)	$220
HP 11716B Interconnect Kit (APC-7)	$300

HP 33320 Series OEM Step Attenuators

The HP 33320 series step attenuators are compact versions of the HP 8495/6/7 benchtop attenuators. They offer the same specifications, but are configured to fit easily into microwave systems and instruments. Both manual and programmable versions are available; the manual version occupies less than 1.5 square inches of panel space. OEM quantity discounts are available for the HP 33320 series; the HP 33320 series has a five-million-cycles-per-step reliability guarantee.

Programmable models are supplied with a 5-ft cable, fitted with a round 12-pin Viking connector that mates with the HP 11713 Attenuator/Switch Driver. A flat ribbon cable with a DIP-type connector, compatible with a standard 14-pin DIP IC socket, is also available.

MICROWAVE TEST ACCESSORIES

Ordering HP 8494/5/6/7 Series Attenuators

How to Order the HP 8494/5/6/7 Series Attenuators

Each order must include basic model number, suffix letter, and connector option.

Optional calibration data

HP 8494 A Option 001 Option 890

4 (1 dB step, 11 dB max) **5** (10 dB step, 70 dB max) **6** (10 dB step, 110 dB max) **7** (10 dB step, 90 dB max)	**A** (Manual, dc to 4 GHz) **B** (Manual, dc to 18 GHz) **D** (Manual, dc to 26.5 GHz)* **G** (Programmable, dc to 4 GHz) **H** (Programmable, dc to 18 GHz) **K** (Programmable, dc to 26.5 GHz)*	**001** (N female) **002** (SMA female) **003** (APC-7) **004** (3.5 mm female)*

* Option 004 is only available on D and K models.

HP 355 Series, 8494/5/6/7 Series Specifications

HP Model (Switching Model) (OEM Model No.)	Frequency Range (GHz)	Incremental Attenuation (dB)	SWR Maximum (50 Ω Nominal)	Insertion Loss (0 dB setting)	Attenuation Accuracy	Power Rating, Minimum Life	Solenoid Voltage Speed Power	Size, Shipping Weight	Connector Options Available	Price	
355C (Manual)	dc to 1	0 to 12 1 dB steps	dc to 0.25 GHz: 1.2 dc to 0.5 GHz: 1.3 dc to 1.0 GHz: 1.5	0.11 dB + 1.39 dB/GHz	±0.1 dB @ 1000 Hz ±0.25 dB: dc to 0.5 GHz ±0.35 dB: dc to 1.0 GHz	0.5 W avg 350 W peak 0.3 million cycles per section	—	67 mm H × 70 mm W × 152 mm D (2.6 in × 2.75 in × 6 in) 1.4 kg (3 lb)	BNC (f) See Note 1	$700	☎
355E (Programmable)							15 to 18 V <65 ms 3.0 W			$1,050	☎
355D (Manual)	dc to 1	0 to 120 10 dB steps	dc to 0.25 GHz: 1.2 dc to 0.5 GHz: 1.3 dc to 1.0 GHz: 1.5	0.11 dB + 1.39 dB/GHz	± 0.3 dB @ 1000 Hz ± 1.5 dB to 90 dB, and ±3 dB to 120 dB @ 1 GHz	0.5 W avg 350 W peak 0.3 million cycles per section	—	67 mm H × 70 mm W × 152 mm D (2.6 in × 2.75 in × 6 in) 1.4 kg (3 lb)	BNC (f) See Note 1	$700	☎
355F (Programmable)							15 to 18 V <65 ms 3.0 W			$1,050	☎
8494A (Manual) **(33320A)**	dc to 4	0 to 11 1 dB steps	1.5	0.6 dB + 0.09 dB/GHz	±0.2 dB: 1 to 2 dB ±0.3 dB: 3 to 6 dB ±0.4 dB: 7 to 10 dB ±0.5 dB: 11 dB	1 W avg 100 W peak 10 μs max 5 million cycles per section	—	43 mm H × 73 mm W × 159 mm D (1.7 in × 2.9 in × 6.2 in) 0.9 kg (2 lb)	001 002 003 See Note 2	$650	☎
8494G (Programmable) **(33320G)**							20 to 30 V <20 ms 2.7 W	43 mm H × 73 mm W × 142 mm D (1.7 in × 2.9 in × 5.6 in)		$845	☎
8494B (Manual) **(33320B)**	dc to 18	0 to 11 1 dB steps	dc to 8 GHz: 1.5 dc to 12.4 GHz: 1.6 dc to 18 GHz: 1.9	0.6 dB + 0.09 dB/GHz	**dc to 12.4 GHz** ±0.3 dB: 1 to 2 dB ±0.4 dB: 3 to 4 dB ±0.5 dB: 5 to 6 dB ±0.6 dB: 7 to 10 dB ±0.7 dB: 11 dB **dc to 18 GHz** ±0.7 dB: 1 to 5 dB ±0.8 dB: 6 to 9 dB ±0.9 dB: 10 to 11 dB	1 W avg 100 W peak 10 μs max 5 million cycles per section	—	43 mm H × 73 mm W × 159 mm D (1.7 in × 2.9 in × 6.2 in) 0.9 kg (2 lb)	001 002 003 See Note 2	$950	☎
8494H (Programmable) **(33320H)**							20 to 30 V <20 ms 2.7 W	43 mm H × 73 mm H × 142 mm D (1.7 in × 2.9 in × 5.6 in)		$1,220	☎
8495A (Manual) **(33321A)**	dc to 4	0 to 70 10 dB steps	1.35	0.4 dB + 0.07 dB/GHz	±1.7% of setting or ±0.4 dB, whichever is greater	1 W avg 100 W peak 10 μs max 5 million cycles per section	—	43 mm H × 73 mm H × 130 mm D (1.7 in × 2.9 in × 5.1 in) 0.9 kg (2 lb)	001 002 003 See Note 2	$550	☎
8495G (Programmable) **(33321G)**							20 to 30 V <20 ms 2.7 W	43 mm H × 73 mm W × 114 mm D (1.7 in × 2.9 in × 4.5 in)		$720	☎
8495B (Manual) **(33321B)**	dc to 18	0 to 70 10 dB steps	dc to 8 GHz: 1.35 dc to 12.4 GHz: 1.5 dc to 18 GHz: 1.7	0.4 dB + 0.07 dB/GHz	±3%: dc to 12.4 GHz ±4%: dc to 18 GHz % in dB from Atten. Setting	1 W avg 100 W peak 10 μs max 5 million cycles per section	—	43 mm H × 73 mm W × 130 mm D (1.7 in × 2.9 in × 5.1 in) 0.9 kg (2 lb)	001 002 003 See Note 2	$700	☎
8495H (Programmable) **(33321H)**							20 to 30 V <20 ms 2.7 W	43 mm H × 73 mm W × 114 mm D (1.7 in × 2.9 in × 4.5 in)		$920	☎
8495D (Manual) **(33321D)**	dc to 26.5	0 to 70 10 dB steps	dc to 6 GHz: 1.25 6 to 12.4 GHz: 1.45 12.4 to 18.0 GHz: 1.6 18.0 to 26.5 GHz: 1.8	0.6 dB + 0.09 dB/GHz	±0.3 dB at 6 GHz 10 dB attenuation to ±2.8 dB at 26.5 GHz 90 dB attenuation. See Data Sheet 5952-8278 for details.	1 W avg 100 W peak 10 μs max 5 million cycles per section	—	43 mm H × 52 mm W × 159 mm D (1.7 in × 2.1 in × 6.2 in) 0.9 kg (2 lb)	004 3.5 mm See Note 2	$900	☎
8495K (Programmable) **(33321K)**							20 to 30 V <20 ms 2.7 W	43 mm H × 52 mm W × 168 mm D (1.7 in × 2.1 in × 6.6 in)		$1,170	☎
8496A (Manual) **(33322A)**	dc to 4	0 to 110 10 dB steps	1.5	0.6 dB + 0.09 dB/GHz	±1.7% of setting or ±0.4 dB, whichever is greater	1 W avg 100 W peak 10 μs max 5 million cycles per section	—	43 mm H × 73 mm W × 159 mm D (1.7 in × 2.9 in × 6.2 in) 0.9 kg (2 lb)	001 002 003 See Note 2	$650	☎
8496G (Programmable) **(33322G)**							20 to 30 V <20 ms 2.7 W	43 mm H × 73 mm W × 142 mm D (1.7 in × 2.9 in × 5.6 in)		$845	☎
8496B (Manual) **(33322B)**	dc to 18	0 to 110 10 dB steps	dc to 8 GHz: 1.5 dc to 12.4 GHz: 1.6 dc to 18 GHz: 1.9	0.6 dB + 0.09 dB/GHz	±3%: dc to 12.4 GHz +4%: dc to 18 GHz % in dB from Atten. Setting	1 W avg 100 W peak 10 μs max 5 million cycles per section	—	43 mm H × 73 mm W × 159 mm D (1.7 in × 2.9 in × 6.2 in) 0.9 kg (2 lb)	001 002 003 See Note 2	$950	☎
8496H (Programmable) **(33322H)**							20 to 30 V <20 ms 2.7 W	43 mm H × 73 mm W × 142 mm D (1.7 in × 2.9 in × 5.6 in)		$1,220	☎
8497K (Programmable) **(33323K)**	dc to 26.5	0 to 90 10 dB steps	dc to 6 GHz: 1.25 6 to 12.4 GHz: 1.45 12.4 to 18.0 GHz: 1.6 18.0 to 26.5 GHz: 1.8	0.6 dB + 0.09 dB/GHz	±0.3 dB at 6 GHz 10 dB attenuation to ±2.8 dB at 26.5 GHz 90 dB attenuation. See Data Sheet 5952-8278 for details.	1 W avg 100 W peak 10 μs max 5 million cycles per section	5 V or 24 V	43 mm H × 52 mm W × 143 mm D (1.7 in × 2.1 in × 5.6 in) 0.9 kg (2 lb)	004 3.5 mm See Note 2	$1,320	☎

Option 890 Calibration Data	Option 890 Frequency List (MHz)	Models	Option 890
	DC to 4 GHz Models: 100, 300, 500, 700, 900, 1000, 1250, 1500, 1750, 2000, 2500, 3000, 3500, 4000. DC to 18 GHz Models: Same as above to 4000 MHz, every 500 MHz to 16000 (plug 12400 MHz), every 250 MHz from 16000 to 18000. DC to 26.5 GHz Models: every 500 MHz 2 to 16 GHz. every 250 MHz 16 to 26.5 GHz.	8494A/G, 8496A/G, 33320A/G, 33322A/G 8495A/G, 33321A/G 8494B/H, 8496B/H, 33320B/H, 33322B/H 8495B/H, 33321B/H 8495D/K, 8497K	add $25 add $25 add $35 add $35 add $50

Note 1: 355C/D/E/F connector options (BNC (f) standard):	Price
Option 001 N(f)	add $25
Option 005 TNC(f)	add $10
Option 007 Transistor protection (355E/F only)	add $55

Note 2: 8494/5/6/7 orders must specify connector option. See ordering example above.	Price
Option 001 N(f)	N/C
Option 002 SMA(f)	N/C
Option 003 APC-7	add $50
Option 004 3.5 mm (HP 8495D/K, 8497K only)	N/C

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

DESIGNED FOR HP-IB SYSTEMS

HP 84904/6/7K, L, and M

High Performance Coaxial Attenuators

The HP 84904/6/7 family of programmable step attenuators offers unmatched attenuation performance to 50 GHz. The new K family brings superior accuracy and reliability to 26.5 GHz, while the L and M families offer unparalleled performance to 40 and 50 GHz respectively.

These families offer the selection, performance, and reliability expected from HP attenuators: attenuation range of 11, 70, or 90 dB; 1 dB and 10 dB step sizes; 5 million cycles per section; better than 0.03 dB repeatability; connector size options; and now the choice of male (plug) or female (jack) connectors. Connector choices include precision 3.5 mm or 2.92 mm on the 26.5 GHz K model, and precision 2.4 mm or 2.92 mm on the L model. *While the 2.92 mm connector format is compatible with both 3.5 mm and SMA connectors, Hewlett-Packard recommends the more rugged 2.4-mm and 3.5-mm connectors.*

Other Features

- Same drive circuits and solenoids as HP 8494/5/6/7 family
- Switching time under 20 milliseconds (includes settling time)
- Permanent magnet latching design; attenuators will withstand over 10 g shock without performance degradation
- Automatic dc circuit interrupts cut power consumption and simplify drive circuit design
- Equipped with 10-pin DIP plugs (m). Optional cables with 10-pin DIP socket (f) connectors are available; see below.
- Attenuation and SWR calibration data (Option 890)

Drive options include the HP 11713A Attenuator/Switch driver, which permits users to easily integrate the attenuator into HP-IB-compatible automatic test systems and the new HP 70611 MMS Attenuator/Switch Driver. Cabling options include 8- or 16-inch ribbon cables (HP 11764C/D) with a 10-pin DIP socket (f) and a 14-pin DIP plug for easy connection to standard 14-pin DIP IC sockets, a 5-foot Interconnect Cable (HP 11764A) with 10-pin DIP socket (f), and a "Viking" cable for the HP 11713 driver, and a 5-foot Interconnect Cable (HP 11764 B) with a 10-pin DIP socket (f) and bare leads for custom applications.

Ordering Information

	Price
Attenuators	
HP 84904M 0 to 11 dB, 1 dB steps, 50 GHz	$3,500
HP 84904L 0 to 11 dB, 1 dB steps, 40 GHz	$2,400
HP 84904K 0 to 11 dB, 1 dB steps, 26.5 GHz	$1,900
HP 84906M 0 to 90 dB, 10 dB steps, 50 GHz	$3,500
HP 84906L 0 to 90 dB, 10 dB steps, 40 GHz	$2,400
HP 84906K 0 to 90 dB, 10 dB steps, 26.5 GHz	$1,900
HP 84907L 0 to 70 dB, 10 dB steps, 40 GHz	$2,200
HP 84907K 0 to 70 dB, 10 dB steps, 26.5 GHz	$1,725
Opt 100 Male 2.4-mm Connector (L models only)	+$75
Opt 104 Male 3.5-mm Connector (K models only)	+$75
Opt 106 Male 2.92-mm Connector (L models only)	+$125
Opt 006 Female 2.92-mm Connector (L models only)	+$75
Opt 890 Atten and SWR data	+$65
Attenuator Accessories	
HP 11764A Interconnect Cable with 10-pin Socket (f) to "Viking" Connector for HP 11713A	$45
HP 11764B Interconnect Cable with 10-pin DIP Socket (f) and Bare Leads	$10
HP 11764C Interconnect Cable- with 203-mm (8 in) Ribbon Cable,10-pin DIP Socket, 14-pin DIP Plug	$10
HP 11764D Interconnect Cable- with 406-mm (16 in) Ribbon Cable, 10-pin DIP Socket, 14-pin DIP Plug	$10

HP 84904/6/7K/L Specifications

HP Model	Frequency Range	Incremental Attenuation	SWR Maximum (50 nominal) Std Opt 006	Insertion Loss 0 dB setting	Shipping Weight
84904L (33324L)	dc to 40 GHz	0 to 11 dB 1 dB steps	dc to 12.4 GHz: 1.3 (1.5) 12.4 to 34 GHz; 1.7 (1.9) 34 to 40 GHz: 1.8 (2.0) 40 to 50 GHz: 2.2 (3.0)	0.8 dB + 0.04 dB/GHz	291g (10.3 oz)
84904M	dc to 50 GHz				
84904K (33324K)	dc to 26.5 GHz				
84906L (33326L)	dc to 40 GHz	0 to 90 dB 10 dB steps	dc to 12.4 GHz: 1.3 (1.5) 12.4 to 34 GHz: 1.7 (1.9) 34 to 40 GHz: 1.8 (2.0) 40 to 50 GHz: 2.2 (3.0)	0.8 dB + 0.04 dB/GHz	291 g (10.3 oz)
84906M	dc to 50 GHz				
84906K (33326K)	dc to 26.5 GHz				
84907L (33327L)	dc to 40 GHz	0 to 70 dB 10 dB steps	dc to 12.4 GHz: 1.25 (1.4) 12.4 to 34 Gz: 1.5 (1.7) 34 to 40 GHz: 1.7 (1.9)	0.6 dB + 0.03 dB/GHz	229 g (8.1 oz)
84907K (33327K)	dc to 26.5 GHz				

Attenuation Accuracy dc to 26.5 GHz	Attenuation Accuracy 26.5 to 40 GHz
0.4 dB: 1 dB	0.6 dB: 1 dB
0.5 dB: 2 dB	0.6 dB: 2 dB
0.7 dB: 3 dB	0.7 dB: 3 dB
0.7 dB: 4 dB	0.7 dB: 4 dB
0.7 dB: 5 dB	0.7 dB: 5 dB
0.7 dB: 6 dB	0.8 dB: 6 dB
0.8 dB: 7 dB	0.9 dB: 7 dB
0.8 dB: 8 dB	0.9 dB: 8 dB
0.85 dB: 9 dB	1.0 dB: 9 dB
0.9 dB: 10 dB	1.1 dB: 10 dB
1.10 dB: 11 dB	1.2 dB: 11 dB
	0.5 dB: 10 dB
	0.6 dB: 20 dB
	0.7 dB: 30 dB
	1.0 dB: 40 dB
	1.2 dB: 50 dB
	1.6 dB: 60 dB
	1.9 dB: 70 dB
	2.3 dB: 80 dB
	2.7 dB: 90 dB

Sensitivity power dB/dB/watt (temperature dB/dB/° C): 0.001 (0.0001)
Power rating: 1 W ave, 50 W peak, 10 μS max pulse width
Minimum life: 5 million cycles per section
Solenoid voltage/speed/power: 20-30 V / <20 ms / 2.7 W

For the most current prices and product information, contact your local Hewlett-Packard sales office. See page 383.

MICROWAVE TEST ACCESSORIES

Custom Switch Interfaces

HP 11713A, 70611/12/13, 87130A, 84940A, 84941A

HP 11713A Attenuator/Switch Driver

The HP 11713A attenuator/switch driver provides simple HP-IB control of up to 10 bistatic, 24 Vdc solenoid-activated switches or attenuator sections. It can drive two of the HP 8494/5/6/7, HP 84904/6/7, or HP 33320 Series programmable attenuators, and up to 2 electromechanical switches, concurrently. The HP 11713A supplies 24 Vdc common and ten pairs of current sinking contacts to achieve control of up to 10 relays. The internal +24 Vdc power supply of the HP 11713A can deliver control signals totaling 0.625 A continuously or 1.25 A for one second. Each HP 11713A comes equipped with two plug-in drive cables for driving attenuators. Other cables are also available. The convenient front panel controls allow manual control of individual attenuator sections and/or switches.

HP 70611A Attenuator/Switch Driver for MMS

The HP 70611A is a ⅛ MMS module capable of driving up to 248 electromechanical switches or attenuator switch sections. The HP 70611A is MSIB, SCPI, and HP-IB compatible. In addition to being programmable, the HP 70611A features an extremely user friendly manual interface via any MMS display unit. The highlight of the manual interface is the operator's ability to customize groups of switch control lines and their settings, then identify these switch settings with user-defined alphanumeric labels. In this manner, end users of the HP 70611A can define custom menus with their own identification labels for simplified manual control. The HP 70611A can store up to 256 user-defined labeled paths. Path definitions can be stored in non-volatile EEROM. Groups of paths can be stored in directories for easy access to similar path commands.

Other features of interest are the ability to program control signal pulse widths and delays, the status read back of switch state of switches and attenuators with indicator circuitry, and the ability to configure the driver into a "power fail" condition, which will automatically set switches into a predefined state on driver power up.

The HP 70611A controls switches or attenuator sections in banks of 31 (eight banks total) through individual HP 84940A I/O driver cards which are wired, in turn, directly to the switches and/or attenuators. Option 001 for the HP 70611A includes one HP 84940A I/O driver card. The HP 70611A, Option 001, is capable of driving 31 switches and/or attenuators sections directly. Total drive capacity can be increased by adding HP 84940A I/O cards.

HP 70612 and HP 70613 MMS Interface Modules

In addition to custom interface modules, HP offers off-the-shelf interface solutions in MMS. The HP 70612 (1x6 switch tree) and the HP 70613 (2x5 switch tree) are matrixes available in 2/8 MMS modules with integrated controllers. They are equipped with front panel indicators to facilitate manual use. The integrated controller has all the capabilities of the HP 70611A attenuator/switch driver. A variety of options are available for the HP 70612 and HP 70613 including performance to 26.5 GHz, terminated or unterminated switches, integrated attenuators, and a choice of port locations. For a more detailed description of these products, refer to the Modular Measurement System section of this catalog. Custom MMS interface are available from HP. Please call your local HP sales representative for additional information.

HP 87130A Attenuator/Switch Driver

The HP 87130A is a 3½-in, full-width System II attenuator/switch driver capable of driving up to 248 bistatic electromechanical switches or attenuator sections. The HP 87130A is controlled over HP-IB via Standard Commands for Programmable Instruments (SCPI) commands. The HP 87130A has been designed for use in both ATE switching systems and computer-controlled bench top applications. Control and programming are accomplished via application programs in IBASIC, RMB, C, or Pascal. An ITG driver is also available for use separately or in conjunction with HP's Visual Engineering Environment (HP VEE).

Expandable Versatility

The HP 87130A is electronically identical to the HP 70611A and shares its performance characteristics, with the exception of the manual control method. The HP 87130A has no front panel controls. Manual control of the HP 87130A is realized through its ITG driver and a computer controller. The HP 87130A can drive 31 switches or attenuator sections directly, and up to an additional 217 switches via seven additional HP 84940A driver cards. A distribution board, HP 84941A (see below), is available to facilitate the interconnection of the HP 87130A to switches or attenuators it's driving. The cabinet of the HP 87130A has been designed to allow the end user or HP to customize the HP 87130A by integrating microwave components directly into the HP 87130A.

VXI Drivers for Microwave Components

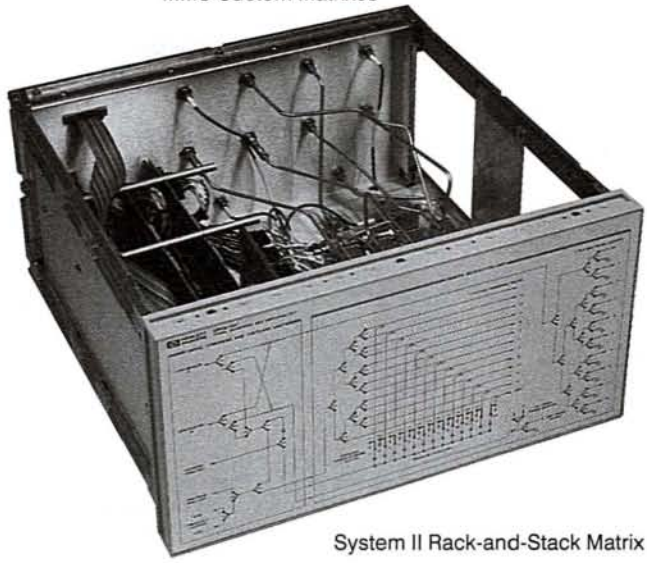
Hewlett-Packard can provide switch/attenuator drivers in VXI with compatible ITG drivers. Contact your local HP sales representative for additional information.

HP 84940A Switch Driver and HP 84941A Distribution Card

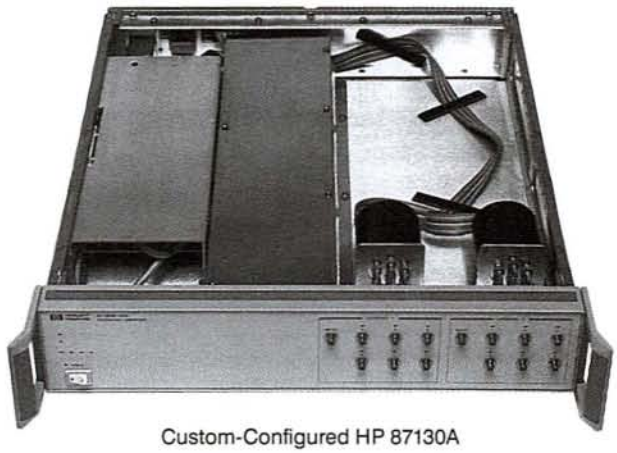
The HP 84940A is an expansion driver card for the HP 70611/2/3 family of MMS attenuator/switch drivers and the HP 87130A attenuator/switch driver. The HP 84940A has been designed for incorporation into large interfaces located remotely from their controller. A single HP 84940A can control up to 31 switches when located up to 150 ft (45 m) from an HP 70611/2/3 or HP 87130A. The physical interconnection to the switches or attenuators is realized via 31 four-pin output connectors, which permit quick connection and disconnection of the switches or attenuators. The HP 84941A is a signal distribution card designed to simplify the interconnection of the drive cable from an HP 70611 (Option 001) or HP 87130A to the 31 components driven directly by these controllers. The HP 84941A also provides 31 four-pin connectors for convenient interconnection to switches or attenuators.

MMS Custom Matrixes

Ordering Information	Price
HP 11713A Attenuator/Switch Driver	$1,720
HP 11717A Attenuator/Switch Driver Rack Mount Support Shelf	$65
HP 11761A; HP 8765 to **HP 11713A** Adapter Cable	$65
HP 11764A; HP 84904/6/7 to **HP 11713A** Adapter Cable	$45
HP 11764B; HP 84904/6/7 5-ft Ribbon Cable with 14-pin DIP Connector	$10
HP 11764E; HP 8494/5/6/7 to **HP 84940A** or **HP 84941A** Adapter Cable	$50
HP 11764F; HP 84904/6/7 to **HP 84940A** or **HP 84941A** Adapter Cable	$50
HP 11764G; HP 87104/6 to **HP 84940A** or **HP 84941A** Adapter Cable	$50
HP 11764H Wire Harness Cables for HP 84940A or HP 84941A	$195
HP 34530T Microwave Switch Terminal Block for HP 3235A (Holds up to four HP 8762/3/4 Switches)	$380
HP 44476B Microwave Switch Module for HP 3488A (Holds up to two HP 8762/3/4 Opt 011 Switches)	$550
HP 70611A MMS Attenuator/Switch Controller	$3,600
Opt 001 Add Switch Driver Card	$1,000
HP 70612A MMS 1X6 Switching Module, 6 GHz	$8,400
HP 70613A MMS 2X5 Switching Module, 6 GHz	$8,400
HP 70612A and **HP 70613A** Include Controller Board and Terminated Switches Standard. The following options are available for the HP 70612A and HP 70613A.	
Opt 002 Replace with Unterminated Switches	−$1,000
Opt 003 Add 0 to 11 dB, 1 dB Step Attenuator	$825
Opt 004 Add 0 to 110 dB, 10 dB Step Attenuator	$825
Opt 005 Input Connectors to Rear Panel	$250
Opt 006 Input Connectors to Rear Panel, Delete Controller Card	−$950
Opt 007 Add 0 to 11 dB and 0 to 110 dB Step Attenuator	$1,650
Opt 008 Add Output Drive Cable	$100
Opt 011 Delete Controller Card	−$1,200
Opt 910 Add Extra Operating and Service Manual	$35
HP 70612C MMS 1X6 Switching Module, 26.5 GHz	$9,400
HP 70613C MMS 2X5 Switching Module, 26.5 GHz	$9,400
HP 70612C and **HP 70613C** Include Controller Board and Terminated Switches Standard. The following options are available for the HP 70612C and HP 70613C.	
Opt 002 Replace with Unterminated Switches	−$1,000
Opt 003 Add 0 to 11 dB, 1 dB Step Attenuator	$1,800
Opt 004 Add 0 to 90 dB, 10 dB Step Attenuator	$1,300
Opt 005 Input Connectors to Rear Panel	$250
Opt 006 Input Connectors to Rear Panel, Delete Controller Card	−$950
Opt 007 Add 0 to 11 dB and 0 to 90 dB Step Attenuator	$3,100
Opt 008 Add Output Drive Cable	$100
Opt 011 Delete Controller Card	−$1200
Opt 910 Add Extra Operating and Service Manual	$35
HP 84940A Attenuator/Switch Driver Expansion Card	$1,000
HP 84941A Distribution Expansion Card	$350



System II Rack-and-Stack Matrix



Custom-Configured HP 87130A

Custom Switch Matrixes and Test Sets

Hewlett-Packard will custom-configure a switch matrix or test set for your specific measurement and signal-routing requirements. Featuring automated or manual control, these matrixes and test sets can be configured in System II rack-and-stack, MMS, or VXI platforms. Depending upon your particular needs, components other than switches, such as step attenuators, mixers, couplers, power splitters, detectors, power sensors, and noise sources can be included. Each HP matrix is fully documented with a general description, RF and dc schematics, interior-parts identifier photos, parts list drive logic, and operating instructions.

More information on how to specify and order a custom matrix from HP is available in Product Note 8760-1 (HP p/n 5959-7860).

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

MICROWAVE TEST ACCESSORIES

Switching Solutions – Coaxial Switches

HP 8761A/B, 8762/3/4, 8765 Series

Coaxial Switches

HP coaxial switches feature low SWR, low insertion loss, and excellent isolation. All HP switches feature μs latching solenoids and break-before-make switching circuits.

HP 8761A/B Switches

The HP 8761A/B are single-pole double-throw (SPDT) switches for dc to 18 GHz use. Each port has 6 connector options plus a 50 Ω termination, making these switches useful for switching between components with different connector types or for making switch "trees."

HP 8762 Switches

The HP 8762A/B/C switches (dc to 4 GHz, dc to 18 GHz and dc to 26.5 GHz) are also SPDT type. They feature exceptional isolation (90 dB to 18 GHz) and internally switched 50 Ω loads so that all ports maintain a 50 Ω match. The internal loads are rated for 1 W average or 100 W peak (10 μs pulse width).

HP 8763 Switches

The HP 8763A/B/C switches (dc to 4 GHz, dc to 18 GHz and dc to 26.5 GHz) are used for transfer switching. They can be used to insert or remove a component from a signal path. They can also be used as the intersection switching elements in a larger microwave matrix. They include 1 internal 50 Ω switched load.

HP 8764 Switches

The HP 8764A/B/C switches (dc to 4 GHz, dc to 18 GHz and dc to 26.5 GHz) are 5-port switches with essentially the same internal structure as the HP 8762 switches. Elimination of the internal load makes it possible to utilize the extra ports for a variety of purposes, such as adding external high-power loads to extend power handling capability or reversing signal path.

The HP 8762/3/4 switches all use latching solenoids and have dc circuit interrupts to cut off solenoid current when switching is complete.

HP 8765A/B/C/D

These are SPDT switches that offer outstanding performance with a life of 5 million cycles (HP 8765A, dc to 4 GHz; HP 8765B, dc to 20 GHz; HP 8765C, dc to 26.5 GHz; HP 8765D, dc to 40 GHz). They are designed for long life and high repeatability. Unlike the HP 8762 switches, they do not have internally switched loads or dc-current interrupts. Voltage options cover the complete range from 4.5 to 32 Vdc. The standard HP 8765 comes with a ribbon cable and 0.025 in² pins in a single inline connector for convenient connection to the HP 11761A adapter cable or to any other Berg single inline connector package. Solder terminals are also available. Other features include magnetically latching solenoids and configuration solenoid control.

75 Ω Switching

The HP 8762F and 8765F switches are 75 Ω switches designed around the proven reliability of the HP 8762 and 8765 families of 50 Ω switches. The HP 8762F has a single pole double throw (SPDT) action and terminates the unselected port to internal 75 Ω loads. The HP 8765F is an SPDT switch without internal terminations. Both switches come with subminiature 75 Ω SMB (m) snap-on connectors and give the long life and high repeatability expected from HP switches. Useful in ATE switching systems and test equipment destined for video, television, and cable TV applications, the HP 8762F and 8765F offer a new standard of quality in 75 Ω switching (dc to 2 GHz).

HP-IB Compatible

All the HP 8760 series switches can be remotely controlled by the HP-IB interface bus with the HP 11713A attenuator/switch driver,the HP 3235A, the HP 3488A, or the HP E1700A. For the HP 70000 modular measurement system, the HP 70611A is available to drive up to 31 switches.

Ordering Information

Price

HP 8761A/B Coaxial Switches

Specify voltage and connectors (including built-in 50 Ω terminations) by alphabetic suffix on the switch model number and the appropriate 3-digit option number. Specify all connectors.

HP 8761A 12 to 15 V Solenoids	$400
HP 8761B 24 to 30 V Solenoids	$400

Connector options (Port 1, Port 2, Port C)

Option Code	Connector Type	Option Code	Connector Type
0	N(f)	4	APC-7 for UT-250 coax
1	N(m)	5	SMA(f)
2	APC-7 w/threaded sleeve	6	SMA(m)
3	APC-7 w/coupling nut	7	50 Ω termination

HP 8762, HP 8763, HP 8764 Coaxial Switches

Specify the frequency and voltage by the alphabetic suffix and option number. The standard model has 24 V solenoids.

HP 8762A SPDT, dc to 4 GHz	$450
HP 8762B SPDT, dc to 18 GHz	$510
HP 8762C SPDT, dc to 26.5 GHz	$575
HP 8762F SPDT, dc to 2 GHz, 75 Ω	$550
HP 8763A 4-Port, dc to 4 GHz	$500
HP 8763B 4-Port, dc to 18 GHz	$560
HP 8763C 4-Port, dc to 26.5 GHz	$645
HP 8764A 5-Port, dc to 4 GHz	$500
HP 8764B 5-Port, dc to 18 GHz	$560
HP 8764C 5-Port, dc to 26.5 GHz	$645
Opt 011 5 Vdc Solenoids	$0
Opt 015 15 Vdc Solenoids	$0

HP 8765 Coaxial Switches

A voltage option must be ordered with the mainframe. Specify frequency, voltage, dc connectors, and ribbon cable extension options by alphabetic suffix and option number.

HP 8765A SPDT, dc to 4 GHz	$200
HP 8765B SPDT, dc to 20 GHz	$225
HP 8765C SPDT, dc to 26.5 GHz	$280
HP 8765D SPDT, dc to 40 GHz	$600
HP 8765F SPDT, dc to 2 GHz, 75 Ω	$350
Opt 005 5 Vdc Solenoids	$0
Opt 010 10 Vdc Solenoids	$0
Opt 015 15 Vdc Solenoids	$0
Opt 024 24 Vdc Solenoids	$0
Opt 100 Solder Terminals	$0
Opt 108 8-in Ribbon Cable Extension	+$10
Opt 116 16-in Ribbon Cable Extension	+$10
Opt 890 Test Data Report	
For HP 8765A	+$25
For HP 8765B	+$35
For HP 8765C	+$50
For HP 8765D	+$75

For off-the-shelf shipment, call 800-452-4844.

HP 8761-9 Series Specifications (OEM Equivalent Model No.)

HP Model	Frequency Range (GHz)	SWR 50 Ω Nominal	Insertion Loss	Isolation	Switching Speed	RF Connectors	Dimensions HxWxD (mm)	Shipping Weight (g)	Price	
8761A SPDT	dc to 18	<1.2 to 12.4 GHz <1.25 to 18 GHz	0.8 dB @ 18 GHz	>50 dB to 12.4 GHz >45 dB to 18 GHz	35 to 50 mS	See table on page 378	41 × 38 × 38	300	$400	
8761B SPDT	dc to 18	<1.2 to 12.4 GHz <1.25 to 18 GHz	0.8 dB @ 18 GHz	>50 dB to 12.4 GHz >45 dB to 18 GHz	35 to 50 mS	See table on page 378	41 × 38 × 38	300	$400	
8762A SPDT (33311A)	dc to 4	<1.1 to 2 GHz <1.2 to 4 GHz	<0.2 db @ 2 GHz <0.25 dB @ 4 GHz	>100 dB to 4 GHz	<30 mS	SMA (f)	14 × 53 × 54	220	$450	☎
8762B SPDT (33311B)	dc to 18	<1.10 to 2 GHz <1.2 to 12.4 GHz <1.3 to 18 GHz	<0.2 dB @ 2 GHz <0.5 dB @ 18 GHz	>90 dB to 18 GHz	<30 mS	SMA (f)	14 × 53 × 54	220	$510	☎
8762C SPDT (33311C)	dc to 26.5	<1.15 to 2 GHz <1.25 to 12.4 GHz <1.4 to 18 GHz <1.8 to 26.5 GHz	<0.2 dB @ 2 GHz <0.5 dB @ 18 GHz <1.25 dB @ 26.5 GHz	>90 dB to 18 GHz >50 dB to 26.5 GHz	<30 mS	3.5 mm (f)	14 × 53 × 54	220	$575	☎
8762F 75 Ω	dc to 2	<1.15 to 1 GHz <1.20 to 2 GHz	<0.18 dB @ 1 GHz <0.24 dB @ 2 GHz	>100 dB to 1 GHz >90 dB to 2 GHz	<30 mS	75 Ω, SMB (m)	14 × 53 × 54	300	$550	
8763A 4-port (33312A)	dc to 4	<1.1 to 2 GHz <1.2 to 4 GHz	<0.2 dB @ 2 GHz <0.25 dB @ 4 GHz	>100 dB to 4 GHz	<30 mS	SMA (f)	14 × 53 × 54	220	$500	☎
8763B 4-port (33312B)	dc to 18	<1.10 to 2 GHz <1.2 to 12.4 GHz <1.3 to 18 GHz	<0.2 dB @ 2 GHz <0.5 dB @ 18 GHz	>90 dB to 18 GHz	<30 mS	SMA (f)	14 × 53 × 54	220	$560	☎
8763C 4-port (33312C)	dc to 26.5	<1.15 to 2 GHz <1.25 to 12.4 GHz <1.4 to 18 GHz <1.8 to 26.5 GHz	<0.2 dB @ 2 GHz <0.5 dB @ 18 GHz <1.25 @ 26.5 GHz	>90 dB to 18 GHz >50 dB to 26.5 GHz	<30 mS	3.5 mm (f)	14 × 53 × 54	220	$645	☎
8764A 5-port (33313A)	dc to 4	<1.1 to 2 GHz <1.2 to 4 GHz	<0.2 dB @ 2 GHz <0.25 dB @ 4 GHz	>100 dB to 4 GHz	<30 mS	SMA (f)	14 × 53 × 54	220	$500	☎
8764B 5-port (33313B)	dc to 18	<1.10 to 2 GHz <1.2 to 12.4 GHz <1.3 to 18 GHz	<0.2 dB @ 2 GHz <0.5 dB @ 18 GHz	>90 dB to 18 GHz	<30 mS	SMA (f)	14 × 53 × 54	220	$560	☎
8764C 5-port (33313C)	dc to 26.5	<1.15 to 2 GHz <1.25 to 12.4 GHz <1.4 to 18 GHz <1.8 to 26.5 GHz	<0.2 dB @ 2 GHz <0.5 dB @ 18 GHz <1.25 dB @ 26.5 GHz	>90 dB to 18 GHz >50 dB to 26.5 GHz	<30 mS	3.5 mm (f)	14 × 53 × 54	220	$645	☎
8765A SPDT (33314A)	dc to 4	<1.2 to 4 GHz	<0.3 dB @ 4 GHz	>110 dB to 4 GHz	<15 mS	SMA (f)	14 × 33 × 45	200	$200	☎
8765B SPDT (33314B)	dc to 20	<1.2 to 4 GHz <1.35 to 12.4 GHz <1.45 to 18 GHz <1.7 to 20 GHz	<0.3 dB @ 4 GHz <0.7 dB @ 20 GHz	>110 dB to 4 GHz >75 dB to 20 GHz	<15 mS	SMA (f)	14 × 33 × 45	200	$225	☎
8765C SPDT (33314C)	dc to 26.5	<1.25 to 4 GHz <1.45 to 18 GHz <1.7 to 26.5 GHz	<0.3 dB @ 4 GHz <0.75 dB @ 20 GHz <1.0 dB @ 26.5 GHz	>110 dB to 4 GHz >68 dB to 20 GHz >50 dB to 26.5 GHz	<15 mS	3.5 mm (f)	14 × 33 × 45	200	$280	☎
8765D (33314D)	dc to 40	<1.25 to 4 GHz <1.45 to 18 GHz <1.7 to 40 GHz	<0.2 dB @ 4 GHz <0.5 dB @ 20 GHz <1.0 dB @ 40 GHz	>110 dB to 4 GHz >90 dB to 20 GHz >50 dB to 40 GHz	<15 mS	2.4 mm (f) 2.92 mm Opt 292	14 × 33 × 45	200	$600	
8765F 75 Ω	dc to 4	<1.15 to 1 GHz <1.20 to 4 GHz	<0.18 dB @ 1 GHz <0.24 dB @ 2 GHz <0.40 dB @ 4 GHz	>100 dB to 1 GHz >90 dB to 4 GHz	<15 mS	75 Ω, SMB (m)	14 × 33 × 45	200	$350	
8766K SP3T (33363K)	dc to 26.5 or dc to 18 for Opt 002	<1.3 to 8 GHz <1.5 to 12.4 GHz <1.6 to 18 GHz <1.8 to 26.5 GHz	Port 1: 0.2 dB + 0.05 dB/GHz Port 2: 0.2 dB + 0.06 dB/GHz Port 3: 0.2 dB + 0.08 dB/GHz	Consult Technical Data Sheet	<20 mS	3.5 mm (f)	23 × 45 × 82	178	$675	☎
8767K SP4T (33364K)	dc to 26.5 or dc to 18 for Opt 002	<1.3 to 8 GHz <1.5 to 12.4 GHz <1.6 to 18 GHz <1.8 to 26.5 GHz			<20 mS	3.5 mm (f)	23 × 45 × 105	235	$750	☎
8768K SP5T (33365K)	dc to 26.5 or dc to 18 for Opt 002	<1.3 to 8 GHz <1.5 to 12.4 GHz <1.6 to 18 GHz <1.8 to 26.5 GHz	Port 4: 0.25 dB + 0.095 dB/GHz Port 5: 0.25 dB + 0.108 dB/GHz Port 6: 0.25 dB + 0.12 dB/GHz		<20 mS	3.5 mm (f)	23 × 45 × 133	292	$800	☎
8769K SP6T (33366K)	dc to 26.5 or dc to 18 for Opt 002	<1.3 to 8 GHz <1.55 to 12.4 GHz <1.8 to 18 GHz <2.05 to 26.5 GHz			<20 mS	3.5 mm (f)	23 × 45 × 160	349	$1000	☎

☎ For off-the-shelf shipment, call 800-452-4844.

MICROWAVE TEST ACCESSORIES

Switching Solutions — Multiport Coaxial Switches

87104/6 Series, 8766/7/8/9 Series

HP 87104/6A,B,C Multiport Coaxial Switches

Hewlett-Packard now offers the new HP 87104/6 multiport 50 Ω coaxial switches, with the quality and high reliability you've come to expect from Hewlett-Packard electromechanical switches. Long life, high performance, and exceptional repeatability are the hallmark of these new multiport switches. Available in 4 GHz and 20 GHz versions, with SMA (f) connectors, the HP 87104/6 switches are available with or without internal 50 Ω terminations. Internal switching logic assures that only one section is activated at a time; electronic interrupts and indicators cut off solenoid current after switching is completed to reduce power consumption and give positive indication of switch position. Other available options include dc solder terminals or ribbon connectors, and test data report. These switches are well suited for ATE switching matrixes, test sets, precision test equipment, and any application requiring long, reliable life and high repeatability.

HP 8766/7/8/9K Series Single-Pole Multi-Throw Switches

The HP 8766/7/8/9K Series switches are modified versions of the coaxial edgeline design (dc to 26.5 GHz) for applications requiring single-pole, 3-throw, 4-throw, 5-throw, or 6-throw coaxial switches.

These compact switches offer the same reliability, repeatability (typically 0.01 dB), and long life (5 million switching cycles per section) as the HP 8494/5/6/7K series step attenuators from which they are derived.

The switches are also available with flat ribbon cables and DIP-type connectors compatible with standard 14-pin DIP IC sockets.

Isolation and insertion loss vary with frequency and depend on the port selected on the HP 8766/7/8/9 switch. For applications in which isolation and insertion loss are critical, it is suggested that you obtain a copy of the data sheet for further application information. Ask your Hewlett-Packard Sales Representative for the data sheet "HP 8766/7/8/9K Microwave Single-Pole Multi-Throw Switches" (p/n 5959-7831). See the table on page 379 for product specifications.

Specify the switch by model number, solenoid voltage, optional extension cables or solder terminals, and calibration data. A standard model comes with an 8-inch ribbon cable and connector for dc control signals.

Ordering Information	Price
HP 87104A SP4T, dc to 4 GHz	$1,100
HP 87104B SP4T, dc to 20 GHz	$1,350
HP 87104C SP4T, dc to 26.5 GHz	$1,750
HP 87106A SP6T, dc to 4 GHz	$1,300
HP 87106B SP6T, dc to 20 GHz	$1,500
HP 87106C SP6T, dc to 26.5 GHz	$1,900
Opt 100 Solder Terminals	$0
Opt 890 Test Data Report	$40 to $70

HP 8766K, HP 8767K, HP 8768K, HP 8769K Coaxial Switches

Specify RF connectors (and frequency), solenoid voltages, dc connectors by option number. Standard unit is 24 Vdc, 3.5 mm (f) RF connectors (dc to 26.5 GHz), and Viking-type dc connector.

HP 8766K SP3T Multi-Port Switch	$675
HP 8767K SP4T Multi-Port Switch	$750
HP 8768K SP5T Multi-Port Switch	$800
HP 8769K SP6T Multi-Port Switch	$1,000
Opt 002 Replace 3.5 mm (f) w/ SMA (m) Connectors	−$25
Opt 008 8-in Ribbon Cable w/DIP Connector	−$50
Opt 011 5 Vdc Solenoids	$0
Opt 015 15 Vdc Solenoids	$0
Opt 016 16-in Ribbon Cable w/DIP Connector	−$50
Opt 890 Test Data Report	$35

☎ For off-the-shelf shipment, call 800-452-4844.

HP Model	Frequency Range (GHz)	SWR 50 Ω Nominal	Insertion Loss (dB)	Isolation (dB)	Switching Speed	RF Connectors	Dimensions H×W×D (mm)	Shipping Weight (g)	Price
87104A SP4T	dc to 4	<1.2 to 4 GHz	<0.3 to 4 GHz	>110 to 4 GHz	<20 ms	SMA(f)	74×57×57	360	$1,100
87104B SP4T	dc to 20	<1.2 to 4 GHz <1.35 to 12.4 GHz <1.45 to 18 GHz <1.7 to 20 GHz	<0.3 to 4 GHz <0.7 to 20 GHz	>110 to 4 GHz >90 to 20 GHz	<20 ms	SMA(f)	74×57×57	360	$1,350
87104C SP4T	dc to 26.5	<1.2 to 4 GHz <1.35 to 12.4 GHz <1.45 to 20 GHz <1.7 to 26.5 GHz	<0.3 to 4 GHz <0.7 to 20 GHz <1.2 to 26.5 GHz	>110 to 4 GHz >90 to 20 GHz >75 to 26.5 GHz	<20 ms	SMA(f)	74×57×57	380	$1,750
87106A SP6T	dc to 4	<1.2 to 4 GHz	<0.3 to 4 GHz	>110 to 4 GHz	<20 ms	SMA(f)	74×57×57	360	$1,300
87106B SP6T	dc to 20	<1.2 to 4 GHz <1.35 to 12.4 GHz <1.45 to 18 GHz <1.7 to 20 GHz	<0.3 to 4 GHz <0.7 to 20 GHz	>110 to 4 GHz >90 to 20 GHz	<20 ms	SMA(f)	74×57×57	380	$1,500
87106C SP6T	dc to 26.5	<1.2 to 4 GHz <1.35 to 12.4 GHz <1.45 to 20 GHz <1.7 to 26.5 GHz	<0.3 to 4 GHz <0.7 to 20 GHz <1.2 to 26.5 GHz	>110 to 4 GHz >90 to 20 GHz >75 to 26.5 GHz	<20 ms	SMA(f)	74×57×57	380	$1,900

HP 8474 Series

HP 8471D/E

HP 83036C

Low-Barrier Schottky Diode Detectors

HP 423B, HP 8472B, HP 8473B/C

These low-barrier Schottky diode (LBSD) detectors have been widely used for many years in a variety of applications, including leveling and power sensing. They offer good performance and ruggedness. Matched pairs (Option 001) offer very good detector tracking. A video load option (Option 002) extends the square-law region to at least 0.1 mW (−10 dBm).

Planar-Doped Barrier Detectors

HP 8471D/E

The HP 8471D and HP 8471E are economy detectors based on the planar-doped barrier (PDB) diodes. The PDB diodes give them superior frequency response, square-law response, and temperature performance. The HP 8471D has a BNC (m) input connector and a frequency range of 100 kHz to 2 GHz, making it ideal for use in RF and low microwave applications. The HP 8471E has an SMA (m) input connector and an SMC (m) output connector. Its frequency range is 10 MHz to 12 GHz. Both models come standard with a negative output; a positive output can be specified as an option (Option 103).

HP 8473D/E Planar-Doped Barrier Detectors

The HP 8473D and 8473E detectors were the first gallium arsenide PDB diodes introduced. They feature broadband performance and excellent flatness vs. frequency, along with superior temperature stability. The HP 8473D is available with a 3.5 mm (m) RF connector and a BNC output connector. The HP 8473E features a 2.4 mm (m) RF connector with a BNC output connector.

HP 8474A/B/C/D/E High-Performance Planar-Doped Barrier Detectors

These detectors are the newest addition to the HP family of high-performance detectors. Utilizing a gallium arsenide PDB diode as the detecting element, these detectors offer superior performance when compared to earlier detector designs. They feature extremely flat frequency response over their entire band of operation (typically better than ±1 dB to 50 GHz) and very good frequency response stability versus temperature. For applications where broadband frequency coverage is not required, octave band options are available in specific bands, usually with improved frequency response specifications.

The HP 8474 detectors are available with APC-7 (0.01 to 18 GHz), Type N (0.01 to 18 GHz), 3.5 mm (mates with SMA, 0.01 to 33 GHz), 2.92 mm (0.01 to 40 GHz), or 2.4 mm (0.01 to 50 GHz) connectors. These detectors are offered with options for optimal square-law loads (Option 102) and for positive polarity output (Option 103). Because the unit-to-unit frequency response tracking of these devices is typically better than ±0.3 dB, no matched response option is offered.

Waveguide Detectors

In addition to coaxial detectors, Hewlett-Packard offers a line of waveguide detectors that cover a portion of the millimeter frequency band. The HP Q422A (33 to 50 GHz) and HP U422A (40 to 60 GHz) are silicon, low-barrier Schottky diode detectors. The HP K422C (18 to 26.5 GHz) and the HP R422C (26.5 to 40 GHz) are GaAs PDB diode detectors. All four models have a negative output polarity as the standard; the HP Q422A and HP U422A are also available in a positive-polarity option.

Broadband Directional Detector

HP 83036C

The HP 83036C is a broadband microwave power sampler, which operates in much the same way as a directional coupler and detector combination. The HP 83036C is composed of a resistive bridge and PDB diode, which yields a very broadband device with excellent frequency response, superior temperature response, and square-law response characteristics. With a 10 MHz to 26.5 GHz frequency range, a single HP 83036C can be used in many applications where two directional couplers and detectors were once required, such as in broadband power monitoring and source leveling.

The HP 83036C has a maximum SWR of 1.7 above 50 MHz on both the input and output ports. Directivity of 14 dB matches that of most miniature couplers currently available. The maximum insertion loss is 2.2 dB.

The HP 83036C can be used as the monitoring element inside an instrument's ALC loop, as the monitoring element for external leveling of a microwave source, or for forward and reverse power monitoring.

MICROWAVE TEST ACCESSORIES

Coaxial and Waveguide Detectors

HP 8470 Series, 420 Series, 83036C

Planar-Doped Barrier Diode Detectors (OEM Equivalent Model No.)

HP Model	Frequency Range (GHz)	Frequency Response (dB)	SWR Maximum (50Ω Nom.)	Low-Level Sensitivity	Maximum Input (Peak or Average)	Short-Term Maximum Input (<1 Min.)	Option 002/102 Optimum Square-Law Load	Option 003/103 Positive Polarity Output	Other Options	Input/ Output Connector	Price
8471D (33331D)	0.0001 to 2	±0.2 to 1 GHz ±0.4 to 2 GHz	<1.23 to 1 GHz <1.46 to 2 GHz	>0.5 mV/μW	100 mW	0.7 W	Yes	Yes		BNC(m) BNC(f)	$175
8471E (33331E)	0.01 to 12	±0.23 to 4 GHz ±0.6 to 8 GHz ±0.85 to 12 GHz	<1.2 to 4 GHz <1.7 to 8 GHz <2.4 to 12 GHz	>0.4 mV/μW	100 mW	0.7 W	No	No		SMA(m) SMC(m)	$225
8473D	0.01 to 33	±0.25 to 12.4 GHz ±0.40 to 26.5 GHz ±1.25 to 33 GHz	<1.2 to 14 GHz <1.36 to 26.5 GHz <2.96 to 33 GHz	>0.4 mV/μW	200 mW	1 W	Note 2	Note 3		3.5mm(m) BNC(f)	$475
8473E (33330E)	0.01 to 50	±0.25 to 12.4 GHz ±0.40 to 26.5 GHz ±0.6 to 40 GHz ±1.0 to 50 GHz	<1.4 to 26.5 GHz <1.9 to 40 GHz <2.3 to 50 GHz	>0.4 mV/μW	200 mW	1 W	Note 2	Note 3		2.4mm(m) SMC(m)	$750
8474A	0.01 to 18	±0.25 to 12.4 GHz ±0.35 to 18 GHz	<1.3 to 15 GHz <1.4 to 18 GHz	>0.4 mV/μW	200 mW	.75 W	Note 2	Note 3	Octave Bands (See Data Sheet)	APC-7 BNC(f)	$375
8474B (33334B)	0.01 to 18	±0.35 to 18 GHz	<1.3 to 18 GHz	>0.4 mV/μW	200 mW	.75 W	Note 2	Note 3	Octave Bands (See Data Sheet)	Type N(m) BNC(f)	$340
8474C (33334C)	0.01 to 33	±0.45 to 26.5 GHz ±0.70 to 33 GHz	<1.4 to 26.5 GHz <2.2 to 33 GHz	>0.4 mV/μW	200 mW	.75 W	Note 2	Note 3	Octave Bands (See Data Sheet)	3.5mm(m) SMC(m)	$325
8474D (33334D)	0.01 to 40	±0.35 to 26.5 GHz ±0.6 to 40 GHz	<1.3 to 26.5 GHz <1.8 to 40 GHz	>0.4 mV/μW	200 mW	.75 W	Note 2	Note 3	Octave Bands (See Data Sheet)	2.92m(m) SMC(m)	$475
8474E (33334E)	0.01 to 50	±0.4 to 26.5 GHz ±0.6 to 40 GHz ±1.0 to 50 GHz	<1.2 to 26.5 GHz <1.6 to 40 GHz <2.8 to 50 GHz	>0.4 mV/μW	200 mW	.75 W	Note 2	Note 3	Octave Bands (See Data Sheet)	2.4mm(m) SMC(m)	$485

Directional Detector

HP Model	Frequency Range (GHz)	Frequency Response (dB)	Input SWR Maximum (50 Nom.)	Output SWR Maximum (50 Nom.)	Maximum Thru Line Loss (dB)	Low Level Sensitivity	Minimum Directivity (dB)	Maximum Input (into 50-Ohm Load)	Maximum Input (into Open) with a 2:1 Source Match	Input/ Output Connector	Price
83036C (33336C)	0.01 to 26.5	±1.0	1.7	1.7	2.2	18 uV/μW	14	32 dBm	21 dBm	3.5 mm(f)	$785

Low-Barrier Schottky Diode Detectors

HP Model	Frequency Range (GHz)	Frequency Response (dB)	SWR Maximum (50Ω Nom.)	Low-Level Sensitivity	Maximum Input (Peak or Average)	Short-Term Maximum Input (<1 Min.)	Option 001 Matched Response	Option 002 Optimum Square-Law Load	Option 003 Positive Polarity Output	Input/ Output Connector	Price
423B	0.01 to 12.4	±0.2/octave to 8 GHz ±0.3 overall	<1.15 to 4 GHz <1.3 to 12.4 GHz	>0.5 mV/μW	200 mW	1 W (typical)	±0.2 dB to 12.4 GHz	Yes	Yes	N(m) BNC(f)	$295
8470B 8470B Opt 012	0.01 to 18	±0.2/octave to 8 GHz ±0.3 to 12.4 GHz ±0.6 to 18 GHz	<1.15 to 4 GHz <1.3 to 15 GHz <1.4 to 18 GHz	>0.5 mV/μW	200 mW	1 W (typical)	±0.2 dB to 12.4 GHz ±0.3 to 18 GHz	Yes	Yes	APC-7 BNC(f) N(m) BNC(f)	$400 $390
8472B	0.01 to 18	±0.2/octave to 8 GHz ±0.3 to 12.4 GHz ±0.6 to 18 GHz	<1.2 to 4.5 GHz <1.35 to 7 GHz <1.5 to 12.4 GHz <1.7 to 18 GHz	>0.5 mV/μW	200 mW	1 W (typical)	±0.2 dB to 12.4 GHz ±0.3 to 18 GHz	Yes	Yes	SMA(m) BNC(f)	$360
8473B	0.01 to 18	±0.2/octave to 8 GHz ±0.3 to 12.4 GHz ±0.6 to 18 GHz	<1.2 to 4 GHz <1.5 to 18 GHz	>0.5 mV/μW	200 mW	1 W (typical)	±0.2 dB to 12.4 GHz ±0.3 to 18 GHz	No	Yes	3.5mm(m) BNC(f)	$350
8473C	0.01 to 26.5	Same as 8473B to 8 GHz ±1.5 from a −3.3 dB slope from 18 to 26.5 GHz	<1.2 to 4 GHz <1.5 to 18 GHz <2.2 to 26.5 GHz	>0.5 mV/μW	200 mW	1 W (typical)	±0.2 dB to 12.4 GHz ±0.3 to 18 GHz ±0.5 to 26.5 GHz	No	Yes	3.5mm(m) BNC(f)	$380

Waveguide Detectors

K422C	18 to 26.5	±0.6	<1.78	>0.42 mV/μW	100 mW	1 W (typical)	Note 1	Note 2	Note 3	UG-595/U MIL-W-85/1-102 (EIA WR-42) (MIL-F-3922/54C-001)	$840
R422C	26.5 to 40	±0.6	<1.78	>0.42 mV/μW	100 mW	1 W (typical)	Note 1	Note 2	Note 3	UG-599/U MIL-W-85/3-008 (EIA WR-28) (MIL-F-3922/54-003)	$860
Q422A	33 to 50	±1.5	<2.0	>0.25 mV/μW	100 mW	0.5 W	Note 1	Note 2	Yes	UG-383/U MIL-W-85/3-010 (EIA WR-22) (MIL-F-3922/67B-006)	$1,200
U422A	40 to 60	±1.5	<2.0	>0.20 mV/μW	100 mW	0.5 W	Note 1	Note 2	Yes	UG-383/U (mod.) MIL-W-85/3-014 (EIA WR-19) (MIL-F-3922/67B-007)	$1,550

Note 1: Not applicable for HP K422C and R422C. Available as a special option for Q/U422A. Consult an HP representative.
Note 2: Available as a special option on request. Consult your HP representative.
Note 3: Available as a special option on request. Consult your HP representative.

For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Microcircuit design and test package
- Streamline design cycles
- Off-the-shelf delivery, convenience
- Excellent repeatability
- Flexible modular design
- 0.635 and 0.254-mm (0.010 and 0.025-in) thick substrates

HP 83040 Series

HP 83040 Series Modular Microcircuit Package

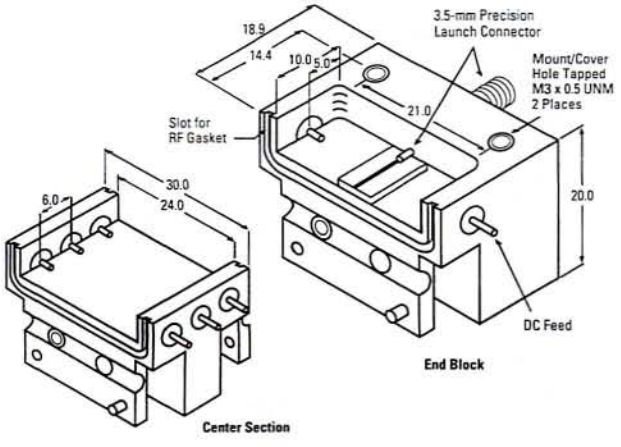
This unique package bridges the gap between custom model shop microcircuit packages and chip test fixtures. It offers flexibility and delivery not normally available with model shop packages, calibration methods usually associated with test fixtures, and prices to beat both. Off-the-shelf availability and modular design mean no model shop lead times or setup charges. Pre-designed launches and package parts let you spend time designing circuits.

The HP 83040 Series is compatible with many of the HP vector network analyzer calibration techniques, such as Adapter Swap, Adapter Removal, Port Extension, Normalization, Gating, De-embedding, and TRL, each fully described in Product Note 83040-2. Typical performance: 0.5 dB insertion loss (through 1 launch), 20 dB return loss, 30 dB repeatability, and 40 dB source match to 26.5 GHz.

Unlike most test fixtures, this is a microcircuit package. Build circuits, test them, then seal them up for use as stand-alone components. No bulky vises or complex spring-loaded pins to worry about and keep track of.

Applications

- Breadboard design package
- Combine circuit modules; build sub-circuit libraries
- Sample test MMIC devices
- "Connectorize" chips and circuit components for use as stand-alone components in microwave chains



- Support literature available:
  1. Data sheet, HP Lit. No. 5952-1418
  2. Product Note 83040-1 (Assembly Instructions), HP Lit. No. 5952-1906
  3. Product Note 83040-2 (Calibration and Modeling Techniques), HP Lit. No. 5952-1907
  4. Product Note 83040-3 (Pre-assembled MMIC Devices), HP Lit. No. 5091-0531

0.635-mm (0.025-in) Substrates	HP Model	Price
Starter Kit	83040B	$975
Evaluation Kit	83040B Opt 001	$500
Reorder Kits		
Single end blocks (w/circuit)	83041B	$375
Double end blocks	83042B	$200
Center sections		
1 of each length	83043B Opt 100	$350
1-mm center section	83043B Opt 001	$125
2-mm center section	83043B Opt 002	$125
5-mm center section	83043B Opt 005	$175
10-mm center section	83043B Opt 010	$225
20-mm center section	83043B Opt 020	$250
Through line circuits		
1 of each length	83045B Opt 100	$175
1-mm through line	83045B Opt 001	$75
2-mm through line	83045B Opt 002	$75
5-mm through line	83045B Opt 005	$100
10-mm through line	83045B Opt 010	$125
20-mm through line	83045B Opt 020	$125
Launch circuit	83046B	$100

0.254-mm (0.010-in) Substrates	HP Model	Price
Starter Kit	83040C	$1,250
Evaluation Kit	83040C Opt 001	$500
Reorder Kits		
Single end blocks (w/circuit)	83041C	$450
Double end blocks	83042C	$300
Center sections		
1 of each length	83043C Opt 100	$350
1-mm center section	83043C Opt 001	$125
2-mm center section	83043B Opt 002	$125
5-mm center section	83043B Opt 005	$175
10-mm center section	83043B Opt 010	$225
20-mm center section	83043C Opt 020	$250
Through line circuits		
1 of each length	83045C Opt 100	$175
1-mm through line	83045C Opt 001	$85
2-mm through line	83045C Opt 002	$85
5-mm through line	83045C Opt 005	$125
10-mm through line	83045C Opt 010	$150
20-mm through line	83045C Opt 020	$150
Launch circuit	83046C	$100
Both substrate thicknesses		
Cover	83044X	$65
Clamp kit	83047X	$65
Calibration Short	83048A Opt 001	$75

Starter Kit Contents	
	Quantity/Pkg
Single end blocks (with circuits)	2
Double end block	1
1-mm center section	1
2-mm center section	1
5-mm center section	1
10-mm center section	1
20-mm center section	1
Cover	1
1-mm through line	1
2-mm through line	1
5-mm through line	1
10-mm through line	1
20-mm through line	1
Launch circuits	2
Clamp kit	4

Evaluation Kit Contents	
83040B Opt 001 0.635-mm (0.025-in) Substrates	**83040C Opt 001 0.254-mm (0.010-in) Substrates**
2 Single launch end blocks (with circuits)	2 Single launch end blocks (with circuits)
1 20-mm center section	1 10-mm center section
1 20-mm center through line	1 10-mm center through line
2 Clamps	2 Clamps

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MICROWAVE TEST ACCESSORIES

Coaxial and Waveguide Terminations, Coaxial Shorts and Opens

HP 908A, 909A/C/D/E/F, 910A/B/C, 914A/B/C, 920C, 921A, 11511A, 11512A, 11565A, 85138A/B, 85140A/B, 85141A/B

HP 909C

HP 909D

HP U920C

HP 908A, 909A/C/D/E/F, 85138A/B Coaxial Fixed Terminations (50 and 75 Ω)

The HP 908A, 909A and 909D terminations are low-reflection loads for terminating 50 Ω coaxial systems in their characteristic impedance. The HP 909C (50 Ω) and HP 909E (75 Ω) are precision ultra-low-reflection terminations intended for use as calibration standards.

HP 908A, 909A/C/D/E/F, 85138A/B Specifications

HP Model	Frequency Range (GHz)	Impedance (ohms)	SWR	Power Rating	Connector	Price
908A	dc to 4	50	1.05	0.5 W avg 1 kW pk	N (m)	$185
909A	dc to 18	50	1.05: 0 to 4 GHz 1.1: 4 to 12.4 GHz 1.25: 12.4 to 18 GHz	2W avg 300 W pk	APC-7	$250
909A Opt 012 Opt 013			1.06: 0 to 4 GHz 1.11: 4 to 12.4 GHz 1.3: 12.4 to 18 GHz		Opt 012 N (m) Opt 013 N (f)	−$15
909C	dc to 2	50	1.005	0.5W avg 100 W pk	APC-7	$365
909C Opt 012 Opt 013			1.01		Opt 012 N (m) Opt 013 N (f)	−$25
909C Opt 200	dc to 0.2	50	52 dB to 200 MHz	0.5 W avg 100 W pk	Must be ordered with Opt 012 N (m) or Opt 013 N(f)	$0
909C Opt 201			1.01		Must be ordered with Opt 012 N(m)	−$20
909D	dc to 26.5	50	1.02: dc to 3 GHz 1.036: 3 to 6 GHz 1.12: 6 to 26.5 GHz	2 W avg 100 W pk	3.5 mm (m)	$250
909D Opt 011					Opt 011 3.5 mm (f)	$0
909D Opt 040			1.02: dc to 4 GHz 1.036: 4 to 6 GHz 1.12: 6 to 26.5 GHz		3.5 mm (m)	+$15
909E	dc to 2	75	1.01	0.5 W avg 100 W pk	N(m)	$335
909F	dc to 6	50	1.005: dc to 5 GHz 1.01: 5 to 6 GHz	0.5 W 100 W pk	APC-7	$475
909F Opt 012	dc to 6	50	1.007: dc to 2 GHz 1.01: 2 to 3 GHz 1.016: 3 to 6 GHz	0.5 W 100 W pk	N(m)	−$25
909F Opt 013					N(f)	−$25
85138A	dc to 50	50	1.07: dc to 26.5 GHz 1.12: 26.5 to 40 GHz 1.22: 40 to 50 GHz	0.5 W	2.4 mm (m)	$475
85138B					2.4 mm (f)	$525

HP 920C, 921A Waveguide Shorts

The HP R920C, Q920C and U920C are low-loss movable shorts for waveguide systems operating from 26.5 to 60.0 GHz.

The HP R921A, Q921A and U921A are fixed shorts for waveguide systems.

HP 920C, 921A Specifications

HP Model	Frequency Range (GHz)	Type	Waveguide Size EIA	Price
R920C	26.5 to 40.0	movable	WR28	$800
Q920C	33.0 to 50.0	movable	WR22	$800
U920C	40.0 to 60.0	movable	WR19	$810
R921A	26.5 to 40.0	fixed	WR28	$85
Q921A	33.0 to 50.0	fixed	WR22	$75
U921A	40.0 to 60.0	fixed	WR19	$175

HP 910A/B/C, 914B/C Waveguide Fixed and Movable Terminations

The HP 910A/B/C are fixed terminations for waveguide systems. The HP 914A/B are similar to the HP 910A/B/C, except that their absorptive elements are movable and locking plungers control the position of the elements. HP 914C models use micrometer adjustment.

HP 910A/B/C, 914A/B/C Specifications

HP Model	Frequency Range (GHz)	SWR	Power Rating	Type	Waveguide Size (EIA)	Price
X910B	8.2 to 12.4	1.015	1 watt	fixed	WR90	$450
P910A	12.4 to 18.0	1.02	1 watt	fixed	WR62	$425
R910A	26.5 to 40.0	1.03	1 watt	fixed	WR42	$365
Q910A	33.0 to 50.0	1.03	1 watt	fixed	WR22	$400
U910A	40.0 to 60.0	1.04	1 watt	fixed	WR19	$375
V910C	50.0 to 75.0	1.025	0.3 watt	fixed	WR15	$650
W910C	75.0 to 110.0	1.03	0.2 watt	fixed	WR10	$725
X914B	8.2 to 12.4	1.01	1 watt	sliding	WR90	$1,050
P914A	12.4 to 18.0	1.01	0.5 watt	sliding	WR62	$1,350
K914B	18.0 to 26.5	1.01	0.5 watt	sliding	WR42	$950
R914C	26.5 to 40.0	1.01	0.5 watt	sliding	WR28	$900
Q914C	33.0 to 50.0	1.01	0.5 watt	sliding	WR22	$825
U914C	40.0 to 60.0	1.01	0.5 watt	sliding	WR19	$1,000

HP 11511A, 11512A, 11565A Coaxial Shorts and Opens

These shorts and opens are used for establishing measurement planes for known reflection phase and magnitude in 50 Ω and 75 Ω coaxial systems for various connectors.

Ordering Information	Price
HP 11511A N(f) Short (50 Ω)	$60
HP 11512A N(m) Short (50 Ω)	$60
HP 11565A APC-7 Short (50 Ω)	$110
HP 11652-60001 BNC (m) 50 Ω Termination	$120
HP 85138A 2.4 mm (m) 50 Ω Termination	$475
HP 85138B 2.4 mm (f) 50 Ω Termination	$525
HP 85140A 2.4 mm (m) Short	$250
HP 85140B 2.4 mm (f) Short	$275
HP 85141A 2.4 mm (m) Open	$275
HP 85141B 2.4 mm (f) Open	$300

For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 87300B/C, 87301D, 87310B

HP 87300 Series Directional Couplers

Hewlett-Packard offers a line of compact, broadband directional and hybrid couplers that are designed for signal monitoring or, when combined with a coaxial detector, signal leveling. The HP 87300B is supplied with SMA (f) connectors, the HP 87300C has 3.5-mm (f) connectors, and the HP 87301D has 2.4-mm (f) standard or optional 2.92-mm (f) connectors.

The HP 87310B is a 3 dB hybrid coupler intended for applications that require a phase difference of 90 degrees between signals. The HP 87310B features SMA (f) connectors.

HP 87300 Series Specifications

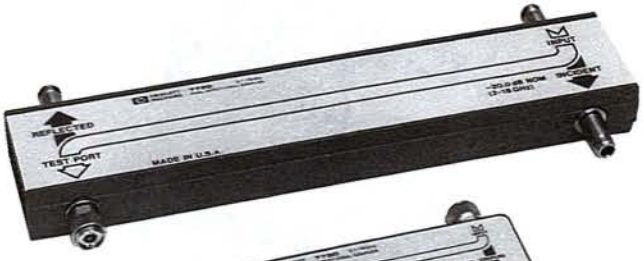
HP model	Frequency range (GHz)	Nominal coupling & (dB) variation	Minimum directivity (dB)	SWR maximum	Insertion loss (dB)	Price
87300B	1 to 20	10 ±.5	16	1.35	<1.4	$495
87300C	1 to 26.5	10 ±1	>14	1.40	1 to 12.4: <1.1 12.4 to 26.5: <1.6	$925
87301D	1 to 40	13 ±1	1 to 20: 14 20 to 40: 10	1 to 20: 1.5 20 to 40: 1.7	1 to 20: <1.1 20 to 40: <1.8	$1,350
87310B	1 to 18	3 ±.5		1.35	<1.8	$1,100

HP 773D Directional Coupler and HP 772D Dual-Directional Coupler

The HP 772D and 773D are high-performance couplers designed for broadband swept measurements in the 2 to 18 GHz range. The HP 773D is ideal for leveling broadband sources when used with an HP 8474B detector. (See also the HP 83036C directional detector.) For reflectometer applications, the HP 772D is the best coupler to use with HP power sensors and power meters (such as the HP 438A dual power meter). Forward and reverse power measurements on transmitters, components, or other broadband systems are made simpler using the HP 772D. The broadband design allows the use of a single test setup and calibration for tests spanning the entire 2 to 18 GHz frequency range.

HP 774D to 778D Dual-Directional Couplers

The economical HP 774D–778D couplers cover frequency spreads of more than 2:1, each centered on one of the important VHF/UHF bands. With their high directivity and mean coupling accuracy of ±0.5 dB, these are ideal couplers in reflectometer applications. The close tracking of the auxiliary arms makes these couplers particularly useful for reflectometers driven by sweep oscillators such as the HP 8350B with its appropriate plug-in. Power ratings are 50 W average, 10 Kw peak.



HP 772D

HP 773D

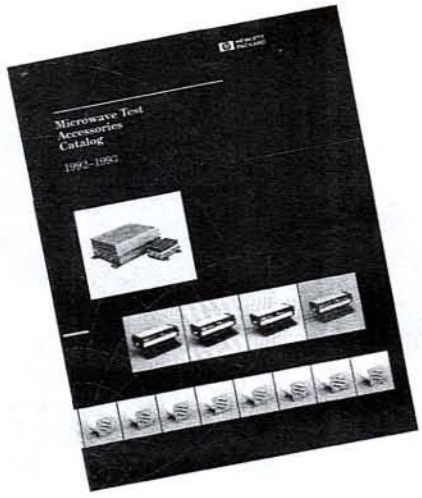
HP 772-779D, 11691D, 11692D Specifications

HP model	Frequency range (GHz)	Nominal coupling (dB)	Maximum coupling variation (dB)	Minimum directivity (dB)	SWR Primary line maximum (50 Ω Nom.)	Price
772D	2 to 18	20	±0.9	2 to 12.4: 30 12.4 to 18: 27	2 to 12.4: 1.3 12.4 to 18: 1.4	$2,950
773D	2 to 18	20	±0.9	2 to 12.4: 30 12.4 to 18: 27	1.2[4]	$1,525
774D	0.215 to 0.450	20	±1	40	1.15	$1,450
775D[1]	0.450 to 0.940	20	±1	40	1.15	$1,450
776D[1]	0.940 to 1.90	20	±1	40	1.15	$1,450
777D	1.90 to 4.0	20	±0.4	30	1.2	$1,600
778D	0.10 to 2.0	20	±1.5	0.1 to 1 GHz: 36[2] 1 to 2 GHz: 32	1.1	$1,550
779D	1.7 to 12.4	20 ± 0.5	±0.75	1.7 to 4 GHz: 30 4 to 12.4 GHz: 26	1.2[4]	$1,550
11691D	2 to 18	22	±1.0	2 to 8 GHz: 30 8 to 18 GHz: 26	1.2[4]	$2,800
11692D	2 to 18	22	±1 incident to test port	2 to 8 GHz: 30 8 to 18 GHz: 26[3]	2 to 12.4 GHz: 1.3 12.4 to 18 GHz: 1.4	$4,300

HP 772D Standard Connectors Primary line: APC-7, APC-7; auxiliary arms: N(f) **Opt 001** Primary line: N(f), N(f)	 – $15
HP 774D-777D Standard Connectors Primary line: N(m), N(f) Auxiliary arm: N(f), N(f)	 NA
HP 778D Standard Connectors Primary line: N(m), N(f); auxiliary arms: N(f), N(f) **Opt 011** Primary line: APC-7, N(f) **Opt 012** Primary line: N(m), N(f)	 + $25 $0
HP 779D Standard Connectors Primary line: N(m) input, N(f) output; auxiliary arm N(f) **Opt 010** Primary line: N(f) input, N(m) output; auxiliary output N(f) Other options: APC-7 on any or all ports	 $0 Contact HP
HP 11691D and 773D Standard Connectors Primary line: APC-7, APC-7; auxiliary arm: N(f) **Opt 001** All N(f) **Opt 005 (11691D only)** All APC-7	 – $30 + $25
HP 11692D Standard Connectors Primary line: N(f), APC-7; auxiliary arms: N(f), N(f) **Opt 001** Primary line: N(f), N(f) **Opt 002** Primary line: N(f), N(m)	 – $15 – $15

[1]Maximum auxiliary arm tracking: 0.3 dB for HP 776D; 0.5 dB for HP 777D
[2]30 dB, 0.1 to 2 GHz, input port
[3]24 dB with Type N connector on the test port
[4]Apparent SWR at the output port of a coupler when used in a closed-loop leveling system

MICROWAVE TEST ACCESSORIES
Waveguide and Millimeter Waveguide Accessories



Microwave Test Accessories Catalog

Hewlett-Packard offers a wide variety of waveguide accessories to help solve your test and measurement problems.

For more detailed descriptions of all of HP's waveguide accessories, as well as general-purpose microwave and RF test and measurement accessories, please order the 1992-93 *Microwave Test Accessories Catalog* (HP p/n 5091-4269E/4269EUS).

The following represents a brief description of many of the waveguide accessories available.

HP 752 Series Waveguide Directional Couplers

The HP 752 Series couplers are specified to meet a wide variety of microwave applications. Every coupler has a minimum directivity of 30 dB over its entire frequency range. Each coupler is swept-frequency-tested to ensure that the main guide SWR and directivity specifications are accurate. Performance characteristics are unaffected by humidity, temperature, time, making these units especially useful in microwave standards measurements.

The HP R752AS/CS/DS, Q/U752A/C/D, and V/W752C/D use a split block design, allowing for very close control of critical dimensions, which results in the high performance of these couplers.

The HP 752 couplers cover frequencies from 8.2 to 110 GHz in the following bands: X, P, K, R, Q, U, V, and W.

HP 281A/B/C, 292A/B, 11515A/16A Coax and Waveguide Adapters

HP 281A/B/C rugged waveguide-to-coax adapters cover frequencies from 2.6 to 60 GHz. Coaxial connector types include Type N, APC-7, 3.5 mm, 2.4 mm, and 1.85 mm.

HP 292A/B waveguide-to-waveguide adapters connect waveguide sizes with overlapping frequency ranges.

HP 11515A/16A adapt circular waveguide flanges to rectangular flanges in K-band and R-band.

HP 532 Series, 537A Frequency Meters

These direct-reading frequency meters measure frequencies from 33.0 to 60.0 GHz in waveguide, and from 3.7 to 12.4 GHz in coax quickly and accurately. Their long scales and numerous calibration marks provide high resolution, which is particularly useful when measuring frequency differences or small frequency changes. Frequency is read directly in GHz, so neither interpolation nor charts are required.

The instruments make up a special transmission section with a high-Q resonant cavity, which is tuned by a choke plunger. A 1 dB or greater dip in output indicates resonance; virtually full power is transmitted off resonance. Overall accuracy of each frequency meter includes allowance for 0 to 100% relative humidity and temperature variation from 13° to 33° C.

HP 362 Series Waveguide Low-Pass Filters

These low-pass filters facilitate microwave measurements by eliminating undesirable signals (such as harmonics) from the measurement system. Suppression of such signals is particularly important in applications such as broadband reflection and transmission measurements or slotted line measurements, where harmonics generated by the signal source could otherwise impair measurement accuracy. The HP 362 low-pass filters cover the frequency range from 8.2 to 40 GHz in the X, P, K, and R bands.

HP 11540 Series Waveguide Stand, Waveguide Holders

The HP 11540A Series waveguide stand locks HP waveguide holders at any height from 70 to 133 mm (2.75 in to 5.25 in). The waveguide holders are offered in five sizes to hold waveguide covering frequencies from 22 to 40 GHz.

HP 382 Series Waveguide Attenuators

Operation of these HP 382 Series rotary-vane, continuously variable attenuators depends on a mathematical law rather than on the resistivity of the attenuator card. They are direct-reading and provide accurate attenuation from 0 to 50 dB regardless of temperature and humidity. The HP 382 Series attenuators cover the frequency range from 8.2 to 60 GHz in the X, P, K, R, Q, and U bands.

HP 370A/B/C Millimeter-Wave Fixed Attenuators

The HP Q and U 370 fixed attenuators offer precise attenuation, flat frequency response, and low SWR. Their ruggedness, reliability, and small size make them ideal for bench system applications. They are also useful for general-purpose applications, such as reduction of power levels to sensitive components and systems.

HP 373D/G Millimeter-Wave Fixed Attenuators

The HP R, Q, U, V, and W 373 precision fixed attenuators offer very precise attenuation, flat frequency response, very low SWR, and low attenuation drift with age. The split block design offers this excellent performance in a rugged, reliable package. They can be used on the bench in applications requiring very precise signal reduction, or where a precise attenuation standard is needed. Available in 20 and 50 dB values.

HP 365A Millimeter-Wave Waveguide Isolators

The HP Q and U 365A isolators use a Faraday-rotation–type design consisting of a section of waveguide containing low-loss ferrite material and impedance-matching elements. A permanent magnet supplies the external magnetic bias field to the ferrite core. This results in excellent broadband isolation ratios of at least 25 dB, along with low SWR and insertion loss. Models in the R, V, and W bands are also available.

HP 894, 896, 897, 898, 899 Millimeter-Wave Waveguide Accessories

Waveguide accessories, such as E- and H-plane bends, twists, and straight sections are necessary and useful for assembling waveguide measurement systems.

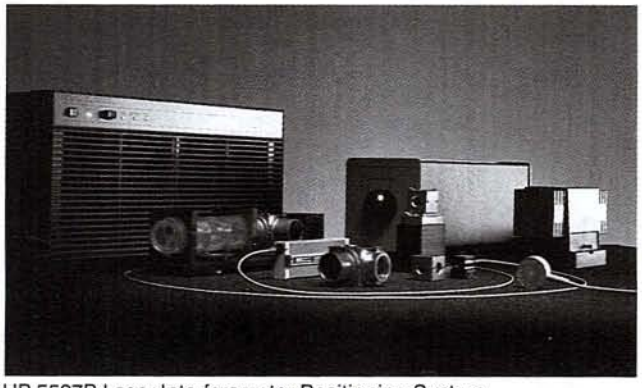
HP offers R, Q, U, V, W 897A/B E-plane and H-plane bends of 90 degrees. HP R, Q, U, V, W 898A/B twists can be specified for either right rotation (A-Model) or left rotation (B-Model) of 90 degrees. And, finally, several HP R, Q, U, V, W 899A/B straight sections are available in 2.5 and 5.0 cm lengths to fill out the proper dimensions of complicated test setups.

Network analysis calibration is verified by measuring a precise and traceable reference impedance. HP's R, Q, U, V, W 896 standard sections and R, Q, U, V, W 894 standard mismatches are these kinds of references.

They have very low SWR of less than 1.016. Impedance is NIST-traceable, using laser interferometry to accurately measure waveguide dimensions.

The HP Q, U 896 has a unique precision flange design. When mating with a standard MIL-spec flange, this design improves repeatability by about a factor of 2 (when mating two HP precision flanges, repeatability is improved by a factor of 5).

- High accuracy (sub-0.5 micron), resolution, and repeatability
- Industry-standard electronics
- Choice of laser head, optics, and electronics
- Fast axis velocity (350 mm/s)—plane mirror optics
- Automatic wavelength-of-light compensation
- Remote sensing with fiber optic receivers



HP 5527B Laser Interferometer Positioning System

NEW

PC-Compatible Laser Interferometer Positioning System with the HP 10885A PC Axis Board and HP 10886A PC Compensation Board

Precision Positioning Products

Laser interferometer precision positioning systems — composed of electronic and optical components — provide very precise position or distance information for dimensional measurements and motion control. When built into manufacturing and inspection processes, a laser interferometer system reports the position of a probe or controls the motion of a product platform with more accuracy than any other method.

Precision laser positioning systems improve product quality and reliability, increase manufacturing consistency for increased production yields, and allow the production of precision products that would otherwise be impossible to manufacture. Laser interferometer positioning systems are vital in many applications:

- Integrated-circuit fabrication, inspection, and repair
- Manufacture of high-capacity disk drives
- Precision machine tools
- Manufacture or calibration of other measurement scales
- Mechanical parts inspection/measurement
- Custom test and measurement
- Precise plotting
- Mechanical vibration analyis
- Antenna testing

Many of HP's innovations have resulted in products, such as digital programmable servo-control electronics for closed-loop positioning, that are unavailable from any other vendor.

System Components

Hewlett-Packard precision positioning systems combine Michelson interferometry with a two-frequency HeNe laser. HP's patented two-frequency design provides greater stability and reduced noise sensitivity, and extends the measurement range — up to 80 meters (260 ft.). Three subsystems make up a laser interferometer system:

- **Laser:** Supplies a monochromatic light source (or beam)
- **Optics:** Direct the beam and generate the interference pattern
- **Electronics:** Detect and count the light and dark interference fringes, process the data, and output distance information

Improving Accuracy and Repeatability

Maximum accuracy and repeatability require compensation for certain parameters. HP laser interferometer systems depend on the high accuracy of the laser's wavelength. However, the wavelength of light in air varies with the air's refractive index which is a function of air temperature, pressure, and composition. In addition to the wavelength-of-light effects, errors can result from thermal expansion of the workpiece. To take full advantage of Hewlett-Packard's high wavelength stability, the HP 10717A Wavelength Tracker compensates for changes in the air's refractive index. The HP 10780F Remote Receiver eliminates thermal effects due to the receiver electronics by using a remote, fiber-optic pickup. The HP 10896A, with wavelength-of-light compensation, increases accuracy and repeatability for VMEbus systems, and the new HP 10886A provides compensation for PC-compatible systems. Product Note 5527A/B-2 describes in detail how to achieve maximum accuracy and repeatability.

HP Laser Interferometer Products

HP offers the components needed to configure laser interferometer positioning systems for a broad range of applications and other requirements. All systems support the same laser sources and optics. The differences are determined by the electronics.

Interferometer Electronics

HP interferometer electronics offer a choice of: backplane (interfacing characteristics), output formats, and environmental compensation options. Table 1 on the next page summarizes the HP products based on these differentiators.

The HP product line offers interferometer electronics tailored for a variety of customer needs. For interfacing to industry-standard backplanes, the VMEbus provides a high-performance alternative and PC products provide the lowest-cost solution. Both are popular industry standards and offer system configuration flexibility. In addition to the standard 32-bit measurement output, the HP 5527B offers a broader choice of output formats compared with the VMEbus and PC electronics.

Each of the electronics alternatives supports the complete range of lasers and optics. In addition, the HP 10780C Receiver and HP 10780F Remote Receiver work with all electronics.

DIMENSIONAL MEASUREMENTS

Laser Interferometer Positioning Systems (cont'd)

HP 5527B, VMEbus, PC-Compatible

Table 1. Key Characteristics of HP Interferometer Electronics

System	Electronics	Backplane	Output Formats	Other Differentiators
HP 5527B	HP 5507B	Proprietary	32-bit digital, GPIO, HP-IB, motor drive (in ±10 Vdc, 16-bit digital, and pulse-width modulated), A-Quad-B, up/down pulse.	High-performance, complete package Servo-axis board Fully compensated A-Quad-B for high-precision machine tools Complete compensation for environmental effects
VMEbus	HP 10895A HP 10896A	VMEbus	32-bit digital (hardware output and backplane output) VME compensation board	High-performance, robust, industry-standard 32-bit backplane Fast system development Complete environmental compensation
PC Compatible	HP 10885A HP 10886A	ISA (PC/AT, PC/XT, and IBM compatibles)	32-bit digital (hardware output and backplane output) PC compensation board	Lowest-cost, most-popular, industry-standard backplane Fast system development Complete environmental compensation

Optics

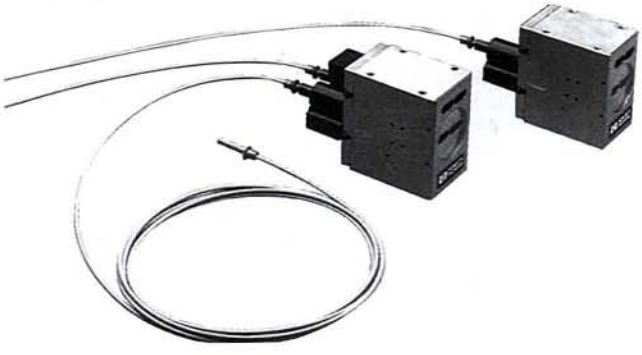
The optics tailor each interferometer system for the physical layout and measurement requirements of each application. The current list of HP optics includes four new products for improved multiaxis stage positioning and sub-0.5-micron accuracy.

- **HP 10702A Linear Interferometer:** The basic for linear measurements
- **HP 10706A/B Plane-Mirror Interferometers:** Commonly used with multiaxis stages
- **HP 10716A High-Resolution Interferometer:** A plane-mirror interferometer with twice the resolution of the HP 10706A/B
- **HP 10715A Differential Interferometer:** A plane-mirror interferometer for differential measurements
- **HP 10705A Single-Beam Interferometer:** Physically smaller for confined spaces or low-mass, non-contact measurements
- **HP 10719A, HP 10721A One- and Two-Axis Differential Interferometers:** For optimized accuracy and repeatability with IC fabrication equipment; the position of the wafer stage is directly referenced to the optics column
- **HP 10735A, HP 10736A Three-Axis Interferometers:** Can be used in pairs to make 5 precise measurements (x, y, pitch, roll, and yaw) simultaneously for IC fabrication

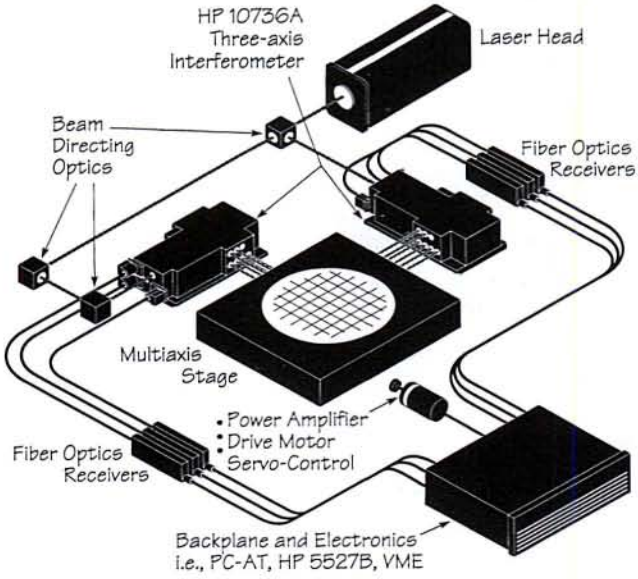
See Table 2 for a summary of HP reflector products and the configurations supported with HP optics.

Table 2. HP Reflectors and Optics: Supported Combinations

Optics	Reflectors/Mirrors			
	HP 10703A	HP 10704A	HP 10724A	Custom Mirrors
HP 10702A	√			
HP 10705A		√		
HP 10706A/B			√	√
HP 10716A			√	√
HP 10715A			√	√
HP 10719A, HP 10721A				√
HP 10735A, HP 10736A				√



The HP 10719A and 10721A Differential Interferometers work together to make highly accurate column-referenced measurements for multiaxis stages.



The new HP 10735A and HP 10736A Three-Axis Interferometers offer greater accuracy for microlithography and other applications that require up to five degrees of freedom.

Laser Heads

Three laser heads are available for HP interferometer systems: The HP 5517A, HP 5517B (500-mm/second axis velocity for linear optics), and HP 5517C (700 mm/sec for linear optics).

The total accuracy of an interferometer system is the sum of the errors from the laser head, the optics, and the effects of the environment. All HP laser heads have a vacuum wavelength accuracy of ±0.1 ppm (±0.02 ppm with factory calibration to MIL-STD 45662) and a demonstrated MTBF greater than 20,000 hours.

Interferometer System Configurations

HP 5527B Laser Interferometer System

The HP 5527B offers improved system performance with finer resolution, faster axis velocities, remote sensing receivers, and complete servo-control capability. It can be configured for closed- or open-loop control, multiaxis capabilities, automatic compensation for environmental effects, and special prototyping abilities for custom electronics.

The HP 5507B system electronics for the HP 5527B combine superior perfomance with greater ease of use and full EMC compliance. The system is controlled with HP-IB. Five outputs are available depending on the boards used:

- **HP 10932B Axis Board:** Open-loop measurements or position data for custom closed-loop positioning. Outputs are in 32-bit digital format, and are available directly and over HP-IB.
- **HP 10934A A-Quad-B Board:** Provides high-resolution, A-Quad-B and Up/Down pulse outputs with full environmental compensation
- **HP 10936B Servo-Axis Board:** Closed-loop motor drive outputs for a range of motor amplifiers. Motor-drive outputs are ±10 V analog, 16-bit digital, and pulse-width modulated for precision positioning. The HP 10936B is a programmable digital servo with built-in motion control algorithms; custom algorithms can be down-loaded. A trace function speeds and simplifies servo-loop characterization and position control.
- **HP 10941A Prototyping Board:** Capabilities for custom electronic designs
- **HP 10946C Automatic Compensation Board:** With HP 10717A wavelength tracker and/or HP 10751A air sensor and HP 10757A material temperature sensor, automatically compensates for wavelength-of-light and material temperature effects.
- **HP 10780C/F Receiver:** Supports up to 6 measurement axes

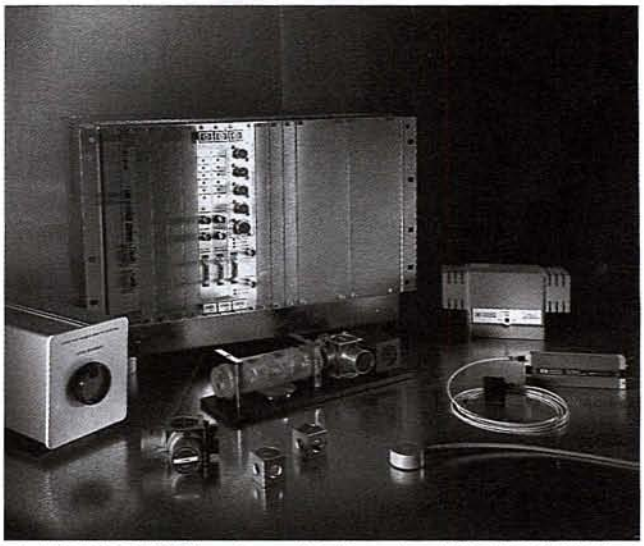
PC-Based Laser Interferometer Positioning System

The HP 10885A PC Axis Board offers a laser interferometer system that can be interfaced with the most popular PC backplanes. Leveraging existing PC/XT, PC/AT, and other IBM-compatible computers significantly lowers start-up costs. The HP 10885A provides a 32-bit digital, real-time position output via hardware. Position can also be read over the PC backplane. The HP 10886A provides complete environmental compensation for increased accuracy and repeatability. Combining the high performance of HP laser interferometers with the most popular, lowest-priced, industry-standard backplane speeds system development and integration and reduces system cost.

VMEbus Laser Interferometer Positioning System

The HP 10895A Laser Axis Board, compatible with VME Rev. C.l, provides capability similar to that of the HP 10932B Axis Board. Position data is output in 32-bit format for closed-loop positioning systems. Position can also be read over the VMEbus backplane. This VME solution permits easy, cost-effective integration of laser electronics into VMEbus systems, and can also be used in VXI backplanes.

The new HP 10896A Compensation Board increases the accuracy and repeatability of positioning systems using the HP 10895A. With wavelength-of-light compensation, laser-positioning systems based on the VMEbus are suitable in many environments.



The HP 10895A VMEbus Laser Axis Board and HP 10896A VMEbus Compensation Board permit easy, cost-effective integration of high-speed laser electronics into this popular industry-standard backplane.

Ordering Information

To configure and order an HP laser interferometer positioning system, please request the appropriate data sheets and ordering information from your local Hewlett-Packard sales office:
Introduction to Laser Systems Brochure, 5091-2507E
Laser Head and Optics Technical Data Sheet, 5091-0728E
HP 5527B Technical Data Sheet, 5091-2508E
VMEbus Technical Data Sheet, 5091-0727
PC Compatible Technical Data Sheet, 5091-4162
Systems Ordering Information, 5091-4163

System Specifications

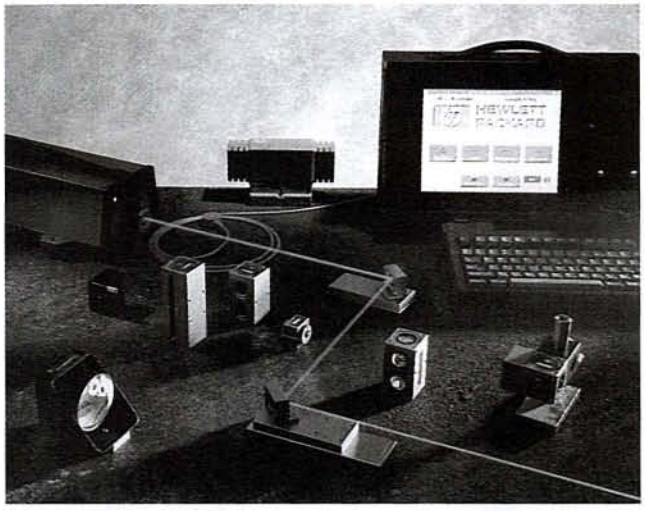
	HP 5527B	VMEbus	PC Compatible
Accuracy			
Vacuum	0.1 ppm	0.1 ppm	0.1 ppm
With MIL STD 45662A	0.02 ppm	0.02 ppm	0.02 ppm
Maximum Resolution			
Linear optics	10 nm	10 nm	10 nm
Plane mirror optics	5 nm	5 nm	5 nm
High-res. optics	2.5 nm	2.5 nm	2.5 nm
Maximum Axis Velocity			
Linear optics	700 mm/s	700 mm/s	700 mm/s
Plane mirror optics	350 mm/s	350 mm/s	350 mm/s
High-res. optics	175 mm/s	175 mm/s	175 mm/s
Maximum Range	40 m	40 m	40 m
Maximum Data Output Rates			
Position/position error	3.0 MHz	3.0 MHz	3.0 MHz
A-quad-B (transition rate)	5.2 MHz	N/A	N/A
Up-down pulse	5.2 MHz	N/A	N/A
Motor-drive	8 kHz	N/A	N/A
Environmental Compensation	Yes	Yes	Yes

DIMENSIONAL MEASUREMENTS

Laser Interferometer Measurement Systems

HP 5529A

- Improves machine-tool accuracy and productivity
- Ensures that new machine tools meet specifications
- Characterizes a machine's dynamic performance
- Reduces scrap and rework
- Easy to use
- Portable
- Versatile data analysis
- Three-year warranty



HP 5529A Dynamic Calibrator for Fast, Accurate Calibration

NEW

The HP 5529A dynamic calibrator—Hewlett-Packard's newest, most accurate, and reliable machine-tool calibration solution—provides substantial improvements in performance and functionality compared with the HP 5528A, the system it replaces. For uncompromised quality, this personal computer-based system can discover errors that would otherwise be undetected. Its error-compensation data maximizes machine-tool productivity quickly, outweighing the cost of calibration downtime.

Finding and Managing Machine-Tool Errors

The HP 5529A makes the standard machine-tool measurements: linear distance, velocity, angle, straightness, parallelism, and squareness. It also makes diagonal measurements, a quick means of checking machine-tool accuracy. Diagonal measurements comply with the new ANSI B5.54 standard. If the diagonal measurements indicate satisfactory machine-tool performance, a full calibration and its associated downtime may be avoided.

The HP 5529A can also be used to calibrate coordinate measuring machines, printed-circuit-board fabrication equipment, and other precision equipment. In addition, the HP 5529A is an ideal reference length standard for metrology labs and R&D tasks.

Easy to Use for Fast Calibration and Reduced Training Costs

The HP 5529A dynamic calibrator was designed for ease of use and operation. Transporting and setting up the instrument is simple. The HP 5529A has new, PC-based electronics and easy-to-use controls. Command choices are clearly displayed and can be quickly selected using color-coded keys on the graphical user interface. The software can save and recall calibration setups to save time and ensure consistency. Easy error recovery avoids wasted time and lost data. Help screens are keyed to the task being performed to provide fast answers to operator questions. Online measurement checklists and setup graphics help users avoid mistakes and omissions. The process of generating the compensation values for a computer numerical controller (CNC) has been streamlined. Calibration reports can be quickly generated to document and track machine-tool performance.

Dynamic Calibration for Speed

The HP 5529A performs dynamic calibration (that is, it collects data while the machine is moving) and so provides fast data collection, which speeds calibration. Dynamic calibration also allows characterization of the machine's dynamic performance, including vibration analysis, a capability that makes the HP 5529A more useful for troubleshooting.

Versatile Data Analysis for Power

The HP 5529A's calibration software is compatible with international calibration standards to accommodate a wide range of requirements, and it includes choices for special needs. The new instrument stores calibration data in files that are compatible with electronic spreadsheets such as Lotus® 1-2-3 and Microsoft® Excel. These spreadsheets allow customized data analysis and can streamline tasks such as vibration analysis, machine-tool volumetric accuracy calculations, and the creation of custom databases. The HP 5529A also calculates and prints tables of compensation values for CNCs. Automatic calculation is faster than manual methods, and it provides more accurate CNC error compensation.

Portability to Reduce Transportation Costs

To reduce system cost and enhance portability, the instrument's laser electronics are integrated into a PC-compatible computer. The basic system fits into two robust transit cases plus a computer case. The HP 5529A is rugged and reliable, and it comes with a three-year warranty.

Specifications

General

Laser: Two-frequency HeNe, 1-mW maximum power output
Safety classification: Class II laser product conforming to U.S. National Center for Devices and Radiological Health Regulations 21 CFR 1040.10 and 1040.11
Data rate: ≥1 kHz

Distance

Accuracy: ±0.1 ppm in vacuum (±0.02 ppm if calibrated to MIL-STD 45662), ±1.7 ppm with HP 10751C/D air sensor (15°–25° C)
Resolution: Linear optics, 10 nm (0.4 μin) standard, 1 nm (0.04 μin) extended; plane-mirror optics, 5 nm (0.2 μin) standard, 0.5 nm (0.02 μin) extended; high-resolution optics, 2.5 nm (0.1 μin) standard, 0.25 nm (0.01 μin) extended
Measurement velocity: 700 mm/s (28 in/s) with linear optics
Measurement range: Up to 40 m (130 ft) with linear optics; up to 80 m (260 ft) with long-range special

Pitch and Yaw

Accuracy: ±0.2% of displayed value
Resolution: 0.05 arc seconds (standard), 0.005 arc seconds (extended)
Measurement range: ±10°

Straightness

Resolution: 5 nm (0.4 μin) (short-range optics), 50 nm (4 μin) (long-range optics)
Measurement range: ±1.5 mm (0.060 in)
Axial range: 0.1 to 3.0 m (0.3 to 10 ft) using short-range optics, 1 to 30 m (3 to 100 ft) using long-range optics

Ordering Information

	Price
HP 5529A Dynamic Calibrator	from $16,000 to $59,000

For detailed information, request the following literature: HP 5529A data sheet (p/n 5091-4369E), HP 5529A ordering information (p/n 5091-4370EUS), Application Note 325-2 Machine Tool Calibration with the Laser Measurement System (5952-7708).

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Broadband 100 kHz to 3 GHz coverage
- +20 dBm output power
- Low harmonics
- 25 dB gain
- Internally leveled

HP 8347A

HP 8347A RF Amplifier

Specifications
Frequency Range: 100 kHz to 3 GHz
Maximum Leveled Output Power: ≥ +20 dBm
Output Power Leveling Range (≥300 kHz): +2 to +20 dBm
Power Flatness (internally leveled, ±300 kHz): ±1.5 dB
Gain: ≥25 dB
Harmonics (at +20 dBm output)
Internal leveling off (ALC off): ≤ −25 dBc
Internal leveling on (ALC on): ≤ −20 dBc

Supplemental Characteristics
Maximum Input for Minimum Internally Leveled Output: −14 dBm
1 dB Compression Point: +22 dBm
Third-Order Intercept: +30 dBm
RF Input and Output Impedances: 50 Ω
VSWR
Input: 2.0:1
Output
Internally leveled: 1.5:1
Unleveled:
Below 2 GHz: 2.0:1
2 to 3 GHz: 3.0:1
Reverse Isolation: 60 dB
Noise Figure
10 MHz to 3 GHz: 15 dB
Below 10 MHz: 20 dB

General
RF Input and Output Connectors: Type N female
Size: 102 mm H × 213 mm W × 298 mm D (4.0 in × 8.4 in × 11.8 in)
Weight: Net, 4 kg (8 lb); shipping, 5 kg (11 lb)

Ordering Information

	Price
HP 8347A RF Amplifier	$4,950
Opt W30 Extended Repair Service (see page 636)	$100

- Continuous 2 to 20 GHz coverage
- 15 dB gain to 18.6 GHz
- 100 mW across 2 to 18.6 GHz
- <13 dB typical noise figure

HP 8349B

HP 8349B Microwave Amplifier

Frequency Specifications
Range: 2 to 20 GHz

Output and Input Specifications (25° C ±5° C)
Minimum Output Power (at +5 dBm input):

Frequency range (GHz)	Output	
	Leveled	Unleveled
2.0 to 18.6	19 dBm (80 mW)	20 dBm (100 mW)
18.6 to 20.0	17 dBm (50 mW)	18 dBm (63 mW)

1 dB Compression Point: +21 dBm, nominal
Power Flatness (Leveled): ±1.25 dB
Minimum Small Signal Gain (at −5 dBm input):
2.0 to 18.6 GHz: 15dB
18.6 to 20.0 GHz: 13dB
Noise Figure: <13 dB, typical
Impedance (Input and Output): 50 Ω, nominal
VSWR:

Frequency range (GHz)	Input	Output	
		Leveled	Unleveled (typical)
2.0 to 5.0	≤2.8	≤2.5	≤4.8
5.0 to 11.0	≤2.8	≤2.5	≤3.8
11.0 to 18.0	≤2.8	≤2.5	≤3.2
18.0 to 20.0*	≤2.8	≤2.5	≤3.2

*VSWR from 18.0 to 20.0 GHz is typical

Maximum Continuous Input, to the Input or Output Ports:
+27 dBm (RF), ±10V (DC)

Spectral Purity
Harmonics (at +20 dBm output):
2.0 to 11.0 GHz: < −20 dBc
11.0 to 20.0 GHz: < −30 dBc typical
Non-Harmonic Spurious: ≤ −55 dBc
Third-Order Intercept: + 33 dBm, nominal

Pulse Transmission Capability
Rise/Fall Time: <10 ns typical

General
Reverse Isolation: >50 dB, typical
RF Input/Output Connectors: Type N female
Size: 133 mm H × 214 mm W × 366 mm D (5.2 in × 8.36 in × 13.6 in)
Weight: Net, 7 kg (15 lb); shipping, 14 kg (31 lb)

Ordering Information

	Price
HP 8349B 2 to 20 GHz Microwave Amplifier	$9,000 ☎
Opt 001 Rear Panel RF Input/Output	+$100
Opt 002 Rear Panel RF Input w/Front Panel RF Output	+$100
Opt W30 Extended Repair Service (see page 636)	+$165

☎ For off the shelf shipment, call 800-452-4844.

AMPLIFIERS

mm-Wave, Microwave Amplifiers

HP 8346A, 8348A

HP 8348A

- Broadband 2.0 to 26.5 GHz coverage
- >23 dB gain
- > +25 dBm (>300 mW) across 2 to 20 GHz
- <13 dB typical noise figure

HP 8346A

- Broadband 26.5 to 40 GHz coverage
- +17 dBm output power to 38 GHz
- Low harmonics
- 2.4-mm coaxial connectors

HP 8348A and HP 8346A

HP 8348A

Specifications

Frequency Range:	2.0 to 26.5 GHz
Maximum Output Power	
(at 0 dBm input)	
1.0 to 2.0 GHz:	≥ +20 dBm (typical)
2.0 to 20.0 GHz:	≥ +25 dBm
20.0 to 26.5 GHz:	≥ +23 dBm
Power Flatness	
(at 0 dBm input):	±4 dB (typical)
Minimum Small Signal Gain	
(at −15 dBm input)	
1.0 to 2.0 GHz:	≥20 dB (typical)
2.0 to 20.0 GHz:	≥25 dB
20.0 to 26.5 GHz:	≥23 dB

Spectral Purity

Harmonics Typical	
(at maximum specified output power)	
1.0 to 2.0 GHz:	< −20 dBc
2.0 to 26.5 GHz:	> −15 dBc
Third-Order Intercept	
2.0 to 20.0 GHz:	+36 dBm, nominal
20.0 to 26.5 GHz:	+31 dBm, nominal
Maximum Continuous Input	
Microwave power:	+22 dBm
dc voltage:	±10 V
Input and Output Impedance:	50 Ω, nominal
Input SWR:	3:1 (typical)
Output SWR (typical)	
1.0 to 2.0 GHz:	6:1
2.0 to 20.0 GHz:	4.5:1
20.0 to 26.5 GHz:	2:1
Reverse Isolation:	>50 dB (typical)
Noise Figure (typical)	
1.0 to 20 GHz:	<10 dB
20 to 26.5 GHz:	<13 dB

Pulse Transmission Capability

Rise/Fall Time:	<5 ns (typical)
Delay Time:	<5 ns (typical)

General

Input and Output Connectors: 3.5 mm male
Power Requirement: 50 to 400 Hz, 100, 120, 200, or 240 volts ac (±10%); 85 VA maximum
Size: 133 mm H × 214 mm W × 366 mm D (5.2 in × 8.4 in × 14.4 in)
Weight: Net, 7 kg (15 lb); shipping, 14 kg (31 lb)

HP 8346A

Specifications

Frequency Range:	26.5 to 40.0 GHz
Maximum Output Power	
(at +7 dBm input)	
25.0 to 26.5 GHz:	≥ +17 dBm (typical)
26.5 to 38.0 GHz:	≥ +17 dBm
38.0 to 40.0 GHz:	≥ +13 dBm
Power Flatness	
(at +7 dBm input)	
26.5 to 38 GHz:	±3 dB (typical)
38 to 40.0 GHz:	±4 dB (typical)
Minimum Small Signal Gain	
(at −5 dBm input)	
25.0 to 26.5 GHz:	≥10 dB (typical)
26.5 to 38.0 GHz:	≥10 dB
38.0 to 40.0 GHz:	≥8 dB

Spectral Purity

Harmonics Typical	
(at maximum specified output power):	< −30 dBc
Maximum Continuous Input	
Microwave power:	+22 dBm
dc voltage:	±10 V
Input and Output Impedance:	50 Ω, nominal
Input SWR:	4:1 (typical)
Output SWR:	3:1 (typical)
Reverse Isolation	
26.5 to 38.0 GHz:	>35 dB (typical)
38.0 to 40.0 GHz:	>25 dB (typical)
Noise Figure:	<13 dB (typical)

Pulse Transmission Capability

Rise/Fall Time:	<10 ns (typical)
Delay Time:	<10 ns (typical)

General

Input and Output Connectors: 2.4 mm male
Power Requirement: 50 to 400 Hz, 100, 120, 200, or 240 Volts ac (±10%); 85 VA maximum
Size: 133 mm H × 214 mm W × 366 mm D (5.2 in × 8.4 in × 14.4 in)
Weight: Net, 7 kg (15 lb); shipping, 14 kg (31 lb)

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 8447D

HP 8449B

HP 8447 Series Amplifiers

These low-noise, high-gain amplifiers have many general-purpose uses. They improve the sensitivity of spectrum analyzers, counters, RF voltmeters, EMI meters, power meters, and other devices. They will also increase the maximum power available from a signal generator or sweeper.

Standard connectors are BNC (f). Other options are:
Option 010: Single-Channel Amplifier, N (f) Connectors
Option 001: Dual-Channel Amplifier, BNC (f) Connectors
Option 011: Dual-Channel Amplifier, N (f) Connectors

Dual-channel, 50 ohm (nominal) amplifiers are ideal for dual-channel systems such as oscilloscopes or network analyzers. Channels may also be cascaded for increased small-signal gain.

General Specifications (all models)

Weight: Net, 1.56 kg (3.4 lb); shipping, 2.3 kg (5.1 lb)
Size: 130 mm W × 85.8 mm H × 216 mm D (5.1 in × 3.4 in × 8.5 in)
Power: 110 or 230 Vac + 10%, 48 to 440 Hz, 15 W

Ordering Information

	Price
HP 8447A Preamplifier	$1,600
HP 8447D Preamplifier	$1,700 ☎
HP 8447E Power Amplifier	$1,925
HP 8447F Preamplifier-Power Amplifier	$2,790

☎ For off-the-shelf shipment, call 800-452-4844.

HP 8449B Preamplifier

This 1 to 26.5 GHz high-gain, low-noise preamplifier is ideal for many general-purpose applications. It increases the sensitivity of any microwave spectrum analyzer, enabling you to detect and analyze very low-level signals in dramatically reduced measurement time. Its improved sensitivity lets you widen bandwidths and measure low-level signals using much shorter sweep times.

General Specifications

Displayed average noise level, 0 dB attn (char)

HP 8563E (1 Hz RBW):		HP 8566B (10 Hz RBW):	
1.0 to 6.46 GHz	−165 dBm	1.0 to 2.5 GHz	−155 dBm
5.86 to 13.0 GHz	−163 dBm	2.0 to 5.8 GHz	−154 dBm
12.4 to 26.5 GHz	−160 dBm	5.8 to 12.5 GHz	−150 dBm
		12.5 to 18.6 GHz	−144 dBm
		18.6 to 22 GHz	−140 dBm

Weight: Net, 4 kg (8.8 lb) nominal
Size: 102 mm H × 213 mm W × 297 mm D (4.0 in × 8.4 in × 11.7 in)
Power: 100, 120, 220, or 240 V, ±10%; 47 to 63 Hz

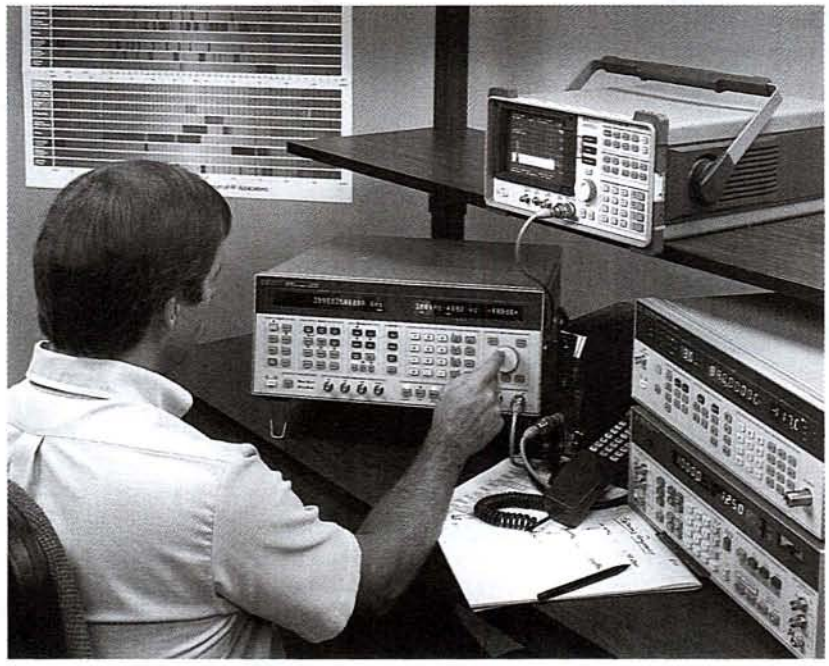
Ordering Information

	Price
HP 8449B 1 to 26.5 GHz Preamplifier	$7,530
Opt 907 Front Handle Kit	$65
Opt 908 Rack Mount Kit (half-rack width)	$50

Specifications Summary

	HP 8447A Preamp	HP 8447D Preamp	HP 8447E Power amp	HP 8447F Preamp-power amp	HP 8449B Preamp
Frequency range	0.1 to 400 MHz	100 kHz to 1.3 GHz	100 kHz to 1.3 GHz	100 kHz to 1.3 GHz	1.0 GHz to 26.5 GHz
Typical 3 dB bandwidth	50 kHz to 700 MHz	75 kHz to 1.7 GHz	75 kHz to 1.4 GHz	50 kHz to 1.4 GHz	
Gain (mean, per channel)	20 dB ±1.0 dB at 10 MHz (20° to 30° C)	>25 dB (20° to 30° C)	22 dB ±1.5 dB (20° to 30° C)	← HP 8447D AND 8447E COMBINED IN A SINGLE PACKAGE →	≥26 dB (20° to 30° C)
Gain flatness across full frequency range	±1.8 dB (0° to 55° C) ±0.7 dB (20° to 30° C) characteristic	±1.5 dB	±1.5 dB		1 to 26.5 GHz ±4.5 dB (0° to 55° C) 2 to 22 GHz ±2.4 dB (20° to 30° C, typ.)
Noise figure	<7 dB	<8.5 dB	<11 dB typical		Band / Specified / Typical: 1.0 to 12.7 GHz ≤8.5 dB 7 dB; 12.7 to 22.0 GHz ≤12.5 dB 9 dB; 22.0 to 26.5 GHz ≤14.5 dB 12 dB
Output power for 1 dB gain compression	> +6 dBm	> +7 dBm typical	> +12.5 dBm 100 MHz to 1 GHz		≤ +7 dBm (characteristic)
Harmonic distortion	−32 dB for 0 dBm output	−30 dB for 0 dBm output (typical)	−30 dB for 0 dBm output		−30 dB for 0 dBm output (characteristic)
Output for < −60 dB harmonic distortion	−25 dBm (characteristic)	−30 dBm	−20 dBm		−30 dBm (characteristic)
VSWR	<1.7	<2.0 input <2.2 output 1 to 1300 MHz	<2.2 input <2.5 output 1 to 1300 MHz		Input: 1.0 to 2.0 GHz 2.0:1; 2.0 to 12.5 GHz 1.5:1; 12.5 to 26.5 GHz 2.0:1; Output: 1.0 to 26.5 GHz 2.0:1
Reverse isolation	>30 dB	>40 dB	>40 dB		>75 dB
Maximum dc voltage input	±10 V	±10 V	±10 V		±20 V
Options available	001	001, 010, 011	010	010	
Option prices	+$725	+$775, $105, $1,190	+$125	+$400	

SIGNAL GENERATORS
Signal Generators to 110 GHz



Hewlett-Packard offers the widest selection of high-performance signal sources from dc to 110 GHz. They cover every application range from low-frequency navigation signals, through cellular mobile radio, to millimeterwave satellite systems. Each offers synthesized frequency accuracy and stability as well as calibrated level and remote programmability. Modulation capabilities range from general purpose AM, FM, ΦM, pulse, and I-Q modulation to more specific formats such as QPSK, 16-QAM, 64-QAM, 0.3 GMSK, and π/4 DQPSK.

Signal Generator Summary

Economy RF

Frequency	Model	Characteristics	Page
0.1 to 990 MHz	HP 8656B	**Economically priced signal generator.** ±1.0 dB absolute level accuracy from +13 to −127 dBm in 0.1 dB steps. Calibrated AM and FM. Frequency resolution of 10 Hz. Timebase aging rate of ±2 ppm/year.	396
0.1 to 1040 MHz	HP 8657A	**Spectral purity and electronic attenuator at an economical price.** < −130 dBc/Hz @ 500 MHz SSB phase noise. < −60 dBc spurious. Electronic attenuator. ±1 dB level accuracy. AM and FM.	396
0.1 to 2060 MHz	HP 8657B	**Spectral purity and pulse to 2 GHz at an economical price.** < −130 dBc/Hz @ 500 MHz SSB phase noise. < −60 dBc spurious. ±1 dB level accuracy. AM, FM, and pulse with >90 dB on/off at 1030 MHz.	396

Digital/I-Q Modulation

Frequency	Model	Characteristics	Page
0.1 to 1040 MHz GSM bands	HP 8657A Opt 022	**0.3 GMSK for GSM radio testing.** Analog performance of the HP 8657A plus 0.3 GMSK from 10 to 130 MHz and 520 to 1040 MHz. <3° rms phase error.	396
0.1 to 2060 MHz GSM and PCN bands	HP 8657B Opt 022	**0.3 GMSK for GSM and PCN radio testing.** Analog performance of the HP 8657B plus 0.3 GMSK from 10 to 130 MHz and 520 to 2060 MHz. <3.5° rms phase error. Baseband I/Q outputs.	396
0.1 to 1030 MHz NADC and JDC bands	HP 8657D	**Analog and digital modulation for North American and Japanese digital cellular.** Analog performance of the HP 8657B to 1030 MHz. π/4 DQPSK from 10 to 129.9 MHz, 810 to 965 MHz, and 1420 to 1540 MHz. <4% error vector magnitude, baseband I/Q outputs.	396
0.1 to 1030 MHz JDCT band	HP 8657J	**π/4 DQPSK for Japanese digital cordless telephone testing.** Analog performance of the HP 8657B to 1030 MHz. π/4 DQPSK from 1800 to 2000 MHz. <3.5% error vector magnitude, baseband I/Q outputs.	398
0.01 to 3 GHz	HP 8780A	**Precision wideband analog and digital modulation source for digital microwave communications and radar.** Synthesized signal generator for wideband and complex modulation formats. Digital formats from BPSK to 64 QAM. Vector (quadrature) bandwidths dc to 350 MHz. +10 to −100 dbm.	402
1 to 250 MHz	HP 8782B	**Precision wideband analog and digital modulation source.** Synthesized signal generator for digital modulations BPSK through 256 QAM. DC to 100 MHz symbol rates. +7 to −100 dBm. Analog I/Q inputs.	403

High-Performance RF

Frequency	Model	Characteristics	Page
0.252 to 1030 MHz 0.252 to 2060 MHz	HP 8643A, HP 8644B	**Performance signal generator for RF design.** < −130 dBc/Hz @ 1 GHz SSB phase noise HP 8643A; < −137 dBc/Hz HP 8644B. < −100 dBc spurious. AM, FM, pulse modulation. Advanced modulation source. Lowest specified leakage. Avionics option available (Opt 009).	404
0.1 to 1057.5 MHz 0.1 to 2115 MHz	HP 8642A HP 8642B	**Broadband spectral purity and FM for phase noise testing.** High spectral purity. 1 Hz frequency resolution. ±1 dB absolute output level accuracy. AM, FM, ΦM, and pulse. Sweep. Two-hour on site repair.	407
0.01 to 1280 MHz	HP 8662A	**Low close-in noise.** 0.1 Hz frequency resolution, 5×10^{-11}/day stability. Calibrated and leveled output from +13 to −140 dBm. Digital sweep. Completely HP-IB programmable. AM/FM modulation. Fast switching.	409
0.1 to 2560 MHz	HP 8663A	**Low close-in noise with complex modulation.** 0.1 Hz frequency resolution, 5×10^{-11}/day stability. Calibrated and leveled output from +16 to −130 dBm. Digital sweep. Completely HP-IB programmable. AM, FM, ΦM, pulse modulation. Fast switching.	409
0.1 to 3.0 GHz 0.1 to 4.2 GHz 0.1 to 6.0 GHz	HP 8664A HP 8665A HP 8665B	**Performance signal generators for 3.0 GHz, 4.2 GHz and 6 GHz testing.** Excellent spectral purity. AM and FM. High Performance pulse modulation. Advanced modulation source.	404

CW Microwave

Frequency	Model	Characteristics	Page
1 to 20 GHz 0.01 to 20 GHz	HP 83711A HP 83712A	**Precision CW signals, pure and simple.** +10 to −90 dBm, < −50 dBc harmonics, $<1.5 \times 10^{-9}$/day stability, optional 1 Hz frequency resolution. Noise figure meter and millimeter compatible. HP-IB and SCPI programming. <35 lbs.	412
2 to 18 GHz 2 to 26 GHz	HP 8671B HP 8673G	**Powerful, flexibility for CW applications.** 1 kHz to 4 kHz frequency resolution, 5×10^{-10}/day stability, +8 to −120 dBm. Digital sweep, millimeter compatible (HP 8673G). Completely HP-IB programmable.	414

Economy Microwave

Frequency	Model	Characteristics	Page
2 to 12.4 GHz 5.4 to 18 GHz	HP 8673H	**High-performance, multiband synthesizers for cost-sensitive applications.** 1 to 3 kHz frequency resolution, 5×10^{-10}/day stability, +8 to −100 dBm output, AM, FM and pulse modulation, digital sweep, millimeter capability. Completely HP-IB programmable.	413

High-Performance Microwave

Frequency	Model	Characteristics	Page
1 to 20 GHz 0.01 to 20 GHz	HP 83731A HP 83732A	**Optimum choice for high-performance microwave receiver and subsystem test.** +10 to −90 dBm, harmonics, < −55 dBc, spurious < −60 dBc. $<1.5 \times 10^{-9}$/day stability, optional 1 Hz frequency resolution. Built-in multimode pulse generator, <10 ns pulse rise/fall time, <25 ns pulse width. Logarithmic AM with >60 dB depth. FM with >300 modulation index 10 MHz peak deviation. HP-IB and SCPI programming. <35 lbs.	415
2 to 26 GHz 0.05 to 18 GHz 0.05 to 26 GHz 2 to 18 GHz	HP 8673B HP 8673C HP 8673D HP 8673E	**A wide range of choices for microwave applications.** 1 kHz to 4 kHz frequency resolution, $<5 \times 10^{-10}$/day stability, +8 to −100 dBm. Pulse, amplitude and frequency modulation. Digital sweep, millimeter compatible. Completely HP-IB programmable.	398
0.01 to 50 GHz	HP 8360 Series	**Programmable, general-purpose sweeper with full network analyzer compatibility.** 1 Hz frequency resolution, 1×10^{-9}/day stability. +20 to −110 dBm output. Pulse, frequency, and amplitude modulation. Continuous analog sweep with spans from 100 Hz to 49.99 GHz. Completely HP-IB programmable. Complete analog, list, and step sweep capability.	416

Swept Frequency Sources

Frequency	Model	Characteristics	Page
0.3 to 3000 MHz	HP 8625	**Synthesized RF sweeper.** Precise frequency and power sweep for accurate component test. Ideal companion source for HP 8753 mixer measurement system.	431
0.01 to 20 GHz	HP 8370	**Synthesized microwave sweeper.** Continuous analog or digital step sweep, 2 MHz swept frequency accuracy, +17 dBm output power available. SCPI and HP-IB programmable, HP 8350 HP-IB mnemonics for drop-in replacement. Optimized for HP 8757 scalar network analyzers.	431
0.01 to 50 GHz	HP 8350	**Versatile programmable sweeper for microwave component test.** Economical plug-ins cover a variety of frequency bands. Full vector and scalar network analyzer compatibility.	427

High-Performance Modular

Frequency	Model	Characteristics	Page
0.252 to 1030 MHz 0.252 to 2060 MHz 0.1 to 4.2 GHz	HP 70320A, 70325A HP 70322A	**High-performance full-rack-width instruments with HP-IB and MSIB control for Modular Measurement System (MMS).** Excellent spectral purity. AM, FM, and pulse modulation. Advanced modulation source. (Identical specifications to 8644B, 8645A, 8665A.)	404
1 to 20 GHz	HP 70340A	**Modular signal generator for MMS.** Full performance signal source in half-rack width (4/8 MMS). Logarithmic AM, FM, and pulse modulation. Optional 1 Hz frequency resolution and internal multimode pulse generator. <10 ns pulse rise/fall times, <25 ns pulse width. HP-IB, SCPI and CIIL programming. Ideal with HP 71500A microwave transition analyzer and HP 71600 Series error performance analyzers and pattern generators.	404
0.01 to 1 GHz	HP 70341A	**Companion low-frequency module to HP 70340A.** 1/8 MMS module adds 0.01 to 1 GHz frequency coverage when used with the HP 70340A. Extend high performance AM, FM, and pulse modulation to RF frequencies.	417

Frequency-Agile/Complex Signal Simulation

Frequency	Model	Characteristics	Page
10 to 3000 MHz	HP 11755A	**Comdisco/Vector arbitrary waveform synthesizer.** Computer-aided engineering for modeling block diagram level design simulations for communications system modules and subsystems. Creates complex software signal formats for testing on the block model, then downloads the complex signal to the HP VAWS simulator for testing hardware with real-life signals with precision impairments.	418
dc to 50 MHz	HP 8770A/S	**High-performance arbitrary waveform source for baseband simulation and advanced modulation.** Simulates highly complex baseband and modulated carriers for radar/EW, video, communications, disk drive, and other applications. 12-bit resolution, excellent spectral purity. 125 MHz clock rate. Free WGL Toolbox Software runs on HP Technical Desktop Computer.	419
0.252 to 1030 MHz 0.252 to 2060 MHz	HP 8645A	**Performance signal generator for testing frequency-agile radios and surveillance receivers.** 15 μs switching speed. Spectral purity. AM, FM, pulse modulation. FM deviation to 20 MHz. Flexible control of frequency.	420
dc to 50 MHz	HP 8791 Model 7	**Baseband FASS.** Architecturally equivalent to the Model 11, the Model 7 provides exceptional baseband performance to 50 MHz. Full arbitrary control of AM, FM, ΦM, and pulse make this high performance direct-digital synthesizer an excellent fit for entry-level FASS users in applications such as communications, digital, video, radar target simulation, and exciter design. Fully upgradable to Model 11 or 21.	422
0.01 to 3 GHz	HP 8791 Model 11	**Reconfigurable agile-signal simulator for radar, EW, and spread-spectrum simulation.** Advanced frequency-agile signal simulation for EW, radar, and communication receiver test. 100 ns frequency-hopping over 3 GHz. Arbitrary control over AM, FM, ΦM, pulse modulation and agile carrier. 40 MHz modulation bandwidth. Easy-to-use application-specific instrument-on-a-disk software. Optional upconversion available to 18 GHz.	422
0.05 to 18 GHz	HP 8791 Model 21	**Microwave-agile simulator.** Same as Model 11 (above), but uses state-of-the-art microwave-agile upconverter with 100 ns (typical) switching time for the entire range from 50 MHz to 18 GHz. Intended for "exotic" modulation requirements in radar/EW and secure communication applications.	422

Millimeter Sources

Frequency	Model	Characteristics	Page
26.5 to 40 GHz 33 to 50 GHz 40 to 60 GHz 50 to 75 GHz 75 to 110 GHz	HP 83554A HP 83555A HP 83556A HP 83557A HP 83558A	**Efficient frequency multipliers.** Effectively extends the performance of an 11 to 20 GHz microwave source HP 8673B/C/D, 8340, 8341, 8350B, or 8360 to the millimeter-wave frequency ranges.	432

SIGNAL GENERATORS

Economy RF

HP 8656B, 8657A/B

HP 8656/57 Series Synthesized Signal Generators

The HP 8656/57 series is a collection of economical synthesized signal sources that support a variety of communications test requirements. Six models are included: 3 for general-purpose analog and 3 specialized for digital modulation. All 6 units offer capabilities ideal for research and development, manufacturing, and support applications.

The series offers high value in meeting your communications test needs. Ease-of-use features, such as store/recall memory and sequencing, help automate and speed tests. High-performance areas, such as good spectral purity and accurate output levels, ensure accurate test results. With the wide range of features and performance levels available, one of the HP 8656/57 series is sure to meet your requirements.

Economy Analog Signal Generators

HP 8656B	• 100 kHz to 990 MHz • AM and FM modulation • Lowest cost of family • In-channel performance
HP 8657A	• 100 kHz to 1040 MHz • AM and FM modulation • Low SSB phase noise • Electronic attenuator for ATE • In- and out-of-channel performance
HP 8657B	• 100 kHz to 2060 MHz • AM, FM and optional pulse modulation • Low SSB phase noise • In- and out-of-channel performance

Digital Modulation

HP 8657A Option 022	• 100 kHz to 1040 MHz • 0.3 GMSK for GSM • Low phase error
HP 8657B Option 022	• 100 kHz to 2060 MHz • 0.3 GMSK for GSM and PCN • Low phase error • Optional pulse
HP 8657D	• 100 kHz to 1030 MHz • $\pi/4$ DQPSK modulation for NADC and JDC • Low error vector magnitude • Pulse modulation
HP 8657J	• 100 kHz to 1030 MHz • $\pi/4$ DQPSK for PHP • Low-error vector magnitude • Pulse modulation

For more details on the 6 signal generators in the HP 8656/57 series, please see the catalog pages of this section. For full performance and specification information, see the documents listed below.

Available Literature	Reference No.
Economical Signal Generator Brochure	5091-1555
Economical Signal Generator Technical Data	5091-1556
Signal Generator Selection Guide	5951-3707

- 100 kHz to 990 MHz
- AM and FM modulation
- ±1 dB absolute level accuracy
- Amplitude offset and phase adjust

HP 8656B

Hewlett-Packard Instrument Drivers

DESIGNED FOR HP-IB SYSTEMS

HP 8656B Synthesized Signal Generator

The 8656B is a programmable synthesized signal generator that offers exceptional value through a powerful combination of performance, quality, and economy.

Communication Band Frequency Coverage

The HP 8656B provides frequency coverage from 0.1 to 990 MHz (with underrange to 10 kHz). This wide range covers the IF and LO frequencies, as well as the RF frequencies of most receivers. Frequency resolution of 10 Hz allows convenient setting of increments including narrow channel spacings, while characterization of phase-sensitive devices is made easier with the help of the phase increment/decrement feature.

Precise Output Control

The 8656B also features ±1.0 dB absolute level accuracy and 0.1 dB resolution for accurate receiver sensitivity tests, circuit characterization, and research and development applications. The output levels are calibrated from +13 dBm (overrange to +17 dBm) to −127 dBm and may be set and displayed in any one of 14 convenient units, including dBm, volts, dBμV or V_{emf}. The output level can also be offset to compensate for cable and/or other losses external to the generator, or turned on or off with a dedicated key. Shielding keeps leakage at <1.0 μV for testing RFI-susceptible devices, and standard resettable reverse power protection for up to 25 W guards against accidental damage from transmitters.

Versatile Modulation

The HP 8656B's modulation capabilities include simultaneous and mixed modulation modes (AM/AM, FM/FM, and AM/FM) from internal (1 kHz and 400 Hz) and external sources. AM is ac-coupled, while FM can be either ac- or dc-coupled. The patented dc-coupling technique used in the HP 8656B provides exceptional long-term stability (<10 Hz/hour drift) and center frequency accuracy (±500 Hz), eliminating the need for retuning in the dc FM mode. For calibrated external modulation, a 1 V peak signal is required, and HI/LO annunciators on the HP 8656B indicate when the external signal is within 5% of the correct amplitude.

Ease of Operation for Improved Productivity

Up to 100 complete front-panel setups can be stored in the HP 8656B's memory for recall during testing. These setups can be accessed sequentially by pushing one front-panel key or by using the rear-panel SEQ port. The SEQ port can be connected to a foot switch or other operator-controlled device.

- 100 kHz to 1040 MHz
- AM and FM modulation
- Electronic attenuator for ATE
- ±1.0 dB level accuracy (typically ±0.5 dB)
- 50 W reverse power protection

HP 8657A

Hewlett-Packard Instrument Drivers

DESIGNED FOR HP-IB SYSTEMS

HP 8657A Synthesized Signal Generator

The 8657A is a 100 kHz to 1040 MHz synthesized signal generator that offers truly outstanding performance at an affordable price. The HP 8657A gives enhanced performance above the HP 8656B signal generator to form a complementary set of low-cost/high-performance RF signal generators from Hewlett-Packard.

Spectral Purity for Demanding Applications

The HP 8657A provides excellent phase noise performance across its full 100 kHz to 1040 MHz range. When characterizing an RF receiver, the SSB phase noise of the HP 8657A (−130 dBc/Hz at 500 MHz) provides the performance for almost all measurements requiring test signals at adjacent or out-of-channel offsets.

RF Output with Electronic Attenuator

The HP 8657A's patented, solid-state attenuator provides accurate output levels to ±1 dB (typically ±0.5 dB). Highly reliable PIN diodes replace mechanical relays to provide an extended switching lifetime. The HP 8657A is backed with a 5-year warranty against attenuator failure, providing you with the highest level of insurance for trouble-free performance.

The HP 8657A provides high RF output power (+13 dBm with over-range to +17 dBm) for driving mixers and overcoming cable losses without the use of external amplifiers. The unique RF leveling loop design also lowers intermodulation distortion to typically better than −50 dBc. Reverse power protection is provided standard for protection up to 50 W and 50 Vdc.

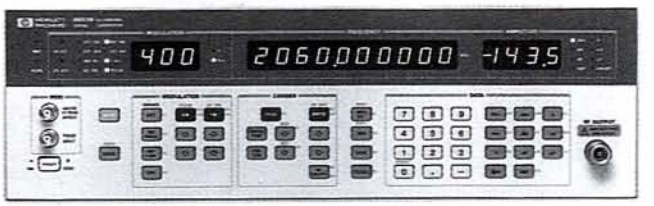
Versatile Modulation

The HP 8657A can combine modulation modes for AM/AM, FM/FM, and AM/FM from both internal and external modulation sources. Like the HP 8656B, the HP 8657A has ac-coupled AM and ac/dc coupling for FM.

The patented dc-coupling technique provides excellent long-term stability (<10 Hz/hour drift) as well as center frequency accuracy (±500 Hz worst-case). When dcFM is enabled, SSB phase noise and residual FM performance are not degraded as with other generators. dcFM allows the HP 8657A to be used as an ideal VCO in a design application, or to be used to faithfully reproduce digital squelch tones when modulating the carrier signal.

Pulse modulation for this frequency range is available, and can be ordered as HP 8657B Option H60.

- 100 kHz to 2060 MHz
- AM, FM, and optional pulse modulation
- ±1 dB absolute level accuracy (typically ±0.5 dB)
- 1 Hz frequency resolution
- 50 W reverse power protection



HP 8657B

Hewlett-Packard Instrument Drivers

DESIGNED FOR HP-IB SYSTEMS

HP 8657B Synthesized Signal Generator

The 8657B is an L-Band synthesized signal generator offering excellent performance at an affordable price. The HP 8657B is ideal for radio-receiver and radar system and subsystem design and testing.

Spectral Purity for Radar and Satellite

The low residual FM and low SSB phase noise make the HP 8657B excellent as a local oscillator, low-noise VCO, or test source with AM, FM, and pulse modulation. In addition to great noise performance, features such as carrier phase adjust allow you to characterize phase-sensitive devices such as phase detectors or phase interferometers, using precise 1-degree phase offsets with respect to another signal source. Display blanking and nonvolatile memory-clear are also available for operation in secure environments.

Advanced Performance

The 8657B offers wide dynamic output range, from +13 to −143.5 dBm, with unparalleled accuracy of ±1 dB. The HP 8657B also has extremely low radiated emissions for making sensitivity measurements on your receiver or for design work on extremely sensitive circuitry. High-stability dcFM keeps center frequency drift below 10 Hz/hour, which allows accurate VCO simulation or low-rate FM modulation.

High-Performance Pulse Modulation

The HP 8657B has a GaAs FET pulse modulator (Option 003) for fast rise time and high isolation pulse. The HP 8657B has 35 to 50 ns rise times (typically 10 to 18 ns) and 70 to 90 dB on/off ratios. For pulse modulation coverage to 1040 MHz only, order the HP 8657B Option H60.

Ease of Operation for Improved Productivity

Up to 100 complete front-panel setups can be stored in the HP 8657B's memory for recall during testing. These setups can be accessed sequentially by pushing one front-panel key or by using the rear-panel SEQ port. The SEQ port can be connected to a foot switch or other operator-controlled device.

SIGNAL GENERATORS

Economy RF (cont'd)

HP 8656B, 8657A/B

Specifications	HP 8656B	HP 8657A	HP 8657B
Frequency			
Range:	100 kHz to 990 MHz	100 kHz to 1040 MHz	100 kHz to 2060 MHz
Resolution:	10 Hz	10 Hz	1 Hz
Timebase aging rate:	±2 ppm/year	±2 ppm/year	±2 ppm/year
Option 001:	1×10^{-9} parts/day after 45 days	1×10^{-9} parts/day after 45 days	1×10^{-9} parts/day after 45 days
Switching Speed (w/in 100 Hz of carrier):	<35 ms (25 ms typ. at 25° C)	<35 ms (30 ms typ. at 25° C)	<35 ms (30 ms typ. at 25° C)
Spectral Purity f_c = 500 MHz			
SSB Phase Noise (20 kHz offset):	< −114 dBc/Hz	< −130 dBc/Hz	< −130 dBc/Hz
Nonharmonics (>5 kHz offset, CW mode):	< −60 dBc	< −60 dBc	< −60 dBc, <1030 MHz, < −54 dBc, ≥1030 MHz
Harmonics:	< −30 dBc, output ≤ +7 dBm	< −30 dBc, output ≤ +10 dBm	< −30 dBc, output ≤ +7 dBm, <1030 MHz; < −25 dBc, output ≤ +7 dBm, >1030 MHz
Subharmonics:	None	None	None, 100 kHz to 1030 MHz < −25 dBc, 1030 to 2060 MHz
Residual FM (0.3 to 3 kHz, CW mode):	<7 Hz rms	<4 Hz rms	<3 Hz rms
Output Level			
Range:	+13 to −127 dBm into 50 Ω	+13 to −143.5 dBm into 50 Ω, +10 dBm, 100 kHz to 1 MHz	+13 to −143.5 dBm into 50 Ω, +10 dBm, <1030 MHz
Resolution:	0.1 dB	0.1 dB	0.1 dB
Absolute Accuracy:	<±1 dB, 123 to 990 MHz, +7 to −124 dBm; <±1.5 dB, 0.1 to 123.5 MHz, and < −124 dBm or < +7 dBm at 0.1 to 990 MHz	<±1 dB, output ≥ −127 dBm <±1.5 dB, > +7 dBm	<±1 dB, output +3.5 to −127 dBm <±1.5 dB, output ≥ +3.5 dBm
Reverse Power Protection:	25 W	50 W	50 W
Amplitude Modulation			
Depth:	0 to 99%, output < +7 dBm, 0.1 to 990 MHz	0 to 99%, output ≤ +7 dBm, f_c ≥400 kHz	0 to 100%, output ≤ +7 dBm
Resolution:	1%	1%	1%
Bandwidth (1 dB):	20 Hz to 40 kHz	20 Hz to 40 kHz	20 Hz to 40 kHz
Accuracy: (internal rates)	<±(2% + 4% of setting), <90% AM	<±(2% + 6% of setting), <90% AM, levels < +7 dBm	<±(2% + 6% of setting), <90% depth, internal rates
Distortion: (0 to 30% AM, internal rates, level < +7 dBm)	<1.5%	<1.5%	<1.5%, <1030 MHz <4%, >1030 MHz
Frequency Modulation			
Maximum Peak Deviation[1]:	99 kHz, f_c <123.5 and >247 MHz 50 kHz, f_c 123.5 to 247 MHz	99 kHz, f_c <130 and >260 MHz 50 kHz, f_c 130 to 260 MHz	50 kHz, f_c 130 to 260 MHz 400 kHz, f_c 1040 to 2060 MHz
Resolution:	100 Hz, deviations <10 kHz, 1 kHz, deviations ≥10 kHz	100 Hz, deviations <10 kHz, 1 kHz, deviations ≥10 kHz	100 Hz, <1040 MHz, dev <100 kHz 200 Hz, >1040 MHz, dev <100 kHz
Bandwidth (1 dB):	dc to 50 kHz	dc to 50 kHz	dc to 50 kHz
Indicator Accuracy:	<±5% of setting	<±5% of setting	<±5% of setting
Distortion: (internal rates, ≥3 kHz peak deviation)	<0.5% THD + noise	<0.5% THD + noise	<0.5% THD + noise, ≥6 kHz peak deviation for f_c ≥1040 MHz

Specifications	HP 8656B	HP 8657A	HP 8657B
Pulse Modulation	Not applicable	Not applicable	Opt 003
On/Off Ratio:			>70 dB, $f_c \geq 130$ MHz, >95 dB, $f_c \geq 1030$ MHz
Rise/Fall Time, 10% to 90%:			<35 ns, $f_c \geq 130$ MHz, <50 ns, $f_c \geq 1030$ MHz
Repetition Rate:			dc to 30 MHz, typical
Duty cycle:			0% to 100%
Remote Programming			
Interface:	HP-IB (HP's implementation of IEEE-488)		
IEEE-488 Functions:	SH0, AH1, T0, L2, SR0, RL1, PP0, DC1, DT0, C0, E1		
General			
Save/Recall/Sequence Registers:	100 nonvolatile registers to save front-panel settings		
Operating Temperature:	0° to 55° C		
Power Requirements:	100 V, 120 V, 220 V or 240 V (+5, −10%); 48 to 440 Hz HP 8656B: 125 VA maximum HP 8657A: 175 VA maximum HP 8657B: 200 VA maximum		
Dimensions:	HP 8656B, 8657A: 133 mm H × 425 mm W × 520 mm D (5.25 in × 16.75 in × 20.5 in) HP 8657B: 133 mm H × 425 mm W × 574 mm D (5.25 in × 16.57 in × 22.6 in)		
Weight:	HP 8656B: 18.1 kg (40 lb) HP 8657A: 18.2 kg (40 lb) HP 8657B: 20.5 kg (45 lb)		

[1]Deviations reduced for low-rate modulation; not specified for $f_c - (f_m) < 100$ kHz.

Ordering Information

Base Price	HP 8656B	$6,720	HP 8657A	$9,425	HP 8657B	$13,660
Options						
001 High-Stability Timebase		+$1,040		+$1,040		+$1,040
002 RF Connectors on Rear Panel Only		+$270		+$270		+$270
003 Pulse Modulation		N/A		N/A		+$890
H60 Pulse Modulation, Frequencies to 1040 MHz		N/A		N/A		−$2,000
907 Front Handle Kit (5061-9689)		$57 ☎		$57 ☎		$57 ☎
908 Rack Flange Kit (5061-9677)		$33 ☎		$34 ☎		$34 ☎
909 Combined Front/Rack Flange Kit (5061-9683)		$82 ☎		$82 ☎		$82 ☎
910 Extra Operation/Calibration and Two Service Manuals		$360 ☎		$360 ☎		$360 ☎
915 Add Service Manual	(08656-90205)	$154 ☎	(08657-90004)	$154 ☎	(08657-90007)	$154 ☎
+W30 3-year Repair Service		$155		$190		$310
+W32 3-year Calibration Service		$405		$450		$500

☎ For off-the-shelf shipment, call 800-452-4844.

SIGNAL GENERATORS

Digital/I-Q Modulation

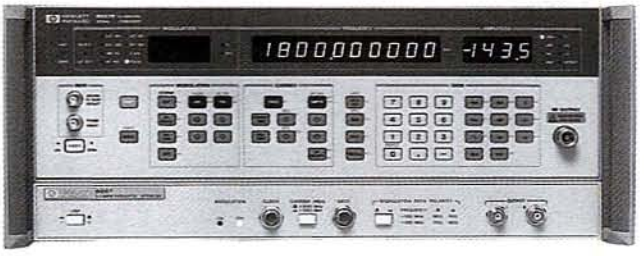
HP 8657A/B Option 022

- 100 kHz to 1040 MHz
- Standard AM and FM modulation
- 0.3 GMSK for GSM cellular system
- <3° rms phase error

- 100 kHz to 2060 MHz
- Standard AM and FM modulation
- 0.3 GMSK for GSM and PCN cellular systems
- <3.5° rms phase error
- Optional pulse modulation

DESIGNED FOR HP-IB SYSTEMS

HP 8657A Option 022



HP 8657B Option 022

HP 8657A Option 022 0.3 GMSK Modulation

The HP 8657A Option 022 generates 0.3 Gaussian Minimum Shift Keying (GMSK) modulation, required to simulate transmitters or to test receivers designed for the Global System for Mobile Communications (GSM) Pan-European digital cellular radio system. Option 022 contains the necessary premodulation filtering and signal-processing circuitry to generate precise 0.3 GMSK modulation over the entire 520 to 1040 MHz and 10 to 130 MHz frequency bands.

High-Performance Digital Modulation

The precision of the digital premodulation filter and I/Q modulator yield a phase error specification of 3 degrees rms and 8 degrees peak for frequencies below 960 MHz. This precision reduces errors during testing of receivers by providing accurate, dependable test signals. A modulation polarity key is provided to invert the sense of the modulation relative to the data. This can be used when modulating with inverted data, when substituting into a receiver's IF (when an inversion may already have taken place), or when using Option 022 in its heterodyne band (10 to 130 MHz). Option 022 provides a high-performance yet cost-effective solution for the design and manufacture of GSM radios.

HP 8657B Option 022 0.3 GMSK Modulation

Option 022 for the HP 8657B signal generator adds the same 0.3 GMSK modulation function as the corresponding option on the HP 8657A, only for the 8657B the frequency range is extended to 2060 MHz. This provides a cost-effective solution for generating the signals needed to test receivers of the GSM system, at the same time covering the frequency range of the new Personal Communications Network (PCN).

Operation of 0.3 GMSK Modulation

To activate 0.3 GMSK modulation on the 8657A/B Option 022, simply connect framed and channel-coded data to the data input connector and a clock to the clock input. When the 0.3 GMSK modulator senses that a valid clock (270.833 kHz) is present, it locks to the clock signal and enables the data input port. Once input, the data is digitally filtered and modulated onto the RF output of the signal generator. A front-panel switch is used to select 0.3 GMSK modulation when operating above or below 1030 MHz.

Specifications

Analog Modulation Mode:
When the 0.3 GMSK modulator is turned off or a clock signal is absent, these instruments perform as standard HP 8657A and 8657B models. Please refer to the HP 8657A or 8657B specifications for analog mode performance.

Frequency

Range:	
HP 8657A Opt 022	520 to 1040 MHz
HP 8657B Opt 022	520 to 2060 MHz
Both, data inverted	10 to 130 MHz

Spectral Purity

Harmonics:	< −30 dBc < −25 dBc, f_c > 1030 MHz (HP 8657B only)
Non-harmonic spurious:	< −50 dBc, > 150 kHz offsets
Noise floor:	< −100 dBc

Modulation

Modulation format:	0.3 Gaussian Minimum Shift Keying
Pre-modulation filter:	Gaussian LPF
Bandwidth × data rate (BT):	0.3
Data rate:	270.833 kHz (±1 kHz)
Modulation phase error:	
890 to 960 MHz and 10 to 130 MHz:	3° rms, typically 1° 8° peak, typically 5°
1030 to 2060 MHz (HP 8657B only):	3.5° rms, typically 1.5° 9° peak, typically 1.5°
Frequency error:	10 Hz, f_c <1030 MHz 20 Hz, f_c > 1030 MHz (HP 8657B only)
Inputs:	Serial data and clock
Outputs (HP 8657B only):	Baseband 0.3 GMSK I and Q signals

General (0.3 GMSK Modulator only)

Size:	44 mm H × 425 mm W × 422 mm D (1.75 in × 16.75 in × 17 in)
Weight:	Net, 4 kg (9 lb); shipping, 9 kg (20 lb)

- 100 kHz to 1030 MHz
- Standard AM and FM modulation
- π/4 DQPSK modulation for NADC, JDC, and PHP
- Pulse modulation
- <3.2% error vector magnitude

HP 8657D

DESIGNED FOR HP-IB SYSTEMS

HP 8657D/J π/4 DQPSK Signal Generators

The HP 8657D and 8657J signal generators add π/4 DQPSK digital modulation capability to conventional AM, FM, and pulse modulation formats. The HP 8657D/J build on the excellent performance of the HP 8657 Signal Generator by adding digital modulation capability. The HP 8657D provides the performance to test mobiles for North American Digital Cellular (NADC) and Japanese Digital Cellular (JDC) radio systems; and the HP 8657J tests radios for Japanese digital cordless telephone system, also called Personal Handiphone (PHP).

Traditional Source

The HP 8657D/J are ideal for in-channel testing of analog receivers. They offer excellent level accuracy (±1 dB), low radiated emissions, low residual noise, and minimal distortion. The HP 8657D/J make system integration easy by being front panel and HP-IB compatible with the HP 8656B/8657A/8657B family of economy signal generators.

HP 8657D π/4 DQPSK for NADC and JDC

Radios produced for the NADC standard must be capable of operating in the analog AMPS cellular mode as well as in the new digital cellular mode. The HP 8657D fulfills the signal generator requirements for both, making it a single-box solution. When operating in the π/4 DQPSK mode, the frequency range is limited to the following three bands: 10 to 129.9 MHz, 810 to 965 MHz, and 1420 to 1540 MHz. The attached π/4 DQPSK modulator accepts serial data and a symbol clock from 20 to 25 kHz. Modulator filtering is selectable between 0.35 or 0.5 root raised cosine filtering. AM and FM modulation are not available in the π/4 DQPSK modulation mode.

HP 8657J π/4 DQPSK for PHP

The HP 8657J provides π/4 DQPSK modulation in the frequency range from 1800 to 2000 MHz to test PHP mobiles and base stations. The attached π/4 DQPSK modulator accepts serial data and symbol clock at 192 kHz ±10 kHz. Modulator filtering is 0.5 root raised cosine. AM and FM modulation are not available in the π/4 DQPSK modulation mode.

Pulse Modulation

A high-performance pulse modulator is included in the HP 8657D/J which can be used in both analog and digital modulation modes. The rise/fall time is <35 ns and on/off ratio is better than 70 dB below 1030 MHz. Pulse modulation combined with π/4 DQPSK modulation capability allows the HP 8657D/J to fully simulate the TDMA properties of these systems.

Specifications

Analog Modulation Mode: In the analog modulation mode, specifications are the same as the HP 8657B up to 1030 MHz. Please refer to the HP 8657B specifications for complete analog mode performance.

π/4 DQPSK Modulation Mode:

Frequency range: 10 MHz to 129.9 MHz (HP 8657D); 810 MHz to 965 MHz (HP 8657D); 1420 to 1540 MHz, data inverted (HP 8657D); 1800 to 2000 MHz (HP 8657J)

Switching speed: <50 ms within 100 Hz of final frequency

Modulation: π/4 DQPSK

Modulation data clock frequency range:

Symbol clock: 20 kHz to 25 kHz (HP 8657D); 192 kHz ±10 kHz (HP 8657J)

Bit clock: 40 kHz to 50 kHz (HP 8657D); 384 kHz ±20 kHz (HP 8657J)

Pre-modulation filter: square-root raised cosine

Filter shape factor: $\alpha = 0.35$ or $\alpha = 0.50$ (HP 8657D)
$\alpha = 0.50$ (HP 8657J)

Error vector magnitude (15°C to 35°C): <4.0%, 10 to 129.9 MHz and 1420 to 1540 MHz, < +3 dBm (HP 8657D); <3.0%, 810 to 965 MHz, < +7 dBm (HP 8657D); <3.2%, 1800 to 2000 MHz, < +3 dBm (HP 8657J)

I/Q origin offset (15° to 35° C): −35 dB, RF output only

Pulse Modulation

On/off ratio: >70 dB, $f_c \leq 1030$ MHz; >50 dB, 1420 MHz $\leq f_c \leq$ 1540 MHz, π/4 DQPSK mode (HP 8657D); >50 dB, 1800 MHz $\leq f_c \leq$ 2000 MHz, π/4 DQPSK mode (HP 8657J)

Rise/fall time (10% to 90%): 35 ns (typically 10 ns)

Ordering Information

	Price	
HP 8657A Synthesized Signal Generator	$9,425	
Opt 022 0.3 GMSK Modulation	+$6,055	
Opt W30 Three-Year Repair Service	+$190	
Opt W32 Three-Year Calibration Service	+$450	
HP 8657B Synthesized Signal Generator	$13,660	
Opt 022 0.3 GMSK Modulation	+$7,345	
Opt W30 Three-Year Repair Service	+$310	
Opt W32 Three-Year Calibration Service	+$500	
HP 8657A and HP 8657B		
Opt 001 High-Stability Reference	+$1,040	
Opt 003 Pulse Modulation (not available on 8657A, order HP 8657B H60)	+$890 −$2,000	
Opt 907 Front Handle Kit (5061-9689)	+$57	
Opt 908 Rack Flange Kit (5061-9677)	+$34	
Opt 909 Rack Flange Kit with Handles (5062-3983)	+$82	
Opt 910 Total of Two Sets of Operating /Calibration (08657-90115) and Two Service Manuals	+$360	
Opt 915 Add Service Manual (does not come standard) (HP 8657A: 08657-90004; HP 8657B: 08657-90007)	+$154	
HP 8657D πDQPSK Signal Generator	$23,625	
Opt 001 High-Stability Reference	+$1,040	
Opt 003 Pulse Modulation	Standard	
Opt 907 Front Handle Kit	Standard	
Opt 910 Total of Two Sets of Operating/Calibration (08657-90107) and Two Service Manuals (08657-90131)	+$600	
Opt 913 Rack Mount Flange Kit (5062-4073)	+$36	
Opt 915 Add Service Manual (does not come standard) (08657-90131)	+$275	
Opt W30 Three-Year Repair Service	+$565	
Opt W32 Three-Year Calibration Service	+$810	
HP 8657J π/4 DQPSK Signal Generator	$25,000	
Opt 001 High Stability Reference	$1,040	
Opt 003 Pulse Modulation	Standard	
Opt 907 Front Handle Kit	Standard	
Opt 913 Rack Mount Flange Kit (5062-4073)	$36	
Opt OBX Add Service Manual (does not come standard) (08657-90007, 08657-91011)	$275	
Opt W30 Three-Year Repair Service	$565	
Opt W32 Three-Year Calibration Service	$810	

For off-the-shelf shipment, call 800-452-4844.

SIGNAL GENERATORS

Digital/I.Q. Modulation

HP 8780A, 11846B

- High-performance, versatile modulation source
- Analog phase modulation for telemetry signals
- BPSK, QPSK, 8PSK, 16QAM, 64QAM, digital modulation, and pulse
- Direct-sequence spread spectrum modulation with chip widths to 7 ns
- Wideband FM: over 200 MHz p-p deviations
- 700 MHz modulation bandwidth using I/Q or vector
- 10 MHz or 3 GHz IF testing
- Pulse modulation with 1-ns rise times
- Coherent carrier output

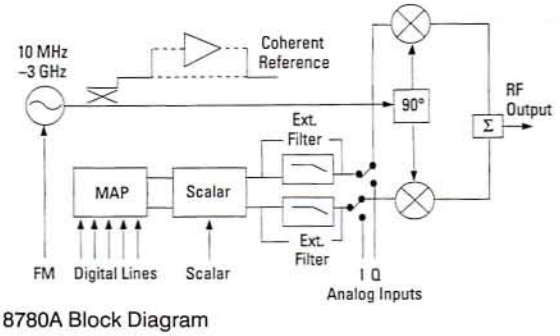
HP 8780A

DESIGNED FOR HP-IB SYSTEMS

HP 11846B Opt 001/002

HP 8780A Vector Signal Generator

The HP 8780A Vector Signal Generator is a synthesized IF source with exceptional modulation for modern receiver and component testing. It is capable of modulation bandwidths almost 100 times wider than previous synthesizer and has a built-in digital baseband (Map) to simplify generation of common digital modulations. Its extra-wide modulation bandwidth comes from a vector modulator that effectively doubles baseband modulation bandwidths for 700 MHz of output modulation. The vector signal generator's wideband modulation is complemented with an unmodulated coherent carrier output for demodulation of test signals.



HP 8780A Block Diagram

The HP 8780A Vector Signal Generator offers a wide variety of modulation using both digital and analog inputs. It generates many standard digital modulations like QPSK and 16QAM and traditional modulations like FM, AM, and pulse. By combining the different modulation types, signals as diverse as Barker-coded radar pulses and Doppler-shifted satellite signals can be simulated.

Applications

The HP 8780A Vector Signal Generator is well suited for receiver measurements where wideband or complex modulations are required. It can be used as a calibrated transmitter to test modern radar EW receivers or communication receivers using vector I/Q modulation techniques. It provides a stable, coherent carrier for phase measurement. It can also be upconverted if receivers operate at frequencies higher than 3 GHz.

Analog Phase Modulation for Telemetry

HP 8780A option H02 offers analog phase modulation capability, which can be used to generate satellite telemetry signals. A ground station needs linear phase modulation to communicate with the satellite and establish command and control. The HP 8780A with Option H02 can generate the signals used during both on-ground and in-orbit testing.

HP 8780A Partial Specifications

Frequency

Range: 10 MHz to 3 GHz
Resolution: 1 Hz

Output

Level Range: +10 to −100 dBm <2.5 GHz
+4 to −100 dBm >2.5 GHz
(+12 dBm ≤3 GHz with Opt 064)

Coherent Carrier Output

Unmodulated (except for FM) and unleveled version of front panel RF output available at rear panel

ac Coupled Frequency Modulation

Rates (3 dB frequencies)**:** 20 Hz to 12 MHz
Deviation Ranges: 50 kHz to 50 MHz peak-to-peak (up to >200 MHz p-p possible with slightly higher distortion by overdriving FM input)

dc Coupled Frequency Modulation

Maximum Rate (3 dB frequency)**:** 10 kHz
Deviation Ranges: 150 Hz to 150 kHz peak-to-peak

Digital Modulation

Modulation Types: BPSK, QPSK, 8PSK, 16QAM (64QAM with Opt 064), Arbitrary 2-State, Burst (except 64QAM)
Parallel Data Rates: 0 to 150 MHz clocked (except 64QAM),
0 to 100 MHz clocked 64QAM with Opt 064
0 to 50 MHz asynchronous
Serial Data Rates (only with Opt 064): 0 to 150 MHz clock and data line for 0 to 25 MHz 64QAM symbol rate

General

Operating Temperature Range: 0° C to +55° C
Power: 100, 120, 220, 240 V, +5%, −10%, 48 to 440 Hz; 500 VA max
Weight: Net, 31.5 kg (70 lb); shipping, 35.5 kg (78 lb)
Size: 425 mm W × 177 mm H × 637 mm D (16.7 in × 7.0 in × 25.1 in)

Ordering Information	Price
HP 8780A Vector Signal Generator	$68,000
Opt 001 Rear Panel Output and Modulation Inputs	+$450
Opt 002 +10 dBm Coherent Carrier Output	$3,000
Opt 064 64 QAM Modulation	$2,000
Opt H02 Analog Phase Modulation	$2,500
HP 11846B π/4 DQPSK I-Q Generator	$5,200
Opt 001 NADC/JDC Format	$0
Opt 002 J PCT Format	$0

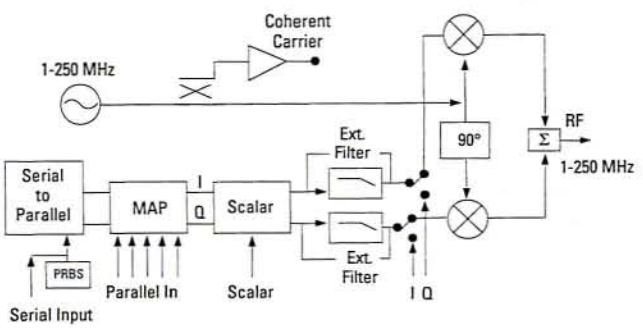
- 1 MHz to 250 MHz covers 70 and 140 MHz IFs
- Calibrated 100 MHz BW I/Q vector modulation inputs
- BPSK, QPSK, 8PSK, 16QAM, 256QAM digital modulation and burst
- Internal pseudo-random binary sequence generator
- AM/SCALAR modulation to simulate flat fading
- Coherent carrier output
- Optional 1 GHz LO for up conversion to 750 MHz to 1.25 GHz

DESIGNED FOR HP-IB SYSTEMS

HP 8782B

HP 8782B Vector Signal Generator

The HP 8782B vector signal generator is a second-generation synthesized generator providing IF signal generation for research and development and manufacturing. It supports a wide range of built-in digital modulation from BPSK to 256QAM for RF and microwave terrestrial and satellite communications applications. Its 1 MHz to 250 MHz frequency range, covers most of the IF frequencies in commercial receivers. An internal pseudo-random bit sequence (PRBS) generator makes all digital modulation possible without using external digital data sources. The HP 8782B also provides an unmodulated coherent carrier output for testing receivers and subsystems before carrier recovery circuits are working. Its cost is substantially lower than that of the HP 8780A vector signal generator.



HP 8782B Simplified Block Diagram

The HP 8782B offers a wide variety of digital modulation using either the internal PRBS generator or a user data source. It generates calibrated test signals as well as specified modulation impairments such as quadrature errors, I/Q imbalance, carrier leakage, and flat fading.

Applications

Using the HP 8782B to align digital radios in manufacturing can improve radio quality. Instead of relying on a golden standard modulator from Research and Development, the HP 8782B can provide calibrated constellations with extremely low quadrature error and amplitude imbalance. Customers can also simulate transmitter impairments by using the HP 8782B to test receiver performance margins.

HP 8782B Specifications

Frequency

Range: 1 to 250 MHz
Resolution: 1 Hz
RF Output Level: +7 to −100 dBm for all formats

Coherent Carrier Output

Typically +10 dBm up to 140 MHz
Typically +8.5 dBm at >150 MHz

Digital Modulation

Modulation Types: BPSK, QPSK, 8PSK, 16QAM, 64QAM, 256QAM, 9PRS, 25PRS, 49PRS, 81PRS
Parallel Data Rates: 0 to 100 MHz clocked, 0 to 50 MHz asynchronous
Serial Data Rates: 0 to 200 MHz clock and data lines for drive signal rise times <1.0 μs

Analog I/Q Inputs:

Frequency Response: dc to 40 MHz (−0.5 dB)
Vector dc Accuracy: <1.5% of full scale
Vector dc Residual: <1.0% of full scale
Sensitivity: ±0.5 V

Burst Modulation

Burst Rates: 0 to 50 MHz
Burst dc On/Off Ratio: >50 dB at 70 MHz carrier typical >50 dB from 1 to 250 MHz
Burst Rise/Fall Time: <2.2 ns
PRBS: Internal pseudo-random binary sequence generator with $2^{23}-1$ sequence length

AM/SCALAR Modulation

Sensitivity: 0 to +1 V for 0 to full-scale output power
Frequency Response: dc to 50 kHz at 70 MHz carrier frequency

General

Operating Temperature Range: 0° C to +55° C
Power: 100, 120, 220, or 240 Vac, 48 to 66 Hz; 100 or 120 Vac 360 to 440 Hz; 360 VA typical

Ordering Information

	Price
HP 8782B Vector Signal Generator	$32,000

For the most current prices and product information, contact your local Hewlett-Packard sales office, see page 665.

SIGNAL GENERATORS

High-Performance RF

HP 8643A, 8644B, 8664A, 8665A, 8665B

- Frequency ranges of 1 GHz, 2 GHz, 3 GHz, 4.2 GHz, or 6 GHz
- Lowest overall noise and spurious
- AM, FM, and pulse modulation
- Lowest specified leakage (optional)
- Internal modulation source for complex waveforms
- Onsite repair and calibration

Hewlett-Packard Instrument Drivers

DESIGNED FOR HP-IB SYSTEMS

These signal generators offer the RF designer/manufacturer a selection of frequency range and high performance. The HP 8643A, HP 8644B and HP 8664A are for traditional out-of channel receiver test applications. The HP 8665A/B are for high performance applications up to 6 GHz, particularly radar, telemetry and spurious testing of UHF receivers. All signal generators within this performance family have options that allow them to be configured to meet specific application needs.

HP 8643A 1 GHz/2 GHz Signal Generator

HP has optimized the HP 8643A's configuration with the performance necessary for out-of-channel receiver tests while maintaining a low price. Options have been limited on the HP 8643A, but many performance/feature capabilities have been included as standard. The HP 8643A combines the most common options that have been purchased with the cost savings of consolidation.

Standard Electronic Attenuator and Advanced Modulation Source

Reliability is enhanced by the use of an electronic attenuator on the 1 GHz version. Instead of using mechanical relays for setting levels, the HP 8643A uses solid-state components accurate to within ±1.0 dB. The HP 8643A comes standard with an advanced internal modulation synthesizer that provides coverage to 400 kHz and 2-tone capability with the selection of sine, square, sawtooth, and white Gaussian noise waveforms.

HP 8644B 1 GHz/2 GHz High-Performance Signal Generator

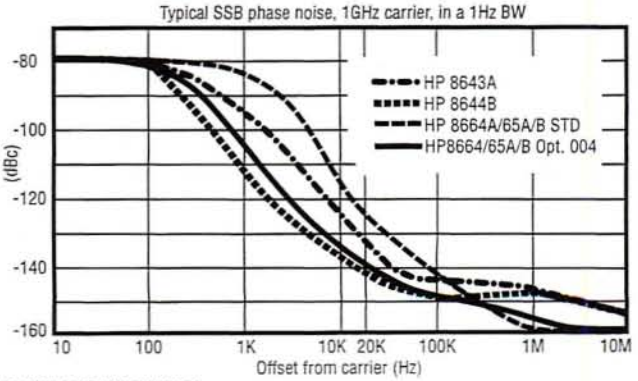
The HP 8644B represents the highest overall performance in HP's line of 1 GHz and 2 GHz signal generators. The HP 8644B builds on the HP 8643A's performance by lowering SSB phase noise (−136 dBc/Hz vs. −130 dBc/Hz) and lowering spurious (−105 dBc vs. −100 dBc). The HP 8644B should be used either for a specific test that requires the lowest SSB phase noise or an application with diversified requirements in which it is hard to identify what signal-generator performance is required.

HP 8664A 3 GHz, HP 8665A 4.2 GHz, and HP 8665B 6 GHz High-Performance Signal Generators

These three signal generators are virtually identical in performance, except for frequency coverage and price. Your application will dictate which instrument is required. The HP 8664A and HP 8665A/B are suited for out-of-channel receiver measurements through the use of Option 004 (low-noise enhancement) and for such applications as radar testing through the use of Option 008 (pulse modulation).

Wideband FM and Optional Pulse Modulation

FM rates of up to 2 MHz and deviations to 20 MHz peak allow use in many applications such as the new higher-rate digital communications. An optional pulse modulator with on/off ratio of >80 dB and rise/fall times of <5 ns is available. Pulse width and delay can be internally adjusted between 50 ns and 999 ms, eliminating the need for an external pulse generator.



TYPICAL SSB PHASE NOISE AT 1 GHz CARRIER

Specifications	HP 8643A	HP 8644B	HP 8664A[1] HP 8665A/B[1]
Frequency			
Range:	0.252 to 1030 MHz 0.252 to 2060 MHz (Opt 002)	0.252 to 1030 MHz 0.252 to 2060 MHz (Opt 002)	0.1 to 3000 MHz (HP 8664A) 0.1 to 4200 MHz (HP 8665A) 0.1 to 6000 MHz (HP 8665B)
Resolution:	0.01 Hz	0.01 Hz	0.01 Hz
Stability:	5×10^{-10}/day (Opt 001)	5×10^{-10}/day (Opt 001)	5×10^{-10}/day (Opt. 001)
Switching Speed (typ.):	<90 ms <200 ms with FM on	<350 ms	<100 ms
Spectral Purity			
SSB Phase Noise @ 1 GHz (20 kHz offset):	−130 dBc/Hz	−136 dBc/Hz	−117 dBc/Hz −134 dBc/Hz (Opt 004)
Nonharmonics:	< −100 dBc, >10 kHz offset, 0.252 to 1030 MHz < −84 dBc, >10 kHz offset, 1030 to 2060 MHz	< −105 dBc, >10 kHz offset, 0.252 to 1030 MHz < −100 dBc, >10 kHz offset, 1030 to 2060 MHz	< −100 dBc, >10 kHz offset, 187.5 to 2060 MHz < −90 dBc, >10 kHz offset, 2060 to 6000[1] MHz, 0.1 to 187.5 MHz
Harmonics:	< −25 dBc, output ≤ +8 dBm	< −30 dBc, output ≤ +10 dBm	< −30 dBc, output ≤ +10 dBm
Subharmonics:	None, 0.252 to 515 MHz < −60 dBc, 515 to 1030 MHz < −40 dBc, 1030 to 2060 MHz	None, 0.252 to 515 MHz < −60 dBc, 515 to 1030 MHz < −40 dBc, 1030 to 2060 MHz	< −75 dBc, 0.1 to 1500 MHz < −40 dBc, 1500 to 3000 MHz < −50 dBc, 3000 to 6000[1] MHz
Residual FM @ 1 GHz: 0.3 to 3 kHz Post Det. BW	<2 Hz rms	<1 Hz rms	<15 Hz rms <2.5 Hz rms (Opt 004)
Output Level			
Range:	+13 to −137 dBm	+16 to −137 dBm, +13 dBm (Opt 002)	+13 to −139.9 dBm +9 dBm (Opt 008)
Resolution:	0.1 dB	0.1 dB	0.1 dB
Absolute Accuracy:	±1 dB, output ≥ −127 dBm	±dB, output ≥ −127 dBm	±1 dB, output ≤ −119.9 dBm, 1 to 3000 MHz ±1.5 dB, output ≤ −119.9 dBm, >3000[1] MHz, <1 MHz
Reverse Power Protection:	50 W	50 W	25 W[2], 0.1 to 2060 MHz 1 W, >2060[1] MHz
Amplitude Modulation			
Depth:	0 to 100%, output ≤ +7 dBm	0 to 100%, output ≤ +7 dBm	0 to 100%, output ≤ +7 dBm
Resolution:	0.1%	0.1%	0.1%
Bandwidth (3 dB) ≤ +7 dBm:	dc to >100 kHz, ≤128 MHz	dc to >100 kHz, >128 MHz	>10 kHz for >10 MHz
Accuracy: 1 kHz rate	±(7% of setting + 1%) up to 80% depth	±(7% of setting + 1%) up to 80% depth	±(6% of setting + 1%) up to 90% depth
Distortion: 30% depth, 1 kHz rate	<3%; <4% (Opt 002)	<3%; <4% (Opt 002)	<4%
Frequency Modulation			
Maximum Peak Deviation:	20 MHz/2 MHz[3], 1030 to 2060 MHz 10 MHz/1 MHz[3], 515 to 1030 MHz Deviation halves per lower octave	20 MHz/200 kHz[3], >1030 MHz 10 MHz/100 kHz[3], >515 MHz Deviation halves per lower octave	20 MHz, 3000 to 6000[1] MHz 10 MHz, 1500 to 3000 MHz Deviation halves per lower octave
Resolution:	2.5% of setting	2.5% of setting	2.5% of setting
Bandwidth (3 dB):	dc to 100 kHz	dc to 100 kHz	dc to 800 kHz
Carrier Accuracy in FM:	±0.5% of setting	±0.5% of setting	±0.4% of setting
Indicator Accuracy:	<5%, <30 kHz rate <10%, <100 kHz rates	<5%, <30 kHz rates <10%, <100 kHz rates	±9%, <20 kHz rates
Distortion:	<5%	<5%	<1%

[1]3000 MHz for HP 8664A, 4200 MHz for HP 8665A, 6000 MHz for HP 8656B
[2]N/A to HP 8665B
[3]Low-noise mode

SIGNAL GENERATORS

High-Performance RF (cont'd)

HP 8643A, 8644B, 8664A, 8665A, 8665B

Specifications	HP 8643A	HP 8644B	HP 8664A[1] HP 8665A/B[1]
Pulse Modulation			Opt 008
On/Off Ratio:	>35 dB >80 dB, >1030 MHz	>35 dB >80 dB, >1030 MHz	>80 dB
Rise/Fall Time, 10 to 90%:	<100 ns	<100 ns	<5 ns
Repetition Rate:	dc to 1 MHz	dc to 1 MHz	dc to 10 MHz
Internal Width/Delay:	N/A	N/A	Yes
Internal Modulation Source			
Waveforms and Rates:		Sine, white Gaussian noise: 0.1 Hz to 400 kHz Triangle, sawtooth, square: 0.1 Hz to 50 kHz	
Frequency Accuracy:		Same as timebase	
Output Level (into 600 Ω):		1 V pk	
Output Resolution:		2 mV pk	
Frequency Sweep			
Digital Sweep:	Digitally stepped sweep over entire frequency range. Linear/log selection. 0.5 to 1000 s sweeps		
Markers/Z-Axis Output:	3 markers available/Z-axis output nominally +5 V/X-axis output nominally 0 to 10 V		
Phase Continuous Sweep:	40 MHz of span available depending on carrier frequency. 20 ms to 10 s sweep times		
Remote Programming			
Interface:	HP-IB (IEEE 488.2-1987)		
Control Language:	Hewlett-Packard Systems Language (HP-SL). All functions controlled except power		
IEEE-488 Functions:	SH1, AH1, T6 TEO, L4, LEO, SR1, PPO, DC1, DTO, CO, E2		
General			
Power Requirements:	±10% of 100 V, 120 V, 220 V, or 240 V; 48 to 440 Hz; 500 VA (except HP 8643A/44B: 400 VA)		
Operation Temperature:	0° to 55° C		
Leakage:	Conducted and radiated interference meets MIL STD 461B REO2 and FTZ 1046		
Calibration Interval:	Recommended 3 years (MTBC)		
Weight:	HP 8643A: 23 kg (50 lb). HP 8644B: 30 kg (67 lb). HP 8664A/65A/B: 35 kg (78 lb)		
Dimensions:	177 mm H × 426 mm W × 624 mm D (7 in × 16.8 in × 24.6 in). (Opt 010 adds 35 mm (1.4 in) to D)		

[1]3000 MHz for HP 8664A, 4200 MHz for HP 8665A, 6000 MHz for HP 8665B
[2]N/A to HP 8665B
[3]Low-noise mode

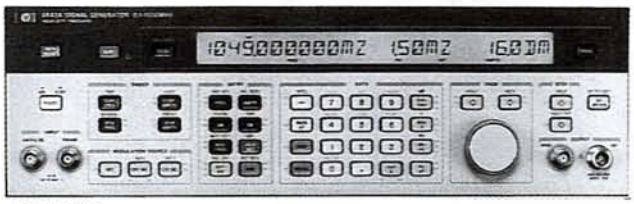
Ordering Information

	HP 8643A	HP 8644B	HP 8664A HP 8665A HP 8665B
Base Price	**$15,500**	**$22,655**	**$28,890** **$38,315** **$39,200**
Options:			
001 High-Stability Timebase	$1,650	$1,650	$1,650
002 2 GHz Doubled Output	$5,000	$7,625	N/A
003 Rear-Panel Input/Output	$430	$430	$430
004 Low-noise Option	N/A	Standard	$4,375
005 Electronic Attenuator (N/A with Opt 002)	Standard	$535	N/A
008 Pulse Modulation	Standard[2]	Standard[2]	$3,835
009 Specified VOR/ILS	$1,600	$1,600	N/A
010 Reduced-Leakage Configuration	$1,600	$1,600	$1,600
011 2 GHz Internal Frequency Counter	$1,065	$1,065	N/A
907 Front-Handle Kit (5061-9690)	$65 ☎	$65 ☎	$65 ☎
908 Rack Flange Kit (5061-9678)	$35 ☎	$35 ☎	$35 ☎
909 Combined Front/Rack Flange Kit (5061-9684)	$90 ☎	$90 ☎	$90 ☎
910 Extra Manual Set (includes service manual)	$190 ☎	$190 ☎	$190 ☎
915 Add Service Manual	$65 ☎	$65 ☎	$65 ☎
Service Kit	(08645-61116) $650	(08645-61116) $650	(08665-61116) $1,250
W30 Add 3 Years to Return Warranty	$425	$425	$875

[1]HP-IB Cables
[2]See specifications

☎ For off-the-shelf shipment, call 800-452-4844.

- 100 kHz to 2.115 GHz
- < −134 dBc/Hz SSB phase noise at 20 kHz offset
- −100 dBc nonharmonic spurious
- +20 dBm maximum output level
- AM, FM, ΦM and pulse modulation
- On-site repair and calibration



HP 8642A

DESIGNED FOR HP-IB SYSTEMS

HP 8642B

DESIGNED FOR HP-IB SYSTEMS

HP 8642A/B Synthesized Signal Generators

The HP 8642A and HP 8642B synthesized signal generators are high-performance programmable signal generators intended for the most demanding out-of-channel RF receiver measurements and other stringent RF applications. The HP 8642A covers the frequency range from 100 kHz to 1057.5 MHz; the HP 8642B, to 2115 MHz.

Low SSB Phase Noise

The HP 8642A/B provide state-of-the-art in SSB phase noise at 20 kHz offsets of −134 dBc/Hz at 1 GHz.

−100 dBc Spurious

Nonharmonic spurious are held to below −100 dBc up to 1 GHz on the HP 8642A/B and to below −94 dBc above 1 GHz. These 2 generators allow receiver spurious rejection tests to be fully automated with the utmost confidence in test results.

Repeatability and Level Accuracy

In addition to a high-reliability attenuator, absolute output level accuracy is ±1 dB down to −127 dBm (0.1 μV). In research and development or on the production line, the HP 8642A/B will accurately measure receiver sensitivities.

Up to +20 dBm Output Level

Up to +20 dBm is available from the HP 8642A/B to perform a variety of high-level measurements, often eliminating the need for external amplifiers. This extra power can be used to overcome cabling losses. With the relative amplitude feature, the display can be offset to show correct output level at the end of the cable.

AM, FM, ΦM, and Pulse Modulation

The HP 8642A/B offer AM, FM, ΦM, and pulse modulation across their full frequency ranges.

A low distortion internal modulation oscillator can be used to modulate the HP 8642A/B up to 100 kHz rates. The internal audio oscillator can also be used as a standalone audio source with variable rates and levels.

HP 8642A/B Specifications

Frequency

Range: 100 kHz to 1057.5 MHz, HP 8642A; 100 kHz to 2115 MHz, HP 8642B

Bands: Both generators cover their ranges in one continuous span. However, many other specifications are dependent on carrier frequency. To simplify such specifications, the HP 8642A and 8642B carrier frequency ranges are divided into bands as shown in the following table.

Band	Carrier Frequency (MHz)	Band	Carrier Frequency (MHz)
10	1057.500001 to 2115 (HP 8642B)	4	16.523438 to 33.046875
9	528.750001 to 1057.5	3	8.261719 to 16.523437
8	264.375001 to 528.75	2	4.130860 to 8.261718
7	132.187501 to 264.375	1	0.1 to 4.130859
6	66.093751 to 132.1875	HET	0.1 to 132.1875
5	33.046876 to 66.09375		

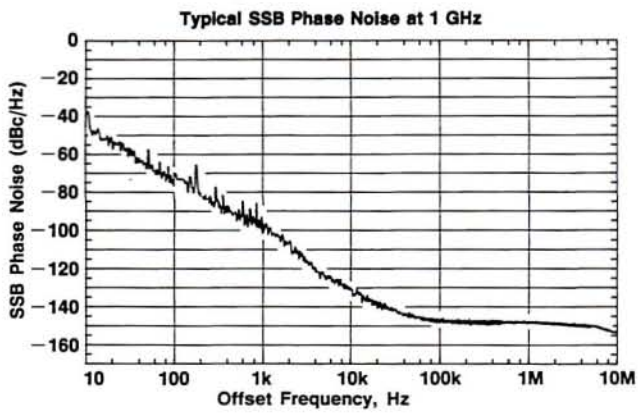
Resolution: 1 Hz, 0.1 Hz with special function
Stability: Same as reference oscillator

Internal Reference Oscillator

Standard: Aging rate: ±2 ppm/year
Option 001: $<10^{-9}$/day aging rate after 8 days warmup

Spectral Purity

Residual FM (in CW, AM or Angle Modulation <⅓ Max. Dev.):
500 MHz: <1.2 Hz (0.3 to 3 kHz BW), <2 Hz (0.05 to 15 kHz BW)
1000 MHz: <2 Hz (0.3 to 3 kHz BW), <5 Hz (0.05 to 15 kHz BW)
2000 MHz: <5 Hz (0.3 to 3 kHz BW), <9 Hz (0.05 to 15 kHz BW)
SSB Phase Noise at 20 kHz Offset (CW, AM or FM/ΦM <1/20 Maximum deviation):
125 MHz: −144 dBc/Hz
250 MHz: −141 dBc/Hz
500 MHz: −137 dBc/Hz
1000 MHz: −134 dBc/Hz
2000 MHz: −125 dBc/Hz
Residual AM: <0.01% AM rms, 0.3 to 3 kHz BW
Spurious
Harmonics: −30 dBc, level ≤ +10 dBm, −25 dBc f_c >1057.5 MHz
Subharmonics: None, f_c ≤1057.5 MHz; −45 dBc, f_c >1057.5 MHz
Nonharmonics (>10 kHz offsets): −100 dBc, (−94 dBc f_c >1057.5 MHz)



SIGNAL GENERATORS

High-Performance RF (cont'd)

HP 8642A, 8642B

Output

Level Range: From maximum available to −140 dBm (0.023 μV).
Maximum Level Available:

	HP 8642A	HP 8642B
+20 dBm (2.24 V)	bands 1 thru 7	bands 1 thru 7
+19 dBm (2.00 V)	n/a	band 8
+18 dBm (1.78 V)	bands 8 & HET	HET
+17 dBm (1.58 V)	n/a	band 9
+16 dBm (1.41 V)	band 9	band 10

Resolution: 0.1 dB.
Absolute Accuracy: ±1 dB, output level ≥ −127 dBm
Flatness: ≤ ±0.75 dB, +10 dBm output level
Impedance: 50 Ω nominal
SWR: <1.5:1, level <0 dBm; <2.0:1, level ≥0 dBm
Reverse Power Protection: 50 W, from a 50 Ω source 25 Vdc (HP 8642A); 25W, 50 Vdc (HP 8642B)
Third Order Intermodulation: < −50 dBc at +10 dBm, 2 generators 25 kHz apart into a resistive combiner. Typically decreases 10 dB for every 5 dB of combined level decrease.

Amplitude Modulation

AM Depth: 0 to 99.9%, output level ≤ +10 dBm
AM Resolution: 0.1%
AM Indicator Accuracy at 1 kHz Rate and Up to 90% AM:
±(3.5% of setting +1% AM), f_c ≤528.75 MHz (8642A), f_c ≤1057.5 MHz (8642B)
±(5% of setting +1% AM), f_c >528.75 MHz (8642A), f_c >1057.5 MHz (8642B)
AM Distortion at 1 kHz Rate:

Depth	Distortion	
	8642A; f_c ≤ 528.75 MHz 8642B; f_c ≤ 1057.5 MHz	8642A; f_c > 528.75 MHz 8642B; f_c > 1057.5 MHz
0 to 30% AM	<1%	<2%
30 to 70% AM	<2%	<4%
70 to 90% AM	<4%	<6%

AM 3 dB Bandwidth, Depth ≤90%:
External dc/ac Coupling: dc/20 Hz to 100 kHz, f_c: 01 to 4.13 MHz, 33.04 to 2115 MHz, HET; dc/20 Hz to 20 kHz, f_c: 4.13 to 33.04 MHz
Internal: Same as external ac
Incidental ΦM at 1 kHz Rate and 30% AM: <0.2 radians peak

Frequency Modulation

Maximum FM Deviation:

Carrier Frequency Band	Maximum Deviation dc-Coupled	Maximum Deviation ac-Coupled or Internal (the smaller of)
10	3 MHz	3 MHz or f_{mod} X 2160
9	1.5 MHz	1.5 MHz or f_{mod} X 1080
8	750 kHz	750 kHz or f_{mod} X 540
7	375 kHz	375 kHz or f_{mod} X 270
6	187 kHz	187 kHz or f_{mod} X 135
5	93.8 kHz	93.8 kHz or f_{mod} X 67.5
4	46.9 kHz	46.9 kHz or f_{mod} X 33.75
3	23.4 kHz	23.4 kHz or f_{mod} X 16.88
2	11.7 kHz	11.7 kHz or f_{mod} X 8.44
1	93.8 kHz	93.8 kHz or f_{mod} X 67.5
HET	1.5 MHz	1.5 MHz or f_{mod} X 1080

FM Resolution: 0.7% of setting or 0.0004% of maximum deviation, whichever is larger
FM Indicator Accuracy, Rates ≤ 100 kHz: ±(5% of setting +10 Hz)
FM Distortion, Rates 20 Hz to 100 kHz: 4% for max. dev., 2% for ½ max. dev., 0.4% for ⅛ maximum dc-coupled deviation
FM 3 dB Bandwidth (dc/ac coupling): dc/20 Hz to 200 kHz
Incidental AM: 0.3%, 20 kHz peak dev., 1 kHz rate, f_c > 400 kHz

Phase Modulation

Maximum Phase Deviation:

Carrier Frequency 1Band	Maximum Deviation (Radians)
10	200
9	100
8	50
7	25
6	12.5
5	6.25
4	3.13
3	1.56
2	0.78
1	6.25
HET	100

ΦM Accuracy: ±(5% of setting +0.09 radians), 1 kHz rate
ΦM Resolution: Greater of 0.7% of setting or 0.0004% of max. dev
ΦM Distortion: <0.4%, 1 kHz rate
ΦM 3 dB Bandwidth: dc/20 Hz to 15 kHz

Pulse Modulation (for output levels ≤ +15 dBm)

Pulse On/Off Ratio: >40 dB; >80 dB, f_c >1057.5 MHz
Rise/Fall Time: <400 ns, 10% to 90%
Maximum Repetition Frequency: 100 kHz
Minimum Pulse Width: 2 μs

Internal Modulation Oscillator

Rates: 20 Hz to 100 kHz
Frequency Resolution: 1% of setting
Frequency Accuracy: 2% of setting
Output Level Range: 0 to 3 V peak into 600 Ω
Output Level Resolution: 4 mV
Distortion: <0.02%, 0.02 kHz to 15.8 kHz; <0.15%, >15.8 kHz
Output Level Accuracy: ±(4% +15 mV) within 1 second
Output Impedance: 600 Ω ±10%

Frequency Sweep

Modes: Start-Stop, Span, and Phase continuous
X-Axis Output: 0 to 10 Vdc, ±10%
Z-Axis Output: TTL positive true for display blanking during retrace

Remote Programming

Interface: HP-IB (IEEE-488-1978)
HP-IB Functions: Listener, talker, and controller. SH1, AH1, T5, TE0, L3, LE0, SR1, RL1, PP1, DC1, DT1, C1, C3, C28, E2

General

Operating Temperature Range: 0° to 55° C
Storage Temperature: −55° to +75° C
Leakage: Conducted and radiated interference is within the requirements of MIL-STD-461B method RE02. Interference is also within the standards set by FTZ-1046. Also, RF leakage of <0.5 μV is induced in a 2 turn loop 2.5 cm in diameter, held 2.5 cm away from any surface for output levels ≤0 dBm.
Power Requirements: 100, 120, 220, or 240 V; +5%, −10%; 48 to 440 Hz; 300 VA max
Size: 425 mm W × 133 mm H × 617 mm D (16.75 in × 5.25 in × 24.3 in)
HP System II Module Size: 1 W × 5¼ H × 23 D
Weight: Net, 32.7 kg (71.5 lb); shipping, 43 kg (95 lb)

Ordering Information

	Price
HP 8642A Synthesized Signal Generator[1]	$30,340
HP 8642B Synthesized Signal Generator[1]	$41,680
Opt 001 High-Stability Time Base	+$2,560
Opt 002 Input/Output Connectors on Rear Panel Only	+$185
Opt 1BN Mil Std 45662A Certificate of Calibration	+$200
Opt 1BP Mil Std 45662A Calibration w/Test Data	+$750
Opt 710 Onsite Repair Manual (08642-90020)	+$74
Opt 907 Front Handle Kit (5061-9689)	+$57
Opt 908 Rack Flange Kit (5061-9677)	+$33
Opt 909 Rack Flange Kit (5061-9683) with Front Handles	+$82
Opt 910 Additional Operation and Calibration Manual (08642-90224) and 2 Service Manuals (08642-90226)	+$565
Opt 915 Add Service Manual (08642-90226)	+$255
HP 8642A Opt W30 Extended Repair Service (see page 636)	+$615
HP 8642B Opt W30 Extended Repair Service (see page 636)	+$845
HP 11801A On-site Repair Kit for HP 8642A	+$22,930
HP 11801B On-site Repair Kit for HP 8642B	+$30,210
HP 11801C On-site Repair Kit for HP 8642A/B	+$31,900

[1]HP-IB cables not supplied. For description and price, see page 124.

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- 10 kHz to 1280 MHz frequency range
- < −147 dBc/Hz SSB phase noise at 10 kHz offset
- 0.1 Hz frequency resolution

HP 8662A

DESIGNED FOR HP-IB SYSTEMS

- 100 kHz to 2560 MHz frequency range
- AM/FM/ØM/pulse in one generator
- Internal variable modulation oscillator

HP 8663A

DESIGNED FOR HP-IB SYSTEMS

HP 8662A/HP 8663A Synthesized Signal Generators

Spectral purity is the key contribution of both the HP 8662A and HP 8663A, making them ideal for many radar, satellite communication, and phase noise measurement applications. Typical absolute phase noise performance of these generators at a 1 kHz offset is as low as −135 dBc/Hz, depending on the band of operation.

The frequency range of the HP 8662A is 10 kHz to 1280 MHz. It offers versatile AM/FM, using either internal 400 Hz and 1 kHz rates or externally applied modulating signals which can be either ac- or dc-coupled. It also has simultaneous modulation capability.

The HP 8663A and the HP 8662A provide the U.S. Air Force MATE (Modular Automatic Test Equipment) capability, Option 700. This option is an external translator that allows the HP 8663A to be controlled by the MATE language CIIL (Control Interface Intermediate Language).

HP 8662A Specifications

Frequency

Range: 10 kHz to 1280 MHz (1279.9999998 MHz)
Resolution: 0.1 Hz (0.2 Hz above 640 MHz)
Accuracy and Stability: Same as reference oscillator
Internal Reference Oscillator: 10 MHz quartz oscillator. Aging rate $< 5 \times 10^{-10}$/day after 10-day warmup (typically 24 hrs in normal operating environment).

Spectral Purity

Front-Panel Absolute SSB Phase Noise (dBc/Hz):

	Frequency Range (MHz)					
	0.01 to 119.9[1]		120 to 159.9[2]		160 to 319.9[2]	
	spec	typ	spec	typ	spec	typ
1 Hz	−68	−78	−66	−76	−60	−70
10 Hz	−98	−108	−96	−106	−90	−100
100 Hz	−116	−126	−115	−125	−109	−119
1 kHz	−126	−132	−129	−135	−124	−130
3 kHz	−126	−135	−129	−138	−124	−133
5 kHz	−128	−138	−131	−141	−126	−136
10 kHz	−132	−138	−142	−148	−136	−142
100 kHz	−132	−139	−142	−148	−136	−142

	Frequency Range (MHz)					
	320 to 639.9[2]		640 to 1279.9[3]		1280 to 2559.9[4]	
	spec	typ	spec	typ	spec	typ
1 Hz	−54	−64	−48	−58	−42	−52
10 Hz	−84	−94	−78	−88	−72	−82
100 Hz	−103	−114	−97	−108	−92	−102
1 kHz	−118	−125	−112	−119	−106	−113
3 kHz	−118	−127	−112	−121	−106	−115
5 kHz	−120	−130	−114	−124	−108	−118
10 kHz	−131	−136	−124	−130	−118	−124
100 kHz	−131	−136	−124	−130	−118	−124

Residual SSB Phase Noise (dBc/Hz):

	Frequency Range (MHz)					
	0.01 to 119.9[1]		120 to 159.9[2]		160 to 319.9[2]	
	spec	typ	spec	typ	spec	typ
10 Hz	−108	−114	−112	−119	−106	−113
100 Hz	−121	−126	−122	−129	−118	−124
1 kHz	−128	−133	−131	−138	−127	−134
3 kHz	−128	−136	−131	−139	−127	−135
5 kHz	−129	−138	−133	−141	−129	−136
10 kHz	−132	−137	−142	−147	−136	−142
100 kHz	−132	−137	−142	−147	−136	−142

	Frequency Range (MHz)					
	320 to 639.9[2]		640 to 1279.9[3]		1.28 to 2559.9[4]	
	spec	typ	spec	typ	spec	typ
10 Hz	−100	−107	−93	−101	−88	−95
100 Hz	−112	−119	−105	−112	−100	−106
1 kHz	−121	−128	−115	−122	−109	−116
3 kHz	−121	−129	−115	−123	−109	−117
5 kHz	−123	−130	−117	−124	−111	−118
10 kHz	−131	−136	−124	−130	−118	−124
100 kHz	−131	−136	−124	−130	−118	−124

[1] HP 8663A band begins at 0.1 MHz; specifications extend up to and including 119.9999999 MHz.
[2] Specifications extend up to and including 0.1 Hz less than the starting frequency of the next band.
[3] Specifications extend up to and including 1279.9999998 MHz.
[4] This band available on HP 8663A only; specifications extend up to and including 2559.9999996 MHz.

Option 003 Specified SSB Phase Noise for Rear-panel 640 MHz Output:

	spec	typ
1 Hz	−54	−64
10 Hz	−84	−94
100 Hz	−104	−114
1 kHz	−121	−126
3 kHz	−121	−127
5 kHz	−129	−138
10 kHz	−145	−149
100 kHz	−157	−159

SIGNAL GENERATORS
High-Performance RF (cont'd)
HP 8662A, 8663A

SSB Broadband Noise Floor in 1 Hz BW at 3 MHz Offset From Carrier: < −146 dBc for f_c between 120 and 640 MHz at output levels above +10 dBm.

Spurious Signals:

	Frequency Range (MHz)				
	0.01 to 120	120 to 160	160 to 320	320 to 640	640 to 1280
Spurious non-harmonically related[1,2]	−90 dBcf	−100 dBc	−96 dBc	−90 dBc	−84 dBc
Sub-harmonically related $\left(\frac{1}{2}, \frac{3f}{2}, \text{etc.}\right)$	none	none	none	none	−75[3] dBc
Power-line (60 Hz) related or microphonically generated (within 300 Hz)[4]	−90 dBc	−85 dBc	−80 dBc	−75 dBc	−70 dBc
Harmonics	< −30 dBc				

Output
Level Range: +13 to −139.9 dBm (1V to 0.023 μV_{rms} into 50 Ω)
Resolution: 0.1 dB
Absolute Level Accuracy (+15° to +45° C): ±1 dB between +13 and −120 dBm, ±3 dB between −120 and −130 dBm
SWR: Typically from 1.5 to 1.8, depending on output level and frequency
Reverse Power Protection: Typically up to 30 W or ±8 Vdc

Amplitude Modulation
Depth: 0 to 95% at output levels of +8 dBm and below (+10 dBm in uncorrected mode). AM available above these output levels but not specified.
Resolution: 1%, 10 to 95% AM; 0.1%, 0 to 9.9% AM
Incidental PM (at 30% AM): 0.15 to 640 MHz, <0.12 radian peak; 640 to 1280 MHz, <0.09 radian peak
Incidental FM (at 30% AM): 0.15 to 640 MHz, $<0.12 \times f_{mod}$; 640 to 1280 MHz, $<0.09 \times f_{mod}$
Indicated Accuracy: ±5% of reading ±1% AM. Applies for rates given in table below, internal or external mode, for depths ≤90%

Rates and Distortion with Internal or External Modulating Signal:

Frequency Range	AM Distortion			
	AM rate	0 to 30% AM	30 to 70% AM	70 to 90% AM
0.15 to 1 MHz	dc to 1.5 kHz	2%	4%	5.75%
1 to 10 MHz	dc to 5 kHz	2%	4%	5.75%
10 to 1280 MHz	dc to 10 kHz	2%	4%	5.75%

Frequency Modulation
FM Rates (1 dB bandwidth): External ac, 20 Hz to 100 kHz; external dc, dc to 100 kHz
FM Deviation: 25 to 200 kHz, depending on carrier frequency
Indicated FM Accuracy: ±8% of reading plus 10 Hz (50 Hz to 20 kHz)
FM Resolution: 100 Hz for deviations <10 kHz, 1 kHz for deviations ≥10 kHz
Incidental AM (AM sidebands at 1 kHz rate and 20 kHz deviation): < −72 dBc, f_c <640 MHz; < − 65 dBc, f_c ≥640 MHz
FM Distortion: <1.7% for rates <20 kHz, <1% for rates <1 kHz
Center Frequency Accuracy and Long-term Stability in ac Mode: Same as CW mode

Supplemental Characteristic
Frequency-Switching Speed:[5] From 420 μs to 12.5 ms, depending on the programming mode.

HP 8663A Specifications
The HP 8663A Signal Generator is related to the HP 8662A in both concept and structure. The HP 8662A concept of an extremely low phase noise signal source, incorporating signal generator modulation capabilities and output characteristics, is carried even further by the HP 8663A. While maintaining high spectral purity, the HP 8663A offers increased frequency range to 2560 MHz, increased output level to +16 dBm, and the addition of phase and pulse modulation. The result is a highly flexible and powerful signal generator that utilizes and extends the proven circuitry of the HP 8662A. Thus, the HP 8662A and HP 8663A share many of the same specifications.

Frequency
Range: 100 kHz to 2560 MHz (2559.9999996 MHz)
Resolution: 0.1 Hz (f_c < 640 MHz)
0.2 Hz (640 MHz ≤ f_c < 1280 MHz)
0.4 Hz (f_c ≥ 1280 MHz)
Accuracy, Stability, and Internal Reference Oscillator: Identical to HP 8662A

Spectral Purity
(See HP 8662A specifications)
Spurious Signals: Identical to HP 8662A, except that for f_c between 1280 and 2560 MHz the spurious non-harmonics are −78 dBc; the sub-harmonically related (f/2, 3f/2, etc.) between 640 and 1280 MHz are −70 dBc and between 1280 and 2560 MHz are −40 dBc; and the power-line (60 Hz) or microphonically generated spurious are −65 dBc.
Harmonics: < −30 dBc, ≤ + 13 dBm output, < −25 dBc, +13 dBm to +16 dBm output, f_c <1280 MHz; < −25 dBc, f_c ≥1280 MHz

Output
Level Range: +16 dBm to −129.9 dBm
Resolution: 0.1 dB
Absolute Level Accuracy (+15° to +45° C): ±1 dB, +16 dBm to −119.9 dBm; ±3 dB, −120 dBm and below
SWR: <1.5

Amplitude Modulation
Depth: 0 to 95% at levels of +10 dBm and below
Resolution: 0.1%
Incidental FM (at 30% AM): Identical to HP 8662A except: $<0.3 \times f_{mod}$ for 1280 ≤ f_c < 2560 MHz
Indicated Accuracy: ±6% of reading ±1% AM (400 Hz and 1 kHz, depth 90%)
AM Bandwidth (1dB):
dc to >1.5 kHz, 0.15 MHz ≤ f_c < 1 MHz; dc to >5 kHz, 1 MHz ≤ f_c ≤ 10 MHz; dc to >10 kHz, f_c > 10 MHz: external dc coupling. External ac coupling or internal; low-frequency coupling is 20 Hz.
Distortion (400 Hz and 1 kHz): <2% (0 to 30% AM); <4% (30 to 70% AM); <6% (70 to 90% AM)

Frequency Modulation
FM Rates (1 dB bandwidth): External ac, 20 Hz to 100 kHz, external dc, dc to 100 kHz
Maximum Allowable Peak Deviation: Identical to HP 8662A for f_c between 100 kHz and 1280 MHz. Up to 400 kHz for f_c between 1280 and 2560 MHz.
Indicated FM Accuracy (50 Hz to 20 kHz): ±9% of setting +10 Hz.
FM Resolution: 100 Hz to 1 kHz, depending on f_c and deviation setting
Incidental AM (AM sidebands at 1 kHz rate and 20 kHz deviation): < −72 dBc (10 ≤ f_c < 640 MHz); < −65 dBc (640 ≤ f_c < 2560 MHz)
FM Distortion: <1.25% (400 Hz and 1 kHz rates); < 1.75% (rates less than 20 kHz)

Phase Modulation (Option 002)
Maximum Peak Phase Deviation: From ±25° for f_c between 120 and 160 MHz to ±400° for f_c between 1280 and 2560 MHz
Maximum Rate: From 10 kHz for f_c between 0.15 and 10 MHz to 10 MHz for f_c between 250 and 2560 MHz
Phase Deviation Resolution: 1° (0.1 ≤ f_c < 640 MHz); 2° (640 ≤ f_c < 1280 MHz); 4 ° (1280 ≤ f_c < 2560 MHz)
Phase Modulation Distortion: 10% at maximum rate

Biphase Modulation
Biphase modulation is available on the standard HP 8663A for f_c less than 640 MHz and available for all f_c with Option 002.
Deviation: ±90°
Carrier Null when Modulated with 1 MHz, 50% Duty Cycle Square Wave: >25 dBc
Modulation Input Required: TTL positive true. The internal modulation oscillator can be used for 50% duty-cycle modulation. External input is on rear panel.

[1] In the remote mode it is possible to have microprocessor clock-related spurious signals spaced 3 MHz apart at an absolute level of typically less than −145 dBm.
[2] Spurious signals can be up to 3 dB higher in the dc FM mode.
[3] f/2 spurs not specified for carrier frequencies above 850 MHz.
[4] At a 50 Hz line frequency, power-line or microphonically related spurious signals may be up to 3 dB higher and appear at offsets as high as 1 kHz from the carrier.
[5] Due to automatic leveling loop bandwidth changes, brief (30 ms) level inaccuracies may occur when switching through 150 kHz and 1 MHz RF output frequencies.

HP 11721A

Pulse Modulation[1]

Pulse On/Off Ratio: >80 dB (50 to 2560 MHz)
Pulse Rise/Fall Time: <250 ns (50 to 120 MHz); <800 ns (120 to 640 MHz); <100 ns ($f_c \geq 640$ MHz)
Pulse Repetition Frequency (50% duty cycle):
Internal: 10 Hz to 99.9 kHz
External: 10 Hz to 2 MHz, 50 MHz < f_c < 640 MHz; 10 Hz to 5 MHz, f_c > 640 MHz
Internal Modulation Oscillator
Rates: 10 Hz to 99.9 kHz
Frequency resolution: 3 digits
Frequency accuracy: Same as reference oscillator
Output level (available on rear panel): 1 V peak into 600 Ω
Output impedance: 600 Ω
Flatness (referenced to 1 kHz): < ±1%
Distortion: <1%

Other HP 8662A and HP 8663A Information

Remote Programming: The HP-IB interface is standard on the HP 8662A and HP 8663A signal generators. All functions controlled from the front panel, with the exception of the line switch, are programmable with the same accuracy and resolution as in manual mode.
Operating Temperature Range: 0° to +55° C
Leakage: Meets radiated and conducted limits of MIL STD 461A methods RE02 and CE03 as well as VDE 0871
Power Requirements: 115 (90 to 126) V or 230 (198 to 252) V; 48 to 66 Hz; 450 VA max
Weight: HP 8662A: net, 30 kg (65.5 lb); shipping, 36 kg (80 lb); HP 8663A: net, 33.8 (74 lb); shipping, 40 kg (88 lb)
Size: HP 8662A: 425 mm W × 178 mm H × 572 mm D (16.75 in × 7 in × 22.5 in). HP 8663A: 425 mm W × 178 mm H × 642 mm D (16.75 in × 7 in × 25.3 in). Note: depth includes front panel depth of 45 mm (1.75 in).

Ordering Information

	Price
HP 8662A 1280 MHz Signal Generator[2]	$41,890
Opt 001 RF Connectors on Rear Panel Only	+$435
Opt 003 Specified SSB Phase Noise for 640 MHz Output	+$625
Opt 700 External MATE Translator	+$11,295
Opt 907 Front Handle Kit (5061-9690)	+$67
Opt 908 Rack Flange Kit (5061-9678)	+$36
Opt 909 Rack Flange Kit with Front Handles (5061-9684)	+$93
Opt 910 Two Sets of Operating and Service Manuals (08662-90069)	+$139
Opt W30 Extended Repair Service (see page 636)	+$900
Opt W32 Calibration Service (see page 636)	+$740
Opt 1BN MIL STD 45662A Calibration Certificate	+$200
Opt 1BP MIL STD 45662A Calibration with Data Provided	+$750
HP 8663A 2560 MHz Signal Generator[2]	+$57,850
Opt 001 RF Connectors on Rear Panel Only	+$435
Opt 002 Wideband Linear Phase Modulation	+$6,300
Opt 003 Specified SSB Phase Noise for 640 MHz Output	+$625
Opt 700 External MATE Translator	+$7,830
Opt 907 Front Handle Kit (5061-9690)	+$67
Opt 908 Rack Flange Kit (5061-9678)	+$36
Opt 909 Rack Flange Kit with Front Handles (5061-9684)	+$93
Opt 910 Additional Operation and Calibration Manual (08663-90069) and Service Manuals (08663-90071)	+$360
Opt 915 Add Service Manual (08663-90071)	+$155
Opt W30 Extended Repair Service (see page 636)	+$1220
Opt W32 Calibration Service (see page 636)	+$860
Opt 1BN MIL STD 45662A Calibration Certificate	+$200
Opt 1BP MIL STD 45662A Calibration with Data Provided	+$800
HP 11714A Service Support Kit (required for servicing HP 8662A/8663A)	$1,800

[1] Pulse modulation is available for f_c < 50 MHz but is unspecified.
[2] HP-IB cables not supplied. For description and price, see page 124.

For off-the-shelf shipment, call 800-452-4844.

HP 11721A Frequency Doubler

The HP 11721A Doubler is an ideal accessory for extending the usable frequency range of signal generators, frequency synthesizers, or other signal sources. Operating on input frequencies of 50 MHz to 1300 MHz, it provides a doubled output in the range of 100 MHz to 2300 MHz. The HP 11721A will work well with any RF source with an output in the range 50 to 1300 MHz.

The 50 Ω passive circuit of the HP 11721A offers low conversion loss, low spurious, and excellent flatness over its entire frequency range when operated above +10 dBm.

HP 11721A Specifications

Input Frequency Range: 50 to 1300 MHz
Output Frequency Range: 100 to 2600 MHz
Conversion Loss (+13 dBm input, 50 to 1280 MHz): <15 dB
Spurious Referenced to Desired Output Frequency f (+13 dBm input with Harmonics < −50 dBc, 50 to 1280 MHz): f/2, −15 dB; 3f/2, −15 dB
Input SWR: 1.5 typical
Input/Output Impedance: 50 Ω nominal
Operating Temperature Range: 0° to +50°C
Connectors: Input, type N male; output, type N female
Size: 161 mm L × 30 mm W × 20.5 mm H (6⅜ in × 1⅛ in × ⅜ in)
Weight: Net, .02 kg (0.5 lb); shipping, 0.4 kg (1 lb)

Ordering Information

	Price
HP 11721A Frequency Doubler	$800
Opt W30 Extended Repair Service (see page 636)	+$50

SIGNAL GENERATORS

CW Microwave

HP 83711A, 83712A

NEW

DESIGNED FOR HP-IB SYSTEMS

Hewlett-Packard Instrument Drivers

HP 83711A Synthesized CW Generator and HP 83712A Synthesized CW Generator

The HP 83711/12A synthesized CW generators are ideal for local oscillator and exciter applications. High output power and exceptional signal purity are combined with broad frequency coverage in these low-cost, performance-packed synthesizers. Light weight and excellent reliability make these units well suited for all applications including field maintenance.

Clean Signals with Plenty of Power

Choose the HP 83711A, 1 to 20 GHz, or the HP 83712A, 10 MHz to 20 GHz, for your applications that demand wide output dynamic range and stringent spectral purity. Fundamental oscillators and switched low-pass filters deliver < -55 dBc harmonics, eliminate subharmonics, and suppress spurious to < -60 dBc. The HP 83711/12A provide plenty of output power (typically $> +14$ dBm), while spectral purity is maintained even at high power levels (typical output power at frequencies below 1 GHz is +20 dBm). The HP 83711/12A deliver >100 dB dynamic range. Level resolution is 0.01 dB with typical accuracy of ± 1.0 dB at any frequency or power level. User Level Correction simplifies generating accurate, leveled power at distant test ports.

Versatile and Reliable

The HP 83711/12A are the recommended local oscillators for the HP 8970B noise figure meter. Low broadband noise minimizes errors in measurements of low gain devices. Use the HP 83711/12A with the HP 83550 Series millimeter wave modules to generate signals to 110 GHz.

All front panel functions are completely HP-IB programmable and SCPI compatible.

The HP 83711/12A are designed to remain within factory specifications for the entire life of the instrument. The recommended two-year performance verification cycle minimizes downtime and cost of ownership. If a unit ever drifts, automated adjustment routines can be run to return the unit to factory performance in <six hours. Extensive use of surface mount technology and a minimum number of adjustments combine to deliver an estimated MTBF of >20,000 hours. Built-in functional verification routines speed servicing.

HP 83711/12A Specifications

(For complete specifications see HP 83711/12A technical data sheet, HP p/n 5091-5152E)

Frequency Characteristics

Frequency range: HP 83711A 1 to 20 GHz
HP 83712A 0.01 to 20 GHz

Frequency resolution: 1 kHz standard, 1 Hz with Opt 1E8

Output Characteristics

Output power (with Opt 1E1):

0.01 to 1 GHz	+13 dBm
1 to 18 GHz	+10 dBm
18 to 20 GHz	+8 dBm

For typical output power plot, see page 415.

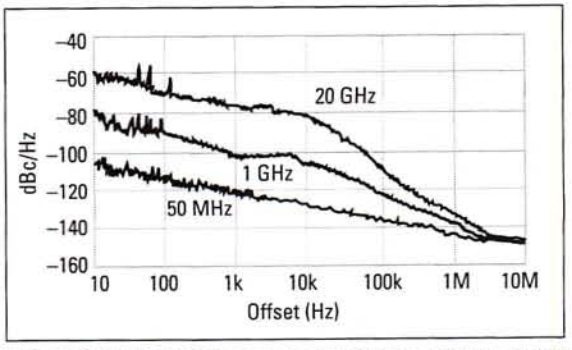
Resolution: 0.01 dB
Accuracy: ± 2 dB at any frequency, power level, or temperature
Flatness: ± 0.5 dB

Spectral Purity

Harmonics: < -50 dBc
Sub-harmonics: None
Spurious: -60 dBc
Phase noise (@ 10 kHz offset):

500 MHz	−103 dBc/Hz
2 GHz	−91 dBc/Hz
18 GHz	−73 dBc/Hz

(Phase noise decreases 6 dB/octave below 500 MHz and reaches a floor of −140 dBc/Hz)



Typical single-sideband phase noise at 50 MHz, 1 GHz and 20 GHz, 25° C, CW mode. Offsets less than 100 Hz require the high stability timebase, Option 1E5.

General Specifications

Operating temperature range: 0° to +55°C
Size: 426 mm W × 133 mm H × 498 mm D (16.8 in × 5.2 in × 19.6 in)
Weight: <16 kg (35 lb)
Power: 90–132 V, 48–440 Hz. 198–264 V, 48–66 Hz. 400 VA maximum.
EMC: Meets or exceeds EN55011/CISPR 11/1990, Class A and Mil-Std-461C Part 2 RE02, CE03, CS02, RS03

Ordering Information

	Price
HP 83711A Synthesized CW Generator	$21,000
HP 83712A Synthesized CW Generator	$25,000
Opt 1E1 Add 90 dB Output Step Attenuator	+$2,000
Opt 1E5 Add High-Stability Timebase	+$1,500
Opt 1E8 1 Hz Frequency Resolution	+$2,000
Opt 0B2 Extra Operating Manual	+$100
Opt 0B3 Service Manuals	+$100
Opt 1CM Rack Mount Kit (HP p/n 5062-3977)	+$65
Opt 1CP Rack Mount and Handle Kit (HP p/n 5062-3983)	+$100
Opt 1CR Rack Slide Kit (HP p/n 1494-0059)	+$35
Opt W30 Two Additional Years Return-to-HP Service	

- 10 MHz to 26.5 GHz frequency range (model dependent)
- < −60 dBc harmonics/subharmonics (model dependent)
- Low spurious and phase noise
- +8 to > −100 dBm calibrated output
- Internally leveled AM/FM/pulse modulation
- Frequency extension capability to 110 GHz (HP 8673 only)
- Digital Sweep (HP 8673 only)

HP 8673B

DESIGNED FOR HP-IB SYSTEMS

HP 8673D

DESIGNED FOR HP-IB SYSTEMS

HP 8673B, 8673C, 8673D, and 8673E Synthesized Signal Generators

The HP 8673B/C/D/E Synthesized Signal Generators are full-performance synthesizers designed to generate precise microwave signals over the 50 MHz to 26.5 GHz frequency range. These generators offer calibrated and leveled power, AM, FM, pulse modulation, digital sweep, programmability, and frequency extension capability to 110 GHz. The HP 8673B covers 2.0 to 26.5 GHz. The HP 8673C/D pair cover 50 MHz to 18.6 GHz and 26.5 GHz respectively and the HP 8673E covers 2.0 to 18.6 GHz.

HP 8673H Synthesized Signal Generator

When full 2.0 to 26.0 GHz frequency coverage is not needed, you can choose the HP 8673H Synthesized Signal Generator with the same reliability and performance at nearly half the cost of a 2 to 26 GHz synthesizer. Choose between Option 212 (2 to 12.4 GHz) and Option 618 (5.4 to 18.0 GHz) for the frequency coverage you need. What does high performance mean? Standard on either option of the HP 8673H is AM, FM, and pulse modulation, digital sweep, millimeter-drive capability and +8 dBm output power.

HP 8671B / HP 8673G Synthesized CW Generators

The HP 8671B and HP 8673G are value-packed synthesized CW generators that meet all the requirements for clean CW sources. The HP 8671B features 128 dB dynamic range, +8 dBm calibrated output power, full programmability, low phase noise and low spurious signals. The HP 8673G adds features including synthesized sweep, mm-drive capability and programming compatibility with other HP 8673 Series synthesized sources.

Ordering Information	Price
HP 8671B Synthesized CW Generator (2 to 18 GHz)	$28,000
Opt 907 Front-Panel Handle Kit (5062-3989)	$55
Opt 908 Rack Mounting Flange Kit (5062-3977)	+$33
Opt 909 Front-Panel Handle Kit Plus Rack Mounting Flange Kit (5062-3983)	+$80
Opt 910 Extra Operating and Service Manual (08671-90023) (08671-90026) (08672-60024)	+$60
Opt W30 Extended Repair Service (see page 636)	+$600
HP 8673G *Synthesized CW Generator (2 to 26 GHz)*	$33,000
Opts 004, 006, 008, 907, 908 909 Same as HP 8673B	
Opt 910 Service Manual and Extra Operating Manual (08673-90105) (08673-90106) (08673-60097)	+$80
Opt 915 Service Manual (08673-90106) (08673-60097)	+$65
Opt W30 Extended Repair Service (see page 636)	+$725
HP 8673B Synthesized Signal Generator	$44,000
Opt 001 Delete RF Output Attenuator	−$600
Opt 002 Delete Reference Oscillator	−$735
Opt 004 Rear-panel RF Output	+$75
Opt 006 Chassis Slide Kit	+$75
Opt 008 +10 dBm Output Level	+$5,000
Opt 907 Front-panel Handle Kit (5062-3989)	+$55
Opt 908 Rack Mounting Flange Kit (5062-3977)	+$33
Opt 909 Front-Panel and Rack Mounting Kits (5062-3983)	+$80
Opt 910 Extra Operating and Service Manual (08673-90114) (08673-90116) (08673-60097)	+$65
Opt W30 Two Additional Years of Return-to-HP Warranty (see page 636)	+$1,050
HP 8673C Synthesized Signal Generator	$60,000
Opts 001, 002, 004, and 006 Same as HP 8673B	
Opt 908 Rack Mounting Flange Kit (5062-3974) (5062-3977)	+$55
Opt 910 Service and Extra Operating Manual (08673-90070) (08673-90138) (08673-60097)	+$85
Opt 913 Rack Flanges for Standard Front Handles (5062-4073)	+$45
Opt 915 Service Manual (08673-90138) (08673-60097)	+$20
Opt 916 Extra Operating Manual (08673-90070)	+$65
Opt W30 Two Additional Years of Return-to-HP Warranty (see page 636)	+$1,170
HP 8673D Synthesized Signal Generator	$62,000
Opts 001, 002, 004, 006, 908, 913, 910, 915, and 916 Same as HP 8673C	
Opt W30 Two Additional Years of Return-to-HP Warranty (see page 636)	+$1,250
HP 8673E Synthesized Signal Generator	$45,000
Opts 001, 002, 004, 006, 907, 908, 909 and 910 Same as HP 8673B	
Opt W30 Two Additional Years of Return-to-HP Warranty (see page 636)	$915
HP 11726A Support Kit (for HP 8673B)	$2,400
HP 8673H Synthesized Signal Generator	
Opt 212 or **Opt 618**	$25,500
Opt 915 Service Manual (08673-90114), (08673-09116), (08673-60097)	+$65
Opt 916 Extra Operating Manual (08673-90119)	+$20
Opt W30 Extended Repair Service (see page 636)	+$575

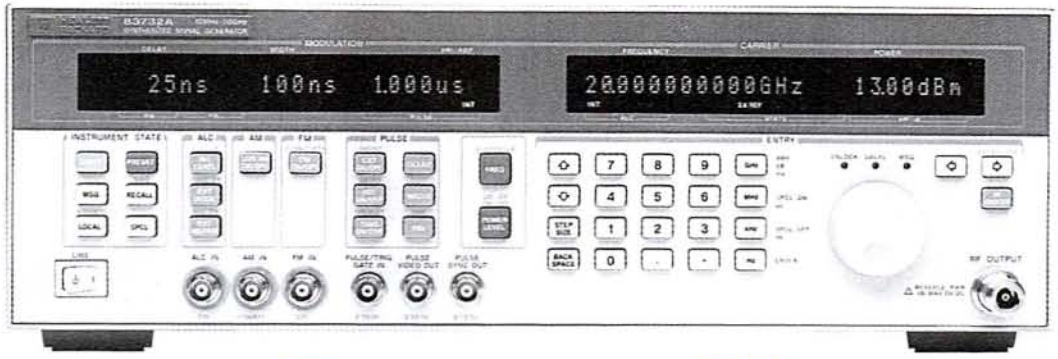
For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales

SIGNAL GENERATORS

High-Performance Microwave

HP 83731A, 83732A



NEW

DESIGNED FOR HP-IB SYSTEMS

Hewlett-Packard Instrument Drivers

HP 83731A Synthesized Signal Generator
HP 83732A Synthesized Signal Generator

The HP 83731/32A synthesized signal generators set new standards for performance at prices that are surprisingly affordable. No longer will you have to give up frequency coverage, modulation, or reliability to meet your budget. The HP 83731/32A will perform beyond your expectations at a price within your reach.

Test radar, electronic warfare (EW), and communication receivers with confidence from 10 MHz through 20 GHz. Excellent spectral purity, high output power, and sophisticated modulation are combined in an affordable, lightweight, easy-to-use signal generator.

Clean Signals with Plenty of Power

Choose the HP 83731A, 1 to 20 GHz, or the HP 83732A, 10 MHz to 20 GHz, for your receiver and system test applications. You can count on the HP 83731/32A for excellent spectral purity. Fundamental oscillators and switched low pass filters deliver < -55 dBc harmonics, eliminate subharmonics, and supress spurious to < -60 dBc. Not only does the HP 83731/32A provide plenty of output power (typically $> +14$ dBm), but spectral purity is maintained even at these high power levels. Typical output power at frequencies below 1 GHz is $+20$ dBm. Level resolution is 0.01 dB with typical accuracy of ± 1.0 dB at any frequency or power level. User Level Correction simplifies generating accurate, leveled power at distant test ports.

Unmatched Modulation Performance

Sophisticated modulation lets you simulate real-world signals. Test state-of-the-art radar and EW receivers with high-fidelity pulse modulation. <10 ns pulse rise/fall times, <25 ns pulse width, and >80 dB pulse on/off ratio give you the performance you need to verify modern receivers. A built-in multimode pulse generator adds the flexibility to generate triggered, doublet, and gated burst pulse modes.

In addition, logarithmic AM is a standard feature in the HP 83731/32A. Use the >60 dB depth log AM and the fast pulse modulation simultaneously (scan modulation) for accurate simulation of antenna scanning patterns. Or sweep power linearly and accurately to test power-sensitive devices.

The HP 83731/32A offer unmatched performance for testing satellite communications and telemetry receivers. 10-MHz peak FM deviations, combined with the highest modulation index available (>300), simplify simulation of these difficult-to-generate signals. The HP 83731/32A remain fully synthesized even at high modulation indices, eliminating the troublesome frequency drift of other signal sources.

Real-world signals often combine two or more modulations. The HP 83731/32A let you use all three modulations simultaneously without any degradation in performance. When your applications require high performance modulation, excellent spectral purity, and high output power, the HP 83731/32A offer unparalleled capability.

Powerful Versatility

For applications at frequencies below 1 GHz, the HP 83732A offers several unique advantages. Digital dividers and switched filters minimize harmonics (< -55 dBc) and spurious signals even at power levels approaching $+20$ dBm. Now you can test receivers at their IF with the same high performance modulation you need at microwave. Phase noise and spurious supression improves by 6 dB/octave as the frequency is reduced, making the HP 83732A a versatile solution for both microwave and in-channel RF receiver tests. Broadband noise is improved greatly compared to older designs.

The HP 83731/32A are recommended local oscillators for the HP 8970B noise figure meter. Low broadband noise minimizes errors in measurements of low gain devices. Use the HP 83731/2A with the HP 83550 Series millimeter wave modules to generate signals to 110 GHz.

All front panel functions are completely HP-IB programmable and SCPI compatible.

Reliable by Design

The HP 83731/32A are designed to remain within factory specifications for the entire life of the instrument. The recommended two-year performance verification cycle minimizes downtime and ownership cost. If a unit ever drifts toward the edge of a performance specification, automated adjustment routines supplied with each unit can be run to return the unit to factory performance. A complete adjustment sequence requires <6 hours. Extensive use of surface mount technology and a minimum number of adjustments combine to deliver an estimated MTBF of $>20{,}000$ hours. If ever needed, built-in functional verification routines speed servicing. Tedious manual adjustments have been designed out while performance and reliability have been designed in.

HP 83731/32A Specifications

(For complete specifications see HP 83731/32A technical data sheet, HP 5091-4318E)

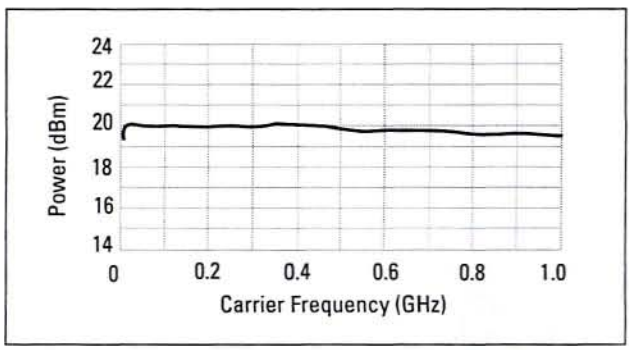
Frequency Characteristics

Frequency range: HP 83731A 1 to 20 GHz
HP 83732A 0.01 to 20 GHz

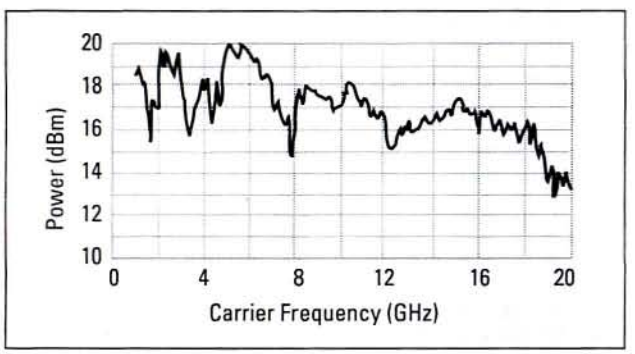
Frequency Resolution: 1 kHz, 1 Hz with Opt 1E8

Output Characteristics

Output power (with Opt 1E1): 0.01 to 1 GHz +13 dBm
1 to 18 GHz +10 dBm
18 to 20 GHz + 8 dBm



Typical maximum available output power from 0.01 to 1 GHz at 25° C.



Typical maximum available output power from 1 to 20 GHz, at 25° C with output step attenuator (Option 1E1) installed.

Resolution: 0.01 dB
Accuracy: ±2 dB over all frequencies, power levels, and temperatures
Flatness: ±0.5 dB

Spectral Purity

Harmonics: < −55 dBc
Sub-harmonics: None
Non-harmonic spurious: −60 dBc
Phase noise (@ 10 kHz offset): 500 MHz −103 dBc/Hz
2 GHz −91 dBc/Hz
18 GHz −73 dBc/Hz

(Phase noise decreases 6 dB/octave below 500 MHz and reaches a floor of < −140dBc/Hz.) For typical phase noise plot, see page 412.

Pulse Modulation

On/off ratio: >80 dB
Rise/fall times: <10 ns
Minimum pulse width: <25ns, 1 to 20 GHz

Internal Multimode Pulse Modulation Source

Modes: Internal free-run, triggered, doublet, and gated burst modes
Pulse repetition frequency: 3 Hz to >3 MHz
Pulse width: 25 ns to 419 ms
Pulse delay: −419ms to +419 ms, free-run mode
225 ns to 419 ms, triggered mode
Minimum pulse parameter resolution: 25 ns

Frequency Modulation

Rates: 1 kHz to >1 MHz
Maximum deviation: 10 MHz pk, 2 to 20 GHz
5 MHz pk, 1 to 2 GHz
Decreases by a factor of 2 for each octave below 1 GHz
Maximum modulation index: >300

Logarithmic Amplitude Modulation

Depth: >60 dB
Sensitivity: −10 dB/V
Step response: <5 us for 50 dB step

General Specifications

Operating temperature: 0° to +55° C
EMC: Meets or exceeds EN55011/CISPR 11/1990, Class A, and Mil-Std-461C Part2 RE02, CS02, CE03, RS03
Power: 90–132 V, 48–440 Hz. 198–264 V, 48–66 Hz. 400 VA maximum.
Net weight: <16 kg (35 lb)
Size: 426 mm W × 133 mm H × 498 mm D (16.8 in × 5.2 in × 19.6 in)

Ordering Information

	Price
HP 83731A Synthesized Signal Generator	$28,500
HP 83732A Synthesized Signal Generator	$32,500
Opt 1E1 Add 90 dB Output Step Attenuator	+$2,000
Opt 1E5 Add High-Stability Timebase	+$1,500
Opt 1E8 Add 1 Hz Frequency Resolution	+$2,000
Opt 1E9 3.5 mm RF Output Connector	+$500
Opt 0B2 Extra Operating Manual	+$100
Opt 0B3 Service Manuals	+$100
Opt 1CM Rack Mount Kit (HP p/n 5062-3977)	+$65
Opt 1CP Rack Mount and Handle Kit (HP p/n 5062-3983)	+$100
Opt 1CR Rack Slide Kit (HP p/n 1494-0059)	+$35
Opt W30 Two Additional Years Return-to-HP Service	

SIGNAL GENERATORS

Synthesized Sweepers, 10 MHz to 50 GHz (or 110 GHz)

HP 8360 Series

- 1 Hz frequency resolution (Option 008)
- Low spurious and phase noise
- +20 dBm to −110 dBm calibrated output

HP 8360 Series Synthesized Sweepers

The HP 8360 series synthesized sweepers are the standard of excellence for applications requiring the high performance and accuracy of a synthesized source and the speed and versatility of a sweep oscillator. The HP 8360 series synthesized sweepers offer the same standard of commitment to quality and reliability that was inherent in the previous industry standard HP 8340/8341.

Frequency Precision and Spectral Purity

The synthesized broadband frequency coverage and precise 1 Hz frequency resolution (Option 008) are generated by indirect synthesis, enabling the HP 8360 to achieve the same low single-sideband phase noise performance as the HP 8671B, the HP 8672A, and the HP 8673 series synthesized signal generators.

< −50 dBc Harmonics

The HP 8360 delivers excellent harmonic performance with harmonics at least 50 dB below the carrier from 2.2 to 20 GHz, and at least 35 dB below the carrier above 20 GHz.

Pulse, Scan, Amplitude, and Frequency Modulation

High-performance pulse modulators with >80 dB on/off ratio, and rise/fall times < 10 ns (Option 006), make the HP 8360 suitable for the most demanding pulse modulation applications.

In addition to its linear AM mode (100%/V), the HP 8360 offers a scan modulation mode (10 dB/V). Both modes have dc-coupled amplitude modulation capability with a 3 dB bandwidth of 100 kHz, and 99.7% (50 dB) of modulation depth. Pulse and amplitude modulation capabilities can be used independently and simultaneously.

The HP 8360 also offers dc-coupled frequency modulation capabilities with rates up to 8 MHz.

Specifications

(See technical data sheet for complete specifications.)

Frequency
Range (by model):
HP 83620A 10 MHz to 20 GHz
HP 83622A 2 to 20 GHz
HP 83623A 10 MHz to 20 GHz (high power)
HP 83624A 2 to 20 GHz (high power)
HP 83630A 10 MHz to 26.5 GHz
HP 83640A 10 MHz to 40 GHz
HP 83650A 10 MHz to 50 GHz
Resolution: 1 kHz standard, 1 Hz optional
Time base: Internal 10 MHz time base. Aging rate: less than 5×10^{-10}/day, 1×10^{-7}/year after 30-day warm-up.

RF Output
Range: +20 to −110 dBm **Resolution:** 0.02 dB

Maximum Leveled Power (by model):

HP 83620A	+13 dBm	**HP 83630A**	+10 dBm
HP 83622A	+13 dBm	**HP 83640A**	+6 dBm
HP 83623A	+17 dBm	**HP 83650A**	+2.5 dBm
HP 83624A	+20 dBm		

RF Output Connector: 3.5 mm on 20 GHz models, 2.4 mm on 40 and 50 GHz models; nominal 50 Ω output impedance

- Pulse, amplitude, and frequency modulation
- Complete analog sweeper
- < −50 dBc harmonics 2.2 to 20 GHz

Spectral Purity
Harmonics and subharmonics:
< −50 dBc at output frequencies < 20 GHz
< −40 dBc at output frequencies < 40 GHz
< −35 dBc at output frequencies > 40 GHz
Non-harmonically related spurious:
< −60 dBc at output frequencies < 20 GHz
< −52 dBc at output frequencies > 20 GHz
Single-sideband phase noise (dBc/1 Hz BW, CW mode):

	Offset from carrier			
Frequency range (GHz)	**100 Hz**	**1 kHz**	**10 kHz**	**100 kHz**
0.01 to 7.0	−70	−78	−86	−107
7.0 to 13.5	−64	−72	−80	−101
13.5 to 20.0	−60	−68	−76	−97
20.0 to 26.5	−58	−66	−74	−95
26.5 to 38.0	−54	−62	−70	−91
38.0 to 40.0	−54	−62	−70	−91
40.0 to 50.0	−52	−60	−68	−89

Modulation
Pulse modulation
On/off ratio: > 80 dB
Rise and fall times: <25 ns (<10 ns optional)
Minimum internally leveled RF pulse width: <1 μs
Minimum RF pulse width: <50 ns (15 ns with Opt 006)
Scan and amplitude modulation
Rates (3dB BW): dc to 100 kHz
Depth: 0 to 90% (20 dB) and 0 to 99.7% (50 dB) above 10 Hz
Sensitivity: 100%/V and 10 dB/V
Frequency modulation
Locked mode
Modulation rate (3 dB BW, 500 kHz deviation): 100 kHz to 8 MHz
Maximum deviations: 8 MHz
Unlocked mode
Modulation rate (3 dB BW, 500 kHz deviation): dc to 8 MHz
Maximum deviations: At rates ≤ 100 Hz: ± 75 MHz
At rates > 100 Hz: ± 8 MHz
Sensitivity: 1 MHz/V or 10 MHz/V, user-selectable

Internal Modulation Generator (Opt 002)

AM, FM
Waveforms: Sine, square, triangle, ramp, noise
Rate range: Sine: 1 Hz to 1 MHz
Square, triangle, ramp: 1 Hz to 100 kHz
Rate resolution: 1 Hz
Depth, deviation
Range and accuracy: Same as base instrument
Resolution: 0.1%
Pulse
Modes: Free-run, gated, triggered, delayed
Period range: 300 ns to 400 ms **Resolution:** 25 ns
Width range: 25 ns to 400 ms **Accuracy:** 5 ns
Video delay
Internal sync pulse: 0 to 400 ms
Externally supplied sync pulse: 225 ns to 400 ms

Ordering Information

	Price
HP 83620A Synthesized Sweeper	$37,600
HP 83622A Synthesized Sweeper	$33,600
HP 83623A Synthesized Sweeper	$45,000
HP 83624A Synthesized Sweeper	$41,000
HP 83630A Synthesized Sweeper	$46,000
HP 83640A Synthesized Sweeper	$53,000
HP 83650A Synthesized Sweeper	$56,000
Opt 001 Add Step Attenuator	$2,500/$4,500
Opt 002 Internal Modulation Generator	$3,500
Opt 003 Delete Front Panel Keyboard/Display	−$1,500
Opt 004 Rear Panel RF Output	$200
Opt 006 Fast Pulse Modulation	$4,000
Opt 008 1 Hz Frequency Resolution	$3,000
Opt 700 Mate System Compatibility	$4,000
Opt W30 Extended Repair Service (see page 636)	
Dedicated HP 8510 Synthesized Sweepers	
HP 83621A Synthesized Source	$34,600
HP 83631A Synthesized Source	$45,000
HP 83651A Synthesized Source	$51,000
Opt W30 Extended Repair Service (see page 636)	

- Broadband frequency coverage: 10 MHz to 20 GHz
- High-performance modulation: AM, FM, and Pulse
- Excellent spectral purity: −55 dBc harmonics
  −60 dBc spurious
- Outstanding output level accuracy and flatness
- Industry standard programming: SCPI

HP 70340A

HP 70341A

NEW

Hewlett-Packard Instrument Drivers

DESIGNED FOR HP-IB SYSTEMS

Hewlett-Packard Instrument Drivers

HP 70340A Modular Synthesized Signal Generator
HP 70341A Frequency Extension Module
All the Performance of Traditional Rack-n-Stack Sources in Half the Rack Space

Test receivers and subsystems from 10 MHz through 20 GHz with confidence knowing that even at full specified power the HP 70340/41A provides superior harmonic (−55 dBc) and spurious (−60 dBc) performance. Excellent output power accuracy (±1 dB) and flatness (±0.5 dB) is maintained across the HP 70340/41A >100 dB dynamic range. Sweep power linearly and accurately to test power sensitive devices. Generate real world signals using the FM, pulse and logarithmic AM modulations. The HP 70340/41A Modular Signal Generator satisfies the demands of tomorrow's ATE for a downsized, high-performance modular signal source.

Extend Your Capabilities to 10 MHz with HP 70341A

The new HP 70341A Frequency Extension Module brings microwave performance to RF and IF testing. Now the HP 70340A's powerful modulation, low harmonics (−55 dBc) and zero subharmonics are available at frequencies from 10 MHz to 1 GHz with higher output power (+13 dBm) and lower phase noise. Digital frequency dividers lower phase noise 6 dB/octave as the output frequency is reduced making the HP 70340A/41A combination a powerful in-channel receiver test stimulus. Elimination of downconversion mixers reduces broadband noise while switched low pass filters generate fast, high-fidelity pulse modulation. Logarithmic AM provides capability not found in conventional RF signal sources. Full 10 MHz to 20 GHz coverage is yours from a single RF output connector without sacrifice in level accuracy or flatness. The HP 70341A is slaved to the HP 70340A so all your system software runs on the combination without change!

Setting the Standard for Modular Signal Sources

The HP 70340A/41A are ideal in modern ATE systems. Their small size, lightweight, excellent reliability and high performance make them the signal sources of choice for downsized and portable ATE. Their high MTBF (>20,000 hours), extended calibration cycle (two years) and low calibration time (<six hours for full cal) reduce system downtime in high throughput commercial ATE. A wide selection of options adds extra capability where you need it and saves money in less stringent systems. SCPI programming assures that system software designed around the HP 70340A/41A will remain compatible and upgradable for years to come.

Specification Summary

(For complete specifications refer to the HP 70340A/41A technical data sheet, p/n 5091-4649E.)

Frequency Range: 1 to 20 GHz; 10 MHz to 20 GHz with HP 70341A
Frequency Resolution: 1 kHz; 1 Hz with Option 1E8
Leveled Output Power (with Option 1E1 installed)
  10 MHz to 1 GHz: +13 dBm to −90 dBm
  1 GHz to 18 GHz: +10 dBm to −90 dBm
  18 GHz to 20 GHz: +8 dBm to −90 dBm
Resolution: 0.01 dB
Accuracy: ±2 dB (all frequencies, power levels, and temperatures)
Flatness: ±0.5 dB
Harmonics: < −55 dBc
Sub-Harmonics: None
Non-Harmonic Spurious: −60 dBc
SSB Phase Noise (10 kHz offset): 500 MHz: −103 dBc/Hz
  2 GHz: −91 dBc/Hz
  18 GHz: −73 dBc/Hz
External Pulse Modulation
  On/off ratio: >80 dB
Minimum Pulse Width: <25 ns 500 MHz to 20 GHz
  <100 ns 64 to 500 MHz
  <1 us 10 to 64 MHz
Maximum Rise/Fall Time: <10 ns 1 to 20 GHz
  <20 ns 500 to 1000 MHz
  <35 ns 128 to 500 MHz
External Frequency Modulation
  Rates: 1 kHz to > 1 MHz
Maximum Deviation: 10 MHz
Maximum Modulation Index: >300
External Amplitude Modulation
  Type: Logarithmic AM
  Depth: 0 to 60 dBc
  Sensitivity: −10 dB/V
  Step response: <5 μs for 50 dB step
Weight: <9 kg (20 lbs) HP 70340A
  <4 kg (10 lbs) HP 70341A
Size: 4/8-in wide MMS module HP 70340A
  1/8-in wide MMS module HP 70341A

Ordering Information

	Price
HP 70340A Modular Signal Generator	$29,500
Opt 1E1 Add Output Step Attenuator	$2,000
Opt 1E2 Internal Pulse Modulation Source	$1,500
Opt 1E8 1 Hz Frequency resolution	$2,000
Opt 1E9 3.5 mm RF Output Connector	$2,000
Opt 0B2 Extra Operation Manual	$500
Opt 0B2 Service Manual	$100
Opt W30 Two Add'l Years HP Service Warranty	$790
HP 70341A Frequency Extension Module	$6,000

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

SIGNAL GENERATORS

Complex Signal Simulation, 10 MHz to 3 GHz, 100 MHz Bandwidth

HP 11755A

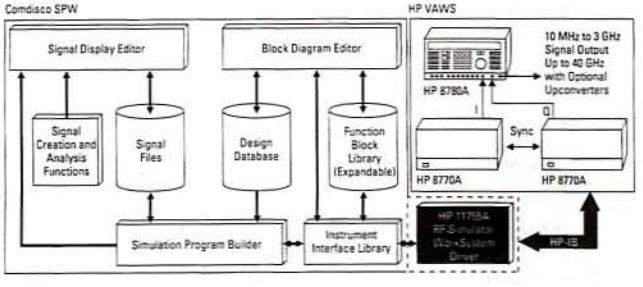
- CAE system design and hardware verification
- Comdisco SPW-compatible
- 100-MHz modulation bandwidth
- Upconversion to 40 GHz
- Exceptional I/Q performance
- Integrated design and verification

The RF Simulator WorkSystem

Use Comdisco's Signal Processing WorkSystem (SPW) to design sophisticated communications systems, then verify your hardware performance with radio frequency (RF) signals generated by an HP Vector Arbitrary Waveform Synthesizer (VAWS). Dramatically reduce your design cycle times with the RF Simulator WorkSystem by doing "what-if" analysis on your system designs before committing to a specific system topology.

The RF Simulator WorkSystem combines the power of system simulation and the reality-check of complex RF simulation by linking SPW and HP VAWS into a self-contained design and verification system.

RF Simulator WorkSystem



Signal Processing WorkSystem (SPW)

Comdisco Systems' SPW is a fully integrated UNIX-based software package that provides you all the tools you need to graphically and interactively capture, simulate, test, and implement a broad range of RF system and digital signal processing (DSP) designs. Using standard library blocks, the Block Diagram Editor (BDE) lets you graphically prototype elements such as modulators, digital filters, transmitters, receivers, and even full satellite channels. Once designed, you can simulate the entire block diagram in software. You can even capture signals from the real world or use mathematically defined waveforms constructed with the Signal Display Editor (SDE) to inject into your simulation. Then use the SDE to analyze signals at any point in a simulated block diagram by displaying Fast Fourier transforms (FFTs), bit error rate, eye diagrams, and more. The applications are limitless. For more details on SPW and a complete list of blocks available, please refer to the SPW datasheet from Comdisco Systems.

HP Vector Arbitrary Waveform Synthesizer (VAWS)

HP VAWS combines two high-performance HP 8770A Arbitrary Waveform Synthesizers (AWS) driving the I and Q modulation inputs of an HP 8780A Vector Signal Generator. The extremely clean AWS outputs and calibrated vector modulator synergistically provide complex modulated signals to 3 GHz with up to 100 MHz instantaneous bandwidth. Signals up to 40 GHz and beyond are yours for the asking with standard and custom HP upconverters. The availability of I/Q baseband outputs, in addition to a wideband modulated carrier and coherent reference, make the HP VAWS an excellent RF test generator for many modern communications applications.

RF Simulator WorkSystem Driver

The HP 11755A RF Simulator WorkSystem Driver brings the power of Comdisco's SPW and HP VAWS together. Select from a palette of SPW blocks to merge HP VAWS into your system block diagram. Then, with just a click of the mouse, you can produce the actual RF signal at that node. To achieve unprecedented image rejection, take advantage of the powerful built-in I/Q compensation algorithm that virtually eliminates quadrature error, gain imbalance, and carrier leakage. With 512-K, 12-bit word pairs (clocked at 125 MHz) HP VAWS can produce a broad range of signals with up to a 100-MHz arbitrary bandwidth and a playback time of at least 4 ms. To put that in perspective, that's over four times the memory required to simulate a 2^{15}-1 sequence at a 36-MHz symbol rate. Much longer scenarios are possible using sequencing techniques or lower clock rates. For example, in certain cellular Rayleigh fading applications, you can achieve a 12-second scenario with a 30-kHz bandwidth.

HP VAWS Specifications

Summarized below are some significant characteristics of an HP VAWS system. Please consult the HP 11755A data sheet for further details.

Output Frequency: 10 MHz to 3 GHz (upconverters available to 40 GHz and beyond)
Modulation Bandwidth: > 100 MHz
Output Level: −100 to +4 dBm
Memory Length: 512 K I/Q word pairs
Clock Rate: 125 Msamples/sec (internal)
10 to 130 MHz (external)
2,4,8...,256 rate dividers
Image Rejection: > 45 dB after compensation (25 dB without)
Carrier Leakage: < −45 dB after compensation (−20 dB without)

Computer Platforms

The HP 11755A RF Simulator WorkSystem Driver is supported on the HP/Apollo 425S, DN3500, DN4500, and Sun-4 platforms. For details on other platforms, contact Comdisco.

Ordering Information

A complete RF Simulator WorkSystem is composed of:

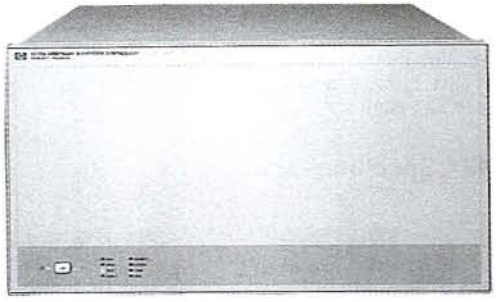
- A workstation equipped with HP-IB running Comdisco's Signal Processing WorkSystem
- HP 11755A RF Simulator WorkSystem Driver
- Two HP 8770A Arbitrary Waveform Synthesizers
- One HP 8780A Vector Signal Generator
- BNC and HP-IB cables and other accessories (see the HP 11755A datasheet for details)

For Signal Processing WorkSystem ordering information, contact Comdisco at:

Comdisco Systems, Inc.
919 E. Hillsdale Blvd.
Foster City, CA 94404
(415) 574-5800, Fax: (415) 358-3601

	Price
HP 11755A RF Simulator WorkSystem Driver	$5,000

- Unmatched spectral purity
- Source of "real-life" signals to 50 MHz
- A software reconfigurable modulation source
- Can simulate very complex baseband and IF signals
- Outstanding reliability (> 100,000 h MTBF)
- 125-MHz sample rate
- 12-bit resolution, 512-K word memory
- Comes with WGL Toolbox software



HP 8770A

DESIGNED FOR HP-IB SYSTEMS

HP 8770A Arbitrary Waveform Synthesizer, dc–50 MHz

Simulate Signals for Communications, Magnetic Disk, Radar, EW, and Other Applications

You design waveforms with the software, then generate the waveforms with the HP 8770A. Use this advanced simulation system to generate complex baseband and IF signals from dc to 50 MHz. Add precise amounts of distortion and noise to test the operating margins of your system early in the development cycle. All signal parameters are under complete software control, allowing quick changes to meet new demands. The HP 8770A has a complete HP-IB command set for full automatic control and easy downloading of wavefrom data previously defined by the WGL (Waveform Generation Language) Toolbox, by R4 software from Rapid Systems, or by other means. Regardless of your application, the use of precise, complex test signals improves the evaluation of your circuits and systems.

Features	Benefits
• 8-ns sample update rate	• Rapid signal parameter changes
• 12-bit words	• High-amplitude resolution
• 125-MHz internal clock (phase-locks to crystal osc.)	• Timebase with synthesizer accuracy
• Special "deglitching" circuits	• Low harmonic and spurious distortion levels
• 110-dB RF attenuator	• 12-bit resolution even at low signal levels
• 12-K memory	• Highly complex waveforms, longer waveform sequences

The WGL Toolbox operates on any computer that runs HP BASIC 5.13 or later. Use it under UNIX with RMB-UX, run it on a PC with a BASIC Language Processor Card, or use it on an HP 9000 Series 300 technical workstation running HP BASIC. Since the WGL Toolbox consists of over 100 easy-to-use subroutines, any HP BASIC user can create and manipulate waveforms instantly. Add noise or spurs to generate real-life test signals. Add wavefroms together to create harmonically distorted waves, or multiply waves to create complex modulated signals. When you are done, download the waveform to the HP 8770A and generate it.

The R4 software, sold and supported by Rapid Systems, is designed specifically for 386-based PCs. Driven by mouse and menu, the software allows you to draw and then modify your waveforms before loading them into the HP 8770A. R4 lets any user, whether a software programmer or an RF engineer, generate the most sophisticated of test signals. Rapid Systems also sells drivers to control other instruments for waveform capture.

Applications Overview

Communications

The HP 8770A is an excellent signal simulator for conventional analog communications systems, digital microwave radios, and satellite communications systems. Design and generate amplitude-, frequency-, and phase-modulated communications signals with digital precision. Exploit memory sequencing to hop from one frequency to the next with fast frequency switching speed and phase continuity. Simulate Nyquist filter responses in software to eliminate time-consuming and costly hardware filters.

Magnetic Disk

The signal simulation system continues to be extremely successful in magnetic disk applications. Replace the head disk assembly to test read/servo channel boards for design integrity, calibrate disk media certifiers, or verify board operation in production tests. Test bit shift susceptibility to less than 50-ps shift resolution. The Programmer's Starter Kit (p/n 08770-60064) interactively creates seven common disk-test waveforms.

Other Applications

- Video and imaging
- Component testing

HP 8770A Performance Specifications

Frequency Range: dc to 50 MHz
Frequency Switching Speed: 8 ns, phase continuous
RF Output
Power range: +10 dBm to −110 dBm
Attenuator: 110 dB in 10-dB steps
Max output voltage: 2 V peak-to-peak into 50 or 75 Ω
Number of DAC bits: 12 true bits, monotonic
Amplitude resolution: 0.024% of full scale
Amplitude flatness: < ±0.65 dB (< 0.1 dB w/predistortion)
Phase linearity (dc–50 MHz): ±5° (< ±1° w/predistortion)
Output impedance: 50 Ω (75 Ω for Opt 002)
Output SWR: < 1.2:1
Connector: Type N (female)
Harmonic distortion (output level = +10 dBm):
−50 dBc (0 to 10 MHz)
−40 dBc (10 to 50 MHz)
In-band spurious and nonharmonic distortion:
−53 dBc (0 to 35 MHz)
−50 dBc (35 to 50 MHz)
Two-tone intermodulation distortion: < −65 dBc for a 10.000 MHz and 10.124 MHz signal at +4 dBm each
SSB phase noise at 10 MHz: < −120 dBc/Hz at 10 kHz offset
Modulation Capabilities
AM, FM, ØM, chirp, pulse, digital (BPSK, QPSK, BPSK, QAM), antenna scan, I/Q
External System Triggering: Repetitive, single-shot, gated
Outputs: Scan start, packet start, sequence start, equal address, packet advance ready
Inputs: Packet advance trigger, system start trigger, system stop trigger
Clock
Sampling clock rate: 125 MHz (externally variable)
Reference oscillator: 10 MHz quartz crystal. Aging rate < 5×10^{-10} per day after a 24-hour warmup and an oscillator time-off of less than 24 hours.
Remote Operation
HP-IB and 16-bit GPIO parallel port

Ordering Information

	Price
HP 8770A Arbitrary Waveform Synthesizer	$28,500
Opt H12 Digital Data Output	$790

R4 Software is available from Rapid Systems.
WGL Toolbox is free with HP 8770A.

For the most current prices and product information, contact your local Hewlett-Packard sales office, see page 665.

SIGNAL GENERATORS

Frequency Agile/Complex Signal Simulation

HP 8645A

- 252 kHz to 1030 MHz frequency range with optional coverage to 2060 MHz
- 15 μs frequency switching
- Standalone control of frequency agility
- Specified performance while fast hopping
- FM rates to 10 MHz, deviations to 20 MHz
- Low spurious and phase noise

HP 8645A

DESIGNED FOR HP-IB SYSTEMS

Hewlett-Packard Instrument Drivers

HP 8645A Agile Signal Generator

The HP 8645A Agile Signal Generator combines high performance with frequency agility for new fast-switching test requirements. These capabilities are important for performance testing of such devices as frequency agile radios and surveillance receivers. Besides extending traditional receiver testing to agile applications, the HP 8645A can be used to create complex signal simulations involving several modulation types and frequency agility. These complex RF signals can quantitatively exercise a receiver's vulnerability to a jamming transmission. The HP 8645A can also be a fast-switching stimulus needed to decrease production test times. The high performance and frequency agility of the HP 8645A provide capability for both static and agile test requirements with just one calibrated signal generator.

Specified Agile Performance

The HP 8645A provides specified signal performance in both static and agile operation. Fully-synthesized outputs with high timebase accuracy are standard when not frequency hopping. The Fast Hop mode activates a frequency-lock loop to allow frequency switching as fast as 15 μsec from 128 to 2060 MHz. Over the frequency range of 8 to 2060 MHz, the fastest switching time is 85 μsec and outputs below 8 MHz require 500 μsec. Frequency accuracy of each output is better than ± 2 ppm while in Fast Hop mode. At each frequency, a specific amplitude can be assigned within a 20 dB range for performance tests versus amplitude while frequency hopping. For a full test of a receiver, up to 8000 frequencies can be entered and sequences of up to 8000 frequency settings can be specified. Performance parameters such as phase noise, spurious, amplitude accuracy, and modulation remain high quality and are completely specified while fast hopping to insure confident test results.

Flexible, High-Performance Modulation

For receiver measurements the HP 8645A offers independent or simultaneous FM and AM for both static and hopped frequency tests. The modulating signal can be the internal 0.1 Hz to 400 kHz synthesizer or an external input that allows FM deviations up to 20 MHz at rates up to 10 MHz. In Fast Hop operation, maximum deviation is 3.5 MHz with 10 MHz rates. AM is available with up to 100 kHz rates and 99% depth. Pulse modulation allows a 35 dB on/off ratio with 100 nsec rise/fall times.

Complete Control of Frequency Hopping

The HP 8645A offers flexible and comprehensive control of the frequency hopping output. Parameters can be entered from the front panel, through the HP-IB port or using TTL inputs on the rear panel. Extensive hopped frequency simulations including hop frequencies, amplitude, dwell times, hop rate, modulation, and so forth can be entered into nonvolatile memory from the front panel. Activating a hop sequence requires only a press of the Hop key. Agile control is available by a computer with the added advantage of using the new Hewlett-Packard Systems Language (HP-SL). For real-time control, rear-panel inputs accept TTL signals for triggering, dwell time, and frequency selection to allow direct connection with the hardware under test. With this wide choice of control, use of the HP 8645A can be readily customized to a wide variety of test situations from bench-top use to ATE systems.

HP 8645A Specifications

Frequency

Range: 251.46485 kHz to 1030 MHz; 251.46485 kHz to 2060 MHz with Option 002 or with HP 11845A 2 GHz Retrofit Kit installed
Frequency Bands: The exact endpoints of each frequency band can be determined by dividing the 1030 to 2060 MHz band by two for each band decrease. The specifications use approximate endpoints.
Phase Offset: Adjustable in 1 degree increments
Reference Oscillator Stability, Option 001: $<5 \times 10^{-10}$/day aging

Fast Hop Operation

Frequency Switching Time: 128 to 2060 MHz: <15 μsec, 8 to 2060 MHz: <85 μsec, 0.25 to 2060 MHz: <500 μsec. Opt. 002: add 5 μsec.
Frequency Hop Range: 0.25 to 2060 MHz. With FM on, limited to any three consecutive frequency bands.
Frequency Accuracy[1]: ± 2 ppm of carrier frequency
Amplitude Accuracy: ± 1 dB, > -127 dBm output
(± 1.5 dB, > -127 dBm output when amplitude level is varied up to -5 dB from the constant learned value during Fast Hop)
Channel and Sequence Tables: In Fast Hop, each specific frequency and amplitude to be output is entered into a Channel Table. The order of channels to be output is entered into a Sequence Table.
Maximum Number of Channels: 8000
Maximum Number of Channels in Sequence Table: 8000
Hop Rate Range: Fixed rates from 8 Hz to 50 kHz using internal timer. An external input allows more range and variable rates.
Dwell Time Range: Fixed times of 6.4 μsec to 99 msec using the internal timer. External input allows longer and variable dwell.
Learn Cycle Time: Typically, 10 sec. to 3.5 min., depending on sequence size
Fast Hop Bus: Allows real-time selection of any channel for output. Typically, frequency switching time increases by 5 μsec.
Modulation: Internal or external AM, FM, or simultaneous AM/FM
Output Level: Allowed amplitude variation of all channels entered is 0 to 20 dB. Output level is reduced by >60 dB while switching between channels. External dc AM can be used to shape the output.

Spectral Purity

SSB Phase Noise (CW, AM, or FM[2] operation):

Carrier Frequency (MHz)	Standard Operation		Fast Hop
	20 kHz (dBc/Hz)	100 kHz (dBc/Hz)	20 kHz (dBc/Hz)
1030 to 2060	−120	−127	−116
515 to 1030	−127	−134	−123
257 to 515	−132	−137	−128
128 to 257	−136	−140	−133
64 to 128	−139	−141	−137
32 to 64	−141	−141	−139
16 to 32	−142	−142	−141
8 to 16	−143	−143	−142
4 to 8	−144	−144	−143
Less than 4 MHz	−144	−144	−144

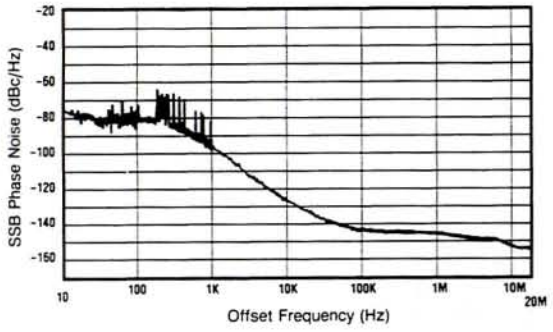
Harmonics: <-30 dBc, output ≤ 10 dBm. Opt 002, output >8 dBm: <-30 dBc, 0.25 to 1030 MHz; <-25 dBc, 1030 to 2060 MHz
Subharmonics: none, <515 MHz. <-60 dBc, 515 to 1030 MHz. <-40 dBc, >1030 to 2060 MHz
Nonharmonics: >20 kHz offset[3]: <-100 dBc, <2060 MHz. <-94 dBc, >1030 to 2060 MHz

[1]Typically, +2 ppm of carrier frequency multiplied by the temperature change in °C must be added if ambient temperature changes occur between the learn operation and the conclusion of frequency hopping. FM at minimum deviation.
[2]FM at minimum deviation.
[3]Typically, nonharmonic spurs at all offsets are <30 dB above the instrument's phase noise level as measured in a 1 Hz bandwidth.

Residual FM[1] (CW, AM, FM[2] operation):

Carrier Frequency (MHz)	Post Detection Bandwidth	
	0.3 to 3 kHz (Hz rms)	0.05 to 15 kHz (Hz rms)
0.25 to 257	<1	<1.2
257 to 515	<1.2	<2
515 to 1030	<2	<4
1030 to 2060	<4	<8

Typical SSB Phase Noise and Spurs at 1 GHz:



Residual AM: <0.01% AM rms, 0.3 to 3 kHz post detection BW
Typical SSB AM Noise Floor, Offsets >100 kHz: < −157 dBc/Hz at +16 dBm output, 0.25 to 1030 MHz. < −150 dBc/Hz at +13 dBm output, 1030 to 2060 MHz.

Output

Maximum Level: +16 dBm, 0.25 to 1030 MHz; Opt 002: +14 dBm, 0.25 to 1030 MHz. +13 dBm, above 1030 MHz.
Minimum Level: −137 dBm
Absolute Accuracy: ±1 dB, output ≥ −127 dBm
Reverse Power Protection: 50 watts from a 50 Ω source, 25 Vdc
Typical Third Order Intermodulation: < −50 dBc, outputs <8 dBm
Typical Output Level Overrange: 2 dB more than maximum level
Typical SWR and Output Impedance: <1.7:1, 50 Ω

Modulation

External Modulation Input: Coupling is ac or dc for AM, FM, and phase modulation. Pulse modulation input is dc coupled. Displayed deviation or depth corresponds to ±1V external input.
Simultaneous Modulation: AM/FM, AM/Phase, AM/Pulse, FM/Pulse, Phase/Pulse, AM/FM/Pulse, AM/Phase/Pulse
Simultaneous Internal/External Modulation: FM and Phase

Amplitude Modulation

Depth: 0 to 99.9%, for output < ±7 dBm
AM Indicator Accuracy: ±(6% of setting + 2%, AM), up to 90% depth and 1kHz rate for carrier frequencies >1 MHz. When amplitude level is varied up to −5 dB from the constant learned value during Fast Hop: ±(7% of setting + 1% AM) up to 80% depth, 1 kHz rate).
Distortion, at 400 Hz and 1 kHz Rates:

Depth	Carrier Frequency	
	0.25 to 1030 MHz	1030 to 2060 MHz
0 to 30%	<2%	<5%
30 to 70%	<3%	<5%
70 to 90%	<5%	<8%

3 dB Bandwidth[3]: >5 kHz, 0.25 to 8 MHz. >50 kHz, 8 to 128 MHz; >100 kHz, 128 to 2060 MHz
Incidental Phase Modulation: <0.2 rad peak, at 30% depth and 1 kHz
Typical External Input Impedance: 600 Ω

[1]Specified for 48 to 63 Hz power line. Typical for 400 Hz power line and Fast Hop operation.
[2]Deviation <0.1% of maximum available
[3]Lower 3 dB bandwidth limit is 0 Hz for dc coupling and typically 20 Hz for ac coupling.

Frequency Modulation

FM Deviation and Rate: In the highest frequency band of 1030 to 2060 MHz, the maximum FM peak deviation is 20 MHz for standard operation and 3.52 MHz for Fast Hop. Maximum FM rate (3 dB bandwidth) in the 515 to 1030 MHz band and above is 10 MHz. Divide rate and deviation by two for each frequency band decrease.
FM Indicator Accuracy: ±10%, <50 kHz rate and <10% of maximum deviation (<50% of maximum deviation in Fast Hop)
FM Distortion: Rates 20 Hz to 100 kHz: <2.7%, deviation <2% of maximum available (Fast Hop: <10% of maximum deviation)
Carrier Frequency Accuracy in FM: ±0.4% of deviation setting, ac or dc coupled. Typically add 1% of deviation in Fast Hop.
Incidental AM: <0.5%, deviation limited to <6% of max. or 20 kHz
Typical External FM Group Delay: 30 μs for rates 20 Hz to 20 kHz, decreases to <1 μs at rates >200 kHz. Fast Hop: <1 μs.
Typical External FM Input Impedance: 50 or 600 Ω

Pulse Modulation

On/Off Ratio: >35 dB
Rise/Fall Time: <100 nsec, between 10% and 90% response points
Maximum Pulse Repetition Frequency: 1 MHz
Minimum Pulse Width: 0.5 μs
Typical Output Level Accuracy: ±2 dB
Typical External Input Levels and Impedance: on: >3.0V peak; off: <0.8V peak. Damage level: ≥ ±10V peak. 600 Ω.

Internal Modulation Source

Waveforms: Sine, square, sawtooth, and white Gaussian noise
Frequency Range: Sine, white Gaussian noise: 0.1 Hz to 400 kHz. Square, sawtooth: 0.1 Hz to 50 kHz
Frequency Accuracy: Same as internal reference oscillator
Output Level: Typically, 1 V_{pk} max. into 600 Ω. Accuracy: ±20 mV.
Output Level Resolution: 2 mV. Typical impedance: 600 Ω.
Distortion: <0.1%, output at 1V peak and ≤15 kHz

Frequency Sweep

Phase Continuous Sweep: Linear sweep with times from 10 ms to 10 s, not dependent on span. Maximum span is 40 MHz from 1030 to 2060 MHz frequency band, divided by two for each band decrease.
Fast Hop Sweep: Linear or log stepped with times from 10 msec to 100 sec. Number of steps varies with time selected. Typical time per step is 30 μs for outputs within 128 to 2060 MHz, 170 μs for 8 to 2060 MHz, and 650 μs for 0.25 to 2060 MHz.
Sweep Control and Markers: X-axis: 0 to +10V. Z-axis: +5V retrace, +1V trace, 0V markers. Three markers available.

General

Remote Control: HP-IB (IEEE-488.2-1987). The control language used is the Hewlett-Packard Systems Language (HP-SL). All front-panel functions except power switch and knob. A unique Fast Hop bus interface accepts TTL levels for frequency agile control.
Operating Temperature Range: 0 to +55° F
Leakage: Meets Mil Std 461B RE02 and FTZ 1046
Storage Registers: 10 full function and 40 freq./ampl. locations
Memory Erasure: All memory contents according to Mil Std 380-380
Weight: Net, 31 kg (69 lbs); shipping, 42 kg (95 lbs)
Size: 177 mm H × 426 mm W × 624 mm D (7 in × 16.8 in × 24.6 in)

Ordering Information

	Price
HP 8645A Agile Signal Generator[4]	$36,195
Opt 001 High Stability Timebase	+$1,650
Opt 002 2 GHz Output	+$7,625
Opt 003 RF Connectors on Rear Panel Only	+$430
Opt 907 Front Handle Kit (5061-9690)	+$65
Opt 908 Rack Flange Kit (5061-9678)	+$35
Opt 909 Rack Flange Kit with Front Handles (5061-9684)	+$90
Opt 910 Provides an additional operation/calibration manual (08645-90023) and 2 service manuals (08645-90104)	+$190
Opt 915 Add Service Manual (08645-90104)	+$65
Opt W30 Extended Repair Service (see page 636)	+$800
08645-61116 Service Kit	$500
9211-2662 Transit Case	$550
1490-0913 Transit Case Wheels	$210
1494-0059 Non-Tilting Rack Slide Kit	$100
1494-0063 Tilting Rack Slide Kit	$190

[4]HP-IB cables not included. For description and price, see page 124.

For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office, see page 636.

SIGNAL GENERATORS

Frequency Agile/Complex Signal Simulation

HP 8791 Models 7, 10, 11, 21, 100, 200

- Advanced dynamic control
- 100-ns frequency agility
- 40-MHz instantaneous modulation bandwidth
- Arbitrary control over AM, FM, ΦM, pulse, and frequency hop
- Easy-to-use application-specific software
- Precise synthesized signal control
- Standalone or subsystem operation
- 40-GHz operation with optional upconverters
- Phase-coherent hopping

HP 8791 Model 21

Model 21 Frequency Agile Signal Simulator (0.05 to 18 GHz)
Model 11 Frequency Agile Signal Simulator (10 to 3000 MHz)
Model 7 Frequency Agile Signal Simulator (dc to 50 MHz)
Model 100 Precision Signal Generator (Instrument-on-a-Disk software)
Model 200 Radar Simulator (Instrument-on-a-Disk software)

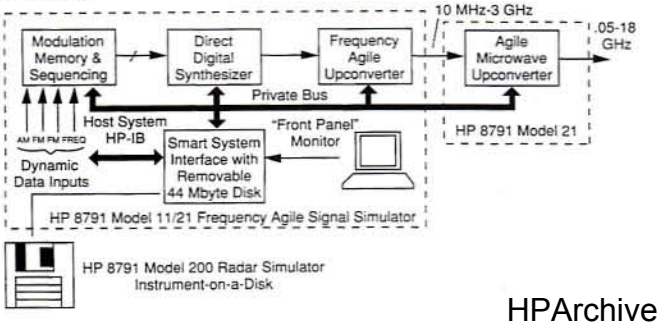
Exotic Test Signals for EW, Radar, and Communications

The new HP 8791 Model 21 Frequency Agile Signal Simulator (FASS) system generates exotic, agile test signals for advanced EW threat simulation, radar-target simulation, and secure communications test. Covering 0.05 to 18 GHz with 100-ns agility and a 40-MHz instantaneous modulation bandwidth, the system is capable of generating advanced spread-spectrum formats like chirps, Barker-coded pulses, maximal-length sequences, QAM, and FSK. Comprehensive application software on a 44-MB removable disk harnesses the power of FASS, giving the system an easy-to-use, mouse-driven front panel.

The application-specific Instrument-on-a-Disk (ID) software includes the HP 8791 Model 200 Radar Simulator, which features various intrapulse modulations and antenna scans, and the HP 8791 Model 100 Precision Signal Generator, which gives easy access to FASS's agile carrier, AM, FM, ΦM, and pulse modulation functions. Optional upconversion extends FASS coverage to 40 GHz.

Description

The Frequency Agile Signal Simulator uses high-speed memory, signal processing, digital-to-analog conversion, and direct digital and analog synthesis for precise signal simulation with unprecedented flexibility.



HP 8791 Model 200 Radar Simulator Instrument-on-a-Disk

The modulation data source's digital memory and sequencers store signal characteristics, namely carrier frequency hop patterns, amplitude, frequency, phase, and pulse modulation data. This data is supplied to the agile carrier synthesizer, where it is processed and converted to an analog signal made up of a carrier and its modulation. This 13.5- to 58-MHz signal is then translated to anywhere between 10 and 3000 MHz by the agile upconverter. A second agile upconverter, used in the HP 8791 Model 21 FASS, translates the signal between 0.05 and 18 GHz. The smart interface manages data flow and signal generation functions within FASS, as specified by inputs from its front panel or over HP-IB.

System Contributions

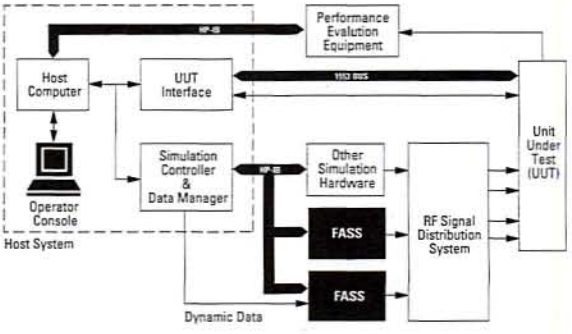
The Frequency Agile Signal Simulator is characterized by:

- High performance modulation and agility
- Instrument-grade, repeatable, accurate
- Easy-to-use, software reconfigurable user interface
- Low cost of ownership
- Off-the-shelf instrumentation

Application Overview

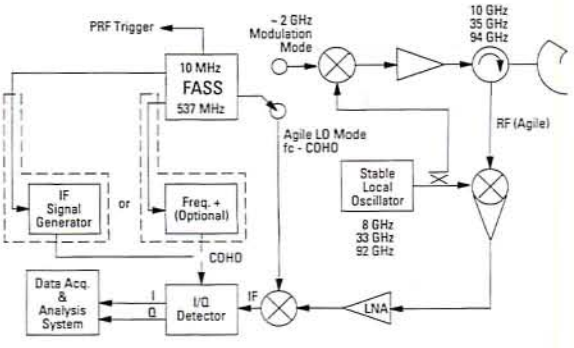
Electronic Warfare

FASS is ideal for simulating advanced threats with intrapulse modulation, PRI stagger, frequency agility, and antenna scan modulation. Being fully synthesized, FASS is especially well suited for pulse Doppler radar simulation.



Radar

FASS can simulate target returns for testing and calibrating radar receivers. FASS can also be used as a major subsystem for instrumentation radars, serving as a complex waveform exciter or a frequency agile STALO for coherent systems.



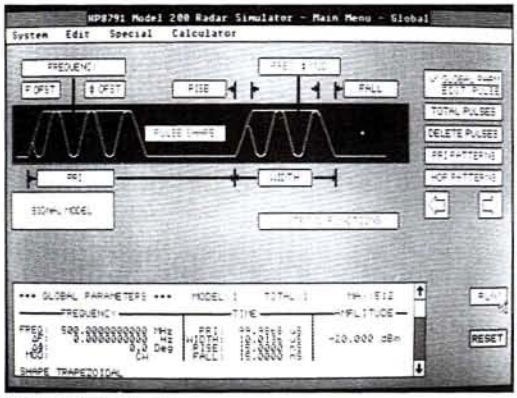
Communications

FASS can produce a variety of sophisticated agile signals useful for testing secure communication systems. Margin and tolerance testing can be accomplished by precisely adding distortion to ideal signals. In addition, common signals for testing sensitivity, bandwidth, frequency accuracy, selectivity, intermodulation, and distortion are readily available.

Modes of Operation

Instruments on a Disk (IDs)

Instruments on a Disk (IDs) make this otherwise complex system easy to use and give FASS the front panel personality of specific applications. By clicking clearly labeled softkeys with the mouse, users can select sophisticated signal characteristics like PRI stagger and antenna scan patterns.



HP 8791 Model 200 screen

Remote HP-IB

Remote HP-IB commands in FASS come in two varieties. There are the commands that simply mimic front-panel keystrokes of an ID and the general-purpose commands that give access to all the functions of FASS. Whichever set of standard HP-IB commands is used, integrating FASS's high-integrity, advanced signal simulation capability into an existing simulation system is very convenient.

Waveform Generation Language (WGL)

For advanced applications where existing ID software is insufficient, users can program FASS with the Waveform Generation Language (WGL) software. WGL could be used to generate a nonstandard signal such as a nonlinear chirp or a pulse with droop.

Dynamic Data/Dynamic Sequence

Dynamic data mode allows selective, external control of instantaneous frequency, FM, ΦM, and AM, as well as pulse modulation and level. In dynamic data mode, data maps are downloaded to the modulation data source's frequency and modulation memories. Dynamic data supplied at rates of up to 33 MHz addresses desired locations in memory. The output of FASS is determined by the values mapped at that location. Dynamic sequence allows external real-time selection of up to 1024 unique waveform sequences.

Performance Characteristics

HP 8791 Model 21 Frequency Agile Signal Simulator

Frequency
- **Range:** 0.05 to 18 GHz (to 40 GHz with upconversion)
- **Resolution:** 0.125 Hz
- **Switching speed:** < 100 ns typical over full 18 GHz BW

Amplitude
- **Fast level control switching speed:** <100 ns typical in 6.02 dB steps
- **Output power:** +10 to −107 dBm

Modulation Capabilities
- **Instantaneous bandwidth:** 40 MHz
- **Formats:** Arbitrary FM, ΦM, AM, Pulse, Frequency Hopping

Spectral Purity
- **Spurious response:** −55 dBc, typical
- **Phase noise:** < −110 dBc/Hz @ 10 kHz offset, 9.77 GHz, typical

Remote Operation

HP-IB compatible
- **Dynamic data:** AM, FM, ΦM, carrier frequency, pulse
- **Dynamic data rates:** Up to 33 megawords/sec/channel

General
- **Size:** Rack: 600 mm W × 1237 mm H × 803 mm D (23.6 in × 48.7 in × 31.6 in); consol: 754 mm W × 1064 mm H × 756 mm D (29.7 in × 41.9 in × 29.8 in)
- **Weight:** Shipping, rack 319 kg (700 lb); consol 75 kg (165 lb)

HP 8791 Model 11 Frequency Agile Signal Simulator

Frequency
- **Range:** 0.01 to 3 GHz (to 18.5 GHz with upconversion)
- **Resolution:** 0.125 Hz
- **Switching speed:** < 100 ns typical over full 3 GHz BW

Amplitude
- **Fast level control switching speed:** < 100 ns typical in 6.02 dB steps
- **Output power:** +10 to −107 dBm

Modulation Capabilities
- **Instantaneous bandwidth:** 40 MHz
- **Formats:** Arbitrary FM, ΦM, AM, Pulse, Frequency Hopping

Spectral Purity
- **Spurious response:** −55 dBc, typical
- **Phase noise:** < −125 dBc/Hz @ 10 kHz offset, 2 GHz, typical

Remote Operation

HP-IB compatible
- **Dynamic data:** AM, FM, ΦM, carrier frequency, pulse
- **Dynamic data rates:** Up to 33 megawords/sec/channel

General
- **Size:** Rack: 1237 mm H × 600 mm W × 803 mm D (48.7 in × 23.6 in × 31.6 in); consol: 1064 mm H × 754 mm W × 756 mm D (41.9 in × 29.7 in × 29.8 in)
- **Weight:** Shipping, rack 295 kg (650 lb); consol 75 kg (165 lb)

HP 8791 Model 100 Precision Signal Generator

The HP 8791 Model 100 Precision Signal Generator Instrument-on-a-Disk (PSID) software configures HP 8791 Model 11/21 FASS to be a precise signal generator with the modulation capabilities of an advanced waveform generator.

Carrier: Amplitude, phase, frequency

AM: Modulation index: 0 to 9999% (80 dB DSB-SC)
Modulation frequency: 0.0625 Hz to 20 MHz

PM: Peak phase deviation: 0° to 180°
Modulation frequency: 0.0625 Hz to 10 MHz
(upper limit dictated by 40-MHz modulation bandwidth)

FM: Frequency deviation: 0.125 Hz to 20 MHz
Modulation frequency: 0.0625 Hz to 10 MHz
(upper limit dictated by 40-MHz modulation bandwidth)

Modulation Waveforms
- **Sine:** AM, PM, FM
- **Rectangle:** 0 to 100% duty cycle AM (allows for pulse modulation)
- **Arbitrary user-defined:** ≤ 8192 points

HP 8791 Model 200 Radar Simulator

The Model 200 Radar Simulator Instrument-on-a-Disk (RSID) software configures HP 8791 Model 11/21 FASS to simulate advanced pulsed radar emitters.

Frequency Hopping: Constant, linear, scheduled, user-defined
Intrapulse Modulation: Coherent, noncoherent, chirp, Barker, user-defined
Pulse Width: 29.8 ns to 100 ms
Rise and Fall: 29.8 ns to 230 us
Pulse Shapes: Trapezoidal, Gaussian, exponential, user-defined
Pulse Repetition Frequency: 1 Hz to 625 kHz
PRF Patterns: Constant, burst, stagger, jitter, wobbulation, user-defined
Antenna Scan Rate: 4 to 100,000 RPM
Main Beam Width: 0.1 to 360°
Antenna Scan Patterns: Circular, conical, raster, sector, user-defined
Antenna Radiation Patterns: Rectangular, Hamming, Hanning, Blackman, 3-term, cosn, programmable

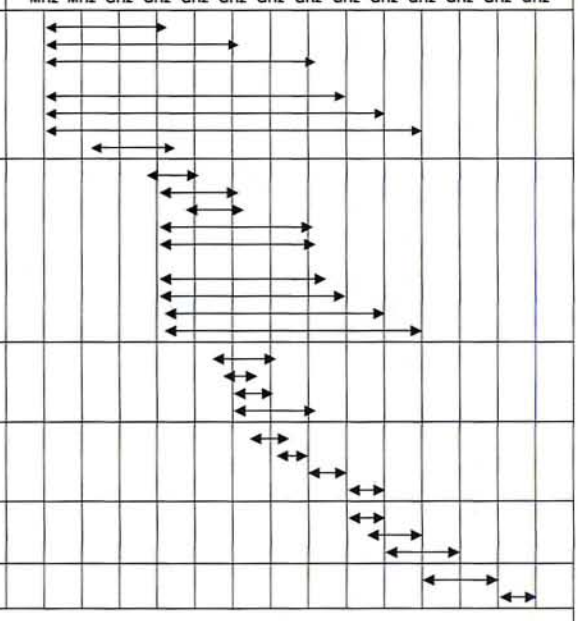
Ordering Information

	Price
HP 8791	
Model 21 Frequency Agile Signal Simulator (E2505A)	$360,000
Model 11 Frequency Agile Signal Simulator (E2500B)	$220,000
Model 10 Frequency Agile Signal Simulator (E2500A)	$150,000
Model 7 Frequency Agile Signal Simulator (E2500B Option 400)	$93,000
Model 100 Precision Signal Generator (E2502A)	$6,500
Model 200 Radar Simulator (E2501A)	$11,500

For the most current prices and product information, contact your local Hewlett-Packard sales office.

SWEEPERS
General Information

Frequency range[1]	Model Number: Synthesized sweepers[2]	HP 8350 Series	Other sweepers[2]
10 MHz to 2.4 GHz		HP 83522A	HP 86222A/B
10 MHz to 8.4 GHz		HP 83525A/B	
10 MHz to 20 GHz	HP 83620A, 83623A	HP 83592A/B/C	
10 MHz to 26.5 GHz	HP 83630A	HP 83595A/C	
10 MHz to 40 GHz	HP 83640A	HP 83597B	
10 MHz to 50 GHz	HP 83650A	HP 83599A	
300 MHz to 3 GHz	HP 8625A		
1.7 to 4.3 GHz			HP 86235A
2 to 8.4 GHz		HP 83540A/B	HP 86240A
3.6 to 8.6 GHz			HP 86240C
2 to 18.6 GHz			HP 86290B/C
2 to 20 GHz	HP 83622A/24A	HP 83590A	
2 to 22 GHz			HP 86290B Opt H08
2 to 26.5 GHz		HP 83594A	
2.4 to 40 GHz		HP 83596B	
2.4 to 50 GHz		HP 83598A	
5.9 to 12.4 GHz		HP 83545A	HP 86245A
7 to 11 GHz			HP 86250D Opt H08
8 to 12.4 GHz			HP 86250D
8 to 20 GHz		HP 83550A	
10 to 15.5 GHz			HP 8620B
12.4 to 18 GHz			HP 86260B
18 to 26.5 GHz		HP 83570A	
26.5 to 40 GHz		HP 83572C	
26.5 to 40 GHz[3]			HP 83554A
33 to 50 GHz[3]			HP 83555A
40 to 60 GHz[3]			HP 83556A
50 to 75 GHz[3]			HP 83557A
75 to 110 GHz[3]			HP 83558A



[1]Other special-frequency ranges can be provided upon request.
[2]HP 86200 Series RF plug-ins are usable with the HP 8350B mainframe via the HP 11869A adapter.
[3]The HP 83550 Series millimeter-wave source modules are frequently multipliers that require a +17 dBm microwave input. See page 424.

Sweepers

RF and microwave sweepers generate microwave signals over a continuous range for device or system response test. By eliminating point-by-point techniques, sweepers increase test speed and convenience while ensuring that critical information is not missed between frequency points.

Hewlett-Packard sweepers and synthesized sweepers feature frequency, modulation and power options to fit most applications, either alone or with HP network analyzers. All HP sweepers feature HP-IB programmability.

Applications

Sweepers are used extensively in component test applications using network analyzers, swept system testing, noise figure, mixer, and receiver testing, and a variety of other applications. High power and low harmonics ensure wide dynamic range while synthesized frequency accuracy (HP 8360, 8625 families) and leveled output power ensure high measurement accuracy.

Vector network analyzers are often used to characterize amplitude and phase (S-parameter) performance on devices or components; scalar network analyzers characterize amplitude only. In either case, HP sweepers ensure accurate measurement results and system compatibility.

Swept-frequency translation measurements on mixers and tuners are easily performed by phase-locking two HP sweepers to a stable reference source while sweeping across the IF band. Amplifier, mixer, and component noise figure measurements benefit from low broadband noise when HP sweepers are used for the local oscillator.

Other applications include swept radiated-susceptibility tests; antenna or radar cross-section tests; swept receiver tests; or other tests requiring accurate swept or CW microwave signals. The HP 8360 synthesized sweeper family adds signal-generator modulation capabilities to its sweeper functions to cover multi-application test needs.

HP Sweeper Families

Hewlett-Packard RF and microwave sweepers fall into several families to cover application needs from 0.01 to 110 GHz.

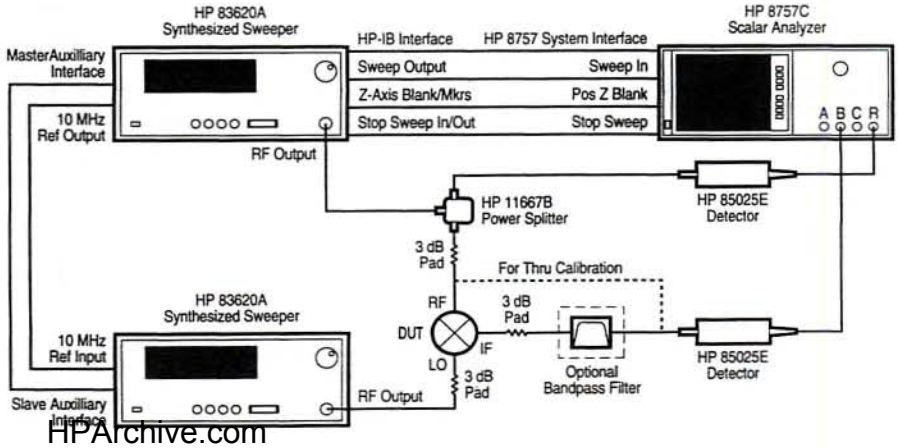
The versatile, high-performance HP 8360 synthesized sweeper family is the ideal multi-application source for general-purpose use. Covering 0.01 to 50 GHz in coax or 110 GHz in waveguide, the HP 8360 family features signal-generator modulation (AM, FM, pulse), high power, very low harmonics, and full compatibility with the HP 8510 vector network analyzer. The HP 8360 family offers options such as an internal modulation generator, fast pulse performance, internal attenuator, and 1-Hz frequency resolution.

The proven HP 8350 sweepers offer plug-in versatility and economy, scalar and vector network analyzer compatibility, microprocessor control, and YIG tuned-oscillator performance for swept and CW applications from 0.01 to 50 GHz. A wide variety of wide- and narrowband plug-ins are available for HP 8350 sweeper mainframes.

HP 8625 RF sweepers offer synthesized performance from 300 KHz to 3 GHz (extendable to 6 GHz), making them ideal for R&D or production swept tests, either alone or as a mixer test companion source with the HP 8753 network analyzer. High output power and synthesized frequency accuracy make the HP 8625 an excellent choice for scalar testing, amplifier or mixer compression testing, and fixed or swept-offset frequency mixer or tuner testing.

Accessories

HP sweepers are compatible with the HP 8355X Series millimeter wave modules (frequency multipliers) and the HP 834X amplifiers.



- 1 Hz frequency resolution (Option 008)
- Low spurious and phase noise
- +20 dBm to −110 dBm calibrated output
- Pulse, amplitude, and frequency modulation
- Complete analog sweeper
- ≤50 dBc harmonics 2.2 to 20 GHz

HP 83650A

DESIGNED FOR HP-IB SYSTEMS

HP 8360 Series Synthesized Sweepers

The HP 8360 Series synthesized sweepers are the standard of excellence for applications requiring the high performance and accuracy of a synthesized source and the speed and versatility of a sweep oscillator. The HP 8360 Series synthesized sweepers offer the same standard of commitment to quality and reliability that was embodied in the previous industry-standard HP 8340/8341.

Frequency Precision and Spectral Purity

The synthesized broadband frequency coverage and precise 1 Hz frequency resolution (Option 008) are generated by indirect synthesis, enabling the HP 8360 to achieve the same low single-sideband phase noise performance as the HP 8671B, the HP 8672A, and the HP 8673 Series synthesized signal generators.

The HP 8360 provides list and stepped frequency switching times as fast as 5 ms. In addition, the HP 8360 provides arbitrary CW switching times less than 50 ms.

Output Power

The HP 8360 provides output power between +20 dBm and −110 dBm (Option 001) with 0.02 dB resolution, and features power sweep capability with >20 dB dynamic range for complete characterization of level-sensitive devices.

≤50 dBc Harmonics

The HP 8360 delivers excellent harmonic performance, with harmonics at least 50 dB below the carrier from 2.2 to 20 GHz, and at least 35 dB below the carrier above 20 GHz.

Pulse, Scan, Amplitude, and Frequency Modulation

High-performance pulse modulators with >80 dB on/off ratio and rise/fall times <10 ns (Option 006) make the HP 8360 suitable for the most demanding pulse modulation applications.

In addition to its linear AM mode (100%/V), the HP 8360 offers a scan modulation mode (10 dB/V). Both of these modes provide dc-coupled amplitude modulation capability with a 3 dB bandwidth of 100 kHz, and 99.7% (50 dB) of modulation depth. Pulse and amplitude modulation capabilities can be used independently and simultaneously. The HP 8360 also offers dc-coupled frequency modulation capabilities with rates up to 8 MHz.

System Compatibility

Network Analysis

The HP 8360 Series includes three dedicated HP 8510 models that are preconfigured as the recommended sources for the HP 8510 vector network analyzer (Rev. 4.0+). They have rear-panel outputs, 1 Hz resolution, and no front panel. The ability of these sources to produce both narrow and broadband, analog, list, and step sweeps makes them the optimum sources for fast and comprehensive device characterization.

The HP 8360 is also compatible with the HP 8757C/E scalar network analyzers, and produces an internal 27.8 kHz square-wave signal for use with the HP 8757C/E AC detection mode.

In addition, five flexible markers, along with useful marker functions such as marker sweep, marker to center frequency, and marker delta, simplify swept device testing.

HP 8970 Noise Figure Systems

High output power and low broadband noise make the HP 8360 the optimum source for the HP 8970 noise figure systems.

Millimeter-Wave Source Systems

When driven by an HP 8360, the HP 8355X Series millimeter-wave source modules provide millimeter-wave test signals from 26.5 to 110 GHz.

HP 85301 Antenna Systems

The broadband frequency coverage and 5 ms/point switching speed of the HP 8360 make it the ideal source for the HP 85301A antenna measurement systems.

SWEEPERS

Model 8350 Series, 10 MHz to 50 GHz

HP 8350 Series

- Versatile microprocessor-controlled mainframe
- Single-band, straddle-band, and broadband plug-ins
- 10 MHz to 50 GHz from a single plug-in
- 13 dBm output power to 26.5 GHz
- Total HP-IB programmability
- Waveguide frequency coverage up to 110 GHz

DESIGNED FOR HP-IB SYSTEMS

HP 8350B Mainframe with HP 83599A RF Plug-in

HP 8350 System

The HP 8350 is a powerful general-purpose source for swept microwave measurements, CW signal generation, and automatic testing. It incorporates the efficiency of microprocessor control with YIG-tuned oscillators and GaAs FET amplifiers to produce a high-performance sweeper system suited for either manual or automatic measurements. When the HP 8350 mainframe is combined with any of the 20 versatile HP 83500 Series RF plug-ins, the source can easily be configured to meet the frequency and/or power requirements of a specific application. The HP 8350 mainframe accepts both the HP 83500 Series plug-ins and the HP 86200 Series plug-ins (via the HP 11869A adapter).

HP 8350 Mainframe

The HP 8350 mainframe has been designed to include many features that simplify or increase the productivity of the measurement system. Five independent, continuously variable markers accurately and efficiently identify critical test frequencies. The marker sweep function, which zooms in on a specific frequency span, allows modification of the output frequencies without changing the original sweep limits. Repetitive measurements can be quickly and easily set up, with the nine save/recall registers that store complete front panel settings in nonvolatile memory locations. The HP 8350 can also alternate between two different front panel settings (that is, frequency span or output power) on successive sweeps. When this alternate sweep function is used with an HP 8757 scalar analyzer the response of the test device under the two different test conditions can be displayed simultaneously.

All front-panel controls of the HP 8350 mainframe and the HP 83500 Series RF plug-ins (except the ac line switch) may be programmed or controlled via HP-IB. The HP 8350 is compatible with the HP 8510 network analyzers and the HP 8757 scalar analyzers for convenient vector and scalar measurements. The HP 5343A counter can be combined with the HP 8350 to measure start, stop, or marker frequencies with up to 100 kHz accuracy while sweeping. Microwave noise figure measurements can be made using the HP 8350 with the HP 8970 noise figure meter. In addition, the HP 8350 mainframe with the appropriate RF plug-in, can drive the HP 83550 Series mm-wave source modules to provide frequency coverage up to 110 GHz in waveguide.

RF Plug-ins

The HP 83500 Series RF plug-ins offer a wide range of frequency coverage and output power capabilities to match a variety of application requirements (see the RF plug-in summary). For example, the HP 83599A covers the entire 10 MHz to 50 GHz range in coax, offering +10 dBm output power with < -45 dBc harmonics from 1.5 to 20 GHz and 0 dBm with < -35 dBc harmonics at 50 GHz. The HP 83595C spans the 10 MHz to 26.5 GHz range with < -50 dBc harmonics and +10 dBm output power (+13 dBm up to 20 GHz). All this performance is complimented by excellent frequency accuracy and stability. Other RF plug-ins provide banded frequency coverage, such as the HP 83522A (.01 to 2.4 GHz), the HP 83525A/B (.01 to 8.4 GHz) and the HP 83570A, which covers 18 to 26.5 GHz in waveguide.

All HP 83500 Series RF plug-ins are internally leveled[1], providing calibrated output power levels with 0.1 dB resolution and up to 80 dB range (with Option 002, step attenuator). External leveling may also be achieved with an external coupler or a number of HP power meters. Calibrated power sweeps are available for characterizing device performance as a function of power. Power may also be increased with frequency to compensate for cable losses in the measurement system, with the power slope feature. The calibrated range of these features is dependent on the maximum and minimum output power capabilities of the individual plug-ins.

Frequency coverage up to 110 GHz can be achieved in waveguide with the HP 83550A RF plug-in and one of the HP 83550 Series mm-wave source modules. The HP 83550A plug-in has a built-in source module interface and delivers +20 dBm output power from 8 to 18.6 GHz, and +18 dBm from 18.6 to 20 GHz. Other HP 83590 Series RF plug-ins can also drive the HP 83550 Series source modules via the HP 8349 microwave amplifier. With 20 HP 83500 Series RF plug-ins to choose from, it is easy to match their performance to specific application requirements.

Combining HP 86200 Series plug-ins with an HP 11869A adapter makes all the convenient digital controls, markers, and HP-IB capability of the HP 8350 immediately available. The following page lists all the HP 86200 Series plug-ins that are compatible with the HP 8350 via the HP 11869A adapter.

HP 8350 Operating Characteristics

Refer to RF plug-in specifications to determine the system's performance.

Frequency Control Modes

Start/stop sweep: Sweeps start to stop
CF/ΔF: Sweeps upward within span centered on CF
CW: Single frequency RF output
Frequency offset: Allows the CW or center frequency to be offset by up to the full range of the plug-in

Frequency Resolution

CW/CF: 0.00038% (262,144 points across band)
ΔF: 0.1% of full band (1,024 points across band)
Marker: 0.4% of selected sweep width (256 points/sweep)
Display: 5 digits

Instrument State Storage

Save n/recall n: Nine front-panel settings
Alt n: Causes the RF output to alternate on successive sweeps between the current front panel setting and a setting stored in memory

[1] The HP 83572C offers only optional external leveling (Option 001).

Sweep and Trigger Modes
Internal: Sweep recurs automatically
Line: Sweep triggered by ac power line frequency
External trigger: Sweep actuated by external trigger signal
Single: Select and trigger a single sweep
Sweep time: Continuously adjustable from 10 ms to 100 s
Manual sweep: Continuously adjustable within sweep range
External sweep: Sweep controlled by signal at Swp Out/Swp In connector
Sweep output: Direct-coupled output, 0 to +10 V, concurrent with swept RF output

Remote Programming
The HP 8350B has both input and output capabilities. All front-panel controls are programmable except for the ac line switch.
HP-IB interface functions: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0, E1

General Specifications

Nonvolatile Memory: Retains contents of storage registers, HP-IB address, and current instrument state when ac line power is off
Operating Temperatures: 0 to 55° C
Power: 100, 120, 220, or 240 V ±10%, 50 to 60 Hz.
Approximately 375 V-A including RF plug-in.
Weight (without RF unit): Net, 16.5 kg (36.4 lb); shipping, 22.7 kg (50 lb)
Size: 425 mm W × 133.3 mm H × 422 mm D (16.75 in × 5.25 in × 16.6 in)

Ordering Information

	Price
HP 8350B Sweeper Mainframe	$5,400
Opt 400 60 to 400 Hz Fan	+$200
Opt 803 HP 5343A Interface Cables	+$60
Opt 910 Extra Manual	+$80
Opt W30 Extended Repair Service (see page 636)	+$125
Opt W32 Calibration Service (see page 637)	+$305

HP 11869A Adapter

The HP 11869A adapter provides the electrical and mechanical interface between the HP 8350 and 86200 Series plug-ins. All of the HP 8350's standard operating features, including HP-IB remote programming, are available. However, specific plug-in functions (output power level, RF on/off, and so on) cannot be controlled or remotely programmed by the HP 8350 mainframe.

Plug-ins Compatible with the HP 11869A Adapter

The following plug-ins will operate with HP 8350 when the HP 11869A adapter is attached to the back. The adapter is equipped with a switch to set the specific interface code for the plug-in in use.

HP 86220A[1,2]	HP 86240A/B[2]/C	(HP 86250A[1]/B[1]/C/D)[2]
HP 86222A[2]/B	HP 86241A[1,2]	HP 86251A[2,3]
HP 86230B[1,2]	(HP 86242A[1]/C/D)[2]	(HP 86260A/B[3]/C[3])[1,2]
HP 86235A	HP 86245A	(HP 86290A/B/C)[2]

Ordering Information

	Price
HP 11869A Adapter	$800
Opt 004 Extension Cables for Plug-Ins with Rear-Panel RF Output	+$200
Opt 006 Type-N Aux Out Interface Connector for HP 86251A and HP 86290A/B/C	+$200
Opt W30 Extended Repair Service (see page 636)	+$45

[1] Not compatible with 27.8 kHz square wave modulation
[2] Models HP 86220A, 86222A, 86230B, 86240B, 86241A, 86242A/C/D, 86250A/B/C/D, 86251A, 86260A/B/C, and 86290A/B/C are obsolete.
[3] Requires the special PROM that was shipped with the HP 86251A or 86260B/C for use with the HP 11869A.

RF Plug-In Summary

	Model number	Frequency range (GHz)	Leveled power output (dBm)	CW frequency accuracy (MHz)	Complete specifications on page
Broad-band plug-ins	HP 83599A	0.01 to 50	0[1]	±25	428
	HP 83598A	2.4 to 50	0[1]	±25	428
	HP 83597B	0.01 to 40	3[1]	±25	428
	HP 83596B	2.4 to 40	3[1]	±25	428
	HP 83595A	0.01 to 26.5	4	±12	428
	HP 83595C	0.01 to 26.5	10[2]	±12	428
	HP 83594A	2 to 26.5	4	±12	428
	HP 83592A/B	0.01 to 20	10[2]	±10	428
	HP 83592C	0.01 to 20	4	±10	428
	HP 83590A	2 to 20	10	±10	428
	HP 83525A/B	0.01 to 8.4	13/10	±12	430
	HP 83522A	0.01 to 2.4	13	±5	430
Straddle-band plug-ins	HP 83540A/B	2 to 8.4	16/13	±12	430
	HP 83550A	8.0 to 20.0	18[3]	±20	430
Single-band plug-ins	HP 83545A	5.9 to 12.4	17	±20	430
	HP 83570A	18 to 26.5	10	±30	430
	HP 83572C	26.5 to 40	6 (Opt 001)[4]	±100	430

Note: The HP 11869A adapter is required to interface HP 86200 Series plug-ins with the HP 8350B mainframe.
[1] The HP 83599A/83598A and HP 83597B/83596B offer 10 dBm to 20 GHz.
[2] The HP 83595C and HP 83592B provide 13 dBm to 20 GHz and 18.6 GHz respectively.
[3] The HP 83550A provides 20 dBm to 18.6 GHz.
[4] Standard HP 83572Cs are unleveled, Option 001 provides an external coupler.

SWEEPERS

Broadband RF Plug-Ins

HP 8350 Series

- 10 MHz to 50 GHz frequency coverage in coax
- +13 dBm to 20 GHz
- 12 MHz frequency accuracy to 26.5 GHz
- −55 dBc harmonics and subharmonics from 3.5 to 20 GHz

DESIGNED FOR HP-IB SYSTEMS

HP 83592C Broadband RF Plug-In

DESIGNED FOR HP-IB SYSTEMS

HP 83599A Broadband RF Plug-In

HP 83590 Series Plug-Ins

Wideband frequency coverage, high output power, and a versatile feature set make the HP 83590 Series plug-ins excellent choices for a variety of application requirements. They all offer flat output power, calibrated over a range of at least 9 dB (some as high as 22 dB). The range may be fully utilized with the power sweep and slope features, with a digitally displayed resolution of 0.1 dB. Full HP-IB programmability, as well as compatibility with a variety of equipment, enhances the usefulness of HP 83590 Series plug-ins in automatic test environments.

The HP 83599A and HP 83598A RF plug-ins provide the highest performance and reliability available up to 50 GHz, from an open-loop sweeper. The HP 83597B and HP 83596B offer the same performance and reliability to 40 GHz. These high-frequency plug-ins provide high output power (10 dBm below 20 GHz) and low harmonics (less than −40 dBc above 1.5 GHz) in coax with the 2.4-mm connector. The 2.4-mm connector features ruggedness, repeatable performance, and excellent match across the entire frequency range. In addition, the 40 and 50 GHz plug-ins offer a high-power mode that is switch selectable. This mode provides 15 dBm leveled output power with less than −20 dBc harmonics from 2.4 to 20 GHz.

HP 83595C plug-ins feature +13 dBm output power to 20 GHz and +10 dBm to 26.5 GHz, with less than −50 dBc harmonics above 2.4 GHz. HP 83592C plug-ins offer less than −50 dBc harmonics above 2.4 GHz and less than −55 dBc harmonics above 7 GHz. HP 83592B plug-ins feature +13 dBm output power to 18.6 GHz. The performance of all these products is achieved over a broad frequency range, without sacrificing narrowband precision.

Broadband swept scalar measurements are easy to achieve with HP 8757 scalar analyzers. The high output power and low harmonic performance of various plug-ins with an HP 8350B mainframe provide high-measurement dynamic range for passive devices such as isolators and filters. These plug-ins are also useful as a local oscillator for mixer characterization or with an HP 8970 noise figure meter for downconverting high-frequency signals to intermediate frequencies for noise figure measurements of active devices. Compatibility with the HP 83550 Series millimeter-wave modules makes it easy to configure waveguide measurement systems up to 110 GHz.

Other Output Characteristics

Minimum Settable Power: −5 dBm
HP 83592B/95C only: −2 dBm
HP 83596B/97B/98A/99A only: −12 dBm
Source Output VSWR (50 Ω nominal), typical: <1.9
HP 83596B/97B/98A/99A only: <2.0
Externally Leveled Power Variation (typical)
Crystal detector or power meter[1]: ±0.2 dB
With temperature: ±0.1 dB/°C
Power Sweep
Range: >12 dB
HP 83592C/94A/95A only: >9 dB
HP 83596B/97B/98A/99A only: >12 dB (22 dB < 20 GHz)
Accuracy (including linearity): ±1.5 dB, typical
Resolution (displayed): 0.1 dB
Power Slope
Range (depends on power sweep range): 0–5 dB/GHz
Linearity, typical: 0.2 dB
Resolution (displayed): 0.01 dB/GHz

Modulation Characteristics

External AM (typical)
Frequency response: 100 kHz
Control range: 15 dB
Sensitivity: 1 dB/V
Internal Square-Wave Modulation: 1 kHz or 27.8 kHz square wave
On/off ratio: >30 dB
External Pulse Modulation (typical)
Rise/fall time: ≤50 ns
Min pulse width:
Internally leveled: ≤5 μs
Unleveled: ≤200 ns
HP 83596B/97B/98A/99A only: ≤1 μs
External FM
Max deviations for modulation frequencies
dc to 100 Hz: ±75 MHz
100 Hz to 1 MHz: ±7 MHz
1 MHz to 2 MHz: ±5 MHz
2 MHz to 10 MHz: ±1 MHz
Sensitivity: −20 or −6 MHz/V

General Specifications

Display Resolution (power): 0.1 dB
Minimum Sweep Time
Single band: 10 ms
HP 83596B/97B/98A/99A only: 30 ms
Full band:
HP 83590A, 83592A/B: 25 ms
HP 83592C: 35 ms
HP 83594A, 83595A/C: 30 ms
HP 83596B/97B/98A/99A: <20 GHz: 75 ms
>20 GHz: 150 ms
Auxiliary Output (rear panel): 2.0/2.3 to 7 GHz fundamental oscillator, nominally 0 dBm
Frequency Reference Output (switch selectable):
1 V/GHz ±25 mV (to 18 GHz) or 0.5 V/GHz ±25 mV (full span)
HP 83596B/97B/98A/99A
0.5 V/GHz (to 38 GHz) or 0.25 V/GHz (full span)
±[25 mV (<2.4 GHz) or 100 mV (>2.4 GHz)]
RF Output Connector
HP 83590A/92A/92B/92C: Type N, female
HP 83594A/95A/95C: 3.5 mm, male
HP 83596B/97B/98A/99A: 2.4 mm, male
Weight: Net, 6.0 kg (13.2 lb); shipping, 9.2 kg (20 lb)
HP 83596B/97B/98A/99A: Net, 6.5 kg (14.4 lb); shipping, 9.5 kg (21 lb)

[1]Sweep times are typically >10 s and ≥5 s/GHz.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 83590A, 83592A/B/C, 83594A, 83595A/C Specifications

	Band 0	Band 1	Band 2	Band 3	Band 4	Full Band
Frequency Characteristics						
Range (GHz)						
HP 83590A		2.0–7.0	7.0–13.5	13.5–20	—	2.0–20
HP 83592A/B/C	0.01–2.4	2.4–7.0	7.0–13.5	13.5–20	—	0.01–20
HP 83594A		2.0–7.0	7.0–13.5	13.5–20	20–26.5	2.0–26.5
HP 83595A/C	0.01–2.4	2.4–7.0	7.0–13.5	13.5–20	20–26.5	0.01–26.5
Accuracy (MHz, 25 ±5° C)						
CW mode	±5	±5	±10	±10	±12	
All sweep modes (sweep times > 100 ms)	±15	±20	±25	±30	±35	±50
Linearity (MHz), typical	±2	±2	±4	±6	±10	
Stability, typical						
With temperature (kHz/° C)	±200	±200	±400	±600	±800	
With time[1] (kHz, in a 10-min period)	±100	±100	±200	±300	±400	
Residual FM, kHz peak (10-Hz–10-kHz BW)	<5	<5	<7	<9	<12	
Output Characteristics (25 ±5° C)						
Maximum leveled power (dBm, internally leveled)						
HP 83590A/83592A	10	10	10	10	—	10
HP 83592B	13	13	13	10	—	10
HP 83592C	10	6	6	4	—	4
HP 83594A, 83595A	10	10	10	10	4	4
HP 83595C	13	13	13	13	10	10
Power level accuracy[2] (dB)	±1.5	±1.3	±1.3	±1.4	±1.7	±1.5 (1.8)[3]
Power variation (dB, max specified power)	±0.9	±0.7	±0.7	±0.8	±0.9	±0.9 (1.0)[3]
Spurious signals (dBc, max specified power)						
Harmonics						
HP 83590A/83592A/B	<−25[4]	<−25	<−25	<−25	—	<−25[4]
HP 83592C	<−25	<−50	<−55	<−55	—	<−25
HP 83594A/83595A	<−25	<−25	<−25	<−25	<−20	<−20
HP 83595C	<−25	<−50	<−50	<−50	<−50	<−25
Nonharmonics	<−25	<−50	<−50	<−50	<−50	<−25

HP 83596B, 83597B, 83598A, 83599A Specifications

	Band 0	Band 1	Band 2	Band 3	Band 4	Full Band
Frequency Characteristics						
Range (GHz)						
HP 83596B		2.4–7.0	7.0–14	14–26.5	26.5–40	2.4–40
HP 83597B	0.01–2.4	2.4–7.0	7.0–14	14–26.5	26.5–40	0.01–40
HP 83598A		2.4–7.0	7.0–14	14–26.5	26.5–50	2.4–50
HP 83599A	0.01–2.4	2.4–7.0	7.0–14	14–26.5	26.5–50	0.01–50
Accuracy (MHz, 25 ±5° C)						
CW mode	±5	±5	±10	±20	±25	
All sweep modes (sweep time > 100 ms)	±15	±20	±25	±50	±65	±100
Linearity (MHz), typical	±2	±2	±4	±10	±20	±20
Stability, typical						
With temperature (kHz/° C)	±200	±200	±400	±800	±1600	
With time[1] (kHz, in a 10 min. period)	±100	±100	±200	±400	±800	
Residual FM, kHz peak (10 Hz–10 kHz BW)	<5	<5	<7	<14	<24	
Output Characteristics (25 ±5° C)						
Maximum leveled power (dBm, internally leveled)						
HP 83596B/83597B	10	10	10	10 (5 > 20 GHz)	5	5
HP 83598A/83599A	10	10	10	10 (5 > 20 GHz)	3 (0 > 40 GHz)	3 (0 > 40 GHz)
[High power][5] (switch selectable)		[15]	[15]	[15]		
Power level accuracy[2] (dB)	±1.5	±1.3	±1.3	±1.4	±2.2	±2.2
Power variation (dB, max specified power)	±0.9	±0.7	±0.7	±0.8	±1.4	±1.5
Spurious signals (dBc, max specified power)						
Harmonics and Subharmonics	<−25	<−45	<−45	<−40	<−40	<−25
	<−50 > 1.5 GHz	[<−20][5]	[<−20][5]	[<−20][5]	<−35 > 40 GHz	
Nonharmonics	<−25	<−50	<−50	<−50	<−50	<−25

[1]After 1-hour warmup at selected CW frequency. [2]Includes power level variations. [3]HP 83594A, 83595A/C only.
[4]HP 83592B harmonics are specified at <−20 dBc below 2.4 GHz, typically <−27 dBc. [5]Performance unique to high-power mode (2.4 to 20 GHz) are in brackets.

RF Plug-In Ordering Information

	Price
HP 83590A 2.0 to 20 GHz	$16,500
HP 83592A 0.01 to 20 GHz	$19,000
HP 83592B 0.01 to 20 GHz (high power)	$21,100
HP 83592C 0.01 to 20 GHz (low harmonics)	$21,100
HP 83594A 2 to 26.5 GHz	$23,400
HP 83595A 0.01 to 26.5 GHz	$25,300
HP 83595C 0.01 to 26.5 GHz (high power, low harmonics)	$27,900
HP 83596B 2 to 40 GHz	$30,500
HP 83597B 0.01 to 40 GHz	$34,000
HP 83598A 2 to 50 GHz	$33,500
HP 83599A 0.01 to 50 GHz	$37,000
Opt 002 Step Attenuator	
HP 83590A, 83592A/B, 70 dB	+$1,500
HP 83592C, 83594A, 83595A, 55 dB	+$1,500
HP 83595C, 60 dB	+$1,800
HP 83596B, 83597B, 83598A, 83599A, 60 dB	+$2,700
Opt 004 Rear Panel RF Output	+$200
Opt W30 Extended Repair Service (see page 636)	See HP 8350B ordering guide
Opt W32 Calibration Service (see page 636)	

SWEEPERS
Model 8350 Series: RF, Plug-Ins
HP 83500 Series

HP 83500 Series plug-ins: Specifications summary	Broadband			Straddle-band			Single-band		
	HP 83522A[1]	HP 83525A[1]	HP 83525B[1]	HP 83540A	HP 83540B	HP 83550A	HP 83545A	HP 83570A[2]	HP 83572C[3]
Frequency characteristics									
Range (GHz)	0.01 to 2.4	0.01 to 8.4	0.01 to 8.4	2 to 8.4	2 to 8.4	8 to 20	5.9 to 12.4	18 to 26.5	26.5 to 40
Accuracy (MHz, 25° C)									
CW Mode	±5	±12[4]	±12[4]	±12	±12	±20	±20	±30	±100
All Sweep Modes (sweep time > 100 ms)	±15	±20[4]	±20[4]	±20	±20	±50	±35	±55	±150
Residual FM									
(kHz peak, 10 Hz to 10 kHz bandwidth)	<5	<7[4]	<7[4]	<7	<7	<25[13]	<15	<30	<60
Output characteristics									
Maximum Leveled Power (dBm, 25° C)	>13	>13	>10	>16	>13	>20[5]	>17	>10	>7[6]
Power Level Accuracy (dB)									
Internally Leveled	±1	±1.5	±1.5	±1.5	±1.5	±1.5	±1	±1.8	±1.5[7]
Power Variation (dB, at max specified power)									
Internally Leveled	±0.25	±1	±1	±1	±1	±1.25	±0.6	±1.4	±3[8]
Externally Leveled, Typical									
(excluding coupler/detector variations)	±0.1	±0.1	±0.1	±0.1	±0.1	±0.1	±0.1	±0.1	±0.2[7]
Spurious Signals (dBc, at max specified power)									
Harmonically Related	< −25	< −20	< −45[4]	< −20	< −45	< −20[9]	< −30[10]	< −25	< −20
Non-Harmonics	< −25	< −60[8]	< −60[8]	< −60	< −60	< −50	< −60	< −50	< −50
Source SWR, Typical									
(50 Ω nominal, internally leveled)	<1.5	<1.6[5]	<1.6[5]	<1.6	<1.6	<2.5	<1.6	<2.5	<1.3[7]
Modulation characteristics									
External Pulse, Typical									
Rise/Fall Time (ns)	n/a	20[4]	20[4]	20	20	25	15	20	300/50[11]
Minimum RF Pulse Width									
Leveled (μs)	n/a	1[4]	1[4]	1	5	1	1	1	n/a
Unleveled (ns)	n/a	100[4]	100[4]	100	100	100	100	100	500[11]
External FM									
Maximum Deviation (MHz)									
DC to 100 Hz Rates	±75	±75	±75	±75	±75	±75	±75	±75	±150
100 Hz to 200 kHz Rates	±7	±7	±7	±7	±7	±12	±7	±7	±7
200 kHz to 1 MHz Rates	±7	±7	±7	±7	±7	±12	±7	±7	±7
1 to 2 MHz Rates	±5	±5	±5	±5	±5	±12	±5	±5	n/a
2 to 6 MHz Rates	±1	±1	±1	±1	±1	±12	±1	±1	n/a
6 to 10 MHz Rates	±1	±1	±1	±1	±1		±1	±1	
Sensitivity (MHz/volt), Typical	−20/−6	−20/−6	−20/−6	−20/−6	−20/−6	−20/−6	−20/−6	−20/−6	−20/−6
External AM									
Frequency Response (kHz), Typical	100	100	100	100	100	100	100	100	10
Range (dB), typical	>15	>15	>15	>15	>15	>20	>15	>11	>11[7]
Sensitivity (dB/volts)	+1	+1	+1	+1	+1	+1	+1	+1	+1[7]
Internal AM (1 kHz/27.8 kHz square wave)									
On/Off Ratio (dB)	>30	>30	>30	>30	>30	>30	>40	>25	>20[11]
Prices									
Plug-in	$8,800	$13,800	$15,000	$10,200	$11,400	$17,200	$10,700	$13,800	$19,900
With Opt 001 (Calibrated External Leveling)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	+$1,600
With Opt 002 (70 dB Attenuator)	+$1,005	+$1,105	+$1,105	+$1,105	+$1,105	+$1,305[12]	+$1,105	n/a	n/a
With Opt 004 (Rear Panel RF Output)	+$200	+$200	+$200	+$200	+$200	+$200	+$200	n/a	n/a
With Opt 006 Int. Sq. Wave Mod. & Ext. Pulse Mod.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	+$1,800
With Opt W30 (Two Years Extended Service)	+$190	+$285	+$285	+$215	+$215	+$380	+$250	+$320	+$425
With Opt W32 Calibration Service (see page 636)	+$810	+$690	+$810	+$665	+$525	+$1,075	+$690	+$690	+$835

[1] Enhanced frequency accuracy is provided by internal crystal markers of 10 MHz and 50 MHz (over full range for HP 83522A, and below 2 GHz for HP 83525A/B). 1 MHz harmonic markers are available below 1 GHz.
[2] WR42 waveguide RF output connector type
[3] WR28 waveguide RF output connector type
[4] Specifications apply from 2 to 8.4 GHz only. 0.01 to 2 GHz specifications are the same as for the HP 83522A plug-in.
[5] 18 dBm from 18.6 to 20 GHz
[6] Unleveled output power
[7] Externally leveled (requires Option 001 which consists of a calibrated crystal detector, external coupler, and BNC cable)
[8] Specifications apply only from 2 to 8.4 GHz; below 2 GHz non-harmonics are < − 30 dBc and SWR is < 2.0.
[9] − 15 dBc from 8 to 11 GHz
[10] − 17 dBc from 5.9 to 7 GHz
[11] Requires Option 006, which provides internal square-wave modulation and external pulse and square-wave modulation capabilities.
[12] 50 dB step attenuator
[13] 20 Hz to 15 kHz bandwidth

- Broad 300 kHz to 6 GHz frequency coverage
- +20 dBm output power available to 3 GHz
- 1-Hz frequency resolution
- Synthesized ramp and step sweep modes

DESIGNED FOR HP-IB SYSTEMS

HP 8625A Synthesized RF Sweeper

The HP 8625A synthesized RF sweeper is a powerful general-purpose source for research & development and production test areas. With broad 300 kHz to 3 GHz frequency coverage, extendable to 6 GHz with Option 1EG, the HP 8625A is an excellent stimulus for RF component tests.

Precise measurements can be achieved with synthesized frequency accuracy, resolution, and stability in analog, stepped sweep, or CW measurement modes. High-level mixers and amplifiers can easily be driven with +20 dBm output power. The power may also be reduced to −75 dBm for power-sensitive devices with Option 1E1.

The HP 8625A is particularly suited for frequency translation device characterization. Fully compatible with the HP 8753C (rev. 4.1 or higher) vector network analyzer, the HP 8625A/8753C use a dedicated source/analyzer interface to provide synergistic performance for frequency converter measurements. This interface allows the HP 8625A to track the internal source of the HP 8753C, and provides direct control of the source's parameters from the front panel of the analyzer. To upgrade existing HP 8753C systems, order the HP 86387B mixer measurement upgrade kit.

The HP 8625A is also an excellent stimulus for scalar detector/display type measurement systems, such as those based on an oscilloscope or scalar analyzer. Sweep out and blanking control lines are provided for analog and step sweep measurements. Five versatile markers can be used to quickly identify critical test frequencies. Two HP 8625As can also track one another to provide two signals with a fixed or swept offset.

Specifications

Frequency Characteristics
Range: 300 kHz to 3 GHz
3 MHz to 6 GHz (with Option 1EG)
Resolution: 1 Hz

CW Mode
Accuracy: ±10 ppm
Stability: ±7.5 ppm, ±3 ppm/year; typical (0° to 55° C)

Sweep Modes: Start/Stop, CF/Span, Marker Sweep
Linearity: ±1% of frequency span, typical
Width: 100 Hz to full span
Time: 20 ms to 100 s

Stepped Sweeps
Number of points: 5 to 1601
Switching time/point: ≤ 5 ms for sweeps within a band

Output Power

Maximum Leveled Power: +20 dBm
+5 dBm (with Option 1EG)
Minimum Settable: −5 dBm, −75 dBm with Option 1E1
Power Sweep: 0 to 25 dB/sweep (300 kHz to 3 GHz)
Slope Compensation: 0 to +2 dB/GHz (300 kHz to 3 GHz)
Source Match: 1.38:1 SWR, typical

Spurious Signals

Harmonics and Subharmonics:
< −20 dBc at +20 dBm
< −40 dBc at 0 dBm
Nonharmonically Related:
< −25 dBc at +20 dBm
< −50 dBc at 0 dBm
Single-Sideband Phase Noise (at 10 kHz offset):
< −90 dBc ≤ 100 MHz
< −63 dBc at 3 GHz
Residual FM: <100 Hz peak at 100 MHz, CW mode, typical (50 Hz to 15 kHz bandwidth)
Signal Purity with Option 1EG Enabled (doubler mode):
Harmonics: < −8 dBc
Subharmonics: < −18 dBc
Single-Sideband Phase Noise (at 10 kHz offset):
< −83 dBc ≤ 100 MHz
< −57 dBc at 6 GHz

General

Internal AM: 1 kHz sine wave
External AM (3 dB BW): DC to 10 kHz
Weight: Net, 18.5 kg (41 lb); shipping, 22 kg (48 lb)

Ordering Information

	Price
HP 8625A Synthesized RF Sweeper	$22,500
Opt 1E1 Add Step Attenuator	$1,000
Opt 1E4 Rear-Panel RF Output	$500
Opt 1EG 6 GHz Operation	$3,000
Opt W30 Extended Repair Service (see page 636)	$525
Opt W32 Calibration Service (see page 636)	$160

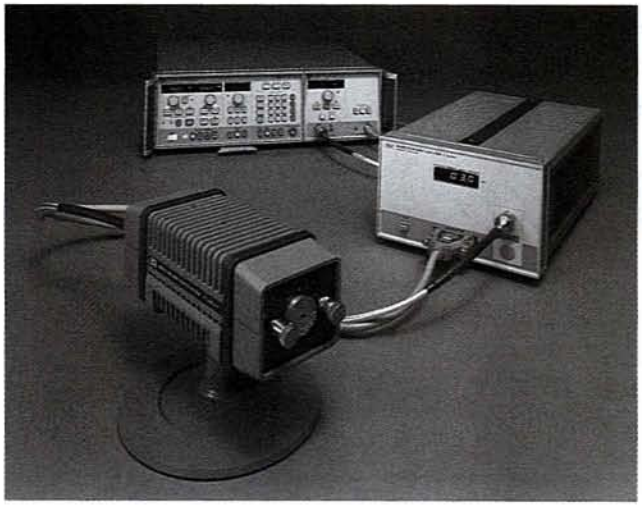
For the most current prices and product information, contact your local Hewlett-Packard sales office. See page 635.

SWEEPERS

HP 83550 Series Millimeter-Wave Source Modules

HP 83554A, 83555A, 83556A, 83557A, and 83558A

- 26.5 to 110 GHz frequency range
- Leveled high output power
- Can be driven by many HP microwave sources
- Source module remotable up to one meter length
- Low entry cost



HP 83550 Series Millimeter-Wave Source Modules

The five HP 83550 Series millimeter-wave source modules provide a simple approach to extend the frequency range of 11 to 20 GHz sources to cover 26.5 to 40 GHz (HP 83554A), 33 to 50 GHz (HP 83555A), 40 to 60 GHz (HP 83556A), 50 to 75 GHz (HP 83557A), and 75 to 110 GHz (HP 83558A) bands. The HP 83550 series source modules offer leveled high output power, full waveguide band frequency coverage, and the high frequency accuracy and resolution of the driving microwave source.

As shown in the figure in the right column, there are three basic ways of configuring a millimeter-wave source to best suit your specific needs. Your choice can range from a sophisticated synthesized sweeper (HP 83623A or HP 83624A) to a sweep oscillator (HP 8350B/8359x) with an HP 8349B amplifier.

Pulse, AM, and FM Modulation

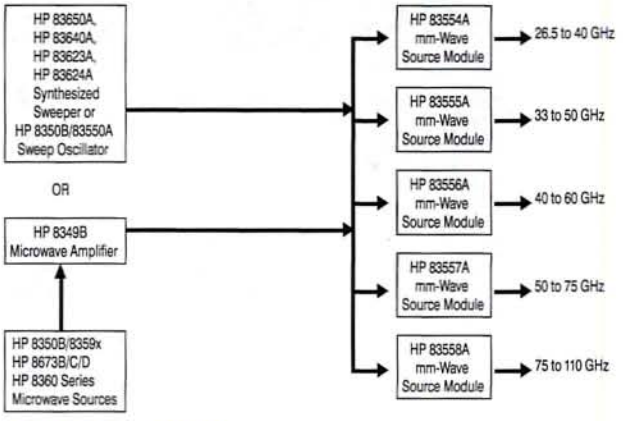
The high-performance pulse modulators of the HP synthesized sources offer >80 dB on/off ratio and <50 ns rise and fall times. Pulse amplitudes are leveled for pulse widths as narrow as 1 μs.

The HP 8340B/8341B also feature dc-coupled AM with a 3 dB bandwidth of 100 kHz. Pulse and amplitude modulation can be used to simultaneously simulate antenna scan patterns.

FM rates between 100 Hz and 10 MHz may be applied to the HP 8673B/C/D synthesizer input to achieve deviations up to 20 MHz (HP 83554A) and 30 MHz (HP 83555A, 83556A), 40 MHz (HP 83557A), and 60 MHz (HP 83558A) at millimeter-wave frequencies.

High Output Power

Leveled output power from the source modules is rated at +8 dBm for the HP 83554A, +3 dBm for the HP 83555A, +3 dBm for the HP 83556A, +3 dBm for the HP 83557A, and 0 dBm for the HP 83558A. This high output power can permit the source module to serve as a mixer LO in some applications, and also expands the available dynamic range in frequency response measurements.



All At a Lower Cost

The HP 83550 Series source modules combines performance and quality with a low cost of entry. This is possible because the source modules are backward-compatible with existing HP microwave sources. Thus you can generate a full waveguide band of millimeter-wave frequencies for just the cost of a source module and an HP 8349B amplifier (where required). Also, the cost of ownership to you is reduced even further by the two-year warranty on the microcircuits of the HP 83550 Series source modules and the HP 8349B microwave amplifier.

HP 83554A Output Characteristics

	HP 8350B/83550A	HP 8350B/ 83590 Series/8349B	HP8360 Series/8349B, HP83623A, 83624A, 83650A	HP 8673B/C/D/8349B
Maximum leveled power (25° C ± 5° C) **Minimum settable power:**	+8 dBm −5 dBm	+8 dBm −5 dBm	+8 dBm −5 dBm	+8 dBm −5 dBm
Power level accuracy[2] (25° C ± 5° C) **Power flatness** (at max leveled power)	±2.00 dB ±1.50 dB	±2.00 dB ±1.50 dB[3]	±2.00 dB ±1.50 dB[3]	±2.00 dB ±1.50 dB[3]
Source output SWR	<2.0	<2.0	<2.0	<2.0
Spurious signals[6] Harmonically related spurious: 26.5 to 26.7 GHz 26.7 to 40.0 GHz	 < −25 dBc < −50 dBc	 < −25 dBc < −20 dBc[4]	 < −25 dBc < −40 dBc	 < −25 dBc < −20 dBc[5]

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 83555A Output Characteristics[1]	HP 8350B/83550A	HP 8350B/ 83590 Series/8349B	HP8360 Series/8349B, HP83623A, 83624A, 83650A	HP 8673B/C/D/8349B
Maximum leveled power (25° C ± 5° C) **Minimum settable power**	+3 dBm −5 dBm	+3 dBm −5 dBm	+3 dBm −5 dBm	+3 dBm −5 dBm
Power level accuracy[2] (25° C ± 5° C) **Power flatness** (at max leveled power)	±2.00 dB ±1.50 dB	±2.00 dB ±1.50 dB[3]	±2.00 dB ±1.50 dB[3]	±2.00 dB ±1.50 dB[3]
Source output SWR	<2.0	<2.0	<2.0	<2.0
Spurious signals[6] Harmonically related spurious: 33.0 to 37.5 GHz 37.5 to 49.5 GHz 49.5 to 50.0 GHz	 < −20 dBc < −50 dBc < −20 dBc	 < −20 dBc < −20 dBc[4] < −20 dBc	 < −20 dBc < −40 dBc[5] < −20 dBc	 < −20 dBc < −20 dBc[5] < −20 dBc

HP 83556A Output Characteristics[1]	HP 8350/83550A	HP 8350B/ 83590 Series/8349B	HP 8360 Series/8349B, HP 83623A, 83624A, 83650A	HP 8673B/C/D/8349B
Maximum leveled power (25° C ± 5° C) **Minimum settable power:**	+3 dBm −5 dBm	+3 dBm −5 dBm	+3 dBm −5 dBm	+3 dBm −5 dBm
Power level accuracy[2] (25° C ± 5° C) **Power flatness** (at max leveled power)	±2.25 dB ±1.75 dB	±2.25 dB ±1.75 dB[3]	±2.25 dB ±1.75 dB[3]	±2.25 dB ±1.75 dB[3]
Source output SWR	<2.0	<2.0	<2.0	<2.0
Spurious signals[6] Harmonically related spurious: 40.0 to 45.0 GHz 45.0 to 60.0 GHz	 < −20 dBc < −50 dBc	 < −20 dBc < −20 dBc[4]	 < −20 dBc < −40 dBc[5]	 < −20 dBc < −20 dBc[5]

HP 83557A Output Characteristics	HP 8350B/83550A	HP 8350B/83592C/ 83595C/8349B	HP8360 Series/ 8349B, HP 83623A, 83624A, 83650A	HP 8673C/D/8349B
Maximum leveled power (25° C ± 5° C) **Minimum settable power**	+3 dBm −2 dBm	+3 dBm −2 dBm	+3 dBm −2 dBm	+3 dBm −2 dBm
Power level accuracy (25° C ± 5° C) **Power flatness** (at max leveled power)	±2.5 dB ±2.0 dB	±2.5 dB ±2.0 dB	±2.0 dB ±1.5 dB	±2.5 dB ±2.0 dB
Source output SWR Leveled: Unleveled:	 <2.0 <3.0	 <2.0 <3.0	 <2.0 <3.0	 <2.0 <3.0
Spurious signals[6] Harmonically related spurious:	< −20 dBc	< −20 dBc	< −20 dBc	< −20 dBc

HP 83558A Output Characteristics	HP 8350B/83550A	HP 8350B/83592C/ 83595C/8349B	HP 8360 Series/ 8349B, HP 83623A, 83624A, 83650A	HP 8673C/D/8349B
Maximum leveled power (25° C ± 5° C) **Minimum settable power**	0 dBm −5 dBm	0 dBm −5 dBm	0 dBm −5 dBm	0 dBm −5 dBm
Power level accuracy (25° C ± 5° C) **Power flatness** (at max leveled power)	±2.5 dB ±2.0 dB	±2.5 dB ±2.0 dB	±2.0 dB ±1.5 dB	±2.5 dB ±2.0 dB
Source output SWR Leveled: Unleveled:	 <2.0 <3.0	 <2.0 <3.0	 <2.0 <3.0	 <2.0 <3.0
Spurious signals[6] Harmonically related spurious:	< −20 dBc	< −20 dBc	< −20 dBc	< −20 dBc

[1]All specifications apply to internally leveled operation only.
[2]Specified with respect to HP 83550A or HP 8349B power display. Includes power level flatness.
[3]Must have 0.5 V/GHz modification on microwave source
[4]Except for the HP 83592C/95C which are −45 dBc
[5]Except for the HP 8673C/D, which are −50 dBc
[6]Expressed in dB relative to the carrier level (dBc)

General Specifications

Waveguide Output Connector
HP 83554A: EIA size WR 28 waveguide; JAN UG-599 flange
HP 83555A: EIA size WR 22 waveguide; JAN UG-383 flange
HP 83556A: EIA size WR 19 waveguide; JAN UG-383 (mod.) flange
HP 83557A: EIA Size WR 15 waveguide: JAN UG-385 flange
HP 83558A: EIA Size WR 10 waveguide: JAN UG-387 flange
Weight: Net, 1.7 kg (4 lb)
Size: Module, 80 mm W × 80 mm H × 210 mm D (3.15 in × 3.15 in × 8.27 in)
Furnished with Each Source Module: Operating and Service Manual, Modification Procedures for 0.5 V/GHz output, Type N RF Cable, Module Base Assembly, Synthesizer Interface Cable

Ordering Information

	Price
HP 83554A 26.5 to 40.0 GHz mm-Wave Source Module	$11,200
HP 83555A 33.0 to 50.0 GHz mm-Wave Source Module	$11,500
HP 83556A 40.0 to 60.0 GHz mm-Wave Source Module	$11,500
HP 83557A 50.0 to 75.0 GHz mm-Wave Source Module	$16,000
HP 83558A 75.0 to 110.0 GHz mm-Wave Source Module	$16,000
Opt 910 Extra Manual	+ $40
Opt W30 Extended Repair Service (see page 636)	
HP 83554/5/6	+ $225
HP 83557/8	+ $375
Opt W32 Calibration Service (see page 636)	
HP 83554/5/6	+ $1,050
HP 83557/8	+ $1,315

FUNCTION GENERATORS & WAVEFORM SYNTHESIZERS
General Information

Introduction
Hewlett-Packard offers a wide variety of signal sources for almost any application, including function generators and frequency or waveform synthesizers. Output frequencies range from 1 μHz to 80 MHz.

For higher frequency applications, refer to the Signal Generators and Sweepers sections of this catalog.

Standard
Standard function generators typically offer a variety of waveforms, such as sine-wave, square, triangle, and ramp.

The HP 8111A also offers pulse capabilities, and the HP 3312A has modulation and sweeping capabilities. Both generators can be used only in manual operation.

Multi-Functional
Functionality describes function generators that are capable of more than generating a variety of waveforms. For example, up to 150 vectors can be defined with the HP 3314A for the generation of arbitrary signals.

HP 8904A

HP 8111A

Analog/Digital Arbitrary Waveforms
The HP 8175A Digital Signal Generator is a data generator, which provides, with the Option 002, arbitrary signals on two analog channels. Digital pattern and analog signals can also be generated simultaneously.

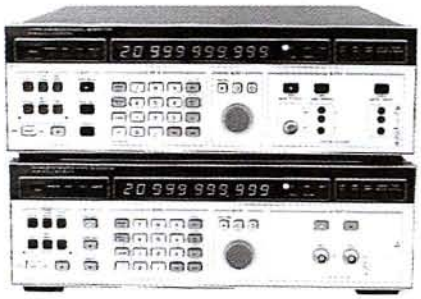
Synthesized Arbitrary Waveforms
The HP 8770A, in conjunction with the WGL Toolbox Software, is a complete system for the generation of most complex arbitrary waveforms with synthesizer accuracy. Waveforms can be created in both the time and frequency domain.

Multifunction Synthesized Waveforms
The HP 8904A Multifunction Synthesizer digitally creates a multitude of complex signals from six simple waveforms. It begins with a Synthesizer/Function generator offering standard waveforms, dc, and noise. Option 001 adds three channels that can modulate the first synthesizer; Option 002 adds a second independent synthesizer output. Modulation capabilities include AM, FM, PM, DSB, and pulse.

Fast
These instruments offer all of the standard waveforms over the full frequency range up to 50 MHz. The HP 8116A and HP 8165A combine these features with different modes, modulation, and sweep capabilities. Both instruments can be used as pulse generators. The HP 8165A, with its frequency stability of 1 ppm/day, has synthesizer quality.

HP Function Generators Summary I

	Standard		Multifunctional					Fast	
	HP 8111A	**HP 3312A**	**HP 3245A**	**HP 3314A**	**HP 8904A**	**HP 8175A**	**HP 8770A**	**HP 8116A**	**HP 8165A**
Sine wave									
Min. frequency	1 Hz	0.1 Hz	0 Hz	1 mHz	0 Hz	dc	dc	1 mHz	1 mHz
Max. frequency	20 MHz	13 MHz	1 MHz	20 MHz	600 kHz	25 MHz	50 MHz	50 MHz	50 MHz
Waveforms									
Square	1 Hz to 20 MHz	0.1 Hz to 13 MHz	0 Hz to 1 MHz	1 mHz to 20 MHz	0.1 Hz to 50 kHz	Full	Full	1 mHz to 50 MHz	1 mHz to 50 MHz
Triangle	1 Hz to 20 MHz	0.1 Hz to 13 MHz		1 mHz to 20 MHz	0.1 Hz to 50 kHz	Arbitrary	Arbitrary	1 mHz to 50 MHz	1 mHz to 50 MHz
Ramp	1 Hz to 20 MHz	0.1 Hz to 13 MHz	0 Hz to 1 MHz	1 mHz to 2 MHz	0.1 Hz to 50 kHz	Waveform	Waveform	1 mHz to 50 MHz	1 mHz to 50 MHz
Pulse	1 Hz to 20 MHz	0.1 Hz to 13 MHz		1 mHz to 2 MHz				1 mHz to 50 MHz	1 mHz to 20 MHz
Arbitrary			2048 points	150 vectors					
Modes					Creates	Full	Full		
Trigger	ext	int/ext	int/ext	int/ext	signals from	Arbitrary	Arbitrary	ext	ext
Gate	ext	int/ext	int/ext	int/ext	six basic	Waveform	Waveform	ext	ext
Counted burst	1 to 1999		int subroutine	1 to 1999	waveforms			1 to 1999	1 to 1999
Modulation									
AM		int/ext	int subroutine	ext	int	Full	Full	ext	ext
FM		int/ext	Arbitrary	ext	int	Arbitrary	Arbitrary	ext	ext
PM					int	Waveform			
PWM								ext	
Sweep									
Lin.		int/ext	int	int	int	Full	Full	ext	
Log.			int	int	none	Arbitrary	int/ext	int/ext	
VCO	ext	int/ext	int subroutine	ext	int	Waveform	Waveform	ext	ext
Output (into 50 Ω)									
Amplitude (p-p)	16 V	10 V	10 V	10 V	10 V	16 V	2 V	16 V	20 V
dc offset	±8 V	±10 V	±5 V	±5 V	±5 V	±8 V		±8 V	±10 V
Output impedance-Ω	50	50	0150	50	50	50	50	50	50/1000
Programmability			HP-IB	HP-IB	HP-IB	HP-IB	HP-IB	HP-IB	HP-IB
Notes			2 independent channels, also ac current and 6-digit precision dc voltage or current	Also ½ cycle bursts, phase lock	4 internal channels; one is modulated or sequenced	2 analog outputs dig./analog signals simultaneously	WGL Toolbox Software included free		
Catalog page	441	436 437	439 440	436 437	446 447	443	419	442	Please request data sheet 5953-6326



Synthesizers

Synthesizers provide sinewaves with the focus on a very high frequency stability and excellent level accuracy. You can choose among different output impedances. The HP 3335A generates sinewaves up to 81 MHz and the HP 3336A/B/C has modulation capabilities.

Synthesized Function Generators

Synthesized function generators combine the frequency stability of a synthesizer with the feature set of the function generator. The HP 3324A has good synthesizer performance and versatile sweep modes that are phase continuous over the full frequency range. In addition, the HP 3325B provides various modulation capabilities and excellent synthesizer performance. The HP 3326A plays a special part because of its two channels, which can be combined in various ways to produce two-tone signals or calibrated two-phase signals.

HP Function Generators Summary II

	Synthesized function generators			Synthesizers	
	HP 3324A	**HP 3325B**	**HP 3326A**	**HP 3335A**	**HP 3336A/B/C**
Sinewave					
Min. frequency	1 mHz	1 μHz	dc	200 Hz	10 Hz
Max. frequency	21 MHz	21 MHz	13 MHz	81 MHz	21 MHz
Freq. stability	10^{-7}/month	4×10^{-7}/month	4×10^{-7}/month	10^{-6}/day	1.5×10^{-6}/day
Freq. resolution	1 mHz	1 μHz	1 μHz	1 mHz	1 μHz
Waveforms					
Square	1 mHz to 11 MHz	1 μHz to 11 MHz	dc to 13 MHz		
Triangle	1 mHz to 11 kHz	1 μHz to 11 kHz			
Ramp	1 mHz to 11 kHz	1 μHz to 11 kHz			
Pulse			dc to 13 MHz		
Modulation					
AM		int/ext	int/ext		ext
FM					
PM		int/ext	int/ext		ext
PWM			ext		
Sweep					
Lin.	int	int	int	int	int
Log.	int	int			int
Discrete	int	int	int		
VCO					
Level range (50 Ω)	10 V p-p	10 V p-p	10 V p-p	−87 to +13 dBm	−71 to +8 dBm
Level resolution	4 digits	4 digits	4 digits	0.01 dB	0.001 dB
Level accuracy (± dB)	0.9	0.1	0.1	0.05	0.05
dc offset (50 Ω)	±5 V	±5 V	±5 V		
Output impedance (Ω)	50	50	50	50/75/124/135	50/75/124/135/150/600
Spurious	−55 dBc	−70 dBc	−70 dBc	−75 dBc	−70 dBc
Phase noise	−50 dBc	−60 dBc	−66 dBc	−58 to −70 dBc	−64/ −72 dBc
Notes	60 MHz TTL clock, multi-interval and multi-marker sweep	Modulation source can be used separately	2 channels, two-tone and two phase signals		
Catalog page	444	438	438	445	445

HP 3324A

Which Function Generator Do You Need?

HP's function generators and synthesizers are the best solution for most applications. The tables shown on these two pages will help you determine the right one for your application. The instruments are split into categories, depending on their main specifications. For an explanation of the instrument's full range of capabilities, see the following information.

Broad Application Range

If your applications involve a large variety of measurements, one of HP's standard function generators is the right solution.

Simulating Real Life Signals

HP's Arbitrary Function Generators are dedicated for the simulation of real-life signals, ranging from disk drive or video test signals to mechanical vibration simulation. Applications such as VOR, FM stereo, and communications signalling are covered by the Multifunction Synthesizer HP 8904A.

Versatility and Speed

Many applications require standard waveforms over the full frequency range up to 50 MHz and with versatile operating modes. These requirements can be fulfilled with the HP 8116A and HP 8165A. The HP 8165A can be recommended especially for those applications requiring 50 MHz in conjunction with good frequency stability.

Highly Accurate Reference Sources

Applications such as PLL-testing, calibration of measurement instruments, and testing of Frequency Division Multiplex equipment are ideally suited for HP's synthesizers. The very stable frequency source and the excellent level accuracy make these synthesizers the right choice if a reference source is required.

Accuracy and Versatility

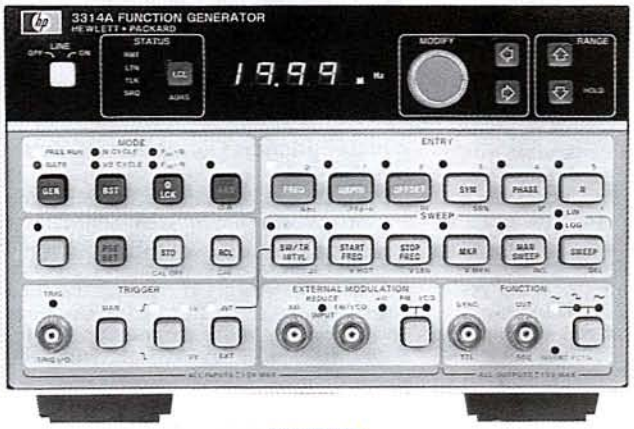
Synthesized function generators are for those applications that require a combination of an accurate frequency source and a versatile function generator. Sweeping over the entire frequency range without any phase discontinuity makes these generators ideal for such applications as simulation of rotation signals and filter testing. Even the calibration of phase measuring instruments is possible by programming a certain phase offset between two generators or using the HP 3326A's two outputs.

FUNCTION GENERATORS & WAVEFORM SYNTHESIZERS

Function Generator

HP 3314A

- Lin/Log sweeps, gate, counted burst, AM/FM/VCO
- Arbitrary waveform generator
- Phase lock × N and ÷ N modes, 1/2-cycle mode



HP 3314A

DESIGNED FOR HP-IB SYSTEMS

HP 3314A Multi-Waveform Generator

Precise Functions

The HP 3314A provides sine, square, and triangle waveforms. It also provides pulses and ramps to 2 MHz using the variable symmetry control over the full 5 percent to 95 percent symmetry range.

Add independent dc offset to ±5 V (into 50 Ω) to any ac signal. A post-attenuator summing technique provides large ac signals with small offsets and vice versa.

Burst and Gate

The N cycle burst mode generates an integer number (1 to 1999) of complete cycles at each trigger. Use variable symmetry and start/stop phase to produce single ramps and haverwaves.

Like burst mode, gate mode can be triggered internally or externally. In gate, the HP 3314A output consists of complete cycles, pulses, or arbitrary waveforms that start when the trigger is true and stop when the trigger goes false.

Half-Cycle and Integer Phase Lock Modes

The half-cycle burst mode allows simulation of specialized signals found in electronics. At each trigger, alternating half cycles of sines or triangles are produced. With the addition of variable start/stop phase and symmetry, pulses with variable rise/fall time and overshoot can be produced. Set repetition rate, half-cycle frequency, symmetry, and phase independently to produce a variety of waveforms.

The Fin × N and Fin ÷ N modes provide powerful phase locking capability. The HP 3314A phase locks to the plus or minus edge of the trigger signal; it can lock to a variety of signals such as sines, squares, pulses, ramps, and others, with complete control of output function, symmetry, N, phase, amplitude and offset.

Modulation and Sweep

Complete AM, FM/VCO modulation give the HP 3314A versatile signal modifying capabilities. With 100 kHz bandwidths, AM and FM/VCO can be used separately or simultaneously to produce many waveforms.

Make multi-frequency measurements with HP 3314A sweep capabilities. Linear, logarithmic, and manual sweep make measurements of filters, amplifiers, and other networks convenient and accurate. X drive, marker, and trigger output signals are also provided.

Arbitrary Waveforms

Use the HP 3314A arbitrary (ARB) waveform mode to create custom waveforms. Values are easy to enter from the front panel. For remote programming, use a desktop or mainframe computer to calculate the values, then program them using the HP-IB.

Two Sources in One

A square-wave trigger source helps you generate complex waveforms with a single HP 3314A. The 0.5 mHz to 500 kHz internal trigger is useful in gated, burst, and phase locked waveforms. This signal is provided as an output for synchronizing the HP 3314A to other devices.

Specifications

Frequency

Range: 0.001 Hz to 19.99 MHz—sine, square, and triangle waveforms, 0.001 Hz through 2 MHz range when symmetry ≠ 50%

Resolution: 3½ digits

Accuracy

Autorange	Range hold	Accuracy
0.001 Hz to 19.99 Hz	0.001 Hz to 19.99 Hz	±(0.4% setting +0.2% range)
15 Hz to 199.9 kHz	0.1 Hz to 199.9 kHz	±(0.2% setting +0.1% range)
150 Hz to 19.99 MHz	1 kHz to 19.99 MHz	±(0.01% setting +50 ppm/yr)

Amplitude

Range: 0.01 mVp-p to 10 Vp-p into 50 Ω

Resolution: 3½ digits

Absolute amplitude accuracy: 10 kHz, 1.00-10.00 Vp-p, Autorange ON

±(1% of display + 0.035 Vp-p), sine and square wave

±(1% of display + 0.06 Vp-p), triangle

Flatness-sinewave: Relative to 10 kHz, 1.00V to 10.0V (range 4)

20Hz	50 kHz	1 MHz	19.99 MHz
±.07 dB	±.33 dB	±1.5 dB	

Modulation Inputs:

Bandwidth	Sensitivity	Range	Z
AM: dc to 100 kHz	2 Vp-p for 100% −1 Vdc for suppressed carrier	>100%	10 kΩ
FM: 100 Hz to 100 kHz	±1 Vp for 1% of range deviation	±1% of freq. range	10 kΩ
VCO: dc to 100 kHz	10%/volt	+1 to −10V	10 kΩ

Waveform Characteristics

Sine harmonic distortion: Individual harmonics will be below these levels, relative to the fundamental.

20 Hz	50 kHz	1999 KHz	19.99 MHz
−55 dB	−40 dB	−25 dB	

Square wave rise/fall time: ≤9 ns, 10% to 90% at 10 Vp-p output

N integer:

N = 1 to 1999, Preset to 1; for Phase-lock Fin ÷ N, Fin × N; or N CYCLE (counted burst)

Function invert: Inverts ac portion of signal outputs

Phase

Phase offset–phase lock modes: Resolution: 0.1° Range: ±199.9°

Start/stop phase-burst modes: Resolution: 0.1° Range: ±90.0° for fs to 19.99 MHz

Trigger

Internal trigger

Range: .002 ms (500 kHz) to 1999 s (0.5 mHz) square wave

Period accuracy: ± (0.01% (+ 50 ppm/year) of displayed interval (excluding sweep intervals)

Trigger output: Low <0.5 V, high >2.5 V; output resistance 1 kΩ

External trigger

For Gate, N Cycle, Half-Cycle, Fin × N, Fin ÷ N, and external sweep triggers; selectable slope, positive or negative

Frequency range: 50 Hz to 20 MHz

Symmetry

Symmetry range: 5% to 95% of period, 2 Hz to 2 MHz ranges

Arbitrary Waveforms

Output consists of a series of voltage ramps called vectors. Arbitrary waveforms can be composed of 2 to 150 vectors. A maximum of 160 vectors can be stored in six available storage registers. Practical frequencies are 0.002 Hz to 2.5 kHz.

Opt 001 - Voltage Multiplier

Simultaneous × 3 amplitude output on rear panel (into > 500 Ω) 30 Vp-p max, dc to 1 MHz

General

Weight: Net, 7.3 kg (16 lb); shipping, 10.5 kg (23 lb)

Size: 132.6 mm H × 212.3 mm W × 419.0 mm D (5.22 in × 8.36 in × 16.50 in)

Ordering Information

	Price
HP 3314A Function Generator	$5,127
Opt 001 Simultaneous × 3 Output	+$275
Opt W30 Extended Repair Service (see page 636)	+$115

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Two function generators in one instrument
- AM-FM, sweep, trigger, gate and burst (int & ext)

HP 3312A

- Fully synthesized microhertz resolution
- Functions—sine, square, triangle, ramps, arbs, dc offset
- Internal programmable modulation source
- LOG, LIN, discrete sweep
- Excellent signal purity
- dc to 60 MHz sync output

HP 3325B

DESIGNED FOR HP-IB SYSTEMS

DESIGNED FOR MATE SYSTEMS

HP 3312A Function Generator

The HP 3312A function generator combines two separate, independent function generators with a modulator section in one compact instrument. The main generator can be triggered—via pushbutton control—by the modulation generator to provide sweep functions, AM, FM, or tone burst, and includes dc offset up to 10 volts p-p into 50 Ω.

Specifications

Output Waveforms: Sine, square, triangle, ±ramp, pulse, AM, FM, sweep, triggered, and gated

Frequency Characteristics

Range: 0.1 Hz to 13 MHz in 8 decade ranges
Dial accuracy: ±5% of full scale. Unspecified in Uncal Mode
Square wave rise or fall time (10% to 90%): <20 ns
Variable symmetry: 80:20:80 to 1 MHz
Sine wave distortion: <0.5% (−46 dB) THD from 10 Hz to 50 kHz. (10 kHz range maximum). (>30 dB below fundamental from 50 kHz to 13 MHz, at full-rated output.)

Output Characteristics

Impedance: 50 Ω ± 10%
Level: 20 Vp-p into open circuit, >10 Vp-p into 50 Ω at 1 kHz
Level flatness (sine wave): < ±3% from 10 Hz to 100 kHz at full rated output (1 kHz reference). < ±10% from 100 kHz to 10 MHz
Sync output: Impedance: 50 Ω ±10%, > 1 Vp-p square wave into open circuit. Duty cycle varies with symmetry control
dc offset: Variable up to ±10 volts. Instantaneous ac voltage + Vdc offset cannot exceed ±10 V (open circuit) or ± 5 V (50 Ω)

Modulation Characteristics

Types: Internal and external AM, FM, sweep, trigger, gate, or burst
Waveforms: Sine, square, triangle, ramp, or variable symmetry pulse
Frequency range: 0.01 Hz to 10 kHz

Amplitude and Frequency Modulation

Depth: 0 to 100% (AM), 0 to 5% (internal FM)
Modulation frequency: 0.01 Hz to 10 kHz (internal), dc to >1 MHz (AM external), dc to >50 kHz (FM external)

Sweep Characteristics

Sweep width: 100:1 on any range
Sweep rate: 0.01 Hz to 10 kHz, 90:10 ramp

Gate Characteristics

Start/stop phase range: +90° to −80°
Frequency range: 0.1 Hz to 1 MHz (useful to 10 MHz)

External Frequency Control and FM

Range: 1000:1 on any range
Linearity: 0.5% of Fmax for Fmax ≤ 1 MHz, freq. span ≤ 100:1

General

Power: 100, 120, 220, 240 V, +5%, −10%, switchable; 48 Hz to 440 Hz; ≤30 V A
Size: 102 mm H × 213 mm W × 377 mm D (4 in × 8.4 in × 14.8 in)
Weight: Net, 3.8 kg (8.4 lb); shipping, 5.9 kg (13 lb)

Ordering Information

	Price
HP 3312A Function Generator	$1,800 ☎
Opt W30 Extended Repair Service (see page 636)	$50

☎ For off-the-shelf shipment, call 800-452-4844.

HP 3325B Synthesizer/Function Generator

Synthesizer Precision, Function Generator Versatility

HP 3325B frequency accuracy is determined by a precision frequency reference and can be set with a resolution of 1 μHz. The phase of the output signal can be precisely controlled ±719.9 deg with 0.1 deg resolution, and multiple HP 3325Bs can be locked together for multi-phase applications.

Use the modulation source as an arbitrary function generator via HP-IB to provide user-defined waveshapes. Save-recall memory includes ten nonvolatile memory locations for simple and rapid access to frequently used test setups.

A built-in programmable modulation source provides sine, square, and arbitrary waveshapes for internal amplitude or phase modulation, or for use as a second source. In addition, a rear panel sync output provides a TTL compatible dc to 60 MHz signal.

All functions, including frequency, amplitude, phase, modulation, sweep, and waveshapes, are programmable via HP-IB or RS-232 interface. The HP 3325B is fully compatible in form, fit, and function with the HP 3325A. All HP-IB programs written for the HP 3325A are fully compatible with the HP 3325B.

Specifications

Waveforms: Sine, square, triangle, negative, and positive ramps

Frequency

Range
Sine: 1 μHz to 20.999 999 999 MHz
Square, triangle/ramps: 1 μHz to 10.999 999 999 MHz
Resolution: 1 μHz, < 100 kHz; 1 mHz ≥ 100 kHz
Accuracy: ±5 × 10^{-6}, 20° to 30° C at time of calibration
Warm-up time: 20 minutes to within specified accuracy

Main Signal Output (all waveforms)

Impedance: 50 Ω
Connector: BNC; switchable to front or rear panel, nonswitchable with Opt 002, except by internal cable change.

Amplitude

Range: 1 mV to 10 Vp-p in 8 amplitude ranges, 1-3-10 sequence (10 dB steps), into 50 Ω load

Function	Sine		Square		Triangle/ramps	
Units displayed	Min	Max	Min	Max	Min	Max
Peak-peak	1.000 mV	10.00 V	1.000 mV	10.00 V	1.000 mV	10.00 V
rms	0.354 mV	3.536 V	0.500 mV	5.000 V	0.289 mV	2.887 V
dBm (50 Ω)	−56.02	+23.98	−53.01	+26.99	−57.78	+22.22

Resolution: 0.03% of full range or 0.01 dB (4 digits)
Amplitude accuracy
(without dc offset, relative to programmed amplitude and accuracy)
Sine wave amplitude accuracy
1 mHz to 100 kHz: ±0.1 dB, ≥3 Vpp; ±0.2 dB, <3 Vpp
100 kHz to 20 MHz: ±0.4 dB, ≥3 Vpp; ±0.6 dB, 0.1 to 3 Vpp

Sine Wave Spectral Purity

Phase noise: −60 dB for a 30 kHz band centered on a 20 MHz carrier (excluding ±1 Hz about the carrier) with high-stability Opt 001 installed.
Spurious: All non-harmonically related output signals will be more than 70 dB below the carrier (60 dB with dc offset) or less than −90 dBm, whichever is greater.

FUNCTION GENERATORS & WAVEFORM SYNTHESIZERS

Two-Channel Synthesizer, dc to 13 MHz

HP 3325B, 3326A

Sine wave harmonic distortion: Harmonically related signals will be less than the following levels (relative to the fundamental) at full output for each range:

0.1 Hz	50 kHz	200 kHz	2 MHz	15 MHz	20 MHz
−65 dB	−60 dB	−40 dB	−30 dB	−25 dB	

Square Wave Characteristics
Rise/fall time: ≤20 ns, 10% to 90% at full output
Overshoot: ≤5% of peak-to-peak amplitude, at full output
Settling time: <1 μs to settle to within .05% of final value
Offset
Range: dc only (no ac signal): 0 to ±5.0 V/50 Ω
dc + ac: Maximum dc offset ±4.5 V on highest range, decreasing to ±4.5 mV on lowest range.
Resolution: 4 digits
Sine Wave Amplitude Modulation
Modulation depth at full output for each range: 0 to 100%
Modulation frequency range: dc to 400 kHz (for 0 to 21 MHz carrier)
Sensitivity: ±5 V peak for 100% modulation
Sine Wave Phase Modulation
Range: ±850°, ±5 V input
Modulation frequency range: dc −5 kHz

Frequency Sweep

Sweep Time
Linear: 0.01 s to 1000s
Logarithmic: 1 s to 1000s single, 0.1 s to 1000s continuous
Discrete Sweep
Number of segments: 100 maximum
Time/Segment: 0.01 s to 1000s, 0.01 s resolution
Maximum Sweep Width: Full frequency range for the waveform in use; min log start frequency 1 Hz.
Phase: Continuous over the full frequency range

Modulation Source

Frequency Range: Sine 0.1 Hz to 10 kHz, square 0.1 Hz to 2 kHz
Frequency Accuracy: 0.1%, typical
Impedance: Drives 10 kΩ or greater load
Sinewave Purity: −34 dBc or better, typical
Waveforms: Sine, square, arbitrary

Auxiliary Inputs and Outputs

Auxiliary Frequency Output: 21 MHz to 60.999 999 999 MHz; 0 dBm; output impedance 50 Ω.
Sync Output: Square wave with V (high) ≥ 1.2 V, V (low) ≤ 0.2 V into 50 Ω. Frequency range is the same as main signal for front panel sync and dc to 60 MHz for rear panel sync.
X-Axis Drive: 0 to > +10 V dc linear ramp proportional to sweep frequency, linearity, 10-90%, ± 0.1% of final value

Opt 001 High Stability Frequency Reference

Aging Rate: ± 5 × 10^{-8}/week (72 hr warm up); ±1 × 10^{-7}/month (after 15 days continuous operation).
Ambient Stability: ±5 × 10^{-8} (0° C to +55° C)
Warm-Up Time: Reference will be within ±1 × 10^{-7} of final value 15 minutes after turn-on for an off time of less than 24 hours.

Opt 002 High Voltage Output

Frequency Range: 1 μHz to 1 MHz
Amplitude
Range: 4.00 mVpp to 40.00 Vpp (≥500 Ω, ≤ 500 pF load)
Accuracy: ± 2% of full output for each range at 2 kHz
Output impedance: < 2 Ω at dc, < 10 Ω at 1 MHz
dc offset range: Four times the specified range of the standard instrument.

General Specifications

Weight: Net, 9 kg (20 lb); shipping, 14.5 kg (32 lb)
Size: 132.6 mm H × 425.5 mm W × 497.8 mm D (5.25 in × 16.75 in × 19.63 in)

Ordering Information*

	Price
HP 3325B Frequency Synthesizer	$4,800 ☎
Opt 001 High Stability Frequency Reference	+$805
Opt 002 High Voltage Output	+$270
Opt H05 Internal MATE Programming	(call HP)
Opt W30 Extended Repair Service (see page 636)	+$115

*HP-IB cable not supplied.

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 3326A

DESIGNED FOR HP-IB SYSTEMS

HP 3326A Two-Channel Synthesizer

The HP 3326A two-channel synthesizer combines two independent synthesizers, flexible modulation, and control circuitry into a single, powerful package. This instrument provides precise phase offset, two-tone sweep, fast frequency switching, internal amplitude and phase modulation, and pulse signals for bench or systems use.

With multiple channels and modes, the HP 3326A does the job of several sources. An internal switch-selected signal combiner sums both source outputs into a single ultra-low IMD signal source. Phase continuous sweeps are available in linear and multi-element discrete modes. DC offset is available in all modes, and all outputs are floating. Frequency resolution is 11 digits, with flexible triggering for frequency, amplitude, and phase changes and sweeps.

Specifications

For complete specifications, refer to the HP 3326A data sheet.
Frequency (Waveforms are sine, square, pulse, and dc)
Range: 0 Hz to 13 MHz
Resolution: 1 μHz below 100 kHz, 1 mHz at and above 100kHz. Stability: ± 5x10^{-6}/year, 20° C to 30° C
Output Amplitude (sine mode)
Range: 1 mVpp to 10 Vpp in 8 ranges without dc offset
Accuracy: Relative to programmed value after self-calibration

	0.001 Hz	100 KHz	1 MHz	13 MHz
+23.98 dBm	±0.1 dB	±0.3 dB	±0.6 dB	
+3.98 dBm	±0.1 dB	±0.3 dB	±0.6 dB	
−36.02 dBm	±0.2 dB	±0.5 dB	±0.8 dB	
−56.02 dBm	±0.2 dB	±0.5 dB	±1.0 dB	

Phase Offset (channel A vs B in two-phase mode)
Range/resolution: ± 720 degrees range, 0.01 degree resolution
Accuracy: After self-calibration, for equal-level sinewaves 1 V to 10

0.1 Hz	10 Hz	100 kHz	1 MHz	13 MHz
±0.5	±0.2	±0.3	±2.0	

Frequency Sweep
Sweep types: Linear, discrete (1 to 63 discrete elements)
Sweep time: 5 ms to 1000 s, linear or per element
Option 001 High Stability Frequency Reference
Stability: ±5 × 10^{-8}/week after 72 hours continuous operation
±1 × 10^{-7}/month after 15 days continuous operation
Option 002 High Voltage Output
Frequency range: dc to 1 MHz
Amplitude range: 4 mV to 40 Vpp into > lk Ω, < 200 pF load
Offset: ±20 V, independent of amplitude range; dc + ac peak must not exceed 20V
General
Power: 100, 120, 220, 240 V, +5%, −10%, 48 to 66 Hz; 290 VA max
Weight: Net, 2 kg (60 lb); shipping, 37 kg (81 lb)
Size: 177 mm H × 425.5 mm W × 497.8 mm D (7 in × 16¾ in × 19⅝ in)

Ordering Information

	Price
HP 3326A Two-Channel Synthesizer	$11,649
Opt 001 High Stability Frequency Reference	+$720
Opt 002 High Voltage Output	+$330
Opt 003 Rear Terminal Outputs (rear only)	$0
Opt W30 Extended Repair Service (see page 636)	+$250

- Precision dc outputs with 6½ digits of resolution
- Synthesized ac with 0.4% amplitude accuracy
- Sine, Square, Triangle, and ARB to 1 MHz
- Floating outputs
- 100-Volt option
- Nonvolatile storage of up to 14 setups
- Second-channel output available
- Phase-continuous frequency changes
- Optional software for waveform modification
- Downloadable subroutines

HP 3245A

DESIGNED FOR HP-IB SYSTEMS

HP 3245A Universal Source

The HP 3245A Universal Source combines precision dc capabilities with versatile ac performance, including arbitrary waveform generation. This creates versatility on the bench, where the HP 3245A may be all the source you ever need. The HP 3245A can also fit into your Computer-Aided Test System, providing the capabilities of ac, dc, ARB, and second-channel options in a single 3.5-inch tall instrument.

Precision dc

The HP 3245A provides precision dc outputs of both voltage and current. In the high-resolution mode, you get 24-bit resolution with 60-ppm, 90-day accuracy. The low-resolution mode provides 12-bit resolution with 100 μsec settling times. This type of precision means you can use the HP 3245A to test A/D converters, Voltage to Frequency converters, VCOs, transducers, and other equipment needing highly accurate dc voltage or current. There are two output ranges in the high-resolution mode: ±1 volt and ±10 volts. In the low resolution mode, there are seven ranges. In current, there are four ranges of output, from 0.1 mA to 100 mA. Output impedance is selectable as either zero ohms or 50 ohms.

Accurate AC

The HP 3245A can generate ac voltage outputs, including sine, triangle, and square waves, at frequencies of up to 1 MHz. Variable duty-cycle pulse and ramp outputs can be generated at up to 100 kHz. In the ac mode, the HP 3245A can make phase-continuous frequency changes "on-the-fly." All ac waveforms are synthesized and have 0.001-Hz resolution and 50-ppm frequency accuracy. Ninety-day amplitude accuracy for sine, ramp, and ARB is 0.35% of output + 0.41% of range.

Arbitrary Waveform

The HP 3245A offers arbitrary waveform operation at a full 1-MHz bandwidth. This is accomplished by a sampling technique in which the values loaded into RAM are sampled at approximately 4.3 MHz and then run through a 1.25-MHz 5-pole low-pass filter. This allows full 1-MHz repetition rate while maintaining 0.001-Hz resolution at any frequency. The HP 3245A can also store multiple arrays that can be accessed for arbitrary waveform generation. Array depth is 2048 bytes.

Second Channel Option

The addition of a second channel allows you to generate two waveforms, either independent or phase related to each other. The second channel output can be phase synchronized to the first channel or to an external input. Such capabilities are especially useful if you are doing modem testing, tone-sequence generation, DTMF generation, FSK generation, or other operations where two outputs are required.

Waveform-Generation Software

A powerful software package for creating specialized waveforms is available as an option to the HP 3245A. This menu-driven software facilitates the capture of a waveform using a separate hardware digitizer, such as the HP 3458A. The waveform can then be modified, if desired, and played back via the HP 3245A. The use of a graphics tablet makes it easy to modify waveforms. The software also contains a library of standard waveforms that can be used as is or mixed with other waveforms to generate complex outputs.

Option 002 High-Voltage Output

Option 002 is a precision voltage amplifier that increases the output voltage 10-fold. Maximum voltage is now ±100 volts, or 200 volts peak-to-peak in ac mode. The second channel slot is used for the high-voltage option. It is not possible to have both second channel and high-voltage options in the same instrument.

System Operation

The HP 3245A includes features that make it especially powerful in system applications. Because it contains many BASIC-like constructs, such as IF..THEN and FOR..NEXT, the HP 3245A can do much of the work that normally falls to the host computer. Now, subroutines can be downloaded to the HP 3245A and run standalone, minimizing host interaction. Built-in math capabilities add to the power of the HP 3245A. Electronic calibration is both easy and accurate and does not require the instrument to be removed from a rack or opened to perform a calibration.

All these features combine to make the HP 3245A a universal source, combining precision dc outputs, accurate ac waveforms, and arbitrary waveform capabilities in a single instrument.

FUNCTION GENERATORS & WAVEFORM SYNTHESIZERS

Universal Source (cont'd)

HP 3245A

Abbreviated Technical Specifications

dc Volts Output

High-Resolution (24-bit) Mode

Range	0 Ω Mode resolution	50 Ω Mode resolution
1 V	1 μV	0.5 μV
10 V	10 μV	5 μV

Low-Resolution (12-bit) Mode

Range	0 Ω Mode resolution	50 Ω Mode resolution
0.078125 V	–	40 μV
0.15625 V	79 μV	79 μV
0.3125 V	157 μV	157 μV
0.625 V	313 μV	313 μV
1.25 V	625 μV	625 μV
2.5 V	1250 μV	1250 μV
5 V	2.5 μV	2.5 mV
10 V	5.0 mV	–

Current Compliance: 100 mA on all ranges
Settling Time (Delay 0):
High-resolution mode:
0.1% of step: 20 ms
0.001% of step: 40 ms
(1 s if function changed)
Low-resolution mode:
0.1% of step (0 Ω Mode): 100 μs
(50 Ω Mode): 25 μs
0.5% of step (50 Ω Mode): 5 μs
Overshoot:
High-resolution mode: <5% of step + 0.15% of range
Low-resolution mode: <30% of step + 2% of range

dc Volts Accuracy

(<10 Hz noise): ± (% of programmed output + volts), impedance mode, >1 M Ω load. Tcal is the temperature of calibration from 18° C to 28° C. One hour warm-up.

24 Hour: T_{cal} ±1° C

Range	High-resolution mode	Low-resolution mode
10 V	0.0007% + 85 μV	0.09% of Output + 0.02% of range (for all ranges)
1 V	0.0008% + 15 μV	

90 Day: T_{cal} ±5° C

High-resolution mode		Low-resolution mode	
Range	Accuracy	Range	Accuracy
10 V	0.0038% + 180 μV	10 V	0.17% + 37 mV
1V	0.0042% + 31 μV	5 V	0.17% + 19 mV
		2.5 V	0.17% + 9.2 mV
		1.25 V	0.17% + 4.6 mV
		0.625 V	0.17% + 2.5 mV
		0.3125 V	0.17% + 1.3 mV
		0.15625 V	0.17% + 0.73 mV

dc Volts Accuracy with Option 002: Ninety-day accuracy in the low-resolution mode is ±(0.2% of output + 370 mV) for 10-volt range. (10x amplifier; 100 volts output)

dc Current Output

Resolution

Range	High resolution	Low resolution
0.1 mA	0.1 nA	50 nA
1 mA	1 nA	500 nA
10 mA	10 nA	5 μA
100 mA	100 nA	50 μA

dc Current Accuracy

90 Day: T_{cal} ±5° C. After one hour warm-up.

High-resolution mode		Low-resolution mode	
Range	Accuracy	Range	Accuracy
100 mA	0.0202% + 3.3 μA	100 mA	0.32% + 400 μA
10 mA	0.0074% + 220 nA	10 mA	0.30% + 52 μA
1 mA	0.0052% + 20 nA	1 mA	0.25% + 3.7 μA
0.1 mA	0.0052% + 3.3 nA	0.1 mA	0.25% + 0.38 μA

ac Volts Output Characteristics

(sine, square, ramp, arbitrary)
Frequency Range:
0 to 1 MHz for sine, arbitrary, and square (at 50% duty cycle)
0 to 100 kHz for ramp
0 to 100 kHz for square w/duty cycle not equal to 50%

Amplitude and/or Offset Resolution

Range (peak-peak)	50 Ω Mode resolution	0 Ω Mode resolution
.15625 V	79 μV	–
.3125 V	157 μV	157 μV
.625 V	313 μV	313 μV
1.25 V	625 μV	625 μV
2.5 V	1250 μV	1250 μV
5 V	2.5 mV	2.5 mV
10 V	5.0 mV	5.0 mV
20 V	–	10.0 mV

Amplitude can be set from 10% to 100% of range.

ac Amplitude Accuracy (sine, ramp, arbitrary):
24 Hour: T_{cal} ±1C 0.16% of output + .25% of range
90 Day: T_{cal} ±5C 0.29% of output + .36% of range
ac Amplitude Accuracy with Option 002: Ninety-day accuracy is ±(0.32% of output + 3.6% of range) for 10-volt range. (10x amplifier; 100 volts output)

Sinewave Characteristics (50 Ω Mode)

Frequency	Harmonic and spurious levels (ampl ≥ 50%) of range)*	THD (ampl ≥ 50% of range)	Flatness in reference to 1 kHz
<3 kHz	< −62 dB	< −56 dB	.07 dB
to 10 kHz	< −62 dB	< −50 dB	.07 dB
to 30 kHz	< −52 dB	< −48 dB	.07 dB
to 100 kHz	< −46 dB	< −46 dB	.20 dB
to 300 kHz	< −40 dB	–	.60 dB
to 1 MHz	< −37 dB	–	2.0 dB

*Additional fixed spurious response > 4 MHz: 500 μVrms.

Squarewave Characteristics (50 Ω Mode):
Rise time: < 250 ns, 10% to 90%
Settling time: < 1 μs to 1% of amplitude
Overshoot: < 5% of peak-to-peak amplitude
Duty cycle range: 5% to 95%, 0 to 100 kHz
50% above 100 kHz
Duty cycle accuracy: ±(0.8% of period + 120 ns)
Frequency Resolution: 0.001 Hz
Frequency Accuracy: ±50 ppm, 18 to 28° C
Frequency Temperature Coefficient: ±1 ppm/° C
Phase Offset:
Range: −360 to +360° C
Resolution: <0.001° C
Ramp Linearity to 1 kHz (50 Ω Mode): 0.3% of peak-to-peak value measured @ 50% duty cycle from 10% to 90% point
Ramp Duty Cycle Range: 5% to 95% with < 0.1% resolution

Ordering Information

	Price
HP 3245A Universal Source	$4,650
Opt 001 Second Channel Output	+$2,750
Opt 002 High-Voltage Amplifier	+$1,530
Opt 005 Waveform Generation Software	+$420
Opt 907 Front Handle Kit	+$60
Opt 908 Rack Flange Kit	+$40
Opt 909 Rack Flange and Handle Combination Kit	+$90
Opt W30 Extended Warranty	+$126

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

FUNCTION GENERATORS & WAVEFORM SYNTHESIZERS

1-Hz to 20-MHz Pulse/Function Generator

HP 8111A

- Sine, triangle, square, and haverfunctions
- 20 MHz, 32 Vpp for all waveforms
- Variable duty cycle or pulse width
- Trigger, gate, VCO, and optional burst
- Digital display for all parameters
- Error recognition

HP 8111A with Option 001, counted burst

HP 8111A Pulse/Function Generator

The HP 8111A combines pulse generator and function generator capabilities in a single, compact unit. Triggered operation for all waveforms, and the ability to define rectangular waveforms in terms of pulse width or duty cycle, are examples of the HP 8111A's versatility.

Saves Space and Equipment

Small size and manifold capability make the HP 8111A an ideal source for service and bench. Digital display, error detector, and good repeatability assure high operating confidence. This reduces the need for output monitoring and consequently saves equipment.

Flexible

Operating modes include VCO which permits frequency-shift keying and dc-to-frequency conversion as well as sweep and FM applications. Option 001's Burst mode simplifies tone burst generation and digital preconditioning by generating a precise number of waveform cycles. An "extra cycle" feature activated after a burst allows critical events to be examined.

Pulse mode's variable width down to 25 ns and clean 10 ns transitions provide useful digital test capability. High analog flexibility is assured because all waveforms can be generated in trigger, gate and burst modes. Adjustable duty cycle up to 999 kHz means that CRT sawtooth waveforms and rectangular signals for dc motor control can be simulated.

Specifications (50-Ω load resistance)

Waveforms

Sine, triangle, ramp, square, pulse, haverfunctions

Timing

Frequency
Range: 1.00 Hz to 20.0 MHz (3-digit resolution)
Accuracy (50% duty cycle): 5% (±10% below 10 Hz)
Jitter: <0.1% + 50 ps
Stability: ±0.2% (1 hour), ±0.5% (24 hours)

Duty Cycle (sine, triangle, square, haverfunctions):

	Calibrated	Variable (below 1 MHz)
Range:	50% nominal	10% to 90%
Resolution:	2 digits	2 digits
Accuracy:	±1 digit	±6 digits (±3 in range 20 to 80%)

Pulse Width
Range: 25.0 ns to 100 ms (3-digit resolution)
Accuracy: ±5% ±2 ns

Output Characteristics (Voltages double into high impedance)

Amplitude
Range: 1.60 mVpp to 16.00 Vpp (3½-digit resolution)
Accuracy: ±5% (at 1 kHz for sine and triangle)
Flatness (sine, triangle): ±3% (+10%, −15% above 1 MHz)

Offset
Range: 0.00 mV to ±8.00 V (3-digit resolution)
Accuracy: ±5% setting ±2% amplitude ±20 mV (ampl ≥ 160 mVpp),
±5% setting ±2% amplitude ±1 mV (ampl < 160 mVpp)

Distortion: THD (1 Hz-1 MHz) < 3% (−30 dB); harmonics (1 MHz to 20 MHz) < −26 dBC. Distortion may increase by 3 dB below 10° C and above 45° C

Linearity (triangle): < ±3% (< ±1% below 1 MHz)

Pulse and Squarewave Performance
Transitions: < 10 ns
Perturbations: < ±5% (< ±10% below 0.16 Vpp)

Output Impedance: ±50 Ω ±5%

Modes

Normal, trigger*, gate*, VCO and (Option 001) burst*
VCO Range: 2 decades, ext. signal 0.1 V to 10 V (dc to 1 kHz)
Burst Length: 1 to 1999 periods for all waveforms

General

Repeatability: Factor 2.5 better than accuracy

Environmental
Storage temperature: −40° C to +75° C
Operating temperature: 0° C to 55° C
Humidity: 95% RH, 0° C to 40° C

Power: 100/120/220/240 V rms; +5% − 10%; 48 to 440 Hz; 70 VA max
Weight: Net, 4.6 kg (10 lb); shipping, 6.6 kg (15 lb)
Size: 89 mm H × 212.3 mm W × 345 mm D (3.5 in × 8.36 in × 13.6 in)

*Adjustable start-phase for haversine, havertriangle

Ordering Information

	Price
HP 8111A Pulse/Function Generator	$2,700
Opt 001 Burst	+$530
Opt 910 Extra Operating and Service Manual	+$39
Opt W30 Extended Repair Service (see page 636)	$65
HP 5062–4001: Bail Handle Kit	$40
HP 5062–3972 Rack Mount Kit (single HP 8111A)	$60
HP 5062–3974 Rack Mount Kit (two instruments)	$35
HP 5061–9694 Lock Link Kit (for use with HP 5062–3974)	$45

For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office. See page 635.

FUNCTION GENERATORS & WAVEFORM SYNTHESIZERS

1-mHz to 50-MHz Pulse/Function Generator

HP 8116A

- Sine, triangle, square, haverfunctions, and dc
- 1 mHz to 50 MHz, 32 V p-p for all waveforms
- Variable (10 ns min) pulse width, 6 ns transitions
- Modulation
- Self-prompting operating concept
- Error recognition and self testing

HP 8116A with Option 001, burst and logarithmic sweep

DESIGNED FOR HP-IB SYSTEMS

Hewlett-Packard Instrument Drivers

HP 8116A Pulse/Function Generator

The fully programmable HP 8116A features pulse as well as function generator capabilities in one small unit. A broad 1-mHz to 50-MHz band for all waveforms and a wide choice of operating and modulating modes assure high flexibility. These factors, plus good repeatability, make the HP 8116A a sound, long-term investment.

Specifications (50-Ω load, 0° C to 55° C)

Functions

Sine, triangle, ramp, square, pulse, haversine, and dc

Timing

Frequency: 1 mHz to 50 MHz
Duty Cycle: 10% to 90% in 1% steps (20% to 80% above 1 MHz, 50% above 10 MHz)
Pulse Width: 10 ns to 999 ms
Pulse/Squarewave Transitions: <7 ns

Output (50-Ω source)

Amplitude: 10 mV p-p to 16.0 V p-p into 50-Ω load
(20 mV p-p to 32.0 V p-p into open)
Offset/dc: 7.95 V (795 mV for amplitude <100 mV p-p) into 50 Ω. Voltages double into open

Accuracy

Typically 5%, please request data sheet 5953-6325 for performance details
Resolution: 3 digits
Repeatability: Typically 1%

Operating Modes

Standard: Internal, trigger, gate, and external width
Option 001: Logarithmic up sweep (single range 1 mHz to 50 MHz)
Sweep time/decade: Selectable 1-2-5 sequence from 10 ms to 500 s
Repetition: Continuous or external trigger
Counted burst: 1 to 1,999 cycles, any waveform up to 40 MHz
Repetition: Internal 100 ns to 999 ms or external trigger (pulse mode, external trigger only)

Control Modes

Frequency Modulation: ±5% max deviation
Sensitivity: 1 V for 1% deviation
Modulating frequency: dc to 20 kHz
Amplitude Modulation
Sensitivity: ±2.5 V for 100% mod. (+2.5 V to −7.5 V for DSBSC)
Modulating frequency: dc to 1 MHz
Pulse Width Modulation
Range: 10 ns to 1 s in 8 nonoverlapping decade ranges
Max width ratio: 10:1
Sensitivity: ±9 V for 1:10 ratio
Voltage-Controlled Oscillator
Range: 2 decades in range 1 MHz to 50 MHz
Sensitivity: 0.1 V to 10 V for 2 decades
Modulating frequency: dc to 1 kHz

Auxiliary Modes

Manual: Simulates external input
1 Cycle (Opt 001): Triggers single output cycle in trigger, gate, and ext burst modes
Auto Vernier: Continuous vernier that can be remotely or manually stopped
Limit: Programmable maximum output levels to protect DUT
Complement: Selectable normal/complement output
Disable: Relay disconnects output

Auxiliary Inputs and Outputs

External Input
Threshold: ±10 V adjustable
Max input voltage: ±20 V
Sensitivity: 500 mV p-p
Min pulse width: 10 ns
Input impedance: 10 kΩ typ
Trigger slope: Positive, negative, and off
Control Input
Max input voltage: ± 20 V
Input impedance: 10 kΩ typ
Trigger Output
Output levels: 0/2.4 V typ
Output impedance: 50 Ω typ
X-Output (Opt 001) for sweep X-Y recording (rear panel)
Output levels: 0 V (= start frequency) to 10 V max
Slope: 1.5 V per sweep decade
Marker Output (Opt 001) for sweep (rear panel)
Output levels: TTL
Leading edge: Positive at selected marker frequency
Hold Input (Opt 001), rear panel
Input levels: TTL
Leading edge: Positive transition causes HP 8116A output (f <10 Hz) to hold at instantaneous level. Output droop 0.01% per second
Max input voltage: ±20 V

General Specifications

Environmental
Storage temperature: −40° C to +70° C
Operating temperature: 0° C to 55° C
Humidity: 95% RH, 0° C to 40° C
Power: 100/120/220/240 V rms; +5%, −10%; 48 to 440 Hz; 120 VA max
Weight: Net, 5.9 kg (13 lb); shipping, 8.0 kg (18 lb)
Size: 212.3 mm W × 89 mm H × 422 mm D (8.36 in × 3.5 in × 16.6 in)

Ordering Information

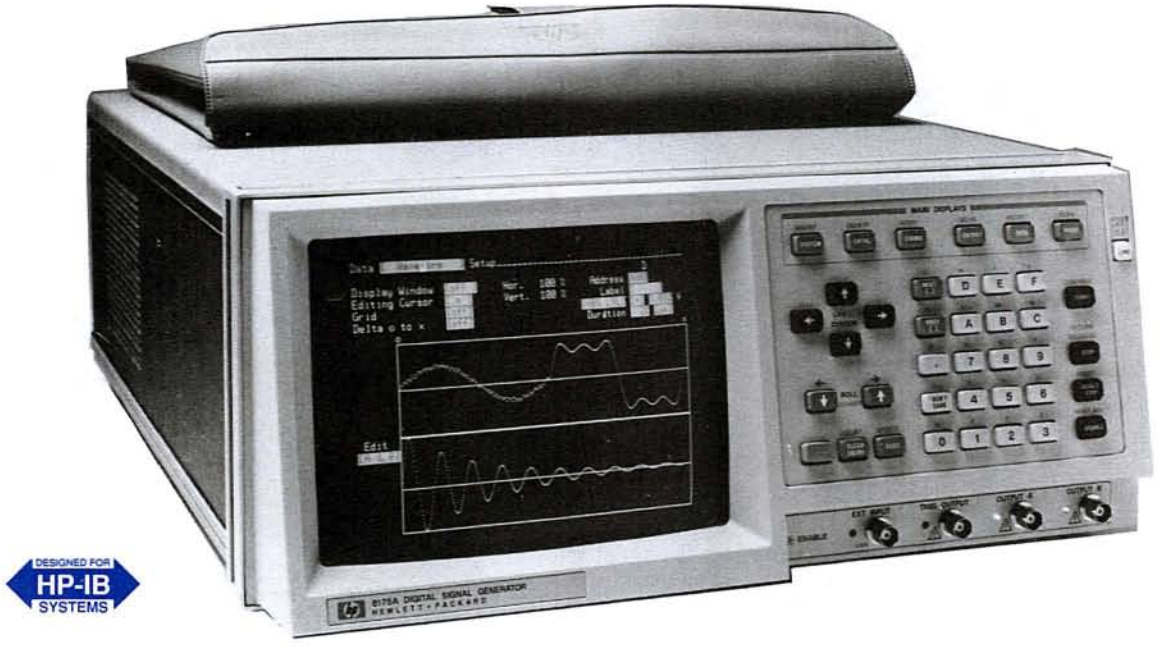
	Prices
HP 8116A Programmable Pulse/Function Generator*	$4,150
Opt. 001 Burst and Logarithmic Sweep	+$550
Opt. 910 Extra Operating & Service Manual	+$41
Opt. W30 Extended Repair Service (see page 636)	$95
HP 5062–4001 Bail Handle Kit	$40
HP 5062–3972 Rack Mount Kit (single HP 8116A)	$60
HP 5062–3974 Rack Mount Kit (two instruments)	$35
HP 5061–9694 Lock Link Kit (for use with HP 5062–3994)	$45

For rack mounting, contact factory.
*HP-IB cables not supplied, see page 124.

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Two analog channels / 1 kpoints ea / 50 MHz ea
- Individual datapoint durations 20 ns to 9.99 s
- Ten-bit amplitude resolution
- Digital and analog signals simultaneously
- Four waveform entry modes; calculator, graphical editing, abs. and rel. levels, various codings
- Up to 32 Vp-p output voltage (into open), separately programmable offset (max ±16 V)



HP 8175A, Option 002;
Data Page:
Waveform Setup

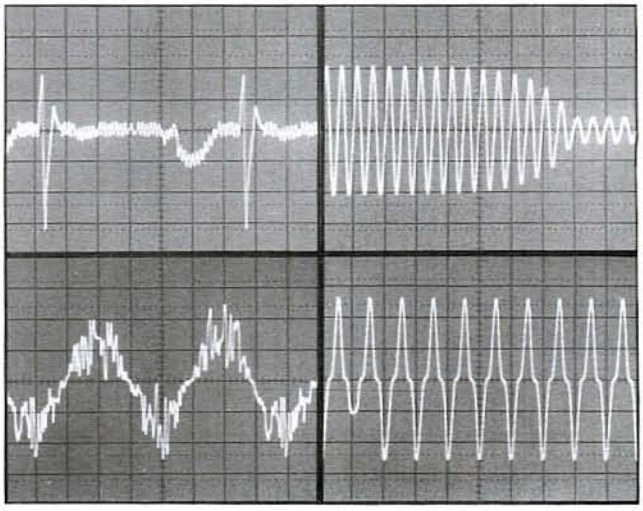
HP 8175A Option 002 Dual Arbitrary Waveform Generator

With the Option 002, the Dual Arbitrary Waveform Generator, the HP 8175A offers the new Arbitrary Waveform mode in addition to the existing Parallel and Serial modes. The Arbitrary Waveform mode gives you dual arbitrary waveform channels and simultaneous equivalent digital signals. This means you have the ideal source for such difficult applications as:

- Simulation of two dependent variables, such as force and distance, at the same time.
- Digital and analog simulation of such devices as programmable filters.
- Stimulus and compare signals at the same time for DACs or ADCs.

The arbitrary outputs are 50 Mpoints/s, synchronous, but independent in shape and amplitude (max 16 V peak-to-peak into 50 ohm and max 32 V peak-to-peak into open). The waveforms can be set up by means of algorithms (a fundamental set of mathematical functions are available, including noise); interpolations (linear and spline); graphic or tabular entry of instantaneous level (or amplitude and offset), or tabular entry of equivalent digital pattern. Additionally, any existing waveform can be modified, simply by tabular or graphical editing. A more powerful alternative method is using the Combine feature. This allows you to combine an algorithm arithmetically with any desired part of the current waveform.

Application Examples



The comprehensive feature set, together with the outstanding memory management and interaction capability, mean that "real-life" simulation for the most exacting circuits is within your grasp.

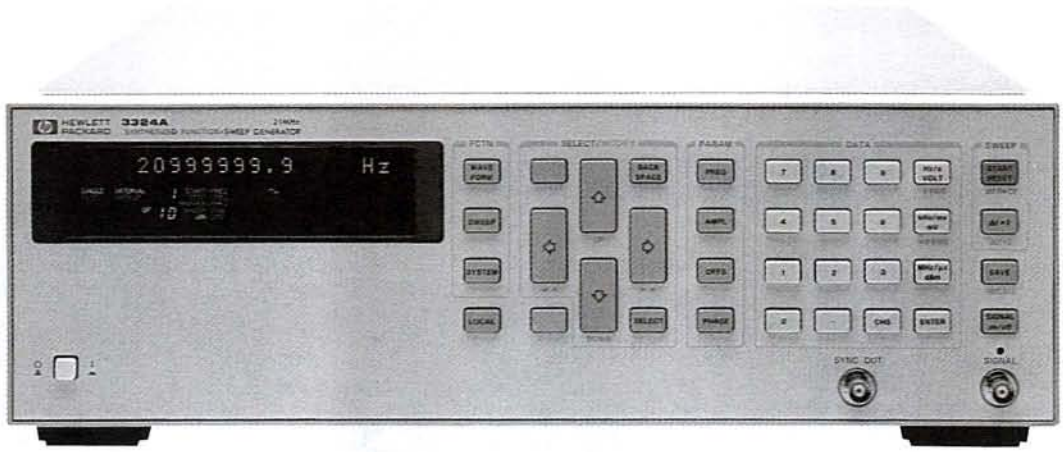
For further information about the digital capabilities of the HP 8175A see page 457.

FUNCTION GENERATORS & WAVEFORM SYNTHESIZERS

1-mHz to 21-MHz Synthesized Function/Sweep Generator

HP 3324A

- Multi-interval sweep
- Master/slave capability
- ±719.9° variable phase
- Additional 60-MHz output
- Outputs and HP-IB isolated
- HP 3325B-software compatible



HP 3324A

DESIGNED FOR HP-IB SYSTEMS

Hewlett-Packard Instrument Drivers

HP 3324A Synthesized Function/Sweep Generator

The HP 3324A provides synthesizer performance and multi-segment sweep at a moderate price, for applications such as speed sensors. Additionally, multi-phase signals can be set up because variable-phase and master/slave capabilities can be used together.

Brief Specifications (50-Ω load, 0° C to 55° C)

For detailed specifications, please request data sheet 5952-9678 and product information sheets *HP 3324A Sweep Parameters* and *HP 3324A Multi-Channel Setups.*

Frequency and Waveforms

1 mHz to: 11 kHz (triangle, ramps), 11 MHz (square), 21 MHz (sine), 60 MHz (auxiliary 0 dBm output)
Accuracy: 5 ppm
Stability: 5 ppm, Opt 001 0.1 ppm
Resolution: 1 mHz (0.1 Hz above 1 MHz)

Main Output (50-Ω source)

Amplitude: 1 mV to 10 V in eight 1-3-10 sequence ranges
Offset: 5 V; voltages double into open
Accuracy: 0.2 dB/2% typical
Resolution: 4 digits
Phase: 719.9° relative to start phase; 0.1° resolution

Sinewave Characteristics

Phase Noise: −50 dB
Spurious: −55 dB
Harmonics: −60 dBc (< 200 kHz), −40 dBc (< 2 MHz), −30 dBc (< 15 MHz), −25 dBc (< 20 MHz)

Squarewave Characteristics

Transitions: < 20 ns
Overshoot/Ringing: < 5%
Duty Cycle: 50% fixed

Triangle/Ramp Characteristics

Linearity: 0.05%

Sweep Capabilities

Cycling: Single or continuous
Modes: Multi-interval, multi-marker
Sweeps: Linear (up, down, constant tone), log up
Intervals: 50, sequence length 100 (in multi-interval mode)
Markers: One per interval (9 in multi-marker mode)
Sweep Time: Programmable up to 100,000 s

Auxiliary Outputs

Sync: 50-Ω source, 1.2 V p-p square wave, same phase as main output
Auxiliary 0 dBm Output: 50-Ω source, square wave
X-Axis Drive Output: Sweep-time ramp, 10 Vp-p, 10-kΩ source
Z-Axis Output: TTL blanking signal during sweep return, 10 mA sink
Sweep Marker Output: TTL pulse at selected marker frequency
1 MHz Reference Output: 0 dBm, 50-Ω source

Reference Input

For phase-locking the HP 3324A to an external frequency reference, signal 0 dBm to 20 dBm into 50 Ω.

Opt 002, High Voltage Output

Amplitude: 4 mV p-p to 40 V p-p into 500 Ω
Frequency: 1 mHz to 1 MHz

Options 003 and 004, Automatic Phase Calibration

Calibration: Refers slave phase to master. Interconnect cables are supplied. If there are two or more slaves, a VHF switch HP 59307A is required. Master/slaving doesn't apply to sweep mode.

General Specifications

Power: 100/120/220/240 V, 48 to 66 Hz, max. 100 VA
Weight: Net 11 kg
Size: 425.5 mm W × 132.6 mm H × 497.8 mm D

Ordering Information

	Price
HP 3324A Synthesized Function/Sweep Generator	$3,950
Opt 001 High Stability Frequency Reference	+$880
Opt 002 High Voltage Output	+$300
Opt 003 Automatic Phase Calibration, Slave	+$530
Opt 004 Automatic Phase Calibration, Master	+$320
Opt 907 Front Handle Kit (5062-3989)	+$55
Opt 908 Rack Flange Kit (5062-3977)	+$33.50
Opt 909 Rack Flange and Handle Combination Kit (5062-3983)	+$82.50
Opt W30 Extended Repair Service (see page 636)	+$90

For off-the-shelf shipment, call 800-452-4844.

- 200 Hz to 81 MHz
- High spectral purity
- Precision amplitude control
- 1 mHz resolution

HP 3335A

DESIGNED FOR HP-IB SYSTEMS

HP 3335A Synthesizer/Level Generator

The HP 3335A synthesizer/level generator has performance characteristics that make it ideally suited for the telecommunications industry as well as for traditional synthesizer applications, including testing of Frequency Division Multiplex (FDM) equipment and research and development and production testing of communications systems.

Precision Amplitude, Frequency

The HP 3335A incorporates a state-of-the-art attenuator with accuracies of up to ±.025 dB over the 81 MHz frequency range. Frequency stability up to $\pm 1 \times 10^{-8}$/day is provided by an internal temperature-controlled oscillator.

Frequency Sweep, Tracking Generator

The HP 3335A combines the frequency, accuracy and stability of a synthesizer with the time-saving convenience of a digital sweeper. In addition, the HP 3335A operates as a tracking generator with the HP 3746A/B Selective Level Measuring Set (SLMS) or the HP 3586A/B/C Selective Level Meter for automatic or semi-automatic testing of FDM systems.

Specifications

Contact your local HP sales office for more information including a data sheet with complete specifications.

Frequency

Standard range: 200 Hz to 81 MHz; **Resolution:** .001 Hz

Opt 002/004 range: 75 Ω, 200 Hz to 81 MHz; 124 Ω, 10 kHz to 10 MHz; 135 Ω, 10 kHz to 2 MHz

Opt 003 range: 75 Ω, 200 Hz to 81 MHz; 150 Ω, 10 kHz to 2 MHz

Opt 001: (high stability frequency reference)
Stability, long term: $<5 \times 10^{-10}$/day; $\pm 1 \times 10^{-7}$/year
Aging rate: $\pm 5 \times 10^{-8}$/day; $\pm 2 \times 10^{-8}$/month

Spectral Purity

Harmonic distortion: 200 Hz to 10 MHz: < −45 dBc; 10 MHz to 80 MHz; < −40 dBc

Phase noise: (30 kHz band, excluding ±1 Hz, centered on the carrier): 9.9 MHz: < −63 dBc; 20 MHz; < −70 dBc; 40 MHz; < −64 dBc; 80 MHz: < −58 dBc

Spurious: Nonharmonically related signals: the greater of −75 dBc or −125 dBm (50/75 Ω), −97 dBm (124 Ω), −68 dBm (135/150 Ω)

Amplitude Range

−88.74 dBm to +13.01 dBm depending on option and impedance.

Resolution: 0.01 dB

Absolute level accuracy (Max. output at 100 kHz, 10° C to 35° C): 50/75 Ω ±0.05 dB; 124/135/150 Ω: ±0.1 dB.

Flatness (Relative to 100 kHz, full amplitude): 50/75 Ω: 1 kHz to 25 MHz: ±0.07 dB, 200 Hz to 80 MHz: ±0.15 dB; 124 Ω: 50 kHz to 10 MHz: ±0.15 dB,10 kHz to 10 MHz ±0.4 dB; 135/150 Ω: 10 kHz to 2 MHz: ±0.18dB.

Ordering Information

	Price
HP 3335A Synthesizer/Level Generator	$13,400
Opt 001 High-Stability Reference $\pm 5 \times 10^{-10}$ day	+$1,330
Opt 002 Connector (75/124/135 Ω)	+$600
Opt 003 Connector (75/150 Ω)	+$380
Opt 004 Connector (75 Ω, miniature WECO on 124/135 Ω)	+$600
Opt C01 Rack Slide Mount	Contact HP

- 10 Hz to 20.999 MHz
- 11 digit resolution
- Excellent amplitude accuracy
- 1 mHz resolution

HP 3336C

DESIGNED FOR HP-IB SYSTEMS

HP 3336C Synthesizer/Function Generator

The HP 3336C is designed for traditional synthesizer applications as well as R&D and production testing of systems or components. It features precision level control, high spectral purity, optional frequency stability of $\pm 5 \times 10^{-8}$/week, internal frequency sweep and numerous other user conveniences.

Precision Frequency Measurements, Amplitude Accuracy

A single loop fractional–N synthesis technique allows synthesizer accuracy with 11 digits of resolution, with completely phase continuous frequency sweep over any of the instrument's frequency ranges. HP attenuator technology coupled with custom designs in leveling loops and thermal converters produce amplitude accuracies of up to ±0.05 dB. The fast leveling loop makes extremely flat sweeps possible at high sweep speeds.

Models HP 3336A and B are also available for the telecommunications industry (see page 535).

Specifications

Contact your local HP Sales Office for more information including a data sheet with complete specifications.

Frequency

Range: 10 Hz to 20.999 999999 MHz

Resolution: 1μHz for frequencies <100 kHz, 1 mHz for frequencies ≥100 kHz

Aging rate: $\pm 5 \times 10^{-6}$/year (20° to 30° C)

Amplitude

Range: 50 Ω: −71.23 to +8.76 dBm; 75 Ω: −72.99 to 7.00 dBm

Absolute accuracy: ±0.05 dB, 20° to 30° C (for the top 9.99 dB of amplitude range at 10 kHz), ±.08 dB, 0° to 55° C

Flatness: 50/75 Ω, ±0.1 dB (±0.07 dB with Opt 005) referenced to 10 kHz

Amplitude Modulation

Modulation depth: 0 to 100%

Modulation frequency range: 50 Hz to 50 kHz

Phase Modulation

Range: 0° to ±850°

Linearity: ±0.5% from best fit straight line

Modulation frequency range: dc to 5 kHz

Frequency Sweep

Sweep time: Linear; 0.01 s to 99.99 s. Single Log: 2 s to 99.99 s Continuous Log: 0.1 s to 99.99 s

Dimensions

Size: 425.5 mm W × 132.6 mm H × 497.8 mm D (16.8 in × 5.2 in × 19.6 in)

Weight: Net, 10 kg. (22 lb); shipping, 15.5 kg. (34 lb)

Ordering Information

	Price
HP 3336C Synthesizer/Level Generator	$6,100
Opt 004 High Stability Frequency Reference	+$720
Opt 005 High Accuracy Attenuator	+$720
Opt 907 Front Handle Kit	+$58
Opt 908 Rack Flange Kit	+$34
Opt 909 Rack Flange and Handle Kit	+$84
Opt W30 Extended Repair Service (see page 636)	+$130

For the most current prices and product information, contact your local Hewlett-Packard sales office.

FUNCTION GENERATORS & WAVEFORM SYNTHESIZERS

Multifunction Synthesizer

HP 8904A

- Sine to 600 kHz, square, ramp, triangle to 50 kHz
- 12 bit direct digital synthesis
- Tone, DTMF, digital, Hop Ram sequence modes
- One or two outputs
- One to four internal channels
- AM, FM, ØM, DSBSC, and pulse modulation
- Unit to unit phase synchronization
- Optional 600 Ω high power, balanced output

HP 8904A

DESIGNED FOR HP-IB SYSTEMS

HP 8904A Function Synthesizer

The standard HP 8904A Multifunction Synthesizer generates accurate sinewaves from 0 Hz to 600 kHz with 0.1 Hz resolution. The HP 8904A also has five other standard functions: square, triangle, ramp, from 0 Hz to 50 kHz plus dc, and Gaussian white noise. All waveform values in the HP 8904A are DIGITALLY calculated in real time by Hewlett-Packard's Digital Waveform Synthesis IC yielding 12 bit digital accuracy. Full HP-IB programmability is also included standard on the HP 8904A.

Two Outputs

Option 002 adds a second, identical synthesizer and floating 50 Ω output section to the HP 8904A. Frequency, amplitude, waveform, and phase can be independently set for the two sources. Either synthesizer can be precisely varied in phase relative to each other from 0 degrees to 359.9 degrees with a resolution of 0.1 degree.

Complex Signal Generation

Option 001 adds internal synthesizers (for a total of four) which can modulate channel A or be summed to give complex waveform generating capabilities to the HP 8904A. All four synthesizers are independent with precise phase offset capabilities. These synthesizers can be DIGITALLY summed before being output. In addition to summing, Option 001 allows channels B, C, and D to modulate channel A with AM, FM, ØM DSBSC, or pulse modulation.

FM Stereo Composite Mode

Option 001 also includes a mode for generating FM Stereo composite signals. Test signals in this mode include Left=Right, Left=−Right, Left Only, and Right Only. Single keystrokes select test tone frequency, composite level, test signal mode, and pilot tone level. Stereo separation is typically greater than 65 dB.

Communication Signaling

Option 001 also adds four sequence modes to the HP 8904A: tone, DTMF, digital, and hop ram sequence modes. These modes make the HP 8904A a powerful tool for use in communications signaling. Tone and DTMF modes allow creation of single or dual tone sequences up to 750 states in length. Digital sequence mode can generate bit streams up to 3000 bits in length with 100 μs resolution. Hop ram sequence mode allows sequencing of 16 tones, each with an associated amplitude, frequency, and phase value.

Fast Hop

Option 003 adds the ability to externally hop channel A in frequency, phase, or amplitude. Up to 16 frequency/phase/amplitude states can be entered into the "HOP RAM" memory. To hop, an external device must address the four-bit wide, TTL-level address bus provided on the rear panel. Phase continuous switching can be done in as little as 20 μs.

Unit to Unit Phase Synchronization

With Option 005, multiple HP 8904A's can be phase synchronized to provide more than two phase related outputs. In the synchronous mode, one unit is specified to be the master clock unit and all others are designated slaves. Two signals are then routed from the clock master unit to all slave units through external low-loss power splitters. To synchronize the units, a phase reset command is given to the master HP 8904A via HP-IB or from the front panel. The total phase error between units will be the larger of ±0.1 degree or 60 ns for frequencies from 0.1 Hz to 100 kHz. Up to eight HP 8904A's may be synchronized.

600 Ω Balanced Output

Option 006 changes output 1 from a 50 Ω electronically floating output to a transformer coupled, 600 Ω balanced output. Option 006 provides high power, balanced signals into 600 Ω loads. Maximum output is 10 volts rms into 600 Ω. The Option 006 output restricts the frequency range of output 1 to 30 Hz to 100 kHz. In addition, complex waveforms such as square, ramp, and triangle waveforms are degraded and DC cannot be passed through the Option 006 output. In many applications, however, the HP 8904A Option 006 is a direct replacement for the HP 200CD Wide Range Oscillator.

HP 8904A Specifications (for 50 Ω output only)

Frequency

Range: Sinewave: 0 Hz to 600 kHz
Square, triangle, ramp: 0 Hz to 50 kHz
Resolution: 0.1 Hz
Accuracy (internal 10 MHz timebase): 50 ppm

ac Amplitude (sinewave only)

Range: 0 to 10 V p-p into a 50 Ω load
Accuracy (>40 mV p-p into 50 Ω): 1%, 0.1 Hz to 100 kHz; 3%, 100 kHz to 600 kHz
Flatness: (>630 mV p-p into 50 Ω): ±0.1% (±0.009 dB), 0.1 Hz to 100 kHz

dc Amplitude

Range: 0 to ± 10 V p-p open circuit
Accuracy: Larger of ± 20 mV or ± 2.1%

Spectral Purity (sinewave only)

THD+N (including spurs, amplitude >50 mV rms into 50 Ω):
−63 dBc rms (0.07%), 20 Hz to 7.5 kHz, 30 kHz BW
−63 dBc rms (0.07%), 7.5 kHz to 20 kHz, 80 kHz BW

Gaussian Noise

Spectral Characteristic: Equal energy per unit bandwidth ("white")
Time Domain Characteristic: Gaussian distribution
Flatness (>100 mV p-p): Typically ± 0.5 dB, 0.1 Hz to 100 kHz

Option 001 Specifications

Modulation is for channel A only, and specified for sinewave carrier and modulation. External modulation is NOT possible.

Amplitude Modulation (with Option 001)
Rate: 0 to 600 kHz
Depth Range: 0% to 100 % of carrier amplitude

Frequency Modulation (with Option 001)
Rate: 0 to 600 kHz
Deviation Range: 0 to 600 kHz

Phase Modulation (with Option 001)
Rate: 0 to 600 kHz
Deviation Range: 0° to 179.9°/channel

Pulse or DSBSC Modulation (with Option 001)
Rate: 0 Hz to 50 kHz (up to 600 kHz for DSBSC)

Summation (with Option 001)
Two, three, or four channels may be summed.
Channel to Channel Phase Accuracy (equal amplitude sinewaves): Larger of ± 0.1° or 30 ns, 0.1 Hz to 100 kHz

FM Stereo Composite Mode (with Option 001)
Test Modes: Left=Right, Left=−Right, Left Only, Right Only
Composite Signal Level: Up to 10 $V_{p\text{-}p}$ into 50 Ω
Pre-emphasis Modes: Off, 25 μs, 50 μs, and 75 μs
Channel Separation: Typically > 65 dB, 20 Hz to 15 kHz rates

Tone Sequence Mode (with Option 001)
Number of frequencies: 16 tones each with user-definable frequency, on-time and off-time
On/Off Time Duration Range: 0 ms, 0.80 ms to 655.35 ms
Timing Accuracy: ±0.02 ms (± 20 μs)
Sequence Length: 750 steps, user-definable

DTMF Sequence Mode (with Option 001)
Number of Tone Pairs: 16 standard DTMF tone pairs (0-9, A-D, #, *) with user-definable on-time and off-time
On/Off Time Duration Range: 0 ms, 1.00 ms to 655.35 ms
Timing Accuracy: ±0.02 ms (± 20 μs)
Sequence Length: 750 steps, user-definable

Digital Sequence Mode (with Option 001)
User Definable: On level, off level, and bit period
Bit Period Duration Range: 0.10 ms to 655.35 ms
Timing Accuracy: ±0.02 ms (± 20 μs)
Sequence Length: Up to 3000 bits, user-definable

Hop Ram Sequence Mode (with Option 001)
Number of Frequencies: 16 tones each with user-definable frequency, phase, and amplitude
Sequence Clock Frequency Range: 0.1 Hz to 10 kHz
Sequence Length: 750 steps (all 16 tones used) or 3000 steps (tones 0 and 1 used), user-definable

Option 002 Specifications (50 Ω outputs)

Output 1 to Output 2 Phase Accuracy (sinewaves at the same frequency): ±0.1° or 30 ns, 0.1 Hz to 100 kHz, whichever is greater

Option 003 Specifications (Fast Hop)

Direct Hopping of Channel A: 16 phase-frequency-amplitude states may be addressed with four TTL-compatible inputs.
Switching Speed (via digital port): Typically <20 μs

Option 005 Specifications (50 Ω outputs)

Unit to Unit Phase Accuracy (sine waves only): Larger of ± 0.1 degree or 60 ns, 0.1 Hz to 100 kHz
Maximum Number of Synchronized Units: 8 units

Option 006 Specifications (sine wave)

All specifications for the standard 50 Ω output HP 8904A are degraded by the accuracy, flatness, and distortion specifications of the Option 006, 600 Ω transformer coupled output.

Output Type: Fully floating/balanced transformer coupled output
Usable Frequency Range: Typically 30 Hz to 200 kHz
AC Amplitude Range: 0 to 10 Vrms into 600 Ω
AC Amplitude Accuracy (> 40 mVrms into a balanced 600 Ω load):
6% (0.5 dB), 30 Hz to 20 kHz
12% (1.0 dB), 30 Hz to 100 kHz
Flatness (>40 mVrms into a balanced 600 Ω load): +0.15 dB, −0.75 dB, 30 Hz to 100 kHz
THD+Noise (including spurs, >140 mVrms into a balanced 600 Ω load): −63 dB (0.07%), 7.5 kHz to 20 kHz, 80 kHz BW

General
Store Recall: 35 nonvolatile registers
Output Type (standard unit): 50 Ω electronic floating or grounded output, HP-IB programmable
Maximum Float Voltage (50 Ω output, signal+float): 10 V peak maximum from high or low output to chassis ground
External Timebase Input: 10 MHz accepted at a nominal level of 0.1 to 5 V peak, automatic switching
Operating Temperature Range: 0° C to 50° C
Storage Temperature Range: −20° C to 70° C
Remote Operation: HP-IB
Weight: Net, 5.9 kg (12.8 lb); shipping, 13 kg (28.6 lb)
Size: 133 H × 213 W × 513 mm D (5.25 in × 8.36 in × 20.2 in)

Ordering Information	Price
HP 8904A Multifunction Synthesizer[1]	$3,175
Opt 001 Adds three (two when ordered with Opt 002) internal channels, Channel A modulation, summation, FM stereo mode, and sequence capability	+$1,835
Opt 002 Adds second internal synthesizer and output	+$1,345
Opt 003 Adds fast hop and digital modulation	+$570
Opt 004 Connectors on rear panel only (not available with Opt 005 or 006)	+$60
Opt 005 Adds unit to unit phase synchronization	+$540
Opt 006 Changes output 1 from a 50 Ω output to a transformer coupled, 600 Ω balanced output	+$860
Opt 910 Provides an additional operation and calibration manual (08904-90007) and two service manuals (08904-90008)	+$123 ☎
Opt 915 Adds Service Manual (08904-90008)	+$36 ☎
Opt W30 Extended Repair Service (see page 636)	+$95
Opt W32 Calibration Service (see page 636)	+$210
08904-61024 Rack Mount Kit for a single HP 8904A	+$125
08904-61025 Rack Mount Kit for mounting two HP 8904A's side by side	+$90

HP 8904A Retrofit Kits (customer retrofittable):

HP 11816A Retrofit Kit for Opt 001	+$2,055
HP 11817A Retrofit Kit for Opt 002	+$1,640
HP 11818A Retrofit Kit for Opt 003	+$675
HP 11827A Retrofit Kit for Opt 005[2]	+$645
HP 11837A Retrofit Kit for Opt 006[2]	+$1,040

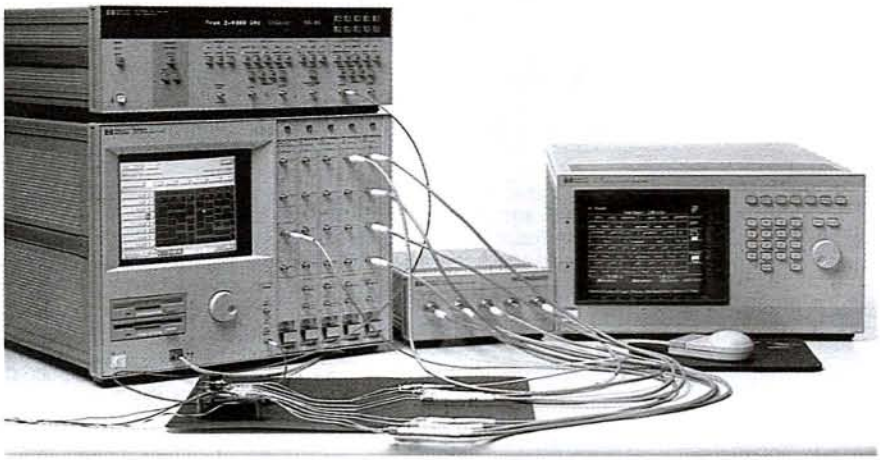
[1]HP-IB cables not included. For description and price see page 124.
[2]Not available for units with serial prefix less than 2948A.

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office. See page 635.

PULSE GENERATORS & DATA GENERATORS
General Information

High-Speed Digital Design Verification



MUX prototype test: The HP 8133A (top left) supplies a very stable 2 GHz clock, and the HP 80000 system delivers 8 synchronous channels at 250 Mb/s. The serialized MUX output—a true prbs thanks to a special 80000 feature—is assessed on the HP 54120 Series oscilloscope using an eye-pattern technique.

IC Test Head Performance

Fast, clean pulses are needed to verify prober or test head performance. Transition-time converters are available for HP's faster digital stimuli, so a virtually ideal pulse is available. See pages 450 and 451.

Complex Devices

Good stimulus performance is essential for measuring limiting conditions reliably. But complex devices need an added dimension of stimulus flexibility in order to exercise all functions fully. This challenge is answered by the HP 80000 modular platform for such diverse devices as DACs for image presentation, multichannel receivers, parallel-to-serial converters, and fast custom LSI.

Cell Evaluation

Pulse generation is fundamental to any digital characterization task in order to emulate real conditions. Edge positioning repeatability has a major effect on device yield, so timing resolution, fast linear edges, and stability are crucial pulse generator specifications.

Computer Backplanes

No matter how well active devices perform, they can only be as good as the interconnections between them. Pulse generators make it easy to assess bandwidth and crosstalk limits under realistic conditions, independent of device development status. Essential stimulus features are adequate edge speed for the technology used and narrow pulse width for interference pulse simulation.

High-Speed Stimulus Selection Chart (see pages 129 and 317 for response instruments)

Special features / Catalog page	HP 8082A / –[1]	HP 8130A / 450	HP 8131A / 450	HP 8133A Pulse pattern / 451	HP 80000 Modular data system / 452
Transition time	Variable	Variable	Fixed	Fixed	Fixed
10%-90% spec	1 ns	1 ns	200 ps	100 ps	250 ps
10%-90% typ	900 ps	750 ps	170 ps	60 ps	150 ps
20%-80% typ	600 ps	500 ps	120 ps	40 ps	100 ps
Var delay, width: Resolution	● Manual	● 10 ps	● 10 ps	● 1 ps	delay 2 ps
Max rate, MHz: Accuracy	250 Manual	300 5%	500 5%	3,000 0.5%	1,000 120 ppm
Data capability (per channel)	—	—[2]	—[2]	32-bit RZ/NRZ, prbs	16 Kb RZ/NRZ, prbs, and mixed
Channels per mainframe	1	1 or 2[3]	1 or 2[3]	1 or 2[3]	4 to 20

[1] For further information on the HP 8082A, please request data sheet 5952-9672.
[2] Clock and 101010....data can be simulated in dual-channel instruments by selecting double pulse mode in 1 channel.
[3] Up to 6 channels feasible by using master/slave configuration.

Selection Chart for Stimuli up to 150 MHz

Special features / Catalog page	HP 214B High voltage / 459	HP 8160A (8161A) MATE / –[1]	HP 8112A (8115A) Modulation / 456	HP 8118A Pulse patterns / 457	HP 8175A (Opt 002) Data and (AWG) / 457(443)	HP 8110A Pulse patterns / 454
Max rate, MHz	10	50(100)	50	50	50	150
Transition time: 10%-90% spec	Fixed 15 ns	Variable 6(1.3) ns	Variable 5.5 ns	Variable 5.5 ns	Fixed —[2]	Variable 2 ns
Var delay, width: Resolution	● Manual	● 100 ps	● 100 ps	● 100 ps	—[3]	● 10 ps
Data capability (per channel)	—	—[4]	(—[4])	16 Kb RZ/NRZ	1 Kb looping	4 Kb RZ/NRZ, prbs
Output into 50 Ω: Window	100 V p-p	20(5) V p-p	16 V p-p	16 V p-p	—[2]	20 V p-p
Norm/compl	+ or –	±20(5) V Select	±8 V Select	±8 V Select		±20 V Select
Modulation	—	—	●	●		—
Channels per mainframe	1	1 or 2	1(2)	2	24 data/ 2 arb	1 or 2
Channel addition	—	●	(●)	●		●

[1] Please request data sheets 5952-9611 (HP 8160A) and 5952-9538 (HP 8161A) for more information on these instruments.
[2] Data output levels and transitions depend on mix of pods (ECL, TTL, and variable CMOS) fitted. Arbitrary waveform channels (Option 002) 16 V p-p.
[3] Bit duration can be set individually, best case resolution 10 ns. Option 001 provides delay on 4 data channels, resolution 100 ps.
[4] Clock and 101010....data can be simulated in dual-channel instruments by selecting double pulse mode in 1 channel.

General Purpose and Logic Tests Up to 150 MHz

Whether you work with analog or with digital devices, you will need many different kinds of stimulus: a square wave for amplifier testing or clocking a step to measure a threshold or test a servo, a triangle for stress-testing, needle-pulses for interference measurements, or a fast pulse to characterize a diode. A flexible pulse generator like the HP pulse generators will save you from looking for individual solutions each time.

Functional Test

Serial devices need more than just pulses. To test them during development, real data signals are needed, often with three or four voltage levels. You may have a bus device that talks, but it won't allow you to adjust timing and voltages. The HP 8118A has been designed especially for this purpose.

General Purpose and Logic Test Up to 150 MHz (continued)

Through the 50 MHz Boundary

As consumer-goods processors and data links get faster, you'll need faster stimuli. With up to 150 MHz rate, 2 ns transitions, and 20 V p-p output, the new HP 8110A has plenty of reserve and can generate all waveforms needed to test TTL and CMOS, including glitch/spike simulation and 3- or 4-level codes.

Compact and CAT-Friendly

The low height of the HP 8110A means less clutter on the bench and less rack space. SCPI programming makes it straightforward to port R&D test know-how to production.

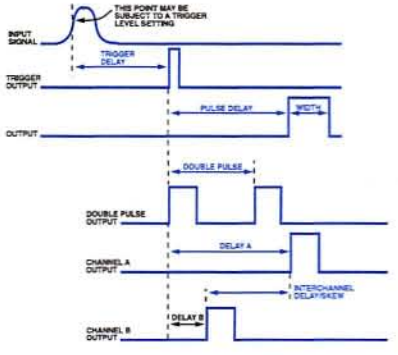
Typical HP 8110A pulse generator stimulus-response set up with the HP 54503A oscilloscope for testing analog and digital circuits up to 150 MHz.

Real-World Signal Simulation

Sensor outputs and radar signals can often be approximated with a pulse generator through variable transitions and modulation modes. For closer imitation, HP has a range of arbitrary waveform generators. One of these, the HP 8175A, also has digital capabilities, so analog and digital signals—as needed for DACs, ADCs, and programmable filters—can be generated at the same time from a single source. Interactive, tri-state, and looping capabilities make this instrument ideal for bus simulation/stimulation.

Pulse Parameter Definitions of Terms Used in Instrument Specifications

Time Reference Point: Median (50% amplitude point on pulse edge).
Pulse Period: The time interval between the leading edge medians of consecutive trigger output pulses.
Trigger Delay: Interval between trigger point of input signal and the trigger output pulse's leading edge median. Applies in trigger, external width, gate and burst modes.

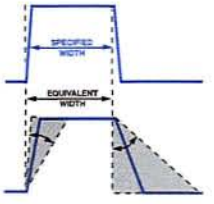


Pulse Delay: Interval between leading edge medians of trigger output pulse and output pulse.
Double Pulse: Interval between leading edge medians of the double pulse.
Interchannel Delay/Skew: Interval between corresponding leading edge medians.
Pulse Width: Interval between leading- and trailing-edge medians.

Additional Information for Pulse Generators with Variable Transition Times

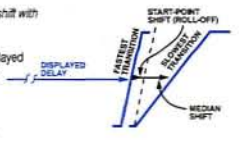
Pulse Width: The specified and displayed value is that obtained with fastest edges; essentially equal to the interval from the start of the leading edge to the start of the trailing edge.

By designing so that the pulse edges turn about their start points, the interval from leading edge start to trailing edge start stays unchanged* when transition times are varied. This is more convenient for programming and the width display is easy to interpret.



**In practice, start points may shift with changes in transition time.*

Delay: The specified and displayed value is that obtained with the fastest leading edge. For a slower edge, the actual delay exceeds the displayed delay by the combined shift of start-point and median.



Transition Time: Interval between the 10%- and 90% amplitude points on the leading/trailing edge.

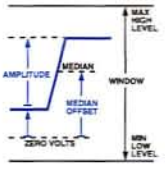
Linearity: Peak deviation of an edge from a straight line through the 10%- and 90%-amplitude points, expressed as percentage of pulse amplitude.

Jitter: Short-term instability of one edge relative to a reference edge. Usually specified as rms value, which is one standard deviation or "sigma." If distribution is assumed Gaussian, six sigma represents 99.74% of the peak-peak jitter.

The reference edge for period jitter is the previous leading edge. That for delay jitter is the leading edge of the trigger output. Width jitter is the stability of the trailing edge with regard to the leading edge.

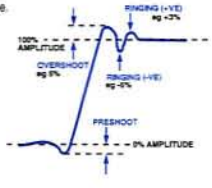
Stability: Long-term average instability over a specific time, for example, hour, year. Jitter is excluded.

Pulse Amplitude: Pulse output is specified as pulse top and pulse base (usually referred to as high level and low level), or as peak-to-peak amplitude and median offset. A "window" specification shows the limits within which the pulse can be positioned.

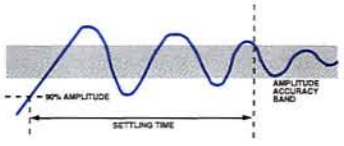


Preshoot, Overshoot, Ringing: Preshoot and overshoot are peak distortions preceding/following an edge. Ringing is the positive peak and negative peak distortion, excluding overshoot, on pulse top or base. A combined preshoot overshoot, ringing specification of e.g. ±5% implies:

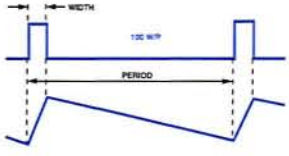
- Overshoot/undershoot < 5%
- Largest pulse-top oscillation < ±5%, of pulse amplitude



Settling Time: Time taken for pulse levels to settle within level specification, measured from 90% point on leading edge.



Duty Cycle: Percentage ratio of pulse width to period. In pulse/function generators, this term is also used to define sine and triangle symmetry. Note that, in pulse generators, this is a secondary parameter derived from period and width settings. The duty cycle achieved is therefore subject to width and period accuracies.



Output Impedance/Resistance: Effective pulse source impedance/dc resistance.

Reflection Coefficient: Reflection at pulse generator output expressed in percent of incident pulse amplitude. (Test pulse edges correspond to generator's fastest transitions).

Repeatability: When an instrument operates under the same environmental conditions and with the same settings, the value of a parameter will lie within a band inside the accuracy window. Repeatability defines the width of this band.

HP-IB Programming Times

Listen Time: The time an instrument occupies the bus to receive and verify a message. The NRFD signal is active during this period.
Settling Time: The time taken by the instrument to execute an HP-IB message and for the output to settle within the accuracy specification. NRFD inactive.
Execution Time: The sum of Listen Time and Settling Time.
Talk Time: The time an instrument occupies the bus to output a specified string. Output data is typically instrument error status, or current or stored parameters.

PULSE GENERATORS & DATA GENERATORS

High-Speed Pulse Generators

HP 8130A, HP 8131A

HP 8130A
- 300 MHz
- 1 ns variable transitions

HP 8131A
- 500 MHz
- 1 GHz transducer mode
- < 200 ps transitions

DESIGNED FOR HP-IB SYSTEMS

Hewlett-Packard Instrument Drivers

HP 8130A with Option 020 second channel (HP 8131A has similar appearance, but with SMA connectors)

HP 8130A, HP 8131A High-Speed Pulse Generators

200 ps Transitions (HP 8131A)

The fast and linear transitions of the HP 8131A are specified from 10 percent to 90 percent of amplitude and therefore match advanced ECL and many GaAs devices. With a 50-Ω termination, the pulse shape is excellent. However, in practice the real load may be reactive or mismatched, causing ringing or reflections. Transition time converters are available to reduce these effects.

1 GHz Transducer Mode (HP 8131A)

This mode generates a fast-edge square wave up to 1 GHz for toggle rate testing. A sine wave from a signal generator is needed.

Variable Transitions (HP 8130A)

Clean variable edges down to less than 1 ns address a wide range of technologies such as BICMOS, ECL, and ECLips*, as well as opening to analog applications such as rapid bandwidth assessment or amplifier slew-rate measurements.

10 ps Timing Resolution

This is an order of magnitude higher than typical gate delays and hence eliminates window uncertainties.

5 V p-p Amplitude, 10 mV Resolution

Pulses can be set up from 100 mV to 5 V p-p in a ±5 V window. This means that levels for all fast transistor technologies can be set up simply, even if a power splitter is required in the setup. 10 mv resolution allows limiting levels to be established very accurately.

Data and Clock Simulation

Cell characterization often requires two signals, clock and data, in order to test proper handling of logical zeroes and ones. Dual-channel HP 8130, 8131A generators provide these signals when one channel is set to double-pulse to simulate the clock. The other channel then represents 0101 . . . data.

Glitch Testing

Crosstalk or interference spikes can be simulated by adding different pulses together, such as a 150 Mb/s signal from an HP 8130A with a 500 ps spike from an HP 8131A. Adder accessories HP 15104A, HP 15115A, and HP 15116A make these connections quickly and easily.

*Registered trademark of Motorola Inc.

Brief Specifications (Please request data sheets 5953-6321 and 5953-6320 for more details.)

Timing
- **Period:** 3.33 ns to 99.9 ms (HP 8131A: 2.00 ns to 99.9 ms)
- **Delay:** 0.00 ns to 99.9 ms, not available with double pulse
- **Double pulse:** 3.33 ns to 99.9 ms (HP 8131A: 2.00 ns to 99.9 ms)
- **Width:** 1.50 ns to 99.9 ms (HP 8131A: 0.50 ns to 99.9 ms)
- **Duty cycle** (alternative to width parameter): 1% to 90%
  - **Max delay, width, duty cycle:** Refer to data sheets.
- **Transition times:** 1 ns to 100 μs (8131A: < 200 ps)
- **Accuracy:** Typically 5%
- **Jitter:** Typically < 0.025%

Differential Outputs into 50 Ω
- **High level:** −4.90 V to +5.00 V
- **Low level:** −5.00 V to +4.90 V
- **Amplitude:** 100 mV to 5 V p-p
- **Accuracy:** Typically 5%

Operating Modes: Auto, Trigger, Manual, Gate, External Width, External Burst, and (HP 8131A only) Transducer

Ordering Information

	Price HP 8130A	Price HP 8131A
HP 8130A, HP 8131A Pulse Generator	$12,700	$16,000
Opt 001 Rear Panel Connectors	$0	$0
Opt 020 Second Channel (not retrofittable)	$6,600	$8,250
Opt 908 Rack Flange Kit (p/n 5062-3977)	$36	$36
Opt 910 Operating and Service Manual	$230	$230
Opt 915 Service Manual Only	$200	$200
Opt 916 Additional Operating Manual	$32	$32
Opt H01 Preparation for Rack Slides	$0	$0
Opt W30 Extended Repair Service (see page 636)	$360	$360
Accessories		
HP 15104A Pulse Adder/Splitter, dc to 2 GHz. BNC	$120	$120
HP 15116A Pulse Inverter, 3 MHz to 2 GHz. BNC	$230	$230
HP 15115A Pulse Splitter/Invert, 3 MHz to 2 GHz. BNC	$230	$230
HP 15432B 250 ps Transition Time Converter. SMA	—	$260
HP 15433B 500 ps Transition Time Converter. SMA	—	$260
HP 15434B 1 ns Transition Time Converter. SMA	—	$260
HP 15438A 2 ns Transition Time Converter. SMA	—	$260

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Transition times < 100 ps
- Timing resolution 1 ps
- Optional data and PRBS capabilities
- Jitter < 5 ps
- Optional second pulse channel
- Synchronization of up to 3 instruments

HP 8133A 3-GHz Pulse Generator with Option 002

NEW

DESIGNED FOR HP-IB SYSTEMS

HP 8133A Pulse Generator

The HP 8133A provides pulses with programmable period from 333 ps to 30 ns, with resolution down to 1 ps and accuracy of 0.5%. The pulse width can be programmed from 150 ps to 10 ns with an accuracy of 100 ps; it can be programmed right up to period minus 150 ps. Delay accuracy is 150 ps; delay ranges depend upon configuration but not on the programmed period. The resolution for width and delay is 1 ps.

Transition times of less than 100 ps are specified, and less than 60 ps are typical. Typical jitter of 1 ps, as measured with the HP 54121T digitizing sampling oscilloscope, is specified to be less than 5 ps and therefore creates precise and accurate timing conditions.

As a single unit, the HP 8133A is available with 1 or 2 pulse channels. In addition, up to 3 instruments can be linked together to provide 6-channel operation. Each channel has the full 3 GHz capability and the same accuracy, resolution, and edge specifications. The Multichannel Accessory Kit HP 15436A achieves the correct propagation time compensation.

Instead of a second pulse channel, the instrument can be configured with a pulse/data channel that provides either a 32-bit digital pattern in NRZ or RZ (50 percent duty cycle) or a Pseudo Random Binary Sequence (PRBS). The sequence, which is 2^{23}-1 bits long and conforms to CCITT 0.151, is useful for eye-diagram measurements, and the HP 54120 Series digitizing oscilloscopes are ideal partners for realizing fast analysis through this technique. The pulse/data channel option therefore significantly extends its functionality.

HP 8133A Configuration overview

Channel	Standard	Option 001[1]	Option 002[1]	Option 003[1]
1	Pulse channel width or delay	Pulse channel width and delay	Pulse channel width and delay	Pulse channel width and delay
2	None	None	Data channel 32-bit or PRBS	Pulse channel width or delay

[1]Options are mutually exclusive.

Brief Specifications (Please refer to data sheet 5091-2918 for details.)

Timing
- **Frequency:** 33.0 MHz to 3.0000 GHz, 100 KHz resolution
- **Period:** 300 ps to 30.000 ns, 1 ps resolution
- **Accuracy:** ±0.5 %, ±0.1 % nominal

Pulse Channel(s)

Square Mode (50% duty cycle):
- **Delay:** 0.000 to 10.000 ns (− 5.000 to + 15.000 ns in Channel 1 if Opt 001, 002, or 003 used)

Pulse Mode:
- **Delay:** No variation (− 5.000 to + 5.000 ns in Channel 1 if Opt 001, 002, or 003 used)
- **Width:** 150 ps to 10.000 ns (max: period − 150 ps)
- **Duty cycle:** 0.0 to 100.0%, 0 and 100% mean dc at outputs

Accuracy: Typically 30 ps

Delay Drift Against Delay: 50 ps

Phase: − 360.0 to + 360.0°, subject to delay limits

Outputs, Channels 1 and 2 and (Trigger Output)
- **Amplitude:** 0.30 to 3.00 V p-p (0.5 to 1.80 V p-p)
- **Level window:** −2.00 to + 4.00V (− 4.00 to + 4.00 V)
- **Outputs:** Differential outputs, invertable (single)
- **Transition times:** 10% to 90% of amplitude: <100 ps, 60 ps nominal; 20% to 80% of amplitude: <60 ps, 40 ps nominal (<100 ps)

Ordering Information

	Price
HP 8133A 3-GHz Pulse Generator	$27,100
Opt 001 Delay Channel 1	$5,200
Opt 002 Pulse/Data Channel 2	$13,600
Opt 003 Pulse Channel 2	$13,600

Note: Option 002 and Option 003 contain Option 001.
Options are mutually exclusive.

Accessories

HP 1250-1462 Adapter SMA (m) to SMA (f)	$25
HP 8120-4948 50 Ω Cable, SMA (m-m)	$210
HP 8710-1582 Torque Wrench, 5 in/lb	$260
HP 8493A Series Attenuator	$135
HP 11667B Power Splitter	$1,070
HP 15436A Multichannel Accessory Kit	$2,650
HP 15435A 150-ps Transition Time Converter	$260

See previous page for other transition time converters.

For the most current prices and product information, contact your local Hewlett-Packard sales office, see page 665.

PULSE GENERATORS & DATA GENERATORS

Data Generator System

HP 80000

- Clock or data rate up to 1 GHz
- 16 Kb memory depth
- Delay range ±2 ns, 2 ps resolution
- Amplitude up to 2.5 V in −2 V to 3 V level window
- Color touchscreen, mouse, keyboard, and knob
- Modular system

Example of an HP 80000 Data Generator System configuration

NEW

DESIGNED FOR HP-IB SYSTEMS

HP 80000 Data Generator System

The HP 80000 data generator system provides a modular platform for performance data and clock generators and offers a precise test pattern to characterize high-performance devices, such as fast DACs for image presentation, multichannel receiver, parallel-to-serial converter, and fast custom LSI ICs in the time domain.

The HP 80000 currently consists of a mainframe, a 1 GHz clock/strobe module, and a 1 GHz 4-channel data module.

The HP E2900A mainframe houses the internal clock generation, including the synchronous start-stop generation, the color touch display, a rotary knob, two high-density 3½-in flexible disk drives, and a connector for a keyboard and/or mouse (HP-HIL), and it contains five slots for the plug-in modules.

The HP E2902A 1 GHz clock/strobe module delivers a 1 GHz differential clock, either running continuously or in a start-stop mode. There are also two strobe channels available, which allow triggering on a specific pattern or marking a data stream.

The HP E2903A 1 GHz data module contains 4 channels of 16 Kb data up to 1 GHz in NRZ and RZ mode. The data channels can be delayed independently with respect to each other up to ±2 ns. The data module uses the internal clock but can be used in asynchronous applications with an external user-supplied clock.

A built-in system expansion capability allows the use of an extender frame to add additional modules.

The system can be configured according to the customer needs, starting with 4 channels and going up to 20 channels of 1 GHz data. It can be retrofitted at the customer's site if the need for additional channel arises.

Specifications

For more information, please consult the HP 80000 Data Generator System brochure p/n 5091-2917 and the HP 80000 Data Generator System technical data sheet p/n 5091-2916.

HP E2900A Mainframe

Internal Clock: 7.8 MHz to 1 GHz, 1 ns to 128 ns
External Clock Input
Range: 10 MHz to 3 GHz
External input: Start, start-stop, gate
External reference input: Rear panel
Auxiliary output: Rear panel

General Characteristics

Peripheral Input Devices: Connected via the HP-HIL connector
Built-in Disk Drives: Format 3½-in 1.44 MB HD
HP-IB Capabilities: IEEE 488.1 and 488.2, 1987; SCPI 1992.0
RS-232C Capabilities: Operates as DTE

HP E2902A 1 GHz Clock/Strobe Module

Clock Capabilities
Continuous clock: The clock is always active, independent of the data sequence.
Switched clock: The clock is active during the data sequence and stops synchronously when the sequence is completed.
Strobe Capabilities
Clock and clock divider: Each strobe channel can be used as an additional clock output to generate phase-shifted signals.
Data Patterns
Data format: DNRZ, DRZ (50% duty cycle)
Memory depth: 16 Kb
Data sequence: Preamble data, cycle data, zero run (if data channels are in mixed mode)

HP E2903A 1 GHz Data Module

Data Patterns
Data format: DNRZ, DRZ (50% duty cycle)
Memory depth: 16 Kb
Data sequence: Preamble data, cycle data, PRWS23 (random data based on PRBS sequence $2^{23}-1$)
PRBS Patterns
$2^{23}-1$ (CCITT O.151)
$2^{n}-1$ where n = 7, 10, 11
Zero Substitution: Zeros can be substituted for data to extend the longest run of zeros.
Variable Mark Density: The ratio of 1s to total bits can be set to ⅛, ¼, ½, ¾, and ⅞.
External Clock Input: The external clock input on the data module is used to generate asynchronous data streams with respect to the mainframe clock.
External Input (start, gate): The external input on the data module is used to start and gate the data stream.

Clock, Strobe, and Data Timing

Delay: Clock, strobe, and data delay variation per channel vs. other channel
Range: ±2.00 ns
Resolution: 2 ps
Accuracy (delay variation): ±80 ps
Repeatability: 4 times better than accuracy
Jitter, rms: <25 ps (<10 ps typical)

Clock, Strobe, and Data Outputs

Terminations Selectable: 50 Ω to GND, 50 Ω to −2 V, into open circuit
Levels: All specifications apply for outputs terminated with 50 Ω to GND.
Resolution: 10 mV
High-Level Range: −1.5 V to 3.0 V
Low-Level Range: −2.0 V to 2.5 V
(minimum amplitude 0.5 V, maximum amplitude 2.5 V)
Level Accuracy: 3% ±50 mV
Overshoot, Ringing: 10% ±30 mV
Impedance: 50 Ω nominal
Supplementary Information: 50 Ω to ±2 V:
High-level range: −1.5 V to 1.0 V
Low-level range: −2.0 V to 0.5 V
(minimum amplitude 0.5 V, maximum amplitude 2.5 V)
Into Open Circuit:
High-level range: −2.5 V to 4.5 V
Low-level range: −3.5 V to 3.5 V
(minimum amplitude 1.0 V, maximum amplitude 5.0 V)
Transition Times: 10/90 of amplitude: <250 ps (<150 ps typical)
20/80 of amplitude: <150 ps

Operating Environment

Storage Temperature: −40° C to +70° C
Operating Temperature: +15° C to +40° C
Humidity: Up to 80% relative humidity at +30° C
Power: 100–120/220–240 V rms, ±10%, 900 VA max, 47–63 Hz
Weight: Net, 32 kg (71.1 lb) + (2 kg (4.44 lb) × number of modules); shipping, 56 kg (124.5 lb) + (4 kg (8.89 lb) × number of modules)
Size: 323 mm W × 426 mm H × 602 mm D (12.7 in × 16.8 in × 23.7 in)

Ordering Information

	Price
HP 80000 Data Generator System Components	
HP E2900A Mainframe	$17,200
HP E2902A 1 GHz Clock/Strobe Module	$9,900
HP E2903A 1 GHz Data Module	$12,900
Accessories	
HP 46060A HP-HIL Mouse	$179
HP 46021A HP-HIL Keyboard	$155
HP 15432B 250 ps Transition Time Converter	$260
HP 15433B 500 ps Transition Time Converter	$260
HP 15434B 1 ns Transition Time Converter	$260
HP 15439A 2 ns Transition Time Converter	$260
HP 1250-1462 Adapter SMA(m) to SMA(f)	$25
HP 8120-4948 50 Ω Cable, SMA (m-m)	$210
HP 8710-1582 Torque Wrench 5 in/lb	$260
HP 1182A/1181A Testmobile Carts for Instruments	$950

PULSE GENERATORS & DATA GENERATORS

150-MHz Pulse Generator, All Digital Waveforms

HP 8110A

- 150-MHz timing
- 2-ns variable transitions
- 10-Vpp amplitude, 50 Ω/50 Ω
- 10-ps resolution
- Pattern 4 kbit/channel
- Three and four level signals
- 1 or 2 output channels
- SCPI programming commands

DESIGNED FOR HP-IB SYSTEMS

NEW

HP 8110A 150-MHz Pulse Generator

The HP 8110A 150-MHz pulse generator generates all pulses, digital patterns, and multilevel waveforms necessary to test digital designs—particularly CMOS—confidently. The graphic display makes it ideal for bench operation.

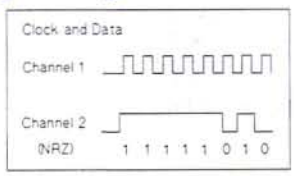
With its small rack size and SCPI standard programming commands for HP-IB control, the HP 8110A is ideal for automated test systems.

The HP 8110A can be configured with one or two channels, with a PLL that enables locking to external reference frequencies, internal triggered bursts or patterns and enhances frequency accuracy.

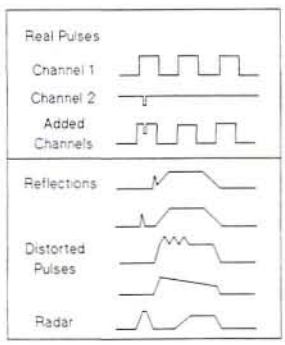
All configurations are available in the factory-configured product or may be purchased later.

All Waveforms for Testing Digital Designs

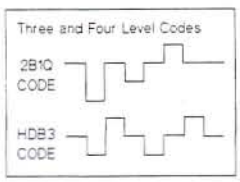
- Clock and data signals can be simulated easily with the pattern capability of HP 8110A
- Synchronization to microprocessor clock is possible with HP 81106A. The strobe output can be used to simulate an additional microprocessor control signal.



- Testing the device under real world conditions is easy with HP 8110A. Reflections, distorted pulses, and radar signals can be simulated with the pattern and channel addition capabilities. All pulse parameters are variable.



- Communication circuits: Three- and four-level codes, like HDB3 or 2B1Q can be generated using channel addition and pattern features of the HP 8110A.



Convenient Test System Integration

The HP 8110A is convenient to integrate into automated test systems. The small rack height saves valuable rack space. Rear panel connectors and rack-mount kits are optional.

All parameters are fully HP-IB programmable using SCPI standard programming commands, which simplifies test program generation and standardization of test software.

Repeatable measurements are guaranteed, as all specifications apply over a temperature range of 0° C to 55° C.

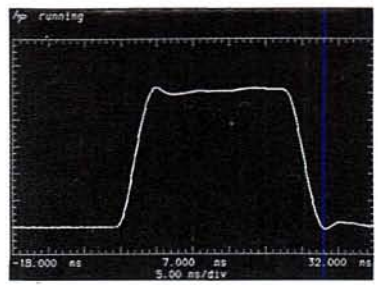
Locking the HP 8110A to an external reference frequency standard allows consistent timing in the test system.

Electromagnetic interference in the test system is no problem with HP 8110A, as it conforms to CISPR 11.

Test system up-time is increased by excellent hardware reliability, built-in diagnostics, and fast turnaround times for calibration and repair in HP Service Centers.

Measurement Confidence

- 10-ps resolution
- 0.1% frequency accuracy (with HP 81106A)
- Clean pulses
- Low jitter
- Locking to external reference frequency
- External clock



Easy Setup and Operation

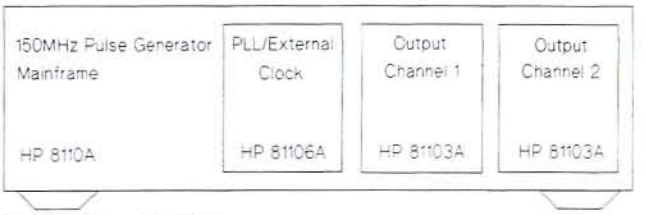
The HP 8110A is extremely easy to setup and shows all important parameters at a glance. Values can be entered in any format, and load impedances can be compensated. Selectable source impedance, voltage, or current mode, preset TTL/ECL levels allow quick adaption to DUT and other test equipment. These features are complemented by explanative help and error messages.

Values can easily be modified with the knob or numeric keys and visualized on the graphic display. Timing-conflicts are easily resolved by pressing the autoset key. Settings can be stored and recalled internally, and externally with the built-in memory-card reader.

HP 8110A 150-MHz Pulse Generator Mainframe

Specifications

Specifications describe the instrument's warranted performance (30 min warm-up, 50 Ω load, 50 Ω source) at 0° C to 55° C ambient temperature.



Configurations available

HP 81103A 10 V/2 ns Output Channel for HP 8110A

Timing Parameters

Frequency Range: 1.00 Hz to 150 MHz (1.000 mHz to 150.0 MHz with HP 81106A)
Period
Range: 6.65 ns to 999 ms (6.65 ns to 999 s with HP 81106A)
Resolution: 10 ps best case, three digits
Accuracy: ±5% ±100 ps (0.1% with HP 81106A)
Width
Range: 3.30 ns to 998 ms
Resolution: Best case 10 ps, three digits
Accuracy: ±5% ±250 ps
Delay
Variable range: 0 ns to 998 ms
Resolution: Best case 10 ps, three digits
Accuracy: ±5% ±1 ns
Transition Times (measured between 10% and 90% of amplitude)
Range: 2.00 ns to 200 ms
Min transition: <2.0 ns for levels within ±5 V window. Refer to data sheet for other load/source conditions
Accuracy: ±10% ±200 ps
Overshoot/Preshoot/Ringing: ±5% of amplitude ±20 mV

Output Parameters (into 50 Ω load)

	From 50 Ω source	From HiZ source
Amplitude:	100 mV to 10.0 Vpp	200 mV to 20.0 V
High Level:	−9.90 V to +10.0 V	−18.8 V to +19.0 V
Low Level:	−10.0 V to +9.90 V	−19.0 V to +18.8 V

Resolution: Three digits
Accuracy: ±1% of amplitude ±50 mV
Source Impedance: Selectable 50 Ω or 1 kΩ (HiZ)
Load Compensation: Actual load resistance value can be entered to correct output levels.
Current: 4.00 mA to 400 mA

Channel Addition (only with two HP 81103A output channels)

Three- and four-level signals can be generated by adding channel 2 to channel 1. Output 2 is disabled.

Pattern Capabilities

Pattern Length: Max 4096 bits per channel and for strobe output
Format: RZ, NRZ, DNRZ
Burst Length: 2 to 65536
Double Pulse
Range: 6.65 ns to 998 ms
Accuracy: ±5% ±250 ps

Trigger Modes

Continuous Pulse, Double-Pulse, Burst, Pattern
External triggered Pulse, Double-Pulse, Burst, Pattern
External gated Pulse, Double-Pulse, Burst, Pattern
External Width:
Internal triggered
Bust, Pattern (HP 81106A only)

HP 81106A PLL/External Clock for HP 8110A

The HP 81106A is useful for multiple applications:

- **External locking:** The pulse period can be locked to an external 5 MHz or 10 MHz reference frequency.
- **External clock:** The pulse period is synchronous to an external system clock.
- **Internal triggered:** Bursts or patterns; the internal PLL takes over the function of the external trigger signal.
- **High accuracy:** The internal PLL generates pulse period with improved period range, jitter, and accuracy.

Period Range: 6.65 ns to 999 s
Period Accuracy: ±0.1%

HP-IB Capabilities

Operates according to IEEE488.2, 1987 and SCPI 1992.0
Function Code: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0

General

Temperature: 0° C to 55° C operating, −40° C to 70° C storage
Humidity: 95% RH at 0° C to 40° C
Power: 100 to 240 Vac, ±10%, 50 to 60 Hz; 270 VA max
120Vac, ±10%, 400 Hz; 270 VA max
EMC: Conforms to EN55011, EN50082-1
Size: 426 mm W × 89 mm H × 445 mm D (17.0 in × 3.5 in × 17.5 in)
Weight: Net, 8.5 kg (18.7 lb)

Ordering Information

	Price
The minimum order must include the HP 8110A mainframe and one HP 81103A output channel. A second output channel and the HP 81106A PLL/external clock are optional. All configurations are available in the factory-configured product or may be purchased later.	
HP 8110A 150-MHz Pulse Generator Mainframe*	$4,950
Opt UN2 Rear Panel Connectors	$0
Opt 0BW Service Documentation	+$100
Opt 1CM Rack Mount Kit (5062-3974)	+$35
HP 81103A 10 V/2 ns Output Channel for HP 8110A	+$3,950
Opt UEJ Customer Upgrade Kit	+$500
HP 81106A PLL/External Clock for HP 8110A	+$1,250
Opt UEJ Customer Upgrade Kit	+$500
Accessories	
HP F1102A 128-kB Memory Card	$200
HP F1003A 512-kB Memory Card	$400

*The HP 8110A 150-MHz pulse generator mainframe must be ordered with one or two HP 81103A 10 V/2 ns output channel. The HP 8110A comes with a complete operating/programming manual for all configurations. BNC cables and memory card not included.

For more detailed information please request the technical data sheet (5091-4945).

PULSE GENERATORS & DATA GENERATORS

Versatile 50-MHz Source

HP 8112A, 8115A

- 50 MHz, 5 ns, 16 V p-p
- Full pulse capability
- Small size
- Modulation
- Ramps and haversines
- Error recognition and self test

DESIGNED FOR HP-IB SYSTEMS
Hewlett-Packard
Instrument Drivers

HP 8112A

HP 8112A Pulse Generator

The HP 8112A is a fully programmable 50-MHz pulse generator with 5 ns transitions and 32 V p-p (into open circuit) max output amplitude. All pulse parameters are variable including delay and double pulse spacing.

Besides the comprehensive trigger modes, external modulation capabilities extend applicability. Three-level signals and upper level, width, period, and delay-modulated signals are available. These can be combined with the trigger modes so that complex real-life signals like modulated bursts are simulated easily.

Step response and trigger hysteresis measurements require fast transitions or sawtooth signals as obtained in the HP 8112A's linear transition model—either fixed 5 ns or variable from 6.5 ns. The new cosine transitions, also variable from 6.5 ns, mean that band-filtered signals are now just as simple to obtain.

Sensitive devices are protected by programming output limits, and the upper level can be controlled by the device supply. Also, constant energy or constant width can be programmed.

For really easy operation a green button gives error-free settings. A new softkey operating concept plus detailed error recognition make the HP 8112A's powerful versatility easy to handle.

For dual channel applications refer to HP 8115A, which has the capabilities of two HP 8112As in one box (426 mm W × 190 mm H × 584 mm D). HP 8115A is ideal for simulating clock and data signals and for three- and four-level signal generation. The large CRT shows all important parameters on both channels at a glance.

HP 8112A Specifications

Specifications apply with 50-Ω load and temperatures in the range 0° C to 55° C.

Timing (Specifications apply for min transition times)
Period: 20.0 ns to 950 ms
Delay: 75.0 ns to 950 ms
Double Pulse: 20.0 ns to 950 ms
Width: 10.0 ns to 950 ms
Accuracy: ±5% of progr value ±2 ns (delay: ±5 ns)

Output Characteristics (Voltages double when driving into open circuit)
Levels
High level: −7.90 V to 8.00 V
Low level: −8.00 V to 7.90 V
Accuracy: ±1% of progr value ±3% amplitude ±40 mV
Output resistance: 50 Ω
Transition Times
Fixed: 5 ns typical
Linear and cosine: 6.5 ns to 95.0 ms (max edge ratio 1:20 within a 1.5-decade range. Ranges overlap by 0.5 decade)
Accuracy: ±5% of programmed value ±2 ns
Preshoot, Overshoot, Ringing: ±5% ±10 mV (variable transitions), ±10% ±10 mV (fixed transitions)
Operating Modes: Normal, Trigger, Gate, Ext Width (pulse restoration), Ext Burst (1 to 1999 pulses)

Control (Modulation) Modes
Period, Delay, Width: Covered in 8 non-overlapping decades (max input frequency 8 kHz)
High Level: −8 V to +8 V, independent of progr low level (min input transition 200 μs)

General
HP-IB: All keys programmable. Learn, status, and error reporting capability. HP-IB interface functions: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1.
Repeatability: Factor 4 better than accuracy
Environmental
Storage temperature: −40° C to +65° C
Operating temperature: 0° C to 55° C
Humidity: 95% RH, 0° C to 40° C
Power: 100/120/220/240 V rms; +5%; −10%; 48 to 440 Hz; 120 VA max
Weight: Net, 5.9 kg (13 lb); shipping, 8.0 kg (18 lb)
Size: 212.3 mm W × 89 mm H × 450 mm D (8.36 in × 3.5 in × 17.7 in)

Ordering Information

	Price HP 8112A	HP 8115A
HP 8112A Programmable Pulse Generator	$6,400	
HP 8115A Dual Channel Pulse Generator*		$12,300
Opt 910 Additional Operating and Service Manual	$49	$220
Opt 908 Rack Flange Kit (p/n 5062-3978)	—	$35
Opt W30 3-Year Return Repair Service (see page 636)	$150 ☎	$140
Opt 1BP Mil Std 45662A Calibration with Test Data	$450	—
HP 5062-4001 Bail Handle Kit	$40 ☎	—
HP 5062-3972 Rack Mount Kit (single 8112A)	$60 ☎	—
HP 5062-3984 Rack Mount Kit (two 8112A)	$35 ☎	—
HP 5061-9694 Lock Link Kit (for use with HP 5062-3974)	$45	—
HP 1494-0059 Rack Slide Kit	—	$115 ☎

For rack mounting, contact factory.
*HP-IB cables not supplied, see page 124.

☎ For off-the-shelf shipment, call 800-452-4844.
*Please refer to technical data sheet for HP 8115A (5952-9675) for more detailed information.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 8175A
- 24 data channels
- 2 arbitrary channels
- Agile memory
- Interactive

HP 8118A
- Dual 16-kb channels
- Variable pulse parameters
- 3- and 4-level signals

HP 8175A with Option 005, TTL/CMOS pods. (HP 8118A has similar appearance, but without pouch and pods.)

HP 8118A Pulse Pattern Generator

For serial applications, the HP 8118A offers two data channels with full pulse-generator capability so that limiting parametric conditions can be measured during functional test. The channels can be added in order to simulate multilevel codes, such as HDB3 or 2B1Q. 16-kb memory in each channel gives plenty of space for ISDN data frames. In addition to the built-in editor, a nonsupported HP BASIC program is available for setting up data.

HP 8175A Interactive Digital and Analog Stimulus

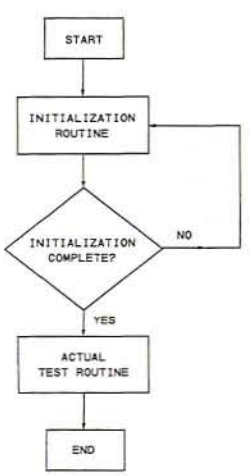
Whether your device needs analog or digital signals or—like programmable filters—both, the HP 8175A helps you emulate the real environment. This is because programmable data patterns and arbitrary waveforms can be made available at the same time. Repeatable timing and voltage settings let you test the device's limits with confidence.

Signal Quality at the Device

The HP 8175A's 24 data outputs are connected to your device or test head by active pods. This reduces distortion because the connections between pod and device can be kept very short.

Each pod supports eight channels so, if you are working with mixed logic, you can use any combination of the available ECL, TTL, or variable-level TTL/CMOS pods.

The two analog channels of the Option 002 arbitrary waveform generator have 50-Ω outputs.



Interactive Test

An agile, segmentable memory makes it possible for the HP 8175A to jump to different routines as needed by a test procedure. In the example on the left, an initial data pattern or waveform is output until the DUT changes state. This change is sensed by the HP 8175A's 8-line trigger pod, which then implements a user-defined jump.

Start, stop, continue, and tri-state can also be implemented from the DUT in this way.

Designed for Stimulus-Response Test

In addition to the 24 data outputs, there are also 8 flag outputs. These depend directly on DUT status, and so can make sure that a measuring device captures the right information.

HP 8175A starts HP 1650A logic analyzer and HP 54110D oscilloscope signal capture.

Capture/Playback Applications

Data patterns or analog signals captured by your HP logic analyzer can be read into the HP 8175A's memory. Thus critical once-in-a-while occurrences that cause device problems are available for detailed evaluation. To help you move captured information into the HP 8175A, a program* is available that converts HP 165x(x) files to HP 8175A-readable form. The transfer can take place online via HP-IB or offline with 3½-in disks.

Convenient Bench and System Implementation

Internal storage plus support of external disk drive and printer make manual setups very convenient. For automation, binary learn strings speed updates over HP-IB from the computer. In racked systems, temperatures can get fairly high; to ensure reliable results under these conditions, the HP 8175A and HP 8118A are fully specified up to 55° C.

*This and other HP 8175A programs are available to users on request. The programs run on HP BASIC 5.1 or HP Pascal 3.1 platforms. The programs are not supported.

PULSE GENERATORS & DATA GENERATORS

Digital Signal Generators (cont'd)

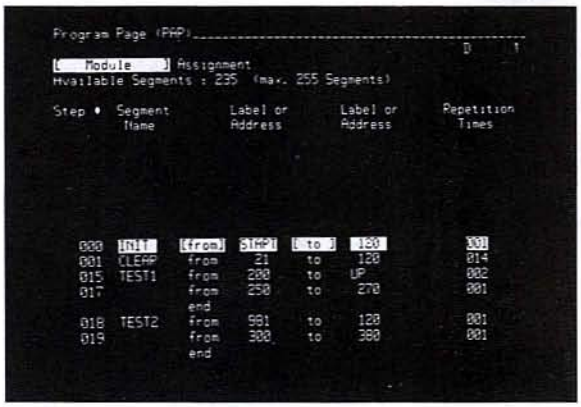
HP 8175A, 8118A

Built-in Editor

The HP 8175A's internal processor lets you set up counter and random patterns in a few keystrokes. It offers copy, insert, and cursor editing on tables and graphics plus special features for arbitrary waveforms.**

Memory Segments Sequenced in Real Time

For long data sequences with repeating elements, the memory can be segmented so that only unique data need be entered. The menu below shows how the segments are set up: The first four lines produce a continuous data stream, reusing areas of memory with common data. A command from the device can cause a real-time jump to the line TEST 2.

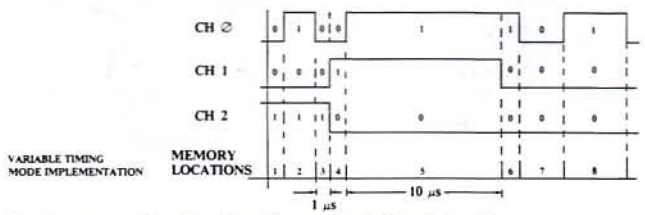


User-defined memory segments.

Flexibility Through Bit-by-Bit Timing

Long wait periods in a data stream or constant levels in an arbitrary waveform can use many k of memory. This is seldom a problem for the HP 8175A because each data pattern or sampling point can be given its own unique duration, from 0.02 μs up to 9.99 s.

Variable Pattern timing gives the user flexibility when programming long, asynchronous data systems. Note that the long, unchanging pattern in this example is implemented by a single 10 μs duration, thus saving 9 addresses.



Each memory location has its own individual duration.

Extra Clock Output for Dynamic Devices

Devices that need a continuous clock do not force you to abandon the HP 8175A's variable timing feature because a clock with independent frequency is available. It is locked to the HP 8175A master crystal so that clock and data remain synchronized.

High-Resolution Edge Placement

All edges can be placed with 20 ns resolution. For critical clock/data or data/data adjustment, Option 001 provides 100 ps resolution delay on four channels.

**More information about the Option 002 arbitrary waveform generator is available on page 443.

HP 8118A Specifications

Pulse Timing, Output, Modulation: Same as HP 8112A/8115A

Pattern

Data capacity: 16384 bits per channel

Format: RZ with programmable delay and width up to 50 Mb/s
NRZ with programmable delay up to 50 Mb/s
NRZ fixed delay up to 100 Mb/s

Strobe output: Bit, word frame. Word length selectable 3 to 256 bits.

Random pattern: Up to 16384 bits. Sequence is PRBS when pattern length is set to $2^n - 1$.

For further information, please request data sheet 5952-9676.

HP 8175A Specifications

(Please request data sheet 5953-6327 for complete specifications.)

Outputs

Data channels: 24, each 1024 bits

Max data rate: 50 Mb/s, NRZ format
(If Serial Mode is selected, two 8-Kb channels are available, max data rate 100 Mb/s, NRZ format.)

Levels: ECL, TTL, or variable-level TTL/CMOS pods. Different pods can be installed for mixed logic applications (each pod handles 8 channels). Variable level from 2.4 V to 9.9 V, programmable from HP 8175A or external pod input. Fanout: 5 ECL/ 15 LSTTL/ 10/ LSTTL loads, depending on pod. Transitions: 3/ 6/ 9 ns into 22 pF, depending on pod. Tristate: Implemented from HP 8175A or by external signal to each pod.

Analog channels (Opt 002): 2 arbitrary waveform channels, each 10-bit vertical resolution with 1024 sample points. Max sample rate: 50 MHz. See page 443.

Level ranges: 7. From 0.2 V p-p max (0.2 mV resolution) to 16 V p-p max (20 mV resolution), into 50 Ω

Source resistance: 50 Ω

Flag and clock channels: 8 flags, or 7 flags and 1 clock. Flags are set by external status (see trigger pod). Clock period can be set from 20 ns to 99 μs, independent of bit duration. Levels: Depends on pods (see Data channels).

Timing

Bit duration: 0.02 μs to 9.99 s, individual or global

Resolution: 3 digits. (Opt 001: 100 ps independent edge positioning on 4 channels in a 20.0 to 40.0 ns window)

Memory: 24 × 1024 bits, up to 255 segments

Capabilities: Start, stop, continue, restart, 2 jumps, and looping

Inputs

Trigger pod: 8 lines to set flags and/or implement start, jump, output disable, stop and continue

BNC inputs: For external clock, external 1 MHz reference and start/stop

Ordering Information

	Price
HP 8118A Pulse/Pattern Generator	$14,600
Opt 908 Rack Flange Kit, p/n 5062-3978	$36
Opt 910 Operating and Service Manual	$220
Opt 915 Service Manual Only	$190
Opt 916 Additional Operating Manual	$32
Opt W30 Extended Repair Service (see page 636)	$140
HP 8175A Data/Waveform Generator	$13,100
Note: To work as a data stimulus, HP 8175A MUST be ordered with one of the following options: 003, 004, or 005, or with individual pods. To work as a waveform generator, Opt 002 MUST be ordered.	
Opt 001 Fine Timing on 4 Channels	$1,600
Opt 002 Dual Arbitrary Waveform Generator	$4,100
Opt 003 Trigger Pod 15463A and 4 ECL Pods 15461A	$5,020
Opt 004 Trigger Pod 15463A and 4 TTL Pods 15464A	$3,420
Opt 005 Trigger Pod 15463A and 4 CMOS Pods 15462A	$7,620
Opts 003, 004, and 005 include solder-in receptacles for the output pods and grabbers for the trigger pod. Following accessories are available for the output pods:	
HP 15408A Set of 5 Grabbers	$100
HP 15409A Set of 5 BNC Adapters	$100
HP 15410A Set of 5 SMB Adapters	$100
HP 15411A Set of 5 Open Coax Adapters	$65
HP 15415A Set of 5 Mini-probes	$100
HP 15430A Cable Master/Slave	$85
Opt 908 Rack Flange Kit, p/n 5062-3978	$36
Opt 910 Operating and Service Manual	$290
Opt 916 Additional Operating Manual	$72
Opt W30 Extended Repair Service (see page 636)	$280

Fast, High Power Pulse Generator

HP 214B

- High power 100 V, 2 A output into 50 Ω
- 10 MHz repetition rate
- Constant duty cycle
- Counted pulse burst option

HP 214B with Option 001, Counted Burst.

HP 214B Pulse Generator

The HP 214B pulse generator employs semiconductor technology for high power pulse generation at up to 10 MHz repetition rate. Delivering 100 V pulses with 15 ns risetimes, the HP 214B meets the speed demands of today's applications.

State-of-the-art VMOS FETS used as current sources for the output amplifier tubes enable pulse width to be specified down to 25 ns. The HP 214B is thus well-equipped for low duty cycle applications such as laser diode pulsing or transient simulation.

Where changing duty cycle threatens destruction to the device under test, the HP 214B Constant Duty Cycle (CDC) mode provides device protection. In CDC operation the duty cycle, hence power, remains constant as frequency is varied. The HP 214B is itself protected against excessive duty cycles via an overload protect circuit.

Easy operation is assured by the timing error indication. Calibrated dials enable fast accurate adjustments. Operating into unmatched loads, clean pulse shape is guaranteed by the low reactance 50 Ω source impedance. Pulse distortions such as preshoot and overshoot are specified as 5% at all amplitudes.

Specifications

Timing

Repetition Rate: 10 Hz to 10 MHz in 6 ranges. In 30 V to 100 V amplitude range, maximum rep. rate is 4 MHz. Calibrated vernier provides continuous adjustment within ranges. **Vernier Accuracy:** ± (10% of setting + 1% full scale). **Period Jitter:** ≤0.1% + 300 ps.
Pulse Delay/Advance: Pulse can be delayed/advanced with respect to the trigger output from 10 ns to 10 ms (± fixed delay of 45 ns) in 5 ranges. Calibrated vernier provides continuous adjustment within ranges. **Vernier Accuracy:** ± (10% of setting + 1% full scale) + fixed delay. **Position Jitter:** ≤0.1% + 500 ps
Maximum Pulse Position Duty Cycle: ≥50%
Double Pulse: 5 MHz maximum in all ranges except 30 V to 100 V range which is max. 2 MHz. Minimum separation is 100 ns.
Pulse Width: 25 ns to 10 ms in 6 decade ranges. Calibrated vernier provides continuous adjustment within ranges. **Accuracy:** ± (10% of setting + 1% full scale) + 5 ns. **Width Jitter:** ≤0.1% + 500 ps
Max. Duty Cycle: ≥10% for 30 to 100 V range. ≥50% all other ranges.
Constant Duty Cycle Mode (disabled in ext. trigger mode): Duty cycle of output pulse remains constant as the period is varied. The duty cycle limits in this mode are typically 8% fixed for the 10 MHz to 1 MHz range (max. 4 MHz); 2.5% to 10% for 1 MHz to 0.1 MHz range; 0.25% to 10% for 0.1 MHz to 10 kHz range; 0.1% for all other ranges. Calibrated vernier provides continuous adjustment within ranges.
Accuracy: ± (15% of setting + 1% of full scale)
Trigger Output
Amplitude: ≥ +5 V (50 Ω into open circuit)
Pulse width: 10 ns typical

External Operating Modes

External Input (impedance 10 kΩ, dc coupled)
Repetition rate: dc to 10 MHz
Sensitivity: 500 mVp-p, dc coupled
Slope: Pos. or neg.
Trigger level: +5 V to −5 V adjustable
Maximum input level: ±100 V
Trigger pulse width: ≥10 ns
EXT TRIG Mode: An output pulse is generated for each input pulse.
GATE Mode: Gate signal turns on rep. rate generator synchronously. Last pulse always completed.
BURST Mode (optional): Preselected number of pulses generated on receipt of trigger signal
Number of pulses: 1 to 9999
Minimum spacing between bursts: 200 ns
Manual: Pushbutton can be used for triggering single pulses (EXT TRIG mode), generating gate signals (GATE mode), or triggering pulse bursts (BURST mode).

Output

Amplitude: 0.3 V to 100 V in 5 ranges. Calibrated vernier provides adjustment within ranges. **Vernier accuracy:** ±10% of setting.
Source Impedance: Fixed 50 Ω nominal on ranges up to 10 V. Selectable 50 Ω nominal or HI-Z on 10 - 30 - 100 V ranges (with 50 Ω / 50 Ω impedance, amplitude decreases to 5 - 15 - 50 V).
Polarity: Pos. or neg. selectable
Transition Times: ≤15 ns for leading and trailing edges
Pulse Top Perturbations: ≤ ±5% of amplitude

General

Operating Temperature: 0° C to 55° C
Power: 100/120/220/240 V rms; +5%, −10%, 48 to 66 Hz, 360 VA max
Size: 426 mm W × 133 mm H × 422 mm D (16.8 in × 5.2 in × 16.6 in)
Weight: Net, 13.6 kg (30 lb); shipping, 15.6 kg (34.3 lb)

Ordering Information

	Price
HP 214B Pulse Generator	$5,950
Opt 001 Counted Burst	$940
Opt H04 48-440 Hz Line	on request
Opt 907 Front Handle Kit (HP p/n 5061-9689)	$56
Opt 908 Rack Mount Kit (HP p/n 5061-9677)	$33
Opt 909 Opt 907, 908 Combined (HP p/n 5061-9683)	$82
Opt 910 Set of Operating/Progr. and Service Manuals	$34
Opt W30 Extended Repair Service (see page 636)	$120

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

PULSE GENERATORS & DATA GENERATORS

High-Resolution Time Synthesizer

HP 5359A

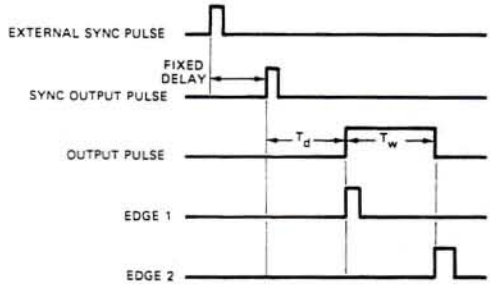
- Precise digital delays, 0-160 ms
- 50 ps increments
- Jitter <100 ps
- Programmable
- Fully synchronous to external trigger
- Automatic calibration

HP 5359A

DESIGNED FOR HP-IB SYSTEMS

HP 5359A Time Synthesizer

The HP 5359A Time Synthesizer produces two extremely-precise low-jitter time delays. These delays, Td and Tw, are individually selectable using the keyboard. Step values of 50 ps or greater set Td or Tw to be delays of up to 160 ms.



The HP 5359A has many applications. It can be used for the calibration of Radar, Loran, DME, and Tacan Systems, for precision generation of delayed sweeps in oscilloscopes, and for extremely accurate "time positioning" control of external gates on frequency counters. In component and circuit test, the instrument can be used for extremely accurate delay line simulation.

Condensed Specifications

Modes

External trigger mode: Selects the delays from the sync out to the beginning of the output pulse, and the width of the output pulse.
Internal trigger mode: Selects the "period" or "frequency" and the width of the output pulse.
Events mode: Substitutes external input (to 100 MHz) for the internally counted clock (delay and width must both be specified in terms of events instead of time).
Triggered frequency mode: The same as internal frequency mode except the output is a burst beginning in synchronism with an external trigger signal, and continuing for the duration of this signal.
Calibrate mode: Performs an internal calibration to remove the effects of internal delay differences.

Range
Delay Td: 0 ns to 160 ms
Width Tw: 5 ns to 160 ms (width & delay ≤160 ms)
Period: 100 ns (or width + 85 ns) min; 160 ms max
Frequency: Same as corresponding "period"
Repetition Rate: 10 MHz max
Accuracy: ±1 ns ± time base error (± 100 ps ± time base error after external calibration)
Insertion Delay: Fixed at <150 ns; selectable as <50 ns for delays >100 ns
Jitter: Typical 100 ps rms; maximum 200 ps rms (delays to 10 ms)
External Trigger Input: −2 V to + 2 V, slope selectable
Sync Output: 1 V at 50 Ω; 5 V at 1 MΩ. Width 35 ns nominal
Output Pulse
Amplitude: 0.5 V to 5 V, into 50 Ω
Polarity: Positive or negative
Offset: −1 V to 1 V, or OFF
Transition time: <5 ns
Note: External voltage must not be applied. Offset and Amplitude voltage into 50 Ω may be displayed.
EDGE 1 & 2 OUTPUTS (rear panel): Occur in Sync with leading edge of output pulse (same specification as Sync out)
HP-IB: All controls except trigger levels are programmable.
Time Base
High Stability Oven Oscillator
Frequency: 10 MHz
Aging rate: $<5 \times 10^{-10}$/day
Temperature: $<4.5 \times 10^{-9}$, 0° C to 50° C
Line voltage: $<1 \times 10^{-10}$, ± 10% from nominal
Size: 133 mm H × 426 mm W × 521 mm D (5.25 in × 16.75 in × 20.50 in)
Weight: 13.6 kg (30 lb)
Power Requirements: 100, 120, 220, or 240 Vac +5% −10%, 48 to 66 Hz, less than 250 VA
Front Handles: Supplied with instrument

Ordering Information

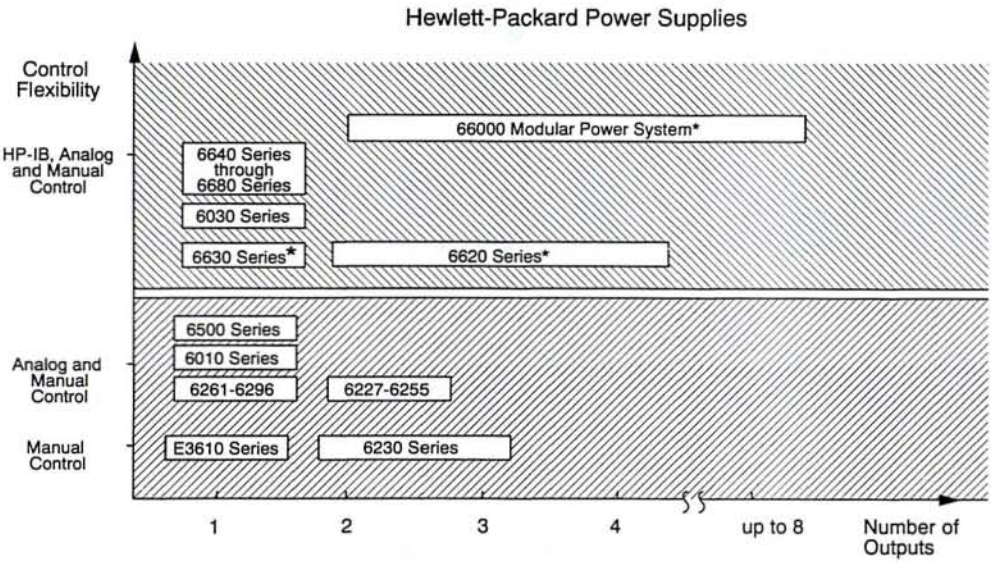
	Price
HP 5359A Time Synthesizer	$17,950
Opt 908 Rack Flange Kit (without handles)	+$45
Opt 910 Additional Manual	+$90
Opt 913 Rack Flange Kit (with handles)	+$45
Opt W30 Extended Repair Service (see page 636)	
Opt W32 Calibration Service (see page 636)	
HP 10870A Service Kit	$1,600

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

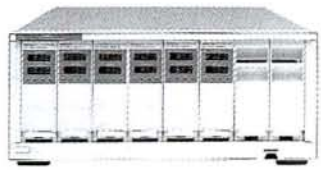
Power Supplies

Hewlett-Packard offers you the industry's best selection of power supplies for test and measurement applications. We suggest looking at the HP-IB system power supplies first when you are choosing a power supply for your application. They offer the widest range of capabilities, combining front panel controls for bench or manual use and an HP-IB interface for system control. This control flexibility insures that both your present and future needs will be met. For applications where cost is especially a concern and you do not expect to need HP-IB control, consider HP's manually controlled and analog-programmable power supplies. HP also offers specialized power supplies with bipolar outputs, as well as precision voltage and current sources. See the selection indexes on pages 462 and 463 for specific models.

For applications that require more than one power supply output, HP offers power supplies with 2, 3, or 4 outputs and a mainframe that can accept up to eight programmable power supply modules. In addition, most HP-IB system power supplies feature a serial link that lets you individually control up to 16 outputs through one HP-IB address.



*These HP-IB system power supplies lack a separate analog-programming input.



HP-IB system power supplies: Voltage index on page 462 and feature index on page 464. Detailed specifications appear on pages 466 to 477.

Manually controlled and analog-programmable power supplies: Voltage index on page 463. Detailed specifications appear on pages 478 to 489.

The front panel of the HP 6641A is typical for HP system power supplies. Most functions and features can be set from the front panel or programmed through the HP-IB interface. A similar front panel is used with the HP 6500 Series power supplies, but these do not have the HP-IB interface.

For More Information

For power supply reference and application information, or more detailed selection guides, call 800-452-4844 ext. 2722 and ask for the *DC Power Supply Catalog.*

For more detailed specifications on a given model, contact your HP sales representative and ask for the Lit-ROM data sheet for that model. For some models, you can have information faxed to you directly by calling HP FIRST at 208-344-4809. For detailed instructions on using HP FIRST, see page 33.

Power Products Modification Service

If you don't find the power supply you need, or if you require an integrated power system, ask your local HP sales representative for information on HP's Power Products Modification Service.

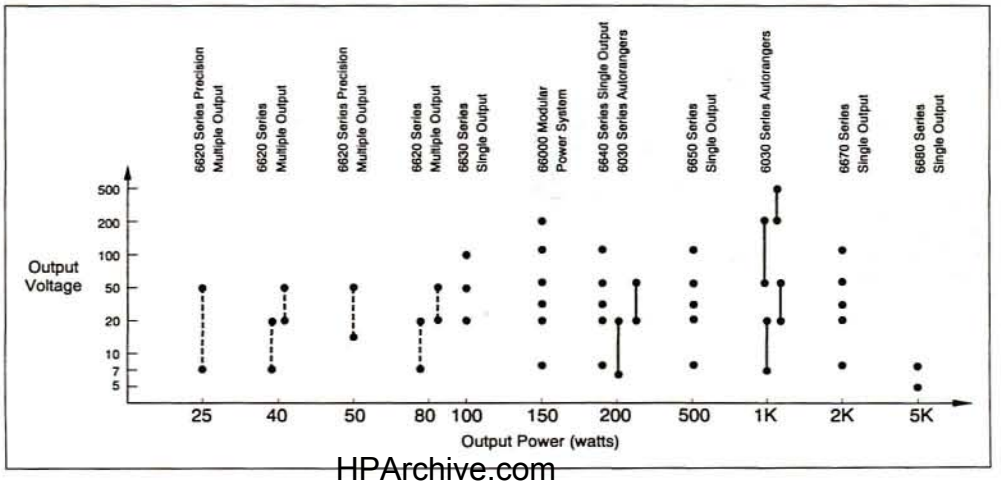
POWER SUPPLIES
Selection Index

HP-IB System Power Supplies
(New models shown in bold)

Max Volts (dc)	Max Amps (dc)	Max Watts	Type	Output Config.	HP Model Number	Page
5	**875**	**4400**	**Rectangular**	**Single**	**6680A**	**474**
6.7	30	200	Autoranging	Single	6033A	475
7	0.015	25	Dual-range	Dual	6625A	469
7	0.015	25	Dual-range	Quad	6626A	469
7	5	40	Dual-range	Triple	6623A	468
7	5	40	Dual-range	Quad	6624A	468
7	10	80	Dual-range	Dual	6621A	468
7	10	80	Dual-range	Triple	6623A	468
7	120	1000	Autoranging	Single	6031A	475
8	16	128	Rectangular	Module	66101A	466
8	20	160	Rectangular	Single	6641A	471
8	50	400	Rectangular	Single	6651A	472
8	220	1760	Rectangular	Single	6671A	473
8	**580**	**4600**	**Rectangular**	**Single**	**6681A**	**474**
16	0.2	50	Dual-range	Dual	6625A	469
16	0.2	50	Dual-range	Quad	6626A	469
16	0.2	50	Dual-range	Dual	6628A	469
16	0.2	50	Dual-range	Quad	6629A	469
16	2	50	Dual-range	Dual	6625A	469
16	2	50	Dual-range	Quad	6626A	469
16	2	50	Dual-range	Dual	6628A	469
16	2	50	Dual-range	Quad	6629A	469
20	2	40	Dual-range	Triple	6623A	468
20	2	40	Dual-range	Quad	6624A	468
20	2	40	Dual-range	Quad	6627A	468
20	4	80	Dual-range	Dual	6621A	468
20	4	80	Dual-range	Dual	6622A	468
20	4	80	Dual-range	Triple	6623A	468
20	5	100	Rectangular	Single	6632A	470
20	7.5	150	Rectangular	Module	66102A	466
20	10	200	Autoranging	Single	6033A	475
20	10	200	Autoranging	Single	6038A	475
20	10	200	Rectangular	Single	6642A	471
20	25	500	Rectangular	Single	6652A	472
20	50	1000	Autoranging	Single	6031A	475
20	50	1200	Autoranging	Single	6032A	475
20	100	2000	Rectangular	Single	6672A	473
35	4.5	150	Rectangular	Module	66103A	466
35	6	210	Rectangular	Single	6643A	471
35	15	525	Rectangular	Single	6653A	472
35	60	2100	Rectangular	Single	6673A	473
50	0.5	25	Dual-range	Dual	6625A	469
50	0.5	25	Dual-range	Quad	6626A	469
50	0.8	40	Dual-range	Triple	6623A	468
50	0.8	40	Dual-range	Quad	6624A	468
50	0.8	40	Dual-range	Quad	6627A	468
50	1	50	Dual-range	Dual	6625A	469
50	1	50	Dual-range	Quad	6626A	469
50	1	50	Dual-range	Dual	6628A	469
50	1	50	Dual-range	Quad	6629A	469
50	2	100	Dual-range	Dual	6622A	468
50	2	100	Rectangular	Single	6633A	470
60	2.5	150	Rectangular	Module	66104A	466
60	3.3	200	Autoranging	Single	6038A	475
60	3.5	210	Rectangular	Single	6644A	471
60	9	540	Rectangular	Single	6654A	472
60	17	1200	Autoranging	Single	6030A	475
60	17.5	1200	Autoranging	Single	6032A	475
60	35	2100	Rectangular	Single	6674A	473
100	1	100	Rectangular	Single	6634A	470
120	1.25	150	Rectangular	Module	66105A	466
120	1.5	180	Rectangular	Single	6645A	471
120	4.5	540	Rectangular	Single	6655A	472
120	18	2160	Rectangular	Single	6675A	473
200	0.75	150	Rectangular	Module	66106A	466
200	5	1000	Autoranging	Single	6035A	475
200	5	1200	Autoranging	Single	6030A	475
500	2	1000	Autoranging	Single	6035A	475

If you don't find a model that meets your needs exactly, contact HP about its modification service.

Output Voltages and Power for Each Power Supply Series



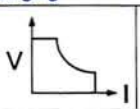
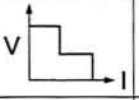
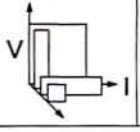
Manually Controlled and Analog-Programmable Power Supplies (New models shown in bold)

Max Volts (dc)	Max Amps (dc)	Max Watts	Type	Manually Controlled, Analog-Prog	HP Model Number	Page
6	1	6	Triple-output	MC	6235A	478
6	2.5	15	Triple-output	MC	6236B	478
6.7	30	200	Autoranging	AP/MC	6023A	484
7	120	840	Autoranging	AP/MC	6011A	484
7.5	5	38	Rectangular	AP/MC	6281A	480
8	3	24	Dual-range	MC	E3610A	478
8	20	160	Rectangular	AP/MC	6541A	482
8	50	400	Rectangular	AP/MC	6551A	482
8	220	1760	Rectangular	AP/MC	6571A	482
8	1000	8000	Rectangular	AP/MC	6464C	486
10	10	100	Rectangular	AP/MC	6282A	480
10	100	1000	Rectangular	AP/MC	6260B	485
15	2	30	Dual-range	MC	E3610A	478
15	200	3000	Rectangular	AP/MC	6453A	486
16	600	9600	Rectangular	AP/MC	6466C	486
18	0.2	3.6	Triple-output	MC	6235A	478
18	1	18	Triple-output	MC	6237B	478
18	500	9000	Rectangular	AP/MC	6466C	486
20	0.5	10	Triple-output	MC	6236A	478
20	0.5	10	Triple-output	MC	6237B	478
20	0.6	12	Dual-output	AP/MC	6205C	478
20	1.5	30	Dual-range	MC	E3611A	478
20	2	40	Precision voltage	AP/MC	6114A	489
±20	±2	40	Bipolar PSA	AP/MC	6825A	488
20	3	60	Rectangular	AP/MC	6284A	480
20	3	60	Dual-output	AP/MC	6253A	480
20	10	200	Autoranging	AP/MC	6023A	484
20	10	200	Autoranging	AP/MC	6024A	484
20	10	200	Rectangular	AP/MC	6286A	480
20	10	200	Rectangular	AP/MC	6542A	482
20	25	500	Rectangular	AP/MC	6552A	482
20	50	1000	Autoranging	AP/MC	6011A	484
20	50	1000	Autoranging	AP/MC	6012B	484
20	100	2000	Rectangular	AP/MC	6572A	482
25	0.2	5	Dual-output	MC	6234A	478
25	2	50	Dual-output	AP/MC	6227B	480
35	0.85	30	Dual-range	MC	E3611A	478
35	6	210	Rectangular	AP/MC	6543A	482
35	15	525	Rectangular	AP/MC	6553A	482
35	60	2100	Rectangular	AP/MC	6573A	482
36	100	3600	Rectangular	AP/MC	6456B	486
36	300	10,800	Rectangular	AP/MC	6469C	486

Max Volts (dc)	Max Amps (dc)	Max Watts	Type	Manually Controlled, Analog-Prog	HP Model Number	Page
40	0.3	12	Dual-output	AP/MC	6205C	478
40	1	40	Precision voltage	AP/MC	6114A	489
40	1.5	60	Rectangular	AP/MC	6289A	480
40	1.5	60	Dual-output	AP/MC	6255A	480
40	5	200	Rectangular	AP/MC	6291A	480
40	5.7	228	Autoranging	AP/MC	6024A	484
40	25	1000	Rectangular	AP/MC	6434B	486
40	30	1200	Autoranging	AP/MC	6012B	484
40	30	1200	Rectangular	AP/MC	6268B	485
40	50	2000	Rectangular	AP/MC	6269B	485
50	0.5	25	Precision current	AP/MC	6177C	489
50	0.8	40	Precision voltage	AP/MC	6115A	489
50	1	50	Dual-output	AP/MC	6228B	480
±50	±1	50	Bipolar PSA	AP/MC	6826A	488
60	0.5	30	Dual-range	MC	E3612A	478
60	1	60	Rectangular	AP/MC	6294A	480
60	3	180	Rectangular	AP/MC	6296A	480
60	3.3	200	Autoranging	AP/MC	6024A	484
60	3.5	210	Rectangular	AP/MC	6544A	482
60	9	540	Rectangular	AP/MC	6554A	482
60	15	900	Rectangular	AP/MC	6274B	485
60	17	1020	Autoranging	AP/MC	6010A	484
60	17.5	1050	Autoranging	AP/MC	6012B	484
60	35	2100	Rectangular	AP/MC	6574A	482
64	50	3200	Rectangular	AP/MC	6459A	486
64	150	9600	Rectangular	AP/MC	6472C	487
100	0.25	25	Precision current	AP/MC	6181C	489
100	0.4	40	Precision voltage	AP/MC	6115A	489
±100	±0.5	50	Bipolar PSA	AP/MC	6827A	488
100	0.75	75	Autoranging	AP/MC	6299A	480
110	100	11,000	Rectangular	AP/MC	6475C	486
120	0.25	30	Dual-range	MC	E3612A	478
120	1.5	180	Rectangular	AP/MC	6545A	482
120	4.5	540	Rectangular	AP/MC	6555A	482
120	18	2160	Rectangular	AP/MC	6575A	482
200	5	1000	Autoranging	AP/MC	6010A	484
200	5	1000	Autoranging	AP/MC	6015A	484
220	50	11,000	Rectangular	AP/MC	6477C	486
300	0.1	30	Precision current	AP/MC	6186C	489
300	35	10,500	Rectangular	AP/MC	6479C	486
440	25	11,000	Rectangular	AP/MC	6483C	486
500	2	1000	Autoranging	AP/MC	6015A	484
500	20	10,000	Rectangular	AP/MC	6483C	486
600	1.5	900	Rectangular	AP/MC	6448B	486
600	15	9000	Rectangular	AP/MC	6483C	486

If you don't find a model that meets your needs exactly, contact HP about its modification service.

POWER SUPPLIES
HP-IB System Power Supplies
Feature Descriptions and Selection Index

		6030 Series Autorangers	6620 Series Multiple Output	6620 Series Precision Multiple Output	6630 Series Single Output	6640 Series Single Output	6650 Series Single Output	6670 Series Single Output	6680 Series Single Output	66000 Modular Power System
dc Range (for each series)	**Max Power** **Max Voltage** **Max Current**	200 & 1000 W 500 V 120 A	80 W 50 V 10 A	50 W 50 V 2 A	100 W 100 V 5 A	200 W 120 V 20 A	500 W 120 V 50 A	2000 W 120 V 220 A	5000 W 500 V 580 A	150W 200 V 16 A
Page		**475**	**468**	**469**	**470**	**471**	**472**	**473**	**474**	**466**
Configuration Features										
"One-box" solution To preserve rack space and interconnections, the voltage and current programmers, current shunt, and DVM are built-in to one package. This also makes the full power-supply programming and monitoring system clearly specifiable, easy to configure, and reliable.		●	●	●	●	●	●	●	●	●
Modular power system (multiple reconfigurable outputs) Up to 8 modules can be installed into a mainframe, and configuration can be changed at any time. All modules in a mainframe (or two connected mainframes) share one HP-IB address.										●
Multiple non-reconfigurable outputs Up to four outputs are included in one package, and they share one HP-IB address.			●	●						
Serial link Up to 16 power-supply outputs can share one HP-IB address when connected with a telephone-style cable. The modular power system mainframe requires 8 of the 16 subaddresses available, regardless of whether it is operating with 8 modules.		●				●	●	●	●	●
Relay connect, disconnect, and polarity reversal A=Optionally integrated with the power supply B=Operates with relay accessories listed on page 476 C=Optionally operates with relay accessories listed on page 476		B	C	C	A	B	B	B	B	A
Auto-parallel, auto-series, parallel, and series operation Auto-parallel, auto-series, parallel, and series operation increase the flexibility of the power supplies in your system. When connected in auto-parallel or auto-series, only one unit has to be programmed to take advantage of the full power from all. AP=auto-parallel AS=auto-series S=series P=parallel		S AP AS	S P	S P		S AP	S AP	S AP	S AP	S, P
Analog programming and monitoring ports Analog programming ports allow the power supply to be used as a power amplifier, responding to an external voltage signal. Monitoring ports allow an external DMM to monitor the power-supply outputs.		●				●	●	●	●	
Output Voltage and Current Range Changing										
Autoranging A wide, continuous range of voltage and current combinations are available automatically at the maximum power level.		●								
Multiple-output range changing Automatic range changing gives maximum power at two different voltage and current combinations.			●							
Precision multiple-output range changing Voltage and current ranges can be chosen independently to provide greater resolution.				●						
Performance Characteristics										
Output ripple and noise (Peak-to-peak, 20 Hz to 20 MHz)		30–160 mV	3 mV	3 mV	3 mV, (25 mV in fast mode)	3–7 mV	3–7 mV	7–16 mV	9–10 mV	5–50 mV
Output programming response time Rise and fall time with full resistive load (10 to 90% and 90 to 10%) Does not include command processing time.		200 W: 100–200 ms 1000 W: 300–2000 ms	2–6 ms	6 ms	15 ms (0.4 ms in fast mode)	15 ms	15 ms	30–195 ms	9–12 ms	20 ms
Programming resolution (percent of full scale)		0.025%	0.03%	0.007%	0.025%	0.025%	0.025%	0.025%	0.025%	0.03%

		6030 Series Autoranging	6620 Series Multiple Output	6620 Series Precision Multiple Output	6630 Series Single Output	6640 Series Single Output	6650 Series Single Output	6670 Series Single Output	6680 Series Single Output	66000 Modular Power System
dc Range (for each series)	**Max Power**	200 & 1000 W	80 W	50 W	100 W	200 W	500 W	2000 W	5000 W	150W
	Max Voltage	500 V	50 V	50 V	100 V	120 V	120 V	120 V	500 V	200 V
	Max Current	120 A	10 A	2 A	5 A	20 A	50 A	220 A	580 A	16 A
Page		475	468	469	470	471	472	473	474	466
HP-IB Programming Features										
HP-IB programming of voltage and current Self-documenting programming commands mean that programming is done in units of volts and amps, not in percentages or binary representations.		●	●	●	●	●	●	●	●	●
Measured voltage and current read-back over the HP-IB The output is read back in units of volts and amps.		●	●	●	●	●	●	●	●	●
Store-recall states Complete operating states can be stored in nonvolatile memory. Each state specifies not only the output voltage and current, but also many of the programmable protection features.										
	Number nonvolatile states (One of these states is automatically accessed on turn-on.)	0	0	4	0	5	5	5	4	5
	Number volatile states	5	10	7	0	0	0	0	0	5
Standard Commands for Programmable Instruments (SCPI) SCPI is fast becoming the standard language for test and measurement equipment. Standard codes make software writing and maintenance more efficient. For example, using this standard, the output voltage of the power supply is measured with the same command (MEASURE:VOLTAGE?) by either a DMM or a power supply.		●				●	●	●	●	●
Protection Features										
HP-IB programmable overvoltage protection Can be enabled to quickly down-program the output and set SRQ and/or DFI/RI. T=Can generate trigger M= Overvoltage, the level is set manually with a front-panel control		M	●	●	●	●	●	●	●	T
HP-IB programmable overcurrent protection Can be enabled to quickly down-program the output and set SRQ and/or DFI/RI. T=Can generate trigger		●	●	●	●	●	●	●	●	T
Overtemperature protection Will down-program the output and can be enabled to set SRQ and/or DFI. T=Can generate trigger		●	●	●	●	●	●	●	●	T
Discrete fault indicator/remote inhibit (DFI/RI) Using these digital ports, power supplies can be connected independently of the HP-IB. If any one experiences an error condition (overvoltage, for example), it can signal the other units to also down-program their outputs. O=Optional		●	O	O	O	●	●	●	●	●
SRQ Almost any fault condition or change of state of the power supply can be enabled to generate an SRQ. This signals the computer to take the appropriate action.		●	●	●	●	●	●	●	●	●
Local lockout Front-panel or keyboard control can be disabled. This keeps unauthorized operators from changing the programmed states.		●	●	●	●	●	●	●	●	●
Fan-speed control Controls the fan speed to provide only the required cooling, reducing unnecessary acoustic noise. O=Optional		O				●	●	●	●	
Active down-programming Active circuits quickly drain the energy from the output when unit is programmed to a lower voltage. This means that a unit under test can be safely removed from its test fixture without danger of arcing. F=Full-rated output current P=Less than 100% rated output current		P	F	F	F	P	P	P	P	P
Maintenance Features										
Electronic calibration in the rack Calibration requires no internal adjustments.			●	●	●	●	●	●	●	●
Calibration security Units can be protected from accidental access to calibration routines by either a password (P) or an internal jumper (J).			J	J	J	P, J	P, J	P	P	P, J
Self-test Extensive self-test is triggered automatically on power-up. Additional tests can be initiated by user programming or front-panel control.		●	●	●	●	●	●	●	●	●

POWER SUPPLIES

HP 66000 Modular Power System

HP 66000A, HP 66001A, and HP 66101A–66106A

- High density: eight slots in 7 inches of rack space
- Output sequencing
- Low ripple and noise
- High-accuracy read-back of voltage and current
- Standard Commands for Programmable Instruments (SCPI)
- Optional keyboard and display unit
- Serial link to connect two mainframes at one HP-IB address
- Optional isolation and polarity-reversal relays
- Built-in self-test

DESIGNED FOR HP-IB SYSTEMS

Hewlett-Packard Instrument Drivers

HP 66000 Modular Power System

The Hewlett-Packard 66000 modular power system is one of the latest additions to the HP family of "one-box" power products. This power system simplifies test-system assembly, cabling, programming, debugging, and operation. It is ideal for ATE and production test environments, where it can supply bias power and stimulus to subassemblies and final products. The HP modular power system saves rack space. The 7-in-high mainframe can accommodate up to eight dc power modules.

Specifications (at 0° to 55° C unless otherwise noted)

		HP 66101A	HP 66102A	HP 66103A	HP 66104A	HP 66105A	HP 66106A
Output ratings (at 40° C)	Output Voltage	8 V	20 V	35 V	60 V	120 V	200 V
	Output Current	16 A	7.5 A	4.5 A	2.5 A	1.25 A	0.75 A
	Output Power	128 W	150 W	150 W	150 W	150 W	150 W
Programming accuracy (at 25° C ±5° C)	Voltage 0.03% +	3 mV	8 mV	13 mV	27 mV	54 mV	90 mV
	Current 0.03% +	6 mA	3 mA	2 mA	1.2 mA	0.06 mA	0.4 mA
Readback accuracy (via HP-IB or keyboard display at 25° C ±5° C)	Voltage 0.02% +	2 mV	5 mV	8 mV	16 mV	32 mV	54 mV
	Current 0.02% +	6 mA	3 mA	2 mA	1 mA	0.5 mA	0.3 mA
Ripple and noise (20 Hz to 20 MHz)	Constant voltage rms	2 mV	3 mV	5 mV	9 mV	18 mV	30 mV
	peak to peak	5 mV	7 mV	10 mV	15 mV	25 mV	15 mV
	Constant current rms	5 mA	3 mA	2 mA	1 mA	1 mA	1 mA
Line regulation	Voltage	0.5 mV	0.5 mV	1 mV	2 mV	3 mV	5 mV
	Current	0.75 mA	0.5 mA	0.03 mA	0.1 mA	50 A	30 A
Load regulation	Voltage	1 mV	1 mV	1 mV	2 mV	4 mV	7 mV
	Current	0.2 mA	0.2 mA	0.2 mA	0.1 mA	50 A	30 A

Transient Response Time: Less than 1 ms for the output voltage to recover within 100 mV of its previous level following any step change in load current up to 10 percent of rated current.

Isolation: Output terminals can be up floated to ±240 Vdc from chassis ground.

Supplemental Characteristics (Non-warranted characteristics determined by design that are useful in applying the product.)

		HP 66101A	HP 66102A	HP 66103A	HP 66104A	HP 66105A	HP 66106A
Average resolution	Voltage	2.4 mV	5.9 mV	10.4 mV	18.0 mV	36.0 mV	60.0 mV
	Current	4.6 mA	2.3 mA	1.4 mA	0.75 mA	0.38 mA	0.23 mA
	Output voltage programming (OVP)	50 mV	120 mV	200 mV	375 mV	750 mV	1.25 mV
OVP accuracy		250 mV	500 mV	800 mV	1 V	1.5 V	2.5 V

Remote Sensing: Up to half the rated output voltage can be dropped across in each load lead. Add 2 mV to the voltage load regulation specification for each 1-V change in the negative output lead caused by a load current change.

Command Processing Time: The average time for the output voltage to change after getting an HP-IB command is 20 ms.

Output Programming Response Time (with full resistive load): The rise and fall time (10% to 90% and 90% to 10%) of the output voltage is less than 20 ms. The output voltage change settles within 1 LSB (0.025% × rated voltage) of the final value in less than 120 ms.

Down-Programming: An active down-programmer sinks approximately 10% of the rated output current.

Calibration Interval: One year

ac Input of System Mainframe

Voltage, Vac	100	120	200	220	230	240
Maximum current, A	29	25	16	16	15	15

Input Power of System Mainframe:
3200 VA (max), 1800 W (max), 1600 W (typ)

HP-IB Capabilities: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, E1, and C0, and a command set compatible with IEEE 488.2 and SCPI.

Regulatory Compliance: Listed to UL 1244; certified to CSA 22.2 No. 231; conforms to IEC 1010

Weight: Net, HP 66000A, 15 kg (33 lb); HP 66001A, 1.05 kg (2.3 lb); HP 66101–66106A, 2.8 kg (6 lb). Shipping, HP 66000A, 19 kg (42 lb); HP 66001A, 1.34 kg (2.95 lb); HP 66101–66106A, 4.1 kg (9 lb).

Size: HP 66000A: 425.7 mm W × 184.94 mm H × 677.93 mm D (16.76 in × 7.28 in × 26.69 in), including feet and rear connectors

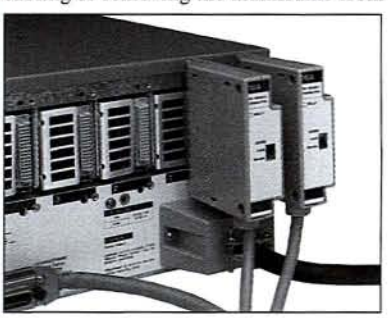
Warranty Period: Three years

Key Features (for details see page 464)

- HP-IB–programmable voltage and current
- Measured voltage and current read back over HP-IB
- Standard Commands for Programmable Instruments (SCPI)
- Serial link to connect up to 16 outputs on one HP-IB address (two mainframes or one mainframe and eight single-output supplies with serial link)
- Programmable overvoltage and overcurrent protection
- Self-test initiated at power-up or from HP-IB command
- Electronic calibration over HP-IB or from keyboard
- Overtemperature protection
- Discrete fault indicator/remote inhibit (DFI/RI)
- Five nonvolatile store-recall states per output
- User-definable power-on state

Output Connections

System assembly is simplified thanks to a quick-disconnect connector assembly on each module. These connectors permit modules to be removed from the front of the mainframe without disconnecting cabling or removing the mainframe from the rack.



Ordering Information

	Price
HP 66000A MPS Mainframe	$1,900
Opt 908 Rack Mount Kit	$37
Opt 909 Rack Mount Kit with Handles	$0
Note: Options 908 and 909 require cabinet rails or a slide kit (HP p/n 1494-0059) to support the loaded mainframe's weight.	
HP 66001A MPS Keyboard (Order HP 34551A to rackmount.)	$750
HP 34551A (rack kit for HP 66001A keyboard)	$80

Module Options:

HP 66101A dc Power Module 8 V, 16 A	$1,750
HP 66102A dc Power Module 20 V, 7.5 A	$1,750
HP 66103A dc Power Module 35 V, 4.5 A	$1,750
HP 66104A dc Power Module 60 V, 2.5 A	$1,750
HP 66105A dc Power Module 120 V, 1.25 A	$1,750
HP 66106A dc Power Module 200 V, 0.75 A	$1,750
Opt 760 Open/Close and Polarity Reversal Relays	$180

Line Cord Options

When ordering the HP 66000A, one of the following line cord options must be specified. Order according to local electrical codes. All line cords are 2.5 m (about 8 ft) long. For details refer to page 476.

Opt 831 12 AWG, 200–240 Vac, Unterminated	$0
Opt 833 1.5-mm² wire, 200–240 Vac, Unterminated	$0
Opt 834 10 AWG; 100–120 Vac, Unterminated	$0
Opt 841 With NEMA 6-20P; 20-A, 250-V Plug	$15
Opt 843 With JIS C8303 Appended Fig 6(2); 20-A, 250-V Plug	$35
Opt 845 With IEC 309; 16-A, 220-V Plug	$35
Opt 846 With NEMA L5-30P; 30A, 120-V Locking Plug	$55
Opt 847 With CEE 7/7; 16-A, 220-V Plug	$35
Opt 848 With BS 546; 15-A, 240-V Plug	$35

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

POWER SUPPLIES

Multiple-Output System Power Supplies, 40 to 80 W

HP 6621A, 6622A, 6623A, 6624A, 6627A

- 2, 3, or 4 independent isolated outputs
- Dual-range linear outputs
- Low ripple and noise
- Fast up- and down-programming

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Instrument Drivers

Specifications (at 0° to 55° C unless otherwise specified)

			40-W output	40-W output	80-W output	80-W output
Output power	Low-range volts, amps		0 to 7 V, 0 to 5 A	0 to 20 V, 0 to 2 A	0 to 7 V, 0 to 10 A	0 to 20 V, 0 to 4 A
	High-range volts, amps		0 to 20 V, 0 to 2 A	0 to 50 V, 0 to 0.8 A	0 to 20 V, 0 to 4 A	0 to 50 V, 0 to 2 A
Output combinations for each Hewlett-Packard model (total number of outputs)	**HP 6621A** (2)		—	—	2	—
	HP 6622A (2)		—	—	—	2
	HP 6623A (3)		1	1	1	—
	HP 6624A (4)		2	2	—	—
	HP 6627A (4)		—	4	—	—
Programming accuracy (at 25° C ±5° C)	Voltage		19 mV + 0.06%	50 mV + 0.06%	19 mV + 0.06%	50 mV + 0.06%
	Current		50 mA + 0.16%	20 mA + 0.16%	100 mA + 0.16%	40 mA + 0.16%
Ripple and noise (peak-to-peak, 20 Hz to 20 MHz; rms, 20 Hz to 10 MHz)	Constant voltage	rms	500 μV	500 μV	500 μV	500 μV
		peak-to-peak	3 mV	3 mV	3 mV	3 mV
	Constant current	rms	1 mA	1 mA	1 mA	1 mA
Readback accuracy (at 25° C ±5° C)	Voltage		20 mV + 0.05%	50 mV + 0.05%	20 mV + 0.05%	50 mV + 0.05%
	+Current		10 mA + 0.1%	4 mA + 0.1%	20 mA + 0.1%	8 mA + 0.1%
	−Current		25 mA + 0.2%	8 mA + 0.2%	50 mA + 0.2%	20 mA + 0.2%
Load regulation	Voltage		2 mV	2 mV	2 mV	2 mV
	Current		1 mA	0.5 mA	2 mA	1 mA
Load cross regulation	Voltage		1 mV	2.5 mV	1 mV	2.5 mV
	Current		1 mA	0.5 mA	2 mA	1 mA
Line regulation	Voltage		0.01% + 1 mV	0.01% + 1 mV	0.01% + 1 mV	0.01% + 1 mV
	Current		0.06% + 1 mA	0.06% + 1 mA	0.06% + 1 mA	0.06% + 1 mA

Transient Response Time: Less than 75 μs for the output to recover to within 75 mV of nominal value following a load change within specifications.

Isolation: All outputs can be floated up to ± 240 Vdc from chassis ground.

Supplemental Characteristics (Non-warranted characteristics determined by design and useful in applying the product.)

		40-W output	40-W output	80-W output	80-W output
Average programming resolution	Voltage	6 mV	15 mV	6 mV	15 mV
	Current	25 mA	10 mA	50 mA	20 mA
	OVP	100 mV	250 mV	100 mV	250 mV
Output programming response time (time to settle within 0.1% of full scale output, after Vset command has been processed)		2 ms	6 ms	2 ms	6 ms

Remote Sensing: Up to 1-V drop per load lead. The drop in the load leads is subtracted from the voltage available for the load.
Command Processing Time: 7 ms typical with front-panel display disabled.
Down Programming: Current sink limits are fixed approximately 10% higher than source limits for a given operating voltage above 2.5 V.
Input Power: 550 W max
HP-IB Interface Capabilities: SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT0
Regulatory Compliance: Listed to UL 1244; certified to CSA 556B; conforms to IEC 348; carries the CE mark
RFI Suppression: Complies with CISPR-11 Group 1 Class B
Size: 425.5 mm W × 132.6 mm H × 497.8 mm D (16.75 in × 5.22 in × 19.6 in)
Weight: Net, 17.4 kg (38 lb); shipping, 22.7 kg (50 lb)
Warranty Period: Three years

Key Features (for more information, see page 464)

- HP-IB programming of voltage and current
- Measured voltage and current readback over the HP-IB
- Two outputs can be connected in parallel or in series
- Automatic selection of operating voltage and current range
- Programmable overvoltage and overcurrent protection
- Overtemperature protection
- Self-test occurs at power-on or from an HP-IB command
- Electronic calibration via HP-IB
- 10 store-recall states
- Option 750 for relay control and DFI/RI

Ordering Information

	Price
HP 6621A Dual-Output System Supply	$4,200
HP 6622A Dual-Output System Supply	$4,200
HP 6623A Triple-Output System Supply	$4,700
HP 6624A Quad-Output System Supply	$5,200
HP 6627A Quad-Output System Supply	$5,200

Option Descriptions

Standard: 104 to 127 Vac, 47 to 66 Hz, 5.4A	
Opt 100 87 to 106 Vac, 47 to 66 Hz Input, 6.3A (Japan only)	$0
Opt 220 191 to 233 Vac, 47 to 66 Hz, 3.0A	$0
Opt 240 209 to 250 Vac, 47 to 66 Hz, 3.0A	$0
Opt 750 Protection Features and Relay Control	$275
Opt 908 Rack Mount Kit (HP p/n 5062-3977)	$40
Opt 909 Rack Mount Kit with Handles (HP p/n 5062-3983)	$90
Opt 910 Service Manual and Extra Operating Manual. (Standard unit is shipped with operating manual only.)	$55

POWER SUPPLIES

Precision Multiple-Output System Power Supplies, 25 to 50 W

HP 6625A, 6626A, 6628A, 6629A

- 14-bit programming and readback of voltage and current
- 2 or 4 independent isolated outputs
- Dual-range linear outputs
- Low ripple and noise
- Fast up- and down-programming

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Hewlett-Packard
Instrument Drivers

Specifications (at 0° to 55° C unless otherwise specified)

			25-watt output		50-watt output	
Output power	Output range		Low range	High range	Low range	High range
	Output volts		0 to 7 V	0 to 50 V	0 to 16 V	0 to 50 V or 0 to 16 V
	Output amps		0 to 15 mA	0 to 500 mA	0 to 200 mA	0 to 1 A or 0 to 2 A
Output combinations for each Hewlett-Packard Model (total number of outputs)	**HP 6625A** (2)		1		1	
	HP 6626A (4)		2		2	
	HP 6628A (2)		0		2	
	HP 6629A (4)		0		4	
Programming accuracy (at 25° C ±5° C)	Voltage		1.5 mV + 0.016%	10 mV + 0.016%	3 mV + 0.016%	10 mV + 0.016%
	Current		15 μA + 0.04%	100 μA + 0.04%	185 μA + 0.04%	500 μA + 0.04%
Ripple and noise (peak-to-peak, 20 Hz to 20 MHz; rms, 20 Hz to 10 MHz)	Constant voltage	rms	500 μV	500 μV	500 μV	500 μV
		peak-to-peak	3 mV	3 mV	3 mV	3 mV
	Constant current	rms	0.1 mA	0.1 mA	0.1 mA	0.1 mA
Readback accuracy (at 25° C ±5° C)	Voltage		2 mV + 0.016%	10 mV + 0.016%	3.5 mV + 0.016%	10 mV + 0.016%
	Current		15 μA + 0.03%	130 μA + 0.03%	250 μA + 0.04%	550 μA + 0.04%
Load regulation	Voltage		0.5 mV	0.5 mV	0.5 mV	0.5 mV
	Current		0.005 mA	0.005 mA	0.01 mA	0.01 mA
Load cross regulation	Voltage		0.25 mV	0.25 mV	0.25 mV	0.25 mV
	Current		0.005 mA	0.005 mA	0.01 mA	0.01 mA
Line regulation	Voltage		0.5 mV	0.5 mV	0.5 mV	0.5 mV
	Current		0.005 mA	0.005 mA	0.01 mA	0.01 mA

Transient Response Time: Less than 75 μs for the output to recover to within 75 mV of nominal value following a load change from 0.1 A to full current.

Isolation: All outputs can be floated up to ±240 Vdc from chassis ground.

Supplemental Characteristics (Non-warranted characteristics determined by design and useful in applying the product.)

		25-W Low range	25-W High range	50-W Low range	50-W High range
Average programming resolution	Voltage	460 μV	3.2 mV	1 mV	3.2 mV
	Current	1 μA	33 μA	13 μA	131 μA
	OVP	230 mV	230 mV	230 mV	230 mV
Output programming response time (time to settle within 50 mV of programmed value after Vset command has been processed)		6 ms	6 ms	6 ms	6 ms

Remote Sensing: Up to 10-V total drop in the load leads. The drop in the load leads subtracts from the voltage available for the load.
Command Processing Time: 7 ms typical with front-panel display disabled
Current Sink Limits: 25-W output: 0.5 A
50-W output: 1 A (2 A below 16 V)
Input Power: 550 W max
HP-IB Interface Capabilities: SH1, AH1, T6, L4, SR1, R1, PP1, DC1, DT0, C0, E1
Regulatory Compliance: Listed to UL 1244; certified to CSA 556B; conforms to IEC 348; carries the CE mark
RFI Suppression: Complies with CISPR-11 Group 1 Class B
Size: 425.5 mm W × 132.6 mm H × 497.8 mm D (16.75 in × 5.22 in × 19.6 in)
Weight:
HP 6625A and 6628A: Net, 15.5 kg (34 lb); shipping, 20.8 kg (46 lb)
HP 6626A and 6629A: Net, 17.7 kg (39 lb); shipping, 23.0 kg (51 lb)
Warranty period: Three years

Key Features (for more information, see page 464)

- HP-IB programming of voltage and current to 0.5mV or 15 μA
- 14-bit measured voltage and current readback over the HP-IB
- Two outputs can be connected in parallel or in series
- Automatic selection of operating voltage and current range
- Programmable overvoltage and overcurrent protection
- Overtemperature protection
- Self-test occurs at power-on or from an HP-IB command
- Electronic calibration via HP-IB
- 11 store-recall states; 4 nonvolatile
- User-definable power-on state
- Option 750 for relay control and DFI/RI

Ordering Information

	Price
HP 6625A Dual-Output System Supply	$5,200
HP 6626A Quad-Output System Supply	$8,350
HP 6628A Dual-Output System Supply	$5,200
HP 6629A Quad-Output System Supply	$8,350

Option Descriptions

Standard: 104 to 127 Vac, 47 to 66 Hz, 5.7A	$0
Opt 100 87 to 106 Vac, 47 to 66 Hz, 6.3A (Japan only)	$0
Opt 220 191 to 233 Vac, 47 to 66 Hz, 3.0A	$0
Opt 240 209 to 250 Vac, 47 to 66 Hz, 3.0A	$0
Opt 750 Relay Control and DFI/RI	$275
Opt 908 Rack Mount Kit (HP p/n 5062-3977)	$40
Opt 909 Rack Mount Kit with Handles (5062-3983)	$90
Opt 910 Service Manual and Extra Operating Manual. (Standard unit is shipped with operating manual only.)	$55

Accessories

14852A Bias cable to connect either the HP 6626A or the HP 6629A to a 3-terminal device test fixture. (See Application Note 376-1, "Biasing Three-Terminal Devices for Test.")	$300

For the most current prices and product information, contact your local Hewlett-Packard sales office.—see page 665.

POWER SUPPLIES
Single-Output System, 100 W
HP 6632A, 6633A, 6634A

- Linear output regulation
- Low ripple and noise
- "One-Box" solution: includes V and I readback
- Fast up- and down-programming

Specifications (at 0° C to 55° C unless otherwise specified)

			HP 6632A	HP 6633A	HP 6634A
Output ratings	Output voltage		0 to 20 V	0 to 50 V	0 to 100 V
	Output current		0 to 5 A	0 to 2 A	0 to 1 A
Programming accuracy at 25° C ±5° C	Voltage		0.05% +10 mV	0.06% +20 mV	0.05% +50 mV
	+ Current		0.15% +7mA	0.15% +2mA	0.15% +1mA
Ripple and noise from 20 Hz to 20 MHz	Voltage (rms/p-p)	Normal Mode	0.3mV/3 mV	0.5mV/3 mV	0.5mV/3 mV
		Fast Mode	1mV/10 mV	1mV/15 mV	2mV/25 mV
	Current	rms	2 mA	2 mA	2 mA
Readback accuracy at 25° C ±5° C	Voltage		0.07% +15 mV	0.07% +30 mV	0.06% +70 mV
	+ Current		0.18% +9 mA	0.17% +3 mA	0.15% +2 mA
	− Current		0.50% +15 mA	0.50% +7 mA	0.50% +6 mA
Load regulation	Voltage		2 mV	4 mV	5 mV
	Current		1 mA	1 mA	1 mA
Line regulation	Voltage		0.5 mV	1 mV	1 mV
	Current		0.5 mA	0.25 mA	0.25 mA

Transient Response Time: Less than 100 μs (50 μs in fast mode) for the output voltage to recover to its previous level (within 0.1% of the voltage rating of the supply) following any step change in load current of up to 50% of rated current.

Isolation: Output terminals can be floated up to ±240 Vdc from chassis ground.

Supplemental Characteristics (Non-warranted characteristics determined by design and useful in applying the products.)

		HP 6632A	HP 6633A	HP 6634A
Programming resolution	Voltage	5 mV	12.5 mV	25 mV
	Current	1.25 mA	0.5 mA	0.25 mA
	OVP	100 mV	250 mV	500 mV
OVP accuracy		2.4% + 240 mV	2.4% + 600 mV	2.4% + 1.2 V
Sink current		5 A	2 A	1 A
Minimum current in constant current mode		20 mA	8 mA	4 mA
Price		$1,850	$1,850	$1,850

Remote Sensing: Up to 2 volts can be dropped in each load lead. Add 5 mV to the voltage load regulation specification for each 1-V change in the negative output lead due to load current change.

Command Processing Time: Average time required for the output voltage to begin to change following receipt of digital data is 10 ms for power supplies connected directly to the HP-IB.

Output Programming Response Time: The rise and fall time (10/90% and 90/10%) of the output voltage is less than 15 ms (400 μs in fast mode). The output voltage change settles within 1 LSB (0.025% × rated voltage) of final value in less than 60 ms (2 ms in fast mode).

Input Power: 350 VA, 250 W at full load

HP-IB Interface Capabilities: SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT0, E1 and C0

Regulatory Compliance: Listed to UL 1244; certified to CSA 556B; conforms to IEC 348; carries the CE mark.

RFI Suppression: Complies with CISPR-11 Group 1 Class B.

Size: 88.1 mm H × 425.5 mm W × 346 mm D (3.5 in × 16.75 in × 13.6 in)

Weight: Net, 10.5 kg (23 lb); shipping, 12.3 kg (27 lb)

Warranty Period: Three years

Key Features (for more information, see p. 464)

- HP-IB programming of voltage and current
- Measured voltage and current readback over the HP-IB
- Programmable overvoltage and overcurrent protection
- Self-test occurs at power-on or from an HP-IB command
- Electronic calibration via HP-IB
- Option 760 for built-in relays and DFI/RI
- Fast or normal mode operation selected via rear-panel switch
- Option 020 provides front panel binding posts

Ordering Information

Option Descriptions	Price
Standard: 104 to 127 Vac, 48 to 63 Hz, 3.3 A	$0
Opt 020 Front Binding Posts	$85
Opt 760 Isolation and Reversal Relays; includes discrete fault indicator and remote inhibit	$420
Opt 100 87 to 106 Vac, 48 to 63 Hz, 2.9 A (Japan only)	$0
Opt 220 191 to 233 Vac, 48 to 63 Hz, 1.7 A	$0
Opt 240 209 to 250 Vac, 48 to 63 Hz, 1.6 A	$0
Opt 908 Rack Mount Kit (HP p/n 5061-9674)	$35
Opt 909 Rack Mount Kit with handles (HP p/n 5061-9675)	$80
Opt 910 Extra Operating Manual (HP p/n 5957-6360) and Service Manual (HP p/n 5957-6365). Standard unit is shipped with operating manual only.	$35
Accessory rack slide kit (HP p/n 1494-0059)	$100

POWER SUPPLIES
Single-Output System, 200 W
HP 6641A, 6642A, 6643A, 6644A, 6645A

- Linear output regulation
- Low ripple and noise
- "One-Box" solution: includes V and I readback
- Fast up and down programming
- SCPI (Standard Commands for Programmable Instruments)

DESIGNED FOR HP-IB SYSTEMS
Hewlett-Packard
Instrument Drivers

Specifications (at 0° C to 55° C unless otherwise specified)

			HP 6641A	HP 6642A	HP 6643A	HP 6644A	HP 6645A
Output ratings	Output voltage		0 to 8 V	0 to 20 V	0 to 35 V	0 to 60 V	0 to 120 V
	Output current	(40° C)	0 to 20 A	0 to 10 A	0 to 6 A	0 to 3.5 A	0 to 1.5 A
	Maximum current	(50° C)	18.0 A	9.0 A	5.4 A	3.2 A	1.4 A
	Maximum current	(55° C)	17.0 A	8.5 A	5.1 A	3.0 A	1.3 A
Programming accuracy at 25° C ±5° C	Voltage	0.06% +	5 mV	10 mV	15 mV	26 mV	51 mV
	Current	0.14% +	26 mA	13 mA	6.7 mA	4.1 mA	1.7 mA
Ripple and noise from 20 Hz to 20 MHz	Constant voltage	rms	300 μV	300 μV	400 μV	500 μV	700 μV
		peak-peak	3 mV	3 mV	4 mV	5 mV	7 mV
	Constant current	rms	10 mA	5 mA	3 mA	1.5 mA	1 mA
Readback accuracy at 25° C ±5° C	Voltage	0.07% +	6 mV	15 mV	25 mV	40 mV	80 mV
	+Current	0.10% +	18 mA	9.1 mA	5 mA	3 mA	1.3 mA
	−Current	0.35% +	40 mA	20 mA	12 mA	6.8 mA	2.9 mA
Load regulation	Voltage		1 mV	2 mV	3 mV	4 mV	5 mV
	Current		1 mA	0.5 mA	0.25 mA	0.25 mA	0.25 mA
Line regulation	Voltage		0.5 mV	0.5 mV	1 mV	1 mV	2 mV
	Current		1 mA	0.5 mA	0.25 mA	0.25 mA	0.25 mA

Transient Response Time: Less than 100 μs for the output voltage to recover to its previous level (within 0.1% of the voltage rating of the supply or 20 mV, whichever is greater) following any step change in load current of up to 50% of rated current.

Isolation: Output terminals can be floated up to ±240 Vdc from chassis ground.

Supplemental Characteristics (Non-warranted characteristics determined by design and useful in applying the product.)

		HP 6641A	HP 6642A	HP 6643A	HP 6644A	HP 6645A
Average programming resolution	Voltage	2 mV	5 mV	10 mV	15 mV	30 mV
	Current	6 mA	3 mA	2 mA	1.2 mA	0.5 mA
	OVP	13 mV	30 mV	54 mV	93 mV	190 mV
OVP accuracy		160 mV	400 mV	700 mV	1.2 V	2.4 V
Down programming current		5.8 A	2.5 A	1.5 A	0.9 A	0.75 A
Price		$2,400	$2,300	$2,300	$2,300	$2,350

Remote Sensing: Up to half the rated output voltage can be dropped in each load lead. The drop in the load leads subtracts from the voltage available for the load. Add 3 mV to the voltage load regulation specification for each 1-volt change in the positive output lead due to load current change.

Command Processing Time: Average time required for the output voltage to begin to change following receipt of digital data is 20 ms for power supplies connected directly to the HP-IB.

Output Programming Response time: The rise and fall time (10/90% and 90/10%) of the output voltage is less than 15 ms. The output voltage change settles within 1 LSB (0.025% × rated voltage) of final value in less than 60 ms.

Modulation: (Analog programming of output voltage and current)
Input signal: 0 to −5 V
Input impedance: 10 KΩ nominal

ac Input:

Voltage	100 Vac	120 Vac	220 Vac	240 Vac
Current	4.4 A	3.8 A	2.2 A	2.0 A

Input Power: 480 VA, 400 W at full load; 60 W at no load.

HP-IB Interface Capabilities: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, E1, and CO. IEEE-488.2 and SCPI-compatible command set

Regulatory Compliance: Conforms to UL 1244 and IEC 1010; certified to CSA 22.2 No. 231; carries the CE mark
RFI Suppression: Complies with CISPR-11 Group 1 Class B

Size: 425 mm W × 88.1 mm H × 439 mm D (16.75 in × 3.5 in × 17.3 in)

Weight: Net, 14.2 kg (31.4 lb); shipping, 16.3 kg (36 lb)
Warranty period: Three years

Key Features (for more information, see page 464)
- HP-IB programming of voltage and current
- Measured voltage and current readback over the HP-IB
- SCPI (Standard Commands for Programmable Instruments)
- Serial link connects up to 16 outputs to one HP-IB address
- Auto-parallel up to three units
- Outputs can be connected in parallel or in series
- Programmable overvoltage and overcurrent protection
- Overtemperature protection
- Discrete Fault Indicator/Remote Inhibit (DFI/RI)
- Self-test occurs at power-on or from an HP-IB Command
- Electronic calibration via HP-IB or front panel
- Five nonvolatile store-recall states
- User-definable power-on state
- Digital I/O controls external relay accessories (see page 476)
- Fan speed control minimizes acoustic noise

Ordering Information **Price**

Option Descriptions

Standard: Vac, 47 to 63 Hz	$0
Opt 100 87 to 106 Vac, 47 to 63 Hz	$0
Opt 220 191 to 233 Vac, 47 to 63 Hz	$0
Opt 240 209 to 250 Vac, 47 to 63 Hz	$0
Opt 908 Rack Mount Kit (HP p/n 5062-3974)	$35
Opt 909 Rack Mount Kit with Handles (HP p/n 5062-3975)	$80

For the most current prices and product information, contact your local Hewlett-Packard sales

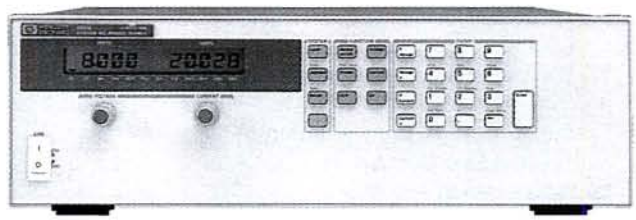
POWER SUPPLIES

Single-Output System, 500 W

HP 6651A, 6652A, 6653A, 6654A, 6655A

- Linear output regulation
- Low ripple and noise
- "One-Box" solution: includes V and I readback
- Fast up and down programming
- SCPI (Standard Commands for Programmable Instruments)

DESIGNED FOR HP-IB SYSTEMS
Hewlett-Packard
Instrument Drivers



Specifications (at 0° C to 55° C unless otherwise specified)

			HP 6651A	HP 6652A	HP 6653A	HP 6654A	HP 6655A
Output ratings	Output voltage		0 to 8 V	0 to 20 V	0 to 35 V	0 to 60 V	0 to 120 V
	Output current	(40° C)	0 to 50 A	0 to 25 A	0 to 15 A	0 to 9 A	0 to 4 A
	Maximum current	(50° C)	45.0 A	22.5 A	13.5 A	8.1 A	3.6 A
	Maximum current	(55° C)	42.5 A	21.3 A	12.8 A	7.7 A	3.4 A
Programming accuracy at 25° C ± 5° C	Voltage	0.06% +	5 mV	10 mV	15 mV	26 mV	51 mV
	Current	0.15% +	60 mA	25 mA	13 mA	8 mA	4 mA
Ripple and noise from 20 Hz to 20 MHz	Constant voltage	rms	300 μV	300 μV	400 μV	500 μV	700 μV
		peak-peak	3 mV	3 mV	4 mV	5 mV	7 mV
	Constant current	rms	25 mA	10 mA	5 mA	3 mA	2 mA
Readback accuracy at 25° C ± 5° C	Voltage	0.07% +	6 mV	15 mV	25 mV	40 mV	80 mV
	+ Current	0.15% +	67 mA	26 mA	15 mA	7 mA	3 mA
	− Current	0.35% +	100 mA	44 mA	24 mA	15 mA	7 mA
Load regulation	Voltage		1 mV	2 mV	3 mV	4 mV	5 mV
	Current		2 mA	1 mA	0.5 mA	0.5 mA	0.5 mA
Line regulation	Voltage		0.5 mV	0.5 mV	1 mV	1 mV	2 mV
	Current		2 mA	1 mA	0.75 mA	0.5 mA	0.5 mA

Transient Response Time: Less than 100 μs for the output voltage to recover to its previous level (within 0.1% of the voltage rating of the supply or 20 mV, whichever is greater) following any step change in load current of up to 50% of rated current.

Isolation: Output terminals can be floated up to ±240 Vdc from chassis ground.

Supplemental Characteristics (Non-warranted characteristics determined by design and useful in applying the product.)

		HP 6651A	HP 6652A	HP 6653A	HP 6654A	HP 6655A
Average programming resolution	Voltage	2 mV	5 mV	10 mV	15 mV	30 mV
	Current	15 mA	7 mA	4 mA	2.5 mA	1.25 mA
	OVP	12 mV	30 mV	54 mV	93 mV	190 mV
OVP accuracy		160 mV	400 mV	700 mV	1.2 V	2.4 V
Price		$2,950	$2,750	$2,750	$2,750	$2,800

Remote Sensing: Up to half the rated output voltage can be dropped in each load lead. The drop in the load lead subtracts from the voltage available for the load. Add 3 mV to the voltage load regulation specification for each 1-V change in the positive output lead due to load current change.

Command Processing Time: Average time required for the output voltage to begin to change following receipt of digital data is 20 ms for power supplies connected directly to the HP-IB.

Output Programming Response Time: The rise and fall time (10/90% and 90/10%) of the output voltage is less than 15 ms. The output voltage change settles within 1 LSB (0.025% × rated voltage) of final value in less than 60 ms.

Down Programming: An active down programmer sinks approximately 20% of the rated output current.

Modulation: (Analog programming of output voltage and current)
Input signal: 0 to −5 V
Input impedance: 10 kΩ nominal

ac Input:

Voltage	100 Vac	120 Vac	220 Vac	240 Vac
Current	12 A	10 A	5.7 A	5.3 A

Input Power: 1,380 VA, 1,100 W at full load; 120 W at no load

HP-IB Interface Capabilities: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, E1, and C0. IEEE-488.2- and SCPI-compatible command set

Regulatory Compliance: Listed to UL 1244; certified to CSA 556B; conforms to IEC 348; carries the CE mark

RFI Suppression: Complies with CISPR-11 Group 1 Class B

Size: 132.6 mm H × 425.5 mm W × 497.8 mm D (5.22 in × 16.75 in × 19.6 in)

Weight: Net, 25 kg (54 lb); shipping, 28 kg (61 lb)

Warranty Period: Three years

Key Features (for more information, see page 464)

- HP-IB programming of voltage and current
- Measured voltage and current readback over the HP-IB
- SCPI (Standard Commands for Programmable Instruments)
- Serial link connects up to 16 outputs to one HP-IB address
- Auto-parallel up to 3 units
- Outputs can be connected in parallel or in series
- Programmable overvoltage and overcurrent protection
- Overtemperature protection
- Discrete Fault Indicator/Remote Inhibit (DFI/RI)
- Self-test occurs at power-on or from an HP-IB command
- Electronic calibration via HP-IB or front panel
- Five nonvolatile store-recall states
- User-definable power-on state
- Digital I/O controls external relay accessories (see page 476)
- Fan speed control minimizes acoustic noise

Ordering Information

Option Descriptions	Price
Standard: 104 to 127 Vac, 47 to 63 Hz	$0
Opt 100 87 to 106 Vac, 47 to 63 Hz	$0
Opt 220 191 to 233 Vac, 47 to 63 Hz	$0
Opt 240 209 to 250 Vac, 47 to 63 Hz	$0
Opt 908 Rack Mount Kit (HP p/n 5062-3977)	$40
Opt 909 Rack Mount Kit with handles (HP p/n 5062-3983)	$90
Opt 910 Service Manual (HP p/n 5959-3321) and Extra Operating Manual (HP p/n 5959-3348). Standard unit is shipped with operating manual only.	$35

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

POWER SUPPLIES

Single-Output System, 2,000 W

HP 6671A, 6672A, 6673A, 6674A, 6675A

- Low ripple and noise
- "One-Box" Solution: includes V and I readback
- Fast up and down programming
- SCPI (Standard Commands for Programmable Instruments)

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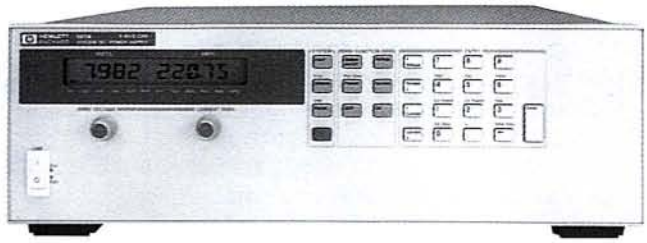

Specifications (at 0° C to 55° C unless otherwise specified)

			HP 6671A	HP 6672A	HP 6673A	HP 6674A	HP 6675A
Output ratings	Output voltage		0 to 8 V	0 to 20 V	0 to 35 V	0 to 60 V	0 to 120 V
	Output current		0 to 220 A	0 to 100 A	0 to 60 A	0 to 35 A	0 to 18 A
Programming accuracy: at 25° C ±5° C	Voltage	0.04% +	8 mV	20 mV	35 mV	60 mV	120 mV
	Current	0.1% +	125 mA	60 mA	40 mA	25 mA	12 mA
Ripple and noise: from 20 Hz to 20 MHz	Constant voltage	rms	650 μV	750 μV	800 μV	1.25 mV	1.9 mV
		peak-to-peak	7 mV	9 mV	9 mV	11 mV	16 mV
	Constant current	rms	200 mA	100 mA	40 mA	25 mA	12 mA
Readback accuracy: at 25° C ±5° C	Voltage	0.05% +	12 mV	30 mV	50 mV	90 mV	180 mV
	± Current	0.1% +	150 mA	100 mA	60 mA	35 mA	18 mA
Load and line regulation	Voltage	0.002% +	300 μV	650 μV	1.2 mV	2 mV	4 mV
	Current	0.005% +	10 mA	7 mA	4 mA	2 mA	1 mA

Transient response time: Less than 900 μsec for the output voltage to recover within 100 mV following a change in load from 100% to 50% or 50% to 100% of the output current rating of the supply.

Isolation: Output terminals can be floated up to ±240 Vdc maximum from chassis ground.

Supplemental Characteristics (Non-warranted characteristics determined by design and useful in applying the product.)

		HP 6671A	HP 6672A	HP 6673A	HP 6674A	HP 6675A
Average programming resolution:	Voltage	2 mV	5 mV	9 mV	15 mV	30 mV
	Current	55 mA	25 mA	15 mA	8.75 mA	4.5 mA
	OVP	15 mV	35 mV	65 mV	100 mV	215 mV
Output voltage programming response time: (excluding command processing time)	Full-load programming rise/fall time (10% to 90% or 90% to 10%)*	30 ms	60 ms	130 ms	130 ms	195 ms
Price		$4,450	$4,400	$4,350	$4,300	$4,400

* With full resistive load equal to rated output voltage/rated output current

Output Common Mode Noise Current: (to signal ground binding post) 500 μA rms, 4 mA peak-peak
Remote Sensing: Up to half the rated output voltage can be dropped in each load lead. The drop in the load leads subtracts from the voltage available for the load.
Command Processing Time: Average time required for the output voltage to begin to change following receipt of digital data is 20 ms for power supplies connected directly to the HP-IB.
Modulation: (Analog programming of output voltage and current)
Input signal: 0 to −4 V for voltage, 0 to 7 V for current
Input impedance: 30 kΩ or greater
See operating manual for exact values.
ac Input Current: (ac input frequency: 47 to 63 Hz) 19A
Input Power: 3,800 VA, 2,600 W at full load; 170 W at no load
HP-IB Interface Capabilities: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, E1, and C0. IEEE 488.2- and SCPI-compatible command set
Regulatory Compliance: Listed to UL 1244; certified to CSA 556B; conforms to IEC 348; carries the CE mark
RFI Suppression: Complies with CISPR-11 Group 1 Class B
Size: 425.5 mm W × 132.6 mm H × 640.0 mm D (16.75 in × 5.22 in × 25.2 in)
Weight: Net, 28.2 kg (62 lb); shipping, 31.8 kg (70 lb)
Warranty Period: Three years

Key Features (for more information, see page 464)

- HP-IB programming of voltage and current
- Measured voltage and current readback over the HP-IB
- SCPI (Standard Commands for Programmable Instruments)
- Serial link connects up to 16 outputs to one HP-IB address
- Auto-parallel up to five units
- Outputs can be connected in series
- Programmable overvoltage and overcurrent protection
- Overtemperature protection
- Discrete Fault Indicator/Remote Inhibit (DFI/RI)
- Self-test occurs at power-on or from an HP-IB command
- Electronic calibration via HP-IB or front panel
- Five non-volatile store-recall states
- User-definable power-on state
- Digital I/O controls external relay accessories (for models that meet relay-box ratings)
- Fan speed control minimizes acoustic noise

Ordering Information

Price

Option Descriptions

Opt 200 174-220 Vac, 47-63 Hz (Japan only) — $0

If Option 200 is not ordered, the power supply will be configured to operate at 191-250 Vac, 47-63 Hz

One of the following line cord options must be specified when ordering. Order according to local electrical codes. All line cords are 2.5 m long (see page 476 for more information).

Opt 831 12 AWG Wire Size; Unterminated Line Cord — $0
Opt 832 4 mm² Wire Size; Unterminated Line Cord — $0
Opt 834 10 AWG Wire Size, Unterminated Line Cord — $0
Opt 841 Line Cord with NEMA 6-20P, 20A/250V Plug — $15
Opt 842 Line Cord with IEC 309, 32A/220V Plug — $75
Opt 843 Line Cord with JIS C8303 Appended Fig 6(2), 20A/250V Plug — $35
Opt 844 Line Cord with NEMA L6-30P, 30A/250V Locking Plug — $55

Opt 908 Rack Mount Kit (HP p/n 5062-3977) — $40
Opt 909 Rack Mount Kit with Handles (HP p/n 5062-3983) — $90
Opt 910 Service Manual and Extra Operating Manual. Standard Unit is Shipped with Operating Manual Only. — $35

For the most current prices and product information, contact your local Hewlett-Packard sales office.

POWER SUPPLIES

Single-Output System, 5,000 W

HP 6680A, 6681A

- "One-box" solution includes V and I read-back
- Low ripple and noise
- Fast up- and down-programming
- High-accuracy current programming and read back
- Standard Commands for Programmable Instruments (SCPI)
- Selectable compensation for inductive loads

NEW

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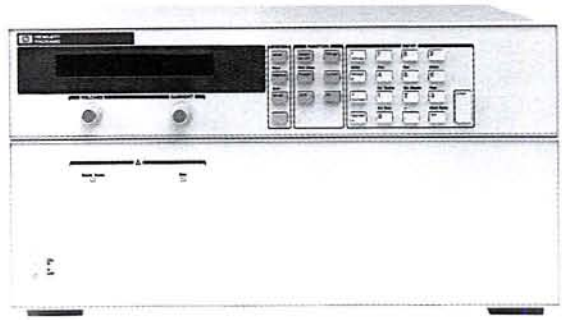
Hewlett-Packard

Instrument Drivers



Specifications (at 0° to 55° C unless otherwise specified)

			HP 6680A	HP 6681A
Output ratings	Voltage		0 to 5 V	0 to 8 V
	Current (derated linearly 1%/°C from 40° C to 55° C)		0 to 875 A	0 to 580 A
Programming accuracy: at 25° C ±5° C	Voltage	0.04% +	5 mV	8 mV
	Current	0.1% +	450 mA	300 mA
Ripple and noise: from 20 Hz to 20 MHz	Constant voltage	rms	1.5 mV	1.5 mV
		peak-to-peak	10 mV	10 mV
	Constant current	rms	250 mA	150 mA
Read-back accuracy: at 25° C ±5° C	Voltage	0.05% +	7.5 mV	12 mV
	Current	0.1% +	600 mA	400 mA
Load and line regulation	Voltage	0.002% +	190 μV	300 μV
	Current	0.005% +	65 mA	40 mA

Transient Response Time: Less than 900 μs for the output voltage to recover within 150 mV following a change in load from 100 to 50 percent or 50 to 100 percent of the output current rating of the supply.

Isolation: Output terminals can be floated up to ±60 Vdc maximum from chassis ground.

Supplemental Characteristics (Nonwarranted characteristics determined by design that are useful in applying this product)

		HP 6680A	HP 6681A
Average programming resolution	Voltage	1.35 mV	2.15 mV
	Current	235 mA	155 mA
	OVP	30 mV	45 mV
Output voltage programming response time (excludes command-processing time)	Full-load programming rise or fall time (10 to 90% or 90 to 10%, resistive load)	9 ms	12 ms
Price		$9,500	$9,500

Output Common Mode Noise Current: (to signal-ground binding post) 1 mA rms, 5 mA peak-to-peak
Remote Sensing: Up to half the rated output voltage can be dropped in each load lead. The drop in the load leads subtracts from the voltage available for the load.
Command Processing Time: Average time required for the output voltage to begin to change following receipt of digital data is 20 ms for power supplies connected directly to the HP-IB.
Modulation (analog programming of output voltage and current):
Input signal: 0 to −5 V for voltage, 0 to +5 V for current
Input impedance: 30 kΩ or greater
ac Input (47 to 63 Hz): 180 to 235 Vac (line-to-line, 3 phase), 27.7 A rms maximum; 360 to 440 Vac, 14.3 A rms maximum (maximum line current includes 5% unbalanced phase voltage condition.) Output voltage derated up to 95% at 50 Hz and below 200 Vac.
Input Power: 7350 VA and 6000 W maximum; 160 W at no load
HP-IB Interface Capabilities: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, E1, and CO. IEEE488.2 and SCPI command set.
Regulatory Compliance: Listed to UL 1244; certified to CSA 22.2 No. 231; conforms to IEC 1010; carries the CE mark.
RFI Suppression: Complies with CISPR-11 Group 1 Class A
Size: 425.5 mm W × 220 mm H × 675.6 mm D (16.75 in × 8.75 in × 26.6 in)
Weight: Net, 51.3 kg (113 lb); shipping, 90.9 kg (200 lb)
Warranty period: Three years

Key Features (For more information, see page 464)

- HP-IB–programmable voltage and current
- Measured voltage and current read back over HP-IB
- SCPI (standard commands for programmable instruments)
- Serial link to connect up to 16 outputs on one HP-IB address
- Auto-parallel up to five units
- Outputs can be connected in series
- Programmable overvoltage and overcurrent protection
- Overtemperature protection
- Discrete fault indicator/remote inhibit (DFI/RI)
- Self-test occurs at power-up or from an HP-IB command
- Electronic calibration via HP-IB or from front panel
- Four nonvolatile store and recall states
- User-definable power-on state
- Digital I/O for control of external relays
- Fan-speed control minimizes acoustic noise

Ordering Information — Price

Option Descriptions

Opt 400 360–440 Vac, 3 phase, 47-63 Hz — $0
If Opt 400 is not ordered, power supply will be configured to operate at 180–235 Vac, 3 phase, 47–63 Hz.
One of these line cord options must be specified when ordering. All line cords are 2.5 m long (see page 476 for more information).
Opt 861 10 AWG; 300 V; 4-wire Unterminated Line Cord — $0
Opt 862 2.5 m²; 450 V; 4-wire Unterminated Line Cord — $0
Opt 601 Output Connector Kit (required for bench applications) includes bus-bar spacer, connector bolts, and output cover (HP p/n 5060-3515) — $80
Opt 602 Two Bus Bar Spacers for paralleling power supplies (HP p/n 5060-3514) — $50
Opt 908 Rack Mount Kit (HP p/n 5062-3977 and p/n 5062-3974). Support rails required. — $75
Opt 909 Rack Mount Kit with Handles (HP p/n 5062-3983 and p/n 5062-3974). Support rails required. — $125

Accessories

HP p/n 5060-3513 Three 30-A Replacement Fuses for 180–235 Vac line — $18
HP p/n 5060-3512 Three 16-A Replacement Fuses for 360–440 Vac line — $18

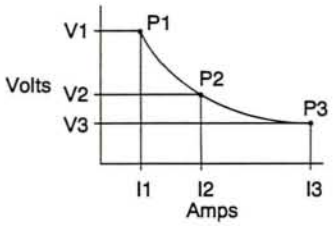
For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

POWER SUPPLIES

Single-Output System: 200- to 1000-W Autoranging

HP 6030A, 6031A, 6032A, 6033A, 6035A, 6038A

- "One-box" solution (includes V and I read-back)
- Standard Commands for Programmable Instruments (SCPI)
- Autoranging output:



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Hewlett-Packard
Instrument Drivers

HP 6033A and 6038A;
HP 6033A and 6038A with Option 001 (on right)

HP 6030A, 6031A, 6032A, and 6035A

Specifications (at 0° C to 50° C unless otherwise noted)

			HP 6030A	HP 6031A	HP 6032A	HP 6033A	HP 6035A	HP 6038A
Output ratings	Voltage		0–200 V	0–20 V	0–60 V	0–20 V	0–500 V	0–60 V
	Current		0–17 A	0–120 A	0–50 A	0–30 A	0–5 A	0–10 A
Autoranging output	P1		200 V, 5 A	20 V, 50 A	60 V, 17.5 A	20 V, 10 A	500 V, 2 A	60 V, 3.3 A
	P2		120 V, 10 A	14 V, 76 A	40 V, 30 A	14 V, 17.2 A	350 V, 3 A	40 V, 6 A
	P3		60 V, 17 A	7 V, 120 A	20 V, 50 A	6.7 V, 30 A	200 V, 5 A	20 V, 10 A
Programming accuracy at 25° C ±5° C	Voltage		0.035% + 145 mV	0.035% + 15 mV	0.035% + 40 mV	0.035% + 9 mV	0.25% + 400 mV	0.035% + 40 mV
	Current		0.2% + 25 mA	0.25% + 250 mA	0.2% + 85 mA	0.15% + 20 mA	0.3% + 63 mA	0.09% + 10 mA
Ripple and noise, 20 Hz to 20 MHz	Constant voltage	rms	22 mV	8 mV	8 mV	3 mV	50 mV	3 mV
		peak-to-peak	50 mV	50 mV	40 mV	30 mV	160 mV	30 mV
	Constant current	rms	15 mA	120 mA	25 mA	15 mA	50 mA	5 mA
Read-back accuracy at 25° C ±5° C	Voltage		0.08% + 80 mV	0.08% + 7 mV	0.08% + 20 mV	0.07% + 6 mV	0.5% + 300 mV	0.07% + 50 mV
	Current		0.36% + 15 mA	0.4% + 100 mA	0.36% + 35 mA	0.3% + 25 mA	0.5% + 50 mA	0.2% + 11 mA
Load regulation	Voltage	0.01% +	5 mV	3 mV	5 mV	2 mV	13 mV	3 mV
	Current	0.01% +	10 mA	15 mA	10 mA	9 mA	35 mA	5 mA
Line regulation	Voltage	0.01% +	5 mV	2 mV	3 mV	1 mV	13 mV	2 mV
	Current	0.01% +	5 mA	25 mA	10 mA	6 mA	18 mA	2 mA
Transient response time 10% step change	Time		2 ms	2 ms	2 ms	1 ms	5 ms	1 ms
	Level		150 mV	100 mV	100 mV	50 mV	200 mV	75 mV
Isolation	Either terminal may be grounded or floated up to ±240 V (±550 V for the HP 6030A and 6035A) from chassis ground.							
Average programming resolution (supplemental characteristic)	Voltage		50 mV	5 mV	15 mV	5 mV	125 mV	15 mV
	Current		4.25 mA	30 mA	12.5 mA	7.5 mA	1.25 mA	2.5 mA
Programming response time (at full load) (supplemental characteristic)		Up	300 ms (40 Ω)	300 ms	300 ms	100 ms	350 ms (250 Ω)	150 ms
		Down	600 ms (40 Ω)	500 ms	2 s	200 ms	600 ms (250 Ω)	150 ms
		Settling band	300 mV	30 mV	90 mV	5 mV	750 mV	15 mV
Price			$4,000	$4,000	$4,000	$2,900	$4,400	$2,900

Remote sensing: Up to 2 V drop in each lead. Voltage regulation spec met with up to 0.5-V drop, but degrades for greater drops.
Modulation: (Analog programming of output voltage and current)
Input signal: 0 to 5V Ω 0 to 4,000 Ω
Regulatory Compliance: Listed to UL 1244; certified to CSA 556B; conforms to IEC 348; carries the CE mark
RFI Suppression: Complies with CISPR-11 Group 1 Class B
ac Input Current: The HP 6030A, 6031A, 6032A, and 6035A draw 24 A at 100 and 120 Vac, 15 A at 220 Vac, and 14 A at 240 Vac. The HP 6033A and HP 6038A draw 6.0 A at 100 Vac, 6.5 A at 120 Vac, 3.8 A at 220 Vac, and 3.6 A at 240 Vac.
Weight: Net weight 16.3 kg (36 lb) for HP 6030A, 6032, and 6035; 17.2 kg (38 lb) for HP 6031; and 9.6 kg (21 lb) for HP 6033A and HP 6038A. Corresponding shipping weights are 21.8 kg (48 lb), 22.7 kg (50 lb), and 11.4 kg (25 lb).
Size: HP 6033A and 6038A: 212.3 mm W × 177.0 mm H × 443.6 mm D (8.36 in × 6.97 in × 17.872 in) HP 6030A, 6031A, 6032A, and 6035A: 425.5 mm W × 132.6 mm H × 503.7mm D (16.75 in × 5.2 in × 19.83 in)
Warranty period: Three years

Key Features

See page 464 for descriptions of features.

Ordering Information

	Price
Opt 001 Front-Panel which has only line switch, line indicator, and OVP adjust (except HP 6035A)	−$300

Input Power: Standard unit configured for 104 to 127 Vac, 48 to 63 Hz.

Opt 100 87 to 106 Vac, 48 to 63 Hz (Power-supply output power is derated to 75%.)	$0
Opt 220 191 to 233 Vac, 48 to 63 Hz	$0
Opt 240 208 to 250 Vac, 48 to 63 Hz	$0

For HP models **6030A, 6031A, 6032A, and 6035A,** one of the following line cords **must be specified** when ordering. For details, refer to page 476.

Opt 831 12 AWG, 200 to 240 Vac, Unterminated	$0
Opt 833 1.5-mm² Wire, 200 to 240 Vac, Unterminated	$0
Opt 834 10 AWG, 100 to 120 Vac, Unterminated	$0
Opt 841 With NEMA 6-20P; 20-A, 250-V Plug	$15
Opt 843 With JIS C8303 App. Fig 6(2); 20-A, 250-V Plug	$35
Opt 845 With IEC 309; 16-A, 220-V Plug	$35
Opt 846 With NEMA L5-30P; 30-A, 120-V Locking Plug	$55
Opt 847 With CEE 7/7; 16-A, 220-V Plug	$35
Opt 848 With BS 546; 15-A, 240-V Plug	$35
Opt 800 Rack Mount Kit for Two Units Side by Side (This applies to HP 6033A and 6038A only	$85
Opt 908 Rack Mount Kit for a Single Unit	
HP 6033A and 6038A (with Blank Filler Panel)	$80
HP 6030A, 6031A, 6032A and 6035A	$40
Opt 909 Rack Mount Kit with Handles for HP Models 6030A, 6031A, 6032A, 6035A	$90
Opt 910 One Extra Operating and Service Manual	$35

Accessory

HP 5080-2148 Serial Link Cable, 2 m (6.6 ft)	$6

For the most current prices and product information, contact your local Hewlett-Packard sales office.

POWER SUPPLIES

Power-Supply Relay and ac Line Cord Options

HP 59510A, 59511A

- Relay accessories to isolate load from dc output
- Switch and sequence power and sense leads
- dc output polarity reversal (HP 59511A only)

HP 59510A and HP 59511A Relay Devices

The HP 59510A and 59511A are remote-controlled relay devices. These can be configured to switch dc power in multiple test fixtures or provide extra protection when a fault condition requires an emergency shutdown. Each unit switches one power-supply output and can be used with any dc power supply within the voltage and current limits. The HP 59511A has all of the features of the HP 59510A, plus relays for reversing polarity. Using the PEM fasteners provided, both models can be mounted to a flat surface on any of three sides.

Relay-Device Specifications

Operating Ranges: 200 V at 20 A, 120 V at 30 A, or 48 V at 60 A
Isolation: Input to output, 200 Vdc; input or output to ground, 500 Vdc; TTL control to ground, 240 Vdc
Settling Time (TTL control): Connect, 440 ms; disconnect, 160 ms; polarity reversal, 600 ms
dc Voltage Drop (at 60 A): 0.5 V maximum on each relay
ac Input: Can be set for 100, 120, 220, or 240 Vac (−13%, +6%) at 48 to 63 Hz
Weight:
HP 59510A: Net, 2.3 kg (5 lb); shipping, 3.6 kg (8 lb); shipping with Opt 850, 4.1 kg (9 lb)
HP 59511A: Net, 3.6 kg (8 lb); shipping, 5.0 kg (11 lb); shipping with Opt 850, 5.5 kg (12 lb)

HP 59511A

Mounting Orientation: Within ±10° from vertical
Size: 185.4 mm W × 130.6 mm H × 198.6 mm D (7.26 in × 5.14 in × 7.81 in)

Ordering Information	Price
HP 59510A Output Isolation Relay Accessory	$1,150
HP 59511A Output Isolation, Polarity Reversal Accessory	$1,550
Options Descriptions	
Opt 850 Rack Mount Kit (side-by-side mounting of two units requires two kits)	+$77
Opt 910 Extra Operating and Service Manual	+$26

Power-Supply ac Line Cord Options

Power distribution regulations and techniques vary greatly among geographic regions. For this reason, line cord type must be specified for high-power (1000- to 5000-W) dc power supplies at the time of ordering. The HP 66000A modular power system mainframe is included because one line cord might supply ac power for up to eight 150-W modules. If no line cord option is specified for these models, an unterminated cable will be shipped with the unit.

Option Descriptions

Order the correct option according to local electrical codes. All the cords listed are 2.5 m (about 8.2 ft) long.

Unterminated Line Cords (User Supplies Plug)

Opt 831: 12 AWG; UL-listed, CSA-certified; unterminated. Suggested for use in North and South America. Note for HP 6670 and 6570 Series: Intended for use on a dedicated branch circuit and not intended for use in Canada. Note for HP 6030 and 66000 Series: Intended for connection to 200- to 240-Vac service.
Opt 832: 4-mm² wire size; harmonized cordage; unterminated. Suggested for use in Europe and other areas not listed.
Opt 833: 1.5-mm² wire size; harmonized cordage; unterminated. For use in Europe and other areas not listed. Note for HP 6030 and 66000 Series: Intended for connection to 200- to 240-Vac service.
Opt 834: 10 AWG; UL-listed, CSA-certified; unterminated. Suggested for use in North and South America. Note for HP 6030 and 66000 Series: Intended for connection to 100- to 120-Vac service.

Options Available

Power Supply Series	6030A (1000 W)	6570A	6670A	6680A	66000A mainframe
Options					
831	X	X	X		X
832		X	X		
833	X				X
834	X	X	X		X
841	X	X	X		X
842		X	X		
843	X	X	X		X
844		X	X		
845	X				X
846	X				X
847	X				X
848	X				X
861				X	
862				X	

Opt 861: 10 AWG; 300-volt, 4-wire connection; UL-listed, CSA-certified; unterminated (suggested for use in North and South America, Taiwan and Japan).
Opt 862: 2.5-mm² wire size, 450-volt, 4-wire connection; harmonized cordage; unterminated (suggested for use in Europe and other countries not listed).

Terminated Line Cords
(Line Cords with Plugs)

Opt 841: 12 AWG; UL-listed, CSA-certified; with NEMA 6-20P, 20-A, 250-V plug. Suggested for use in North and South America. Note for HP 6670 and 6570 Series: Not intended for use in Canada. Intended for use on a dedicated branch circuit.

Opt 842: 4-mm² wire size; harmonized cordage with IEC 309, 32-A, 220-V plug. Suggested for use in Europe and other areas not listed.

Opt 843: 12 AWG; UL-listed, CSA-certified; with JIS C8303 appended fig 6(2), 20-A, 250-V plug. Suggested for use in Japan.

Opt 844: 10 AWG; UL-listed, CSA-certified; with NEMA L6-30P, 30-A, 250-V, locking plug. Suggested for use in North and South America.

Opt 845: 1.5-mm² wire size; harmonized cordage with IEC 309, 16-A, 220-V plug. Suggested for use in Denmark, Switzerland, Austria, China, and other countries not listed.

Opt 846: 10 AWG; UL-listed, CSA-certified; with NEMA L5-30P, 30-A, 120-V locking plug. Suggested for use in North America.

Opt 847: 1.5-mm² wire size; harmonized cordage with CEE 7/7, 16-A, 220-V plug. Suggested for use in continental Europe.

Opt 848: 1.5-mm² wire size; harmonized cordage with BS 546, 15-A, 240-V plug. Suggested for use in India and South Africa.

- 200-watt autoranging dc output
- HP-IB option for voltage or current control
- Built-in overvoltage protection

HP 6002A

HP 6002A Autoranging Power Supply

The HP 6002A 200-W autoranging power supply is recommended only for use in existing systems. For new systems, the HP 6653A or 6654A 500-W supplies, or the HP 6642A, 6643A, or 6644A 200-W supplies offer significant advantages in price and performance. The HP 6033A and 6038A 200-W autorangers are also excellent alternatives to the HP 6002A.

HP-IB Option

Option 001 is required for HP-IB control of voltage or current. Selection of the controlled parameter is made via rear-panel manual switches. A 59501B digital-to-analog converter can be used to program current limit, while the internal HP-IB option programs the voltage.

Specifications

dc Output: Voltage and current output can be adjusted from 0 to 50 V, 0 to 10 A, 200 W maximum by front-panel controls, analog programming, or an optional HP-IB interface
Load Regulation: Voltage, 0.01% +1 mV; current, 0.01% +1 mA
Line Regulation: Voltage, 0.01% +1 mV; current, 0.01% +1 mA
Ripple and Noise: 20 Hz to 20 MHz: voltage, 1 mV rms, 10 mV p-p; current, 5 mA rms
Load-Transient Recovery Time: 100 μs for output voltage to recover within 15 mV of nominal voltage setting following a load current change of 50% to 100% or 100% to 50% of full load current
Programming Response Time: Maximum time for output voltage to change between 0 to 99.9% or 100% to 0.1% of maximum rated output voltage. Up programming: 100 ms. Down programming: 400 ms at no load, 200 ms at full load.
dc Output Isolation: 150 Vdc
ac Power: 100, 120, 220, or 240 Vac (−13%, +6%), 48 to 63 Hz
Temperature Rating: 0° C to 55° C, operating; 40° C to 75° C, storage. Supply is fan cooled.
Size: 212 mm W × 180 mm H × 422 mm D (8.36 in × 6.97 in × 16.6 in)
Weight: Net, 14.5 kg (32 lb); shipping, 15.9 kg (35 lb)

HP-IB Option Specifications

Output	Range	Voltage	Current
Output Ranges	High	0 to 50 V	0 to 10 A
	Low	0 to 10 V	0 to 2 A
Accuracy	High	0.2% +25 mV	0.2% +25 mA
	Low	0.2% +10 mV	0.2% +25 mA
Resolution	High	50 mV	10 mA
	Low	10 mV	2 mA

Ordering Information

	Price
HP 6002A Autoranging dc Power Supply	$3,550
Opt 001: HP-IB Interface	$640
Opt 800: Rack Flange Kit for Two Units	$85
Opt 908: Rack Mounting Kit for One Unit	$80
Opt 910 Extra Operating and Service Manual	$15

- HP-IB control for analog-programmable power supplies
- Unipolar/bipolar HP-IB digital-to-analog converter
- Programmable 10-volt dc output

HP 59501A

HP 59501B Digital-to-Analog Converter

The HP 59501B is an isolated digital-to-analog converter designed to provide a convenient interface between the Hewlett-Packard Interface Bus and those HP power supplies that lack an HP-IB control but can be controlled by analog voltage. With proper wiring, the built-in isolation devices protect other instrumentation on the HP-IB from damage that could be caused by power supply outputs. A programmable high-low range control improves resolution by ten to one.

The HP 59501B also can be used directly as a low-power dc signal source.

Digital-to-Analog Converter Specifications

dc Output Voltage: Programmable in high or low ranges within the voltage limits shown below. Output mode is unipolar or bipolar and is selected by a rear-panel switch.
Unipolar: 0 to 9.99 V (low range, 0 to 0.999 V)
Bipolar: −10 to +9.98 V (low range, −1 to +0.998 V)
dc Output Current: 10 mA maximum
Ripple and Noise: 2 mV rms, 10 mV p-p
Resolution: Unipolar: 10 mV (low range, 1 mV)
Bipolar: 20 mV (low range, 2 mV)
Accuracy: Specified at 23° C ±5° C
Unipolar: 0.1% +5 mV (low range, 0.1% +1 mV)
Bipolar: 0.1% +10 mV (low range, 0.1% +2 mV)

Power Supply Programmer Specifications

In the following specifications, M represents the calibrated full-scale value of the supply being programmed, and P is the actual programmed output. The full-scale value M can be any value within the supply's output range and is calibrated with the HP 59501B programmed to its maximum high-range output.
Accuracy: Specified at 23° C ±5° C
Unipolar: 0.05% M +0.25% P (low range, 0.01% M +0.25% P)
Bipolar: 0.1% M +0.25% P (low range, 0.02% M +0.25% P)
Isolation: 600 Vdc between HP-IB data lines and output terminals
Power: 100, 120, 220, or 240 Vac (−13%, +6%), 47 to 63 Hz, 10 VA (selectable on rear panel)
Size: 212.9 mm W × 101.6 mm H × 294.6 mm D (8.38 in × 4 in × 11.6 in)
Weight: Net, 1.82 kg (4 lb); shipping, 2.27 kg (5 lb)

Ordering Information

	Price
HP 59501B HP-IB isolated D/A Power Supply Programmer	$1,250
Opt 910 Extra Operating and Service Manual	$15
HP p/n 5060-0173 Rack Kit for one unit	$85
HP p/n 5060-0174 Rack Kit for two units	$75

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For the most current prices and product information, contact your local Hewlett-Packard sales

POWER SUPPLIES

Laboratory: Single and Multiple Output, 10 W to 38 W

HP E3610A–E3612A, 6209B, and 6234A–6237B

HP E3610A, E3611A, and E3612A features:
- Dual ranges
- Digital voltage and current meters

HP 6209B features:
- 320 V
- Remote sensing

Multiple-output power supply features:
- Dual output to 24 W
- Triple output to 38 W
- Short-circuit proof
- Independent voltage controls
- Tracking ±20-V outputs

Single-output HP 3610A, E3611A, E3612A, and 6209B

HP E3610A, E3611A, E3612A, and 6209B Single-Output Models

HP E3610A, E3611A, E3612A

These popular low-cost CV/CC bench supplies are designed for general laboratory use. The constant-voltage, constant-current output allows operation as either a voltage source or current source. The changeover occurs automatically, based on the load. This feature also provides an adjustable current limit, letting you set the safest current limit level for a particular DUT. Also, a CC Set button lets you set the current limit without your having to short the output.

Each model has two ranges, allowing more current at a lower voltage. For a higher output voltage, supplies can be connected in series. Either the positive or negative terminal can be connected to ground, providing a positive or negative voltage output. Either terminal can also be floated up to 240 V from ground.

Dual digital meters monitor current and voltage simultaneously. You can adjust each with the 10-turn voltage control and the 10-turn current control. Each power supply is 212 mm W × 88 mm H × 318 mm D (8.4 in × 3.5 in × 12.5 in) and weighs 3.8 kg (8.4 lb).

HP 6209B

This CV/CC power supply covers a range up to 320 V. It is equipped with 10-turn voltage and current controls and front- and rear-panel terminals. Units can be bench-operated or rackmounted individually or in pairs by using accessory rackmounting hardware. The supply is 216 mm W × 89 mm H × 317 mm D (8.50 in × 3.50 in × 12.50 in) and weighs 4.5 kg (10 lb).

HP 6205C, 6234A Dual-Output Models

HP 6205C

This low-cost dual power supply for the bench is equipped with 10-turn output voltage controls, volt-ampere meter, meter function and range switch, and front and rear output terminals. In addition, an output range switch selects a high or low output-voltage range.

The HP 6205C combines the versatility of a dual power supply with the flexibility of auto-parallel and auto-series operation. In addition, with its auto-tracking capability, the supply can conveniently deliver opposite polarity voltages (±20V, ±40 V).

A constant voltage/current-limiting supply, the HP 6205C is short-circuit–protected because it limits current to about 110 percent of rated current. The current-limit point can be reduced by changing an internal resistor.

HP 6234A

The HP 6234A is a low-cost, dual-output bench power supply with two independently adjustable and isolated power sources in one compact unit. Both dc power sources have a constant voltage/current-limit feature. The maximum current available per output is 0.2 A and is automatically limited to prevent overload.

Outputs can be connected in series to provide up to 50 V at 0.2 A. Both sources are fully isolated, so either output terminal can be grounded. Push-button switches select voltage or current for monitoring on the unit's meter. Multiple-turn controls provide precise voltage settings. The HP 6234A is 157 mm W × 93 mm H × 210 mm D (6.17 in × 3.64 in × 8.25 in). It weighs 2.3 kg (5 lb).

Specifications (at 0° C to 55° C unless otherwise specified)

Single-output models		HP E3610A	HP E3611A	HP E3612A	HP 6209B
Number of output ranges		2	2	2	1
Output ratings[1]	Range 1	0 to 8 V, 0 to 3 A[1]	0 to 20 V, 0 to 1.5 A[1]	0 to 60 V, 0 to 0.5 A[1]	0 to 320 V, 0 to 0.1 A
	Range 2	0 to 15 V, 0 to 2 A[1]	0 to 35 V, 0 to 0.85 A[1]	0 to 120 V, 0 to 0.25 A[1]	—
	Power (max)	30 W*	30 W*	30 W*	32 W
Load and line regulation		0.01% + 2 mV	0.01% + 2 mV	0.01% + 2 mV	0.01% + 2 mV
Ripple and noise	rms	200 μV	200 μV	200 μV	1 μV
	peak-to-peak	2 mV	2 mV	2 mV	40 mV
Control mode		CV/CC	CV/CC	CV/CC	CV/CC
Resolution[2] (minimum change using front-panel controls)	Voltage	10 mV	10 mV	100 mV	40 mV
	Current	5 mA	5 mA	2 mA	200 μA
Remote-control coefficients		N/A	N/A	N/A	3 kΩ/V ± 1% 150 kΩ/V ± 10%
Current limit		Variable	Variable	Variable	Variable
Power (115 Vac ± 10%)		47 to 63 Hz 0.8 A, 70 W	47 to 63 Hz 0.8 A, 70 W	47 to 63 Hz 0.8 A, 70 W	48 to 63 Hz 1 A, 60 W
Options available		0E3, 0E9	0E3, 0E9	0E3, 0E9	028, 910
Price		$300 ☎	$300 ☎	$300 ☎	$1,400

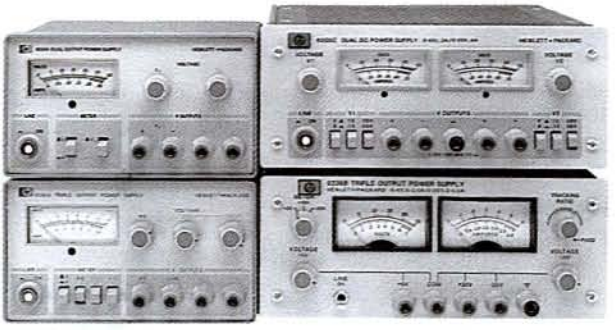
[1]Maximum current is derated 1% per °C between 40°–55° C. [2]Supplemental characteristic.

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

Dual-output HP 6234A and HP 6205C

Triple-output HP 6235A, 6236B, and 6237B



HP 6235A, 6236B, 6237B Triple-Output Models

HP 6235A

Microprocessors, digital and linear integrated circuits, and displays used in lab development frequently require triple-output power supplies for operating prototypes. The HP 6235A—besides offering three adjustable dc output voltages (0 to 6, 0 to +18, and 0 to −18)—can supply 0 to 36 V at 0.2 A by connecting the +18-V and −18-V terminals. One voltage control simultaneously adjusts the +18-V and −18-V outputs, which track one another for circuits requiring balanced positive and negative voltages.

The supply's dual outputs offer added versatility because they are equipped with TRACK, an adjustable tracking ratio control that can set the negative output to a lower voltage than the positive one. A third control sets the 0- to 6-V output voltage.

The supply is a constant voltage/current limit type. The maximum current available is automatically limited to prevent overloading. The outputs share a common terminal and are isolated from the chassis. Output voltage or current can be quickly selected and monitored with the push-button meter switches. The HP 6235A is 157 mm W × 89 mm H × 210 mm D (6.17 in × 3.5 in × 8.25 in) and weighs 2.3 kg (5 lb).

HP 6236B and HP 6237B

Each of these compact constant-voltage, current-limiting supplies has one voltage control that simultaneously adjusts the +20-V and −20-V outputs. The outputs track each other to within 1 percent to power operational amplifiers and circuits requiring balanced voltages. A tracking ratio control can disable the 1:1 tracking feature and set the negative output to a lower voltage than the positive output. Another voltage control sets the 0- to 6-V (HP 6236B) or 0- to 18-V (HP 6237B) output.

All outputs are protected against overload and short-circuit damage by fixed-current limiting circuits. The overload-protection circuit for the 6-V output in the HP 6236B has a current foldback characteristic that reduces the maximum available current from about 2.75 A at a 6-V terminal voltage to 1 A at 0 V (short circuited). This foldback-limiting characteristic maximizes the available current in the crucial 5- to 6-V range while minimizing dissipation during overloads.

Another protective feature safeguards sensitive load circuitry by preventing output voltage overshoot when the supply is turned on or off. Separate dual-range panel meters monitor both the voltage and current of any output simultaneously. A three-position switch selects the output that the meters will monitor. Each model is 216 mm W × 89 mm H × 319 mm D (8.5 in. × 3.5 in × 12.5 in) and weighs 4.3 kg (9.5 lb).

Specifications (at 0° C to 55° C unless otherwise specified)

Multiple Output Models		HP 6205C		HP 6234A	HP 6235A	HP 6236B	HP 6237B
Number of outputs		2		2	3	3	3
Number of output ranges		2		1	1	1	1
Output ratings		Range 1	Range2				
	Output 1	0-20 V, 0-0.6 A	0-40 V, 0-0.6 A	0 to 25 V, 0 to 0.2 A	0 to 6 V, 0 to 1 A	0 to 6 V, 0 to 2.5 A	0 to 18 V, 0 to 1 A
	Output 2	0-20 V, 0-0.6 A	0-40 V, 0-0.6 A	0 to 25 V, 0 to 0.2 A	0 to 18 V, 0 to 0.2 A	0 to +20 V, 0 to 0.5 A	0 to +20 V, 0 to 0.5 A
	Output 3	—	—	—	0 to −18 V, 0 to 0.2 A	0 to −20 V, 0 to 0.5 A	0 to +20 V, 0 to 0.5 A
	Power (max)	24 W		10 W	13 W	35 W	38 W
Load Regulation		0.01% + 4 mV		0.01% + 1 mV	Output 1: 8 mV Output 2: 10 mV Output 3: 10 mV	0.01% + 2 mV	0.01% + 2 mV
Line Regulation		0.01% + 4 mV		0.01% + 1 mV	Output 1: 8 mV Output 2: 15 mV Output 3: 15 mV	0.01% + 2 mV	0.01% + 2 mV
Ripple and noise	rms	200 μV		200 μV	1 mV	350 μV	350 μV
	peak-to-peak	1 mV		1 mV	5 mV	1.5 mV	1.5 mV
Control mode		CV/CL		CV/CL	CV/CL	CV/CL	CV/CL
Resolution (minimum change using front-panel controls)	Voltage	10 mV		—	—	70 mV	70 mV
	Current	Fixed		Fixed	Fixed	Fixed	Fixed
Remote-control coefficients		200 Ω/V ± 1%		N/A	N/A	N/A	N/A
Current limit		Fixed max +100 mA		Fixed max +75 mA	Fixed 128% of max	Fixed 110% of max	Fixed 110% of max
Input power		104 to 127 Vac 48 to 400 Hz 0.5 A, 50 W		104 to 127 Vac 47 to 63 Hz 0.26 A, 35 W	104 to 127 Vac 47 to 63 Hz 0.26 A, 35 W	104 to 127 Vac 47 to 63 Hz 1.2 A, 112 W	104 to 127 Vac 47 to 63 Hz 1.2 A, 112 W
Options available		910, 011, 028, 040		028, 910	028, 910	100, 220, 240, 910	100, 220, 240, 910
Price		$1,275		$730	$790	$1,025	$1,025

Ordering Information

(See tables for which options are available on specific models)

	Price
Opt 0E3 230 Vac ±10%, 47- to 63-Hz Input	$0
Opt 0E9 100 Vac ±10%, 47- to 63-Hz Input. For use in Japan.	$0
Opt 011 Overvoltage Protection for HP 6205C	$210
Opt 028 230 Vac ±10%, Single-Phase Input	$0
Opt 040 Resistance Programming Interface	$80
Opt 100 87 to 106 Vac, 47- to 63-Hz Single-Phase Input	$0
Opt 220 191 to 233 Vac, 47- to 63-Hz Single-Phase Input	$0
Opt 240 208 to 250 Vac, 47- to 63-Hz Single-Phase Input	$0
Opt 910 Additional operating and service manual	$15

Accessories

HP 14513A Rack Kit for One HP 6209B, 6236B, or 6237B Supply	$110 ☎
HP 14523A Rack Kit for two of the above power supplies	$70 ☎

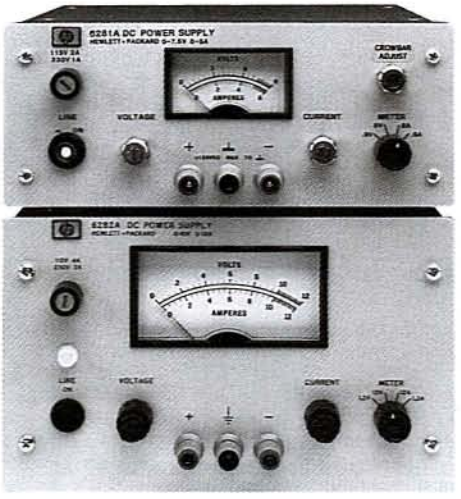
☎ For off-the-shelf shipment, call 800-452-4844.

POWER SUPPLIES

General Purpose, 37- to 200-W Output

HP 6227B–6255A, 6281A–6299A

- Constant voltage, constant current
- Remote sensing and programming
- Auto-series, auto-parallel, and auto-tracking
- Front and rear output terminals
- Floating output to serve as positive or negative source
- Dual-output models with auto-tracking



HP 6281A, 6284A, 6289A, 6294A, 6299A

HP 6282A, 6286A, 6291A, 6296A

Single-Output Power Supplies

This series of constant-voltage, constant-current power supplies is available in two power ranges: 37 to 75 W (in 3½-in–high, half-rack cases) and 100 to 200 W (in 5¼-in–high, half-rack cases). All models have 10-turn voltage and current controls that vary the voltage and current outputs from zero to the maximum rated values. Crossover from constant voltage to constant current operation occurs automatically when the load current exceeds the control settings. A four-position meter-function switch selects either of two output voltage ranges or output current ranges (X1, X0.1) for display.

The 37- to 75-W models are series-regulated designs featuring an output-capacitor discharge circuit that improves programming speed. The 100- to 200-W models employ a series-regulator, SCR-preregulator configuration to achieve the high efficiency necessary for a convection-cooled package of this size.

Specifications (at 0° C to 55° C unless otherwise specified)

			HP 6281A	HP 6282A	HP 6284A	HP 6286A	HP 6289A	HP 6291A	HP 6294A
Output ratings	Voltage		0 to 7.5 V	0 to 10 V	0 to 20 V	0 to 20 V	0 to 40 V	0 to 40 V	0 to 60 V
	Current		0 to 5 A	0 to 10 A	0 to 3 A	0 to 10 A	0 to 1.5 A	0 to 5 A	0 to 1 A
Load regulation	Voltage		5 mV	0.01% + 1 mV	0.01% + 4 mV	0.01% + 1 mV	0.01% + 2 mV	0.01% + 1 mV	0.01% + 2 mV
	Current		0.01% + 250 μA	0.05% + 1mA	0.01% + 250 μA	0.05% + 1 mA	0.01% + 250 μA	0.05% + 1 mA	0.01% + 250 μA
Line regulation	Voltage		0.01% + 2 mV	0.01% + 1 mV	0.01% + 2 mV	0.01% + 1 mV	0.01% + 2 mV	0.01% + 1 mV	0.01% + 2 mV
	Current		0.01% + 250 μA	0.05% + 1 mA	0.01% + 250 μA	0.05% + 1 mA	0.01% + 250 μA	0.05% + 1 mA	0.01% + 250 μA
Ripple and noise	Voltage	rms	200 μV	500 μV	200 μV	500 μV	200 μV	500 μV	200 μV
		peak-to-peak	1 mV	25 mV	1 mV	25 mV	1 mV	25 mV	1 mV
	Current	rms	4 mA	5 mA	2 mA	5 mA	500 μA	3 mA	500 μA
Resistance programming coefficient	Voltage		200 Ω/V ±1%	200 Ω/V ±1%	200 Ω/V ±1%	200 Ω/V ±1%	200 Ω/V ±1%	200 Ω/V ±1%	300 Ω/V ±1%
	Current		200 Ω/A ±10%	100 Ω/A ±10%	500 Ω/A ±10%	100 Ω/A ±10%	500 Ω/A ±10%	200 Ω/A ±10%	1 kΩ/A ±10%
Voltage programming coefficient	Voltage		1 V/V ±1%	1 V/V ±1%	1 V/V ±1%	1 V/V ±1%	1 V/V ±1%	1 V/V ±1%	1 V/V ±1%
	Current		200 mV/A ±10%	100 mV/A ±10%	333 mV/A ±10%	100 mV/A ±10%	666 mV/A ±10%	200 V/A ±10%	1 V/A ±10%
Programming response time (at full load)	Up[1]		2 ms	200 ms	80 ms	150 ms	45 ms	275 ms	80 ms
	Down		6 ms	40 ms	100 ms	70 ms	40 ms	275 ms	175 ms
Overvoltage	Range		2.5 to 10 V	1 to 13 V	2.5 to 23 V	2 to 22 V	2.5 to 44 V	6 to 43 V	5 to 65 V
	Margin		4% ±2 V	7% ±1 V	4% ±2 V	7% ±1 V	4% ±2 V	7% ±1 V	4% ±2 V
Input power	Frequency range		48 to 440 Hz	57 to 63 Hz	48 to 440 Hz	57 to 63 Hz	48 to 440 Hz	57 to 63 Hz	48 to 440 Hz
	Max current		1.3 A	3.5 A	1.5 A	5.5 A	1.3 A	5.5 A	1.3 A
	Max power		118 W	200 W	128 W	320 W	110 W	280 W	114 W
Weight	Net		6.4 kg (14 lb)	11.3 kg (25 lb)	6.4 kg (14 lb)	10.8 kg (26 lb)	6.4 kg (14 lb)	11.3 kg (25 lb)	5.9 kg (13 lb)
	Shipping		7.2 kg (16 lb)	13.6 kg (30 lb)	7.2 kg (16 lb)	13.1 kg (29 lb)	7.2 kg (16 lb)	12.7 kg (28 lb)	6.8 kg (15 lb)
Options			011, 028, 040	05, 011, 028, 040	011, 028, 040	05, 011, 028	011, 028, 040	05, 011, 028	011, 028, 040
Price			$1,330	$1,750	$1,220	$1,750	$1,220	$1,750	$1,280

[1]Up = increasing output voltage

Load Effect Transient Recovery: Time, 50 μs; level, 15 mV
Meter Accuracy: 3% of full scale
Power: Standard input voltage, 115 Vac (±10%) (Order Opt 028 for 230-Vac ±10% operation.)
Isolation: Output terminals floatable up to 300 V from ground and from each other
Regulatory Compliance: Conform to IEC 348

Size:
HP 6227B, 6228B: 197 mm W × 155 mm H × 309.55 mm D (7²⁵⁄₃₂ in × 6³⁄₃₂ in × 12⅛ in)
HP 6253A, 6255A: 483 mm W × 87 mm H × 403 mm D (19 in × 3⅜ in × 15⅞ in)
HP 6281A, 6284A, 6289A, 6294A, 6299A: 209 mm W × 87 mm H × 398 mm D (8²⁵⁄₃₂ in × 3⅜ in × 15⅝ in)
HP 6282A, 6286A, 6291A, 6296A: 210 mm W × 131 mm H × 435 mm D (8¼ in × ⁵⁄₃₂ in × 17⅛ in)

HP 6253A, 6255A

HP 6227B, 6228B

Dual-Output Power Supplies

Each versatile dual-output HP model contains two identical, independently adjustable power supplies (40 W each for the HP 6253A and 6255A; 50 W each for the HP 6227B and 6228B). The HP 6253A and 6255A are full-width rack units; the HP 6227B and 6228B are lab supplies. The regulator, voltage, and current control, as well as the metering circuits of each section of the supply, are electrically identical to those of the individual 37- to 75-W models above and to the right.

By combining the versatility of a dual power supply with the flexibility of auto-series and auto-parallel operation, each supply can deliver twice the maximum-rated output voltage or current of each section. In addition, with auto-tracking capability, opposite-polarity voltages are possible.

Convenient front-panel switches select either independent or tracking operation. In the tracking mode, the right supply tracks the left to within 0.2% ±2 mV. The tracking mode is especially useful for powering operational amplifiers, push-pull stages, deflection systems, or any application where plus and minus voltages must track closely. The independent mode permits operation of the two supplies individually in auto-parallel or in auto-series operation.

Each side of the dual supply can operate as a constant voltage or constant current source, and each has its own crowbar for overvoltage protection. In the tracking mode, an overvoltage condition in any one supply trips both crowbars.

Specifications (at 0° C to 55° C unless otherwise specified)

Model			HP 6296A	HP 6299A	Dual-output models HP 6227B[1]	HP 6228B[1]	HP 6253A[1]	HP 6255A[1]
Output ratings	Voltage		0 to 60 V	0 to 100 V	0 to 25 V	0 to 50 V	0 to 20 V	0 to 40 V
	Current		0 to 3 A	0 to 0.75 A	0 to 2 A	0 to 1 A	0 to 3 A	0 to 1.5 A
Load regulation	Voltage		0.01% + 1 mV	0.01% + 2 mV	0.01% + 1 mV	0.01% + 1 mV	0.01% + 4 mV	0.01% + 2 mV
	Current		0.05% + 1 mA	0.01% + 250 μA	0.01% + 250 μA	0.01% + 250 μA	0.01% + 250 μA	0.01% + 250 μA
Line regulation	Voltage		0.01% + 1 mV	0.01% + 2 mV	1 mV	1 mV	0.02% + 2 mV	0.01% + 2 mV
	Current		0.05% + 1 mA	0.01% + 250 μA	100 μA	100 μA	0.01% + 250 μA	0.01% + 250 μA
Ripple and noise	Voltage	rms	500 μV	200 μV	250 μV	250 μV	200 μV	200 μV
		peak-to-peak	25 mV	1 mV	4 mV	4 mV	1 mV	1 mV
	Current	rms	3 mA	500 μA	250 μA	250 μA	2 mA	500 μA
		peak-to-peak			2 mA	2 mA		
Resistance programming coefficient	Voltage		300 Ω/V ±1%	300 Ω/V ±1%	200 Ω/V ±1%	200 Ω/V ±1%	200 Ω/V ±1%	200 Ω/V ±1%
	Current		500 Ω/A ±10%	1 kΩ/A ±10%	500 Ω/A ±10%	1 kΩ/A ±10%	500 Ω/A ±10%	500 Ω/A ±10%
Voltage programming coefficient	Voltage		1 V/V ±1%	1 V/V ±1%	1 V/V ±1%	1 V/V ±1%	1 V/V ±1%	1 V/V ±1%
	Current		333 mV/A ±10%	1.3 V/A ±10%	0.5 V/A ±10%	1 V/A ±10%	0.33 V/A ±10%	0.66 V/A ±10%
Programming response time (at full load)	Up[2]		600 ms	200 ms	200 ms	350 ms	80 ms	45 ms
	Down		200 ms	200 ms	75 ms	50 ms	100 ms	40 ms
Overvoltage	Range		9 to 66 V	20 to 106 V	5 to 28 V	5 to 55 V	2.5 to 23 V	2.5 to 44 V
	Margin		7% ±1 V	4% ±2 V	7% +1.5 V	7% + 1.5 V	4% + 2 V	4% + 2 V
Input power	Frequency range		57 to 63 Hz	48 to 440 Hz	48 to 63 Hz	48 to 63 Hz	48 to 440 Hz	48 to 440 Hz
	Max current		4.5 A	1.5 A	2.7 A	2.7 A	2.6 A	2.6 A
	Max power		250 W	135 W	260 W	260 W	235 W	235 W
Weight	Net		11.3 kg (25 lb)	5.9 kg (13 lb)	11 kg (24 lb)	11 kg (24 lb)	12.7 kg (28 lb)	12.7 kg (28 lb)
	Shipping		12.7 kg (28 lb)	6.8 kg (15 lb)	12.9 kg (28 lb)	12.9 kg (28 lb)	12.7 kg (39 lb)	17.7 kg (39 lb)
Options			05, 011, 028	011, 028, 040	040	040	010, 011, 028, 040	010, 011, 028, 040
Price			$1,750	$1,260	$2,725	$2,725	$2,310	$2,310

[1]Models 6227B, 6228B, 6253A, and 6255A contain two identical, independently adjustable power supplies. [2]Up = increasing output voltage

Ordering Information

See the option listings in the tables for applicability.

	Price
Option Descriptions	
Opt 005 50-Hz ac Input (optimizes power supplies that require adjustment or modification for 50-Hz operation)	$0
Opt 010 Chassis Slides (enable convenient access to rackmounted power supply for maintenance)	$120
Opt 011 Internal Overvoltage Protection Crowbar	
HP 6281A, 6284A, 6289A, 6294A, 6299A	$150
HP 6253A, 6255A, 6282A, 6286A, 6291A, 6296A	$250
Opt 028 230-Vac, 10%, Single-Phase Input	$0
Opt 040 (equips standard HP power supplies for resistance programming)	
Single-Output Models	$90
Dual-Output Models	$170
Opt 910 Additional Operating and Service Manual	$15

Accessories

HP 14513A 3½-in–High Rack Kit for one HP 6281A, 6284A, 6289A, 6294A, 6299A	$110 ☎
HP 14523A 3½-in–High Rack Kit for two of the above supplies	$70 ☎
HP 14515A 5¼-in–High Rack Kit for one HP 6282A, 6286A, 6291A, 6296A	$150 ☎
HP 14525A 5¼-in–High Rack Kit for two of the above supplies	$80 ☎
HP 5060-8760 Blank Filler Panel for HP 6227B, 6228B	$75 ☎
HP 5060-8762 Adapter Frame for Rackmounting one or two HP 6227B, 6228B	$180 ☎

☎ For off-the-shelf shipment, call 800-452-4844.

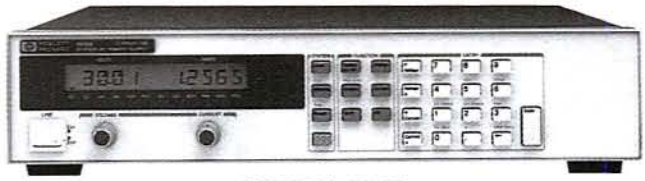
For current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

POWER SUPPLIES

General Purpose, 200- to 2000-W Output

HP 6541A–6575A

- Complete front-panel control and display
- Low ripple and noise
- Constant-voltage, constant-current operation
- Remote programming and sensing
- Overvoltage and overcurrent protection
- Front-panel calibration
- Fan-speed control to minimize acoustic noise



HP 6541A–6545A

This series of high-performance dc power supplies includes 15 models. The 200-W and 500-W models have linear topologies, and the 2000-W models utilize a low-noise, controlled-slope, switching design. For models with equivalent performance, but with built-in HP-IB, see HP 6641A–6675A on pages 471 to 473.

Specifications (at 0° to 55°C unless otherwise noted)

	HP 6541A	HP 6542A	HP 6543A	HP 6544A	HP 6545A	HP 6551A	HP 6552A
Output volts	0–8	0–20	0–35	0–60	0–120	0–8	0–20
Rated amps[1]	0–20	0–10	0–6	0–3.5	0–1.5	0–50	0–25
Ripple and noise (rms/p-p)[2]							
Voltage							
rms	300 μV	300 μV	400 μV	500 μV	700 μV	300 μV	300 μV
p-p	3 mV	3 mV	4 mV	5 mV	7 mV	3 mV	3 mV
Current	10 mA	5 mA	3 mA	1.5 mA	1 mA	25 mA	10 mA
Load regulation							
Voltage	1 mV	2 mV	3 mV	4 mV	5 mV	1 mV	2 mV
Current	1 mA	0.5 mA	0.25 mA	0.25 mA	0.25 mA	2 mA	1 mA
Line regulation							
Voltage	0.5 mV	0.5 mV	1 mV	1 mV	2 mV	0.5 mV	0.5 mV
Current	1 mA	0.5 mA	0.25 mA	0.25 mA	0.25 mA	2 mA	1 mA
Keypad programming accuracy[3]							
Voltage	0.06% + 5 mV	0.06% + 10 mV	0.06% + 15 mV	0.06% + 26 mV	0.06% + 51 mV	0.06% + 5 mV	0.06% + 10 mV
Current	0.14% + 26 mA	0.14% + 13 mA	0.14% + 7 mA	0.14% + 4 mA	0.14% + 2 mA	0.15% + 60 mA	0.15% + 25 mA

[1]For HP 6541A–6555A only, derate output current 1% per degree C from 40 to 55 [2]p-p = peak-to-peak. [3]At 25° C ± 5° C.

Transient Response Time

HP 6541A–6555A: Less than 100 μs for the output voltage to recover to its previous level (within 0.1% of the voltage rating of the supply or 20 mV, whichever is greater) following any step change in load current of up to 50 percent of rated current.

HP 6571–6575A: Less than 900 μs for the output voltage to recover within 100 mV following a change in load from 100 to 50 percent or 50 to 100 percent of the output current rating of the supply.

Isolation: Output terminals can be floated up to ±240 Vdc maximum from chassis ground.

Supplemental Characteristics (nonwarranted characteristics determined by design that are useful in applying the product)

		HP 6541A	HP 6542A	HP 6543A	HP 6544A	HP 6545A	HP 6551A	HP 6552A
Average resolution								
Voltage		2 mV	5 mV	10 mV	15 mV	30 mV	2 mV	5 mV
Current		6 mA	3 mA	2 mA	1.0 mA	0.5 mA	15 mA	7 mA
OVP		13 mV	30 mV	54 mV	93 mV	190 mV	12 mV	30 mV
OVP accuracy		160 mV	400 mV	700 mV	1.2 V	2.4 V	160 mV	400 mV
Output programming response time								
Up (10/90%):	**No load**	3 ms	3 ms	3 ms	3 ms	3 ms	3 ms	3 ms
	Full load	3 ms	3 ms	3 ms	3 ms	3 ms	3 ms	3 ms
Down (90/10%):	**No load**	15 ms	15 ms	15 ms	15 ms	15 ms	15 ms	15 ms
	Full load	15 ms	15 ms	15 ms	15 ms	15 ms	15 ms	15 ms
Price		$1,750 ☎	$1,650 ☎	$1,650 ☎	$1,650 ☎	$1,700 ☎	$2,300 ☎	$2,100 ☎

☎ For off-the-shelf shipment, call 800-452-4844.

ac Input (ac input frequency 47 to 63 Hz):

HP 6541A–6545A		HP 6551A–6555A	
Voltage	**Current**	**Voltage**	**Current**
100 Vac	4.4 A	100 Vac	12 A
120 Vac	3.8 A	120 Vac	10 A
220 Vac	2.2 A	220 Vac	5.7 A
240 Vac	2.0 A	240 Vac	5.3 A

HP 6571A–6575A Line Current: 19 A maximum

Remote Sensing: Up to half the rated output voltage can be dropped in each load lead. The drop in the load leads subtracts from the voltage available for the load.

Analog Programming of Output Voltage and Current:

HP 6541A–6555A:

Input signal: 0 to −5 V

Input impedance: 10 kΩ, nominal

HP 6571A–6575A: Varies with model. See the operating manual for exact values.

Output Common Mode Noise Current (to signal-ground binding post):

HP 6671A–6675A: 500 μA rms, 4 mA peak-to-peak

Regulatory Compliance:

HP 6551A–6575A: Listed to UL 1244; certified to CSA 556B; conforms to IEC 348; carries the CE mark.

HP 6541A–6545A: Conforms to UL 1244; certified to CSA 22.2 No. 231; conforms to IEC 1010; carries the CE mark.

RFI Suppression: Complies with CISPR-11 Group 1 Class B

Size:

HP 6541A–6545A: 425.5 mm W × 88.1 mm H × 439 mm D (16.75 in × 3.5 in × 17.3 in)

HP 6551A–6555A: 425.5 mm W × 132.6 mm H × 497.8 mm D (16.75 in × 5.22 in × 19.6 in)

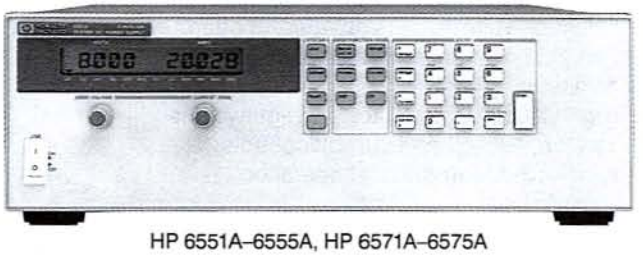
HP 6571A–6575A: 425.5 mm W × 132.6 mm H × 640.0 mm D (16.75 in × 5.22 in × 25.2 in)

Weight:

HP 6541A–6545A: Net, 14.2 kg (31.4 lb); shipping, 16.3 kg (36 lb)

HP 6551A–6555A: Net, 25 kg (54 lb); shipping, 28 kg (61 lb)

HP 6571A–6575A: Net, 28.2 kg (62 lb); shipping, 31.8 kg (70 lb)



HP 6551A–6555A, HP 6571A–6575A

Specifications (cont'd)

HP 6553A	HP 6554A	HP 6555A	HP 6571A	HP 6572A	HP 6573A	HP 6574A	HP 6575A
0–35	0–60	0–120	0–8	0–20	0–35	0–60	0–120
0–15	0–9	0–4	0–220	0–100	0–60	0–35	0–18
Ripple and noise							
400 μV 4 mV 5 mA	500 μV 5 mV 3 mA	700 μV 7 mV 2 mA	650 μV 5 mV 200 mA	750 μV 9 mV 100 mA	800 μV 9 mV 40 mA	1.25 mV 11 mV 25 mA	1.9 mV 16 mV 12 mA
Load regulation							
3 mV 0.5 mA	4 mV 0.5 mA	5 mV 0.5 mA	0.002% + 300 μV 0.005% + 10 mA	0.002% + 650 μV 0.005% + 7 mA	0.002% + 1.2 mV 0.005% + 4 mA	0.002% + 2 mV 0.005% + 2 mA	0.002% + 4 mV 0.005% + 1 mA
Line regulation							
1 mV 0.75 mA	1 mV 0.5 mA	2 mV 0.5 mA	0.002% + 300 μV 0.005% + 10 mA	0.002% + 650 μV 0.005% + 7 mA	0.002% + 1.2 mV 0.005% + 4 mA	0.002% + 2 mV 0.005% + 2 mA	0.002% + 4 mV 0.005% + 1 mA
Keypad programming accuracy							
0.06% + 15 mV 0.15% + 13 mA	0.06% + 26 mV 0.15% + 8 mA	0.06% + 51 mV 0.15% + 4 mA	0.04% + 8 mV 0.1% + 125 mA	0.04% + 20 mV 0.1% + 60 mA	0.04% + 35 mV 0.1% + 40 mA	0.04% + 60 mV 0.1% + 25 mA	0.04% + 120 mV 0.1% + 16 mA

Supplemental Characteristics (cont'd)

HP 6553A	HP 6554A	HP 6555A	HP 6571A	HP 6572A	HP 6573A	HP 6574A	HP 6575A
Average resolution							
10 mV 4 mA 54 mV	15 mV 2.5 mA 93 mV	30 mV 1.25 mA 190 mV	2 mV 55 mA 15 mV	5 mV 25 mA 35 mV	9 mV 15 mA 65 mV	15 mV 8.75 mA 100 mV	30 mV 4.5 mA 215 mV
700 mV	1.2 V	2.4 V	200 mV	500 mV	900 mV	1.15 V	3.0 V
Output programming response time							
3 ms 3 ms 15 ms 15 ms	3 ms 3 ms 15 ms 15 ms	3 ms 3 ms 15 ms 15 ms	30 ms 30 ms 130 ms 30 ms	60 ms 60 ms 250 ms 60 ms	130 ms 130 ms 350 ms 130 ms	130 ms 130 ms 600 ms 130 ms	195 ms 195 ms 600 ms 195 ms
$2,100 ☎	$2,100 ☎	$2,150 ☎	$3,800	$3,750	$3,700	$3,650	$3,750

Key Features

- Analog programming of output voltage and current
- Self-test initiated at power-up
- Electronic calibration from front panel
- Five nonvolatile store and recall states
- User-defined power-on state
- Digital I/O control of external relay accessories (see page 476)
- Fan-speed control to minimize acoustic noise
- Auto-parallel of up to three or five units
- Overvoltage and overcurrent protection
- Overtemperature protection
- Three-year warranty

Ordering Information

	Price
HP 6541A–6555A	
Opt 100 87 to 106 Vac, 47 to 63 Hz	$0
Opt 220 191 to 233 Vac, 47 to 63 Hz	$0
Opt 240 209 to 250 Vac, 47 to 63 Hz	$0
If no line input option is ordered, the power supply will be configured to operate at 104 to 127 Vac, 47 to 63 Hz	$0
HP 6571A–6575A	
Opt 200 174 to 220 Vac, 47 to 63 Hz (Japan only)	$0
If Opt 200 is not ordered, the power supply will be configured to operate at 191 to 250 Vac, 47 to 63 Hz.	
HP 6541A–6545A	
Opt 908 Rack Mount Kit (HP p/n 5062-3974)	$35
Opt 909 Rack Mount Kit with Handles (HP p/n 5062-3975)	$80
HP 6551A–6575A	
Opt 908 Rack Mount Kit (HP p/n 5062-3977)	$40
Opt 909 Rack Mount Kit with Handles (HP p/n 5062-3983)	$90
Line cords are included with HP 6541A–6555A.	
Line cords must be ordered for HP 6571A–6575A.	
Line cord options (for HP 6571A–6575A only): Order according to local electrical codes. All line cords are 2.5 m (about 8 ft) long.	
Opt 831 12 AWG, 200 to 400 Vac, Unterminated	$0
Opt 832 4 mm² Wire Size, Unterminated	$0
Opt 834 10-AWG Wire; 100 to 120 Vac, Unterminated	$0
Opt 841 With NEMA 6-20P; 20-A, 250-V Plug	$15
Opt 842 4 mm² Wire Size with IEC 309, 32-A Plug	$75
Opt 843 With JIS C8303 Appended Fig 6(2); 20-A, 250-V Plug	$35
Opt 844 10 AWG with NEMA L6-30P, 30-A, 250-V Locking Plug	$55

☎ For off-the-shelf shipment, call 800-452-4844.

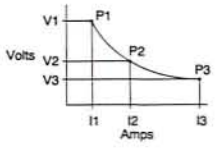
For the most current prices and product information, contact your local Hewlett-Packard sales office – see page 665.

POWER SUPPLIES

Autoranging Power Supplies

HP 6010A, 6011A, 6012B, 6015A, 6023A, 6024A

- Complete front-panel control/display
- Constant-voltage/constant-current operation
- Remote programming and sensing
- Autoranging output
- High-efficiency, compact, and lightweight
- Ten-turn voltage and current controls
- Auto-series, auto-parallel operation



HP 6023A

HP 6024A (right)

HP 6010A, 6011A, 6012B, & 6015A

Specifications (at 0° C to 50° C unless otherwise specified)

			HP 6010A	HP 6011A	HP 6012B	HP 6015A	HP 6023A	HP 6024A
Volts			0 to 200V	0 to 20V	0 to 60V	0 to 500V	0 to 20V	0 to 60V
Amperes			0 to 17A	0 to 120A	0 to 50A	0 to 5A	0 to 30A	0 to 10A
Maximum power			1,200 W	1,064 W	1,200 W	1,050 W	242 W	240 W
Autoranging output	P1		200 V, 5 A	20 V, 50 A	60 V, 17.5 A	500 V, 2 A	20 V, 10 A	60 V, 3.3 A
	P2		120 V, 10 A	14 V, 76 A	40 V, 30 A	350 V, 3 A	14 V, 17.2 A	40 V, 6 A
	P3		60 V, 17 A	7 V, 120 A	20 V, 50 A	200 V, 5 A	6.7 V, 30 A	20 V, 10 A
Load regulation	Voltage		0.01% + 5 mV	0.01% + 3 mV	0.01% + 5 mV	0.01% + 13 mV	0.01% + 2 mV	0.01% + 3 mV
	Current		0.01% + 10 mA	0.01% + 15 mA	0.01% + 10 mA	0.03% + 34 mA	0.01% + 9 mA	0.01% + 3 mA
Source regulation	Voltage		0.01% + 5 mV	0.01% + 2 mV	0.01% + 3 mV	0.01% + 13 mV	0.01% + 1 mV	0.01% + 5 mV
	Current		0.01% + 5 mA	0.01% + 25 mA	0.01% + 10 mA	0.03% + 17 mA	0.01% + 6 mA	0.01% + 5 mA
10% Change transient recovery	Time		2 ms	2 ms	2 ms	5 ms	1 ms	1 ms
	Level		150 mV	100 mV	100 mV	200 mV	50 mV	75 mV
Ripple and noise: from 20 Hz to 20 MHz	Voltage	rms	22 mV	8 mV	8 mV	50 mV	3 mV	3 mV
		peak-to-peak	50 mV	50 mV	40 mV	160 mV	30 mV	30 mV
	Current	rms	15 mA	120 mA	25 mA	50 mA	15 mA	5 mA
Programming response time (at full load)	Settling band		300 mV	30 mV	90 mV	750 mV	5 mV	60 mV
	Up		300 ms	300 ms	300 ms	350 ms	100 ms	200 ms
	Down		600 ms	500 ms	2.0 s	600 ms	200 ms	300 ms
ac input current	100 Vac							5.3 A
	120 Vac		24 A	24 A	24 A	24 A	6.5 A	5.3 A
	220 Vac		15 A	15 A	15 A	15 A	3.8 A	2.9 A
	240 Vac		14 A	14 A	14 A	14 A	3.6 A	2.7 A
Weight	Net		16.3 kg (36 lb)	16.8 kg (37 lb)	15.9 kg (35 lb)	16.3 kg (36 lb)	8.6 kg (19 lb)	5.4 kg (12 lb)
	Shipping		21.7 kg (48 lb)	22.2 kg (49 lb)	21.3 kg (47 lb)	21.7 kg (48 lb)	10.5 kg (23 lb)	7.3 kg (16 lb)
Price			$3,350	$3,350	$3,350	$3,750	$2,250	$2,250

General Specifications

Remote Sensing: Up to 2 V can be dropped in each lead. Voltage regulation specification is met with up to 0.5-V drop, but degrades for greater drops.

Modulation (analog programming of output voltage and current)
Input signal: 0 to 5 V or 0 to 4 kΩ (0 to 2.5 kΩ for HP 6024A).

Inductive Load: The HP 6023A is stable when operating in the CC mode into inductive loads up to 1 H. The HP 6010A, 6011A, 6012B, and 6015A are stable into inductive loads up to 100 mH. Special modifications are available for stability up to 10 H.

Isolation: Either terminal can be grounded or floated from chassis ground up to 240 V for the HP 6011A, 6012B, and 6023A; up to 550 V for the HP 6010A and 6015A.

Regulatory Compliance: Listed to UL 1244; certified to CSA 556B; conform to IEC 348

Size: HP 6010A, 6011A, 6012B, 6015A: 425.5 mm W × 132.6 mm H × 516.4 mm D (16.75 in × 5.2 in × 20.33 in)
HP 6023A: 212.3 mm W × 177.0 mm H × 443.6 mm D (8.36 in × 6.97 in × 17.872 in)
HP 6024A: 212.3 mm W × 133.4 mm H × 415.33 mm D (8.36 in × 5.25 in × 16.35 in)

Key Features (For more information, see page 464)

- Auto-parallel and auto-series operation of up to two units
- Overvoltage protection
- Overtemperature and excess ac-line protection

Ordering Information

	Price
Opt 002 Provides extra programming and monitoring capabilities. (not available with HP 6015A.)	$400
Input Power The standard unit is configured to operate at 104 to 127 Vac, 48 to 63 Hz.	
Opt 100 87 to 106 Vac, 48 to 63 Hz. HP 6024A only. The power supply output power is derated to 75%.	$0
Opt 220 191 to 233 Vac, 48 to 63 Hz	$0
Opt 240 208 to 250 Vac, 48 to 63 Hz	$0
Opt 800 Rack Mount Kit for two units side by side. For HP 6023A and 6024A only.	
HP 6023A (order HP p/n 5061-9694 and 5062-3978)	$85
HP 6024A (order HP p/n 5061-9694 and 5062-3977)	$85

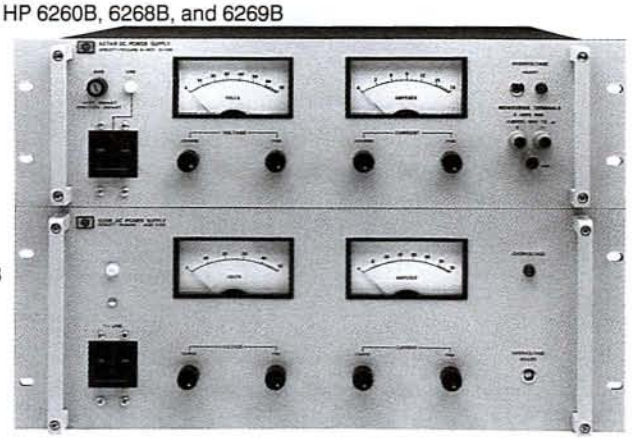
For **HP 6010A, 6011A, 6012B, and 6015A**, one of these line cord options **must be specified** when ordering. Order according to local electrical codes. See page 476.

Opt 831 12 AWG, 200 to 400 Vac, Unterminated	$0
Opt 833 1.5-mm² Wire, 200 to 240 Vac, Unterminated	$0
Opt 834 10 AWG Wire; 100 to 120 Vac, Unterminated	$0
Opt 841 with NEMA 6-20P; 20-A, 250-V Plug	$15
Opt 843 with JIS C8303 Appended Fig 6(2); 20-A, 250-V Plug	$35
Opt 845 with IEC 309; 16-A, 220-V Plug	$35
Opt 846 With NEMA L5-30P; 30-A, 120-V Locking Plug	$55
Opt 847 With CEE 7/7; 16-A, 220-V Plug	$35
Opt 848 with BS 546; 15-A, 240-V Plug	$35
Opt 908 Rack Mount Kit for a Single Unit. A blank filler panel is supplied when ordered for half-rack-width units.	
HP 6010A, 6011A, 6012B, and 6015A	$40
HP 6023A	$80
HP 6024A	$70
Opt 909 Rack Mount Kit with Handles for HP 6010A, 6011A, 6012B, and 6015A	$90
Opt 910 Extra Operating and Service Manual	
HP 6024A	$25
HP 6010A, 6011A, 6012B, 6015A, 6023A	$25

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Overvoltage protection
- Constant-voltage/constant-current operation
- Analog programmable
- Remote sensing
- Auto-series, auto-parallel, and auto-tracking operation
- ≤50-μs load transient recovery

HP 6260B, 6268B, and 6269B



HP 6274B

HP 6260B, 6268B, 6269B, 6274B Power Supplies

This series of constant-voltage/constant-current power supplies employ a transistor series-regulator, triac-preregulator circuit to achieve high efficiency, excellent regulation, low ripple and noise, and moderate programming speeds in a compact, full-rack-width package.

Separate coarse and fine voltage and current controls vary output from zero to the maximum rated value. Crossover from constant voltage to constant current operation occurs automatically when the load current exceeds the value established by the current control settings.

Additional features include built-in overvoltage crowbar protection; remote sensing; and auto-series, auto-parallel, and auto-tracking operation. The crowbar trip point adjustment and associated overvoltage indicator are located conveniently on the front panel.

Auto-series, auto-parallel, and auto-tracking connections should be limited to three supplies. If an application requires more than three supplies in any of the three connections, consult your local HP field engineer for additional information.

All dc output, ac input, sensing, control, and programming connections are made to rear-panel terminals. Models in this series employ cooling fans. They also have terminal blocks for ac input and are shipped without line cords.

Specifications (at 0° C to 55° C unless otherwise specified)

	HP 6260B	HP 6268B	HP 6269B	HP 6274B
dc output				
Volts	0 to 10 V	0 to 40 V	0 to 40 V	0 to 60 V
Amperes	0 to 100 A	0 to 30 A	0 to 50 A	0 to 15 A
Load regulation				
Voltage	0.01% + 200 μV	0.01% + 200 μV	0.01% + 200 μV	0.01% + 200 μV
Current	0.02% + 2 mA	0.02% + 2 mA	0.02% + 2 mA	0.02% + 500 μA
Line regulation				
Voltage	0.01% + 200 μV	0.01% + 200 μV	0.01% + 200 μV	0.01% + 200 μV
Current	0.02% + 2 mA	0.02% + 2 mA	0.02% + 2 mA	0.02% + 500 μA
Ripple and noise				
Voltage				
rms	500 μV	1 mV	1 mV	200 μV
p-p	5 mV	5 mV	5 mV	20 mV
Current				
rms	50 mA	20 mA	25 mA	5 mA
Drift (stability)				
Voltage	0.03% + 2 mV	0.03% + 2 mV	0.03% + 2 mV	0.03% + 2 mV
Current	0.03% + 20 mA	0.03% + 5 mA	0.03% + 10 mA	0.03% + 5 mA
Resistance coefficient				
Voltage	200 Ω/V ± 1%	200 Ω/V ± 1%	200 Ω/V ± 1%	300 Ω/V ± 1%
Current	2 Ω/A ± 10%	6 Ω/A ± 10%	4 Ω/A ± 10%	67 Ω/A ± 10%
Voltage coefficient				
Voltage	1 V/V ± 1%	1 V/V ± 1%	1 V/V ± 1%	1 V/V ± 1%
Current	5 mV/A ± 10%	16.7 mV/A ± 10%	10 mV/A ± 10%	33.3 mV/A ± 10%
Speed, up*				
No load	70 ms	300 ms	350 ms	600 ms
Full load	70 ms	300 ms	350 ms	600 ms
Speed, down**				
No load	200 ms	1 s	1 s	40 s
Full load	75 ms	650 ms	600 ms	800 ms
Overvoltage				
Range	2 to 12 V	4 to 45 V	4 to 45 V	6 to 66 V
Margin	5% + 2 V	5% + 1 V	5% + 1 V	5% + 1 V
Weight				
Net	43.9 kg (97 lb)	34.4 kg (76 lb)	40.3 kg (89 lb)	21.7 kg (48 lb)
Shipping	48 kg (106 lb)	38.1 kg (84 lb)	44 kg (98 lb)	24.5 kg (54 lb)
Options	005, 010, 016, 022, 027, 040	005, 010, 022, 026, 027, 040	005, 010, 022, 027, 040	005, 010, 022, 027, 028, 040
Price	$3,700	$3,300	$3,500	$2,650

* **Up:** Increasing output voltage
** **Down:** Decreasing output voltage

Load-Effect Transient Recovery: Time, 50 μs; level, 10 mV
Resolution: Voltage control, less than 0.02%; current control, less than 0.15%

Temperature Coefficient per C: 0.01% of output plus 200 μV
Temperature Ratings: Operating, 0° C to 55° C; storage, −40° C to 75° C
Isolation: The positive or negative output terminal can be grounded. Supplies can be floated at up to 120 V above ground.
Remote-Control Programming: These power supplies can be programmed in constant-voltage and constant-current operation by using an external resistance or dc voltage with coefficients as shown in the following table. Rear terminal wiring configurations for remote-control operation are specified in the operating and service manual supplied with the power supply. For remote-control programming procedures and timing considerations, contact your local HP field engineer.
Power: Input voltage tolerance is ±10%, 57 to 63 Hz. For other input voltage and frequency options, see the Options list below. Standard input voltage, maximum input current, and maximum power are:
HP 6260B 230 Vac, 12 A, 1,600 W
HP 6268B 230 Vac, 12 A, 1,600 W
HP 6269B 230 Vac, 18 A, 2,500 W
HP 6274B 115 Vac, 15 A, 1,200 W.
A three-terminal barrier strip is provided for ac power connections.
Regulatory Compliance: Conforms to IEC 348; carries the CE mark; HP 6274B listed to UL 1244
RFI Suppression: Complies with CISPR-11 Group 1 Class B
Size:
HP 6260B, 6268B, and 6269B: 483 mm W × 173 mm H × 479.4 mm D (19 in × 6.812 in × 18.875 in)
HP 6274B: 483 mm W × 127 mm H × 479.4 mm D (19 in × 5.00 in × 18.875 in)

Ordering Information

	Price
Opt 005 50-Hz ac Input	$0
Opt 010 Chassis Slides (for access to rack-mounted power supplies)	
HP 6260B, 6268B and 6269B	$200
HP 6274B	$120
Opt 016 115-Vac ±10% Single-Phase Input	$126
Opt 022 Voltage and Programming Adjust	$70
Opt 026 115-Vac ±10%, Single-Phase Input	$0
Opt 027 208-Vac ±10%, Single-Phase Input	$0
Opt 028 230-Vac ±10%, Single-Phase Input	$0
Opt 040 Resistance Programming Interface (includes Opt 022)	$90
Opt 910 One Additional Operating and Service Manual Shipped with Each Power Supply	$15

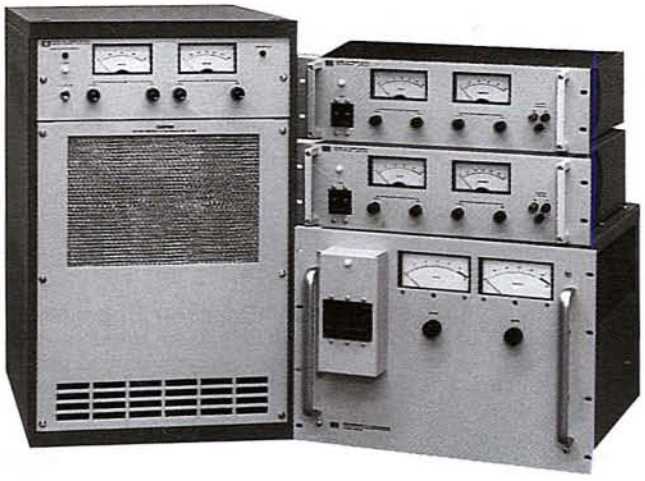
For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

POWER SUPPLIES

General Purpose, 900- to 11,000-W Output

HP 6434B–6483C

- Outstanding value; low cost per watt
- Up to 75% efficiency at full output
- Constant-voltage, constant-current operation



HP 6434B–6483C

HP 6434B–6483C Power Supplies

This series of SCR-regulated power supplies is designed for medium- to high-power applications requiring a fixed or variable dc source with moderate regulation and ripple. For supplies with better regulation, faster response time, and lower ripple, see HP 6571A through 6575A on page 482, or HP 6671A through 6681A on pages 473 and 474.

All supplies in this series are the constant-voltage, constant-current type. Large, easy-to-read panel meters continuously monitor output voltage and current.

Protective Features

In addition to the overload protection inherent in constant-voltage, constant-current operation, these supplies include many other built-in protective features:

HP 6434B, 6448B: Reverse-voltage protection and fused ac input

HP 6453A, 6456B, 6459A: ac line-loss protection circuit, three-phase input circuit breaker, optional internal overvoltage protection (Option 006)

HP 6464C–6483C: Overtemperature and overcurrent protection, optional crowbar for overvoltage condition (except on HP 6464C), peak turn-on current limiter. Units tolerate line-to-line voltage imbalances of up to 8% between phases. Overcurrent and overvoltage circuits can be interlocked between master-slave supplies in auto-series, autoparallel, or autotracking operation.

Auto-Series, Auto-Parallel, Auto-Tracking Operation

Supplies may be connected in auto-series (except HP 6448B and 6483C) or auto-tracking. Up to three low-power models (HP 6434B and 6448B) can be connected in any of these configurations. In high-power models (HP 6453A–6483C), interconnection should normally be limited to two supplies.

Remote Programming

The voltage and current outputs of the supplies can be programmed by a remote resistance or, for most models, a remote voltage source. (See the Specifications table.)

ac Power Requirements

The ac power requirements vary with the three model classifications (see the Options list). Note that these units cannot be reconfigured in the field for different line voltage and frequency options. Therefore, it is especially important that a unit be ordered with the correct voltage and frequency option. When powered from a 50-Hz source (Option 005), the rms ripple and transient response specifications increase by 50%.

Line Cords

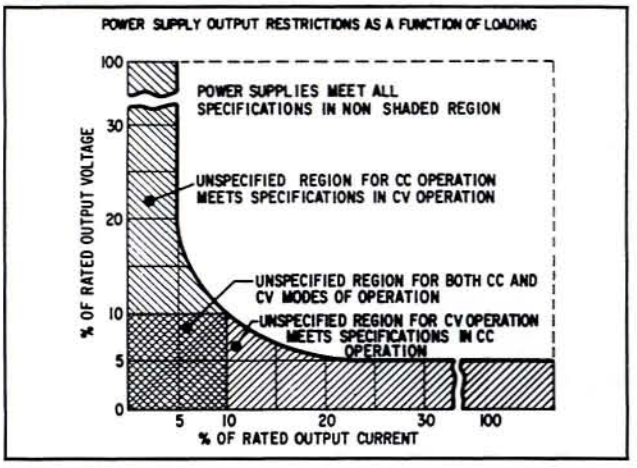
Line cords are not supplied with the models on these pages (486 and 487).

Specifications (at 0° C to 50° C unless otherwise specified)

			HP 6434B	HP 6448B	HP 6453A	HP 6456B	HP 6459A	HP 6464C	HP 6466C
Output ratings	Voltage§		0 to 40 V	1 to 600 V	0 to 15 V	0 to 36 V	0 to 64 V	0 to 8 V	0 to 16 or 18 V
	Current§		0 to 25 A	5 mA to 1.5 A	0 to 200 A	0 to 100 A	0 to 50 A	0 to 1000 A	0 to 600 or 500 A*
Load regulation	Voltage		40 mV	1 V	0.2% + 10 mV†	0.2% + 10 mV†	0.2% + 10 mV†	0.05% + 5 mV	0.05% + 5 mV
	Current		200 mA	40 mA	1% or 2 A†	1% or 1 A†	1% or 0.5 A†	0.1% + 1 A	0.1% + 0.6 A
Line regulation	Voltage		18 mV	600 mV	0.2% + 10 mV†	0.2% + 10 mV†	0.2% + 10 mV†	0.05% + 5 mV	0.05% + 5 mV
	Current		200 mA	15 mA	1% or 2 A†	1% or 1 A†	1% or 0.5 A†	0.1% + 1 A	0.1% + 0.6 A
Ripple and noise	Voltage	rms	40 mV	600 mV	150 mV	180 mV	160 mV	80 mV	180 mV
		peak-to-peak	500 mV	2 V				1 V	1 V
Load transient recovery			200 ms, 200 mV	200 ms, 3 V	50 ms, 150 mV	50 ms, 300 mV	50 ms, 600 mV	100 ms, 500 mV	100 ms, 500 mV
Resistance programming coefficient	Voltage		200 Ω/V ± 2%	300 Ω/V ± 2%	200 Ω/V ± 2%	200 Ω/V ± 2%	300 Ω/V ± 2%	200 Ω/V ± 2%	200 Ω/V ± 2%
	Current		12 Ω/A	600 Ω/A	1Ω/A	2Ω/A	4Ω/A	1Ω/A ± 2%	1.66Ω/A ± 2%
Voltage programming coefficient	Voltage		1 V/V	1 V/V	0.4 V/V	166 mV/V	94 mV/V	1 V/V ± 1%	1 V/V ± 1%
	Current		**	**	30 mV/A	60 mV/A	120 mV/A	6.2 mV/A ± 7%	10.3 mV/A ± 7%
Programming response time (at full load)	Up		1.2 s	1 s	0.5 s	0.5 s	0.5 s	0.6 s	0.6 s
	Down		1.2 s	2 s	0.2 s	0.5 s	0.7 s	0.1 s	0.2 s
Net weight			30.4 kg (67 lb)	27.6 kg (61 lb)	108 kg (238 lb)	108 kg (238 lb)	108 kg (238 lb)	235 kg (518 lb)	226 kg (500 lb)
Options			005, 010, 027, 028	005, 010, 027, 028	001, 002, 003, 005, 006, 010, 031, 032	001, 002, 003, 005, 006, 010, 031, 032	001, 002, 003, 005, 006, 010, 031, 032	001, 002, 003, 005, 023, 031, 032, 040	001, 002, 003, 005, 006, 023, 031, 032, 040
Price			$3,200	$3,200	$8,400	$8,400	$8,400	$18,200	$17,000

* The output current rating is given in the same order as the corresponding voltage rating.
** This feature is not available.
† Specified for combined line and load regulation.
§ Under light loading conditions, the power supply may not meet all published specifications. The accompanying graph defines the permissible operating regions for CV and CC modes of operation.
1. For operation with a 50-Hz input (possible only with Option 005), output currrent is linearly derated from 100% at 40° C to 80% at 50° C.
2. An ac input option must be specified when ordering these three-phase models.
3. Special Option J30 must be ordered with HP 6434B, 6448B, 6466C and 6483C to be programmed with an HP 59501B power supply programmer. Contact your local HP field engineer for ordering instructions.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.



Site Evaluation

Higher-power units (HP 6464C and 6483C) usually require installation to a dedicated electrical branch service. It is suggested that a site evaluation be conducted by a qualified electrician or engineer prior to ordering. At that time, the electrician can help determine the correct line voltage option to order.

Size

HP 6434B, 6448B: 483 mm W × 133 mm H × 432 mm D (19 in × 5.25 in × 17 in)
HP 6453A, 6456B, 6459A: 483 mm W × 356 mm H × 500 mm D (19 in × 14 in × 19.7 in)
HP 6464C, 6466C, 6469C, 6472C, 6475C, 6477C, 6479C, 6483C: 483 mm W × 705 mm H × 715 mm D (19 in × 27.75 in × 28.12 in)

Regulatory Compliance: Conforms to IEC 348

Ordering Information

	Price
Option Descriptions	
HP 6434B, 6448B	
Standard 115-Vac, 10%, single phase, 57 to 63 Hz	$0
Opt 005 Realignment for 50-Hz Operation	$0
Opt 010 Chassis Slides	$200
Opt 027 208-Vac, 10%, Single Phase, 57 to 63 Hz	$0
Opt 028 230-Vac, 10%, Single Phase, 57 to 63 Hz	$0
Opt 910 One Extra Operating and Service Manual shipped with each power supply	$15
HP 6453A, 6456B, 6459A	
An ac input option must be specified when ordering. Three-phase voltages are phase-to-phase values. AC input connections are through a four-conductor connector at the rear of the unit. Low-voltage (208-V and 230-V) models are furnished with an Arrow Hard and Hageman plug (HP p/n 1251-6896). High-voltage (380-V, 400-V, and 460-V) models are furnished with an Arrow Hart and Hageman plug (HP p/n 1251-6897).	
Opt 001 208-Vac, 10%, 3 Phase, 15.5 A/Phase, 57 to 63 Hz	$0
Opt 002 230-Vac, 10%, 3 Phase, 14 A/Phase, 57 to 63 Hz	$0
Opt 003 460-Vac, 10%, 3 Phase, 7 A/Phase, 57 to 63 Hz	$120
Opt 005 Realignment for 50-Hz Operation	$0
Opt 006 Overvoltage Protection	
HP 6453A, 6459A	$700
HP 6456B	$700
Opt 010 Chassis Slides	$300
Opt 031 380-Vac, 10%, 3 Phase, 8.5 A/Phase, 57 to 63 Hz	$200
Opt 032 400-Vac, 10%, 3 Phase, 8.0 A/Phase, 57 to 63 Hz	$200
Opt 910 Extra Operating and Service Manual	$30

Specifications (at 0° C to 50° C unless otherwise specified)

			HP 6469C	HP 6472C	HP 6475C	HP 6477C	HP 6479C	HP 6483C
Output ratings	Voltage		0 to 36 V	0 to 64 V	0 to 110 V	0 to 220 V	0 to 300 V	0 to 440, 500, or 600 V
	Current		0 to 300 A	0 to 150 A	0 to 100 A	0 to 50 A	0 to 35 A	0 to 25, 20, or 15 A*
Load regulation	Voltage		0.05% + 5 mV	0.05% + 100 mV	0.05% + 100 mV	0.05% + 100 mV	0.05% + 100 mV	0.05% + 100 mV
	Current		0.1% + 0.3 A	0.1% + 0.15 A	0.1% + 0.1 A	0.1% + 50 mA	0.1% + 35 mA	0.1% + 35 mA
Line regulation	Voltage		0.05% + 5 mV	0.05% + 100 mv	0.05% + 100 mV	0.05% + 100 mv	0.05% + 100 mV	0.05% + 100 mV
	Current		0.1% + 0.3 A	0.1% + 0.15 A	0.1% + 0.1 A	0.1% + 50 mA	0.1% + 35 mA	0.1% + 35 mA
Ripple and noise	Voltage	rms	180 mV	160 mV	200 mV	330 mV	330 mV	600 mV
		peak-to-peak	1 V	2 V	2 V	2 V	3 V	5 V
Load transient recovery			100 ms, 500 mV	100 ms, 750 mV	100 ms, 1 V	100 ms, 2 V	100 ms, 3 V	100 ms, 5 V
Resistance programming coefficient	Voltage		200Ω/V ± 2%	300Ω/V ± 2%	300Ω/V ± 2%	300Ω/V ± 2%	300Ω/V ± 2%	300Ω/V ± 2%
	Current		3.33Ω/A ± 2%	6.7Ω/A ± 2%	10Ω/A ± 2%	20Ω/A ± 2%	28.6Ω/A ± 2%	40Ω/A ± 2%
Voltage programming coefficient	Voltage		1 V/V	1 V/V ± 3%	1 V/V ± 3%	1 V/V ± 3%	1 V/V ± 3%	1 V/V ± 3%
	Current		20.6 mV/A ± 7%	41.2 mV/A ± 7%	62 mV/A ± 7%	124 mV/A ± 7%	177 mV/A ± 7%	0.25 V/A ± 7%
Programming response time (at full load)	Up		3 s	2.5 s	2 s	2 s	2 s	2 s
	Down		0.5 s	0.7 s	0.7 s	1 s	1.6 s	2 s
Net weight			226 kg (500 lb)	226 kg (500 lb)	226 kg (500 lb)	226 kg (500 lb)	226 kg (500 lb)	226 kg (500 lb)
Options			001, 002, 003, 005, 006, 023, 032, 032, 040	001, 002, 003, 005, 006, 023, 032, 032, 040	001, 002, 003, 005, 006, 023, 031, 032	001, 002, 003, 005, 006, 023, 031, 032	001, 002, 003, 005, 006, 023, 031, 032	001, 002, 003, 005, 006, 023, 031, 032
Price			$16,500	$16,500	$16,500	$16,500	$16,500	$17,000

Important note for HP 6464C–6483C

An ac-input option **must** be specified when ordering. Three-phase voltages are phase-to-phase values. Input connections for ac are made through an enclosed four-wire terminal block.

Opt 001 208-Vac, 10%, 3 Phase, 55 A/Phase, 57 to 63 Hz	$0
Opt 002 230-Vac, 10%, 3 Phase, 50 A/Phase, 57 to 63 Hz	$0
Opt 003 460-Vac, 10%, 3 Phase, 25 A/Phase, 57 to 63 Hz	$300
Opt 005 Realignment for 50-Hz Operation	$0
Opt 006 Overvoltage Protection	
HP 6477C, 6479C, 6483C; HP 6472C, 6475C	$600
HP 6466C; HP 6469C	$700
Opt 023 Rackmounting Attachments for Std 19-in Rack	$180
Opt 031 380-Vac, 10%, 3 Phase, 30 A/Phase, 57 to 63 Hz	$400
Opt 032 400-Vac, 10%, 3 Phase, 28.5 A/Phase, 57 to 63 Hz	$400
Opt 040 Prepares Power Supply to be Programmed with Resistance	$120
Opt 910 Extra Operating and Service Manual	$35
Accessory	
HP 14545B Casters for HP 6464C–6483C (set of four)	$125

POWER SUPPLIES

Special Purpose, dc Power Supply/Amplifiers

HP 6825A–6827A

- High-speed remote programming
- Overload protection
- Wideband response
- Bipolar voltage
- Current sink or source

HP 6825A, 6826A, 6827A

HP 6825A–6827A Power Supply/Amplifiers

The HP 6825A–6827A power supply/amplifiers are general-purpose instruments useful in laboratories engaged in research and development of electronic systems, circuitry, or components. Units can operate as power supplies or power amplifiers. Access to various internal control points expands the operational capabilities of the instruments and lends them to an almost unlimited number of applications.

The HP 6825A–6827A feature dual-range bipolar outputs that are remotely controllable with a resistance, voltage, or current. High-speed programming characteristics adapt the units to a wide variety of laboratory and production testing applications. Because a unit can sink, as well as source current, it can serve as a variable load device.

As a direct-coupled power amplifier, each unit offers a signal-to-noise ratio of approximately 80 dB at full output, with low distortion and a frequency response up to 40 kHz in the fixed-gain mode.

General Specifications

Temperature: Operating, 0° to 55° C; storage, −40° to 75° C
Power: Switchable, 100, 120, 220, or 240 Vac, −13% +6%, 48 to 63 Hz, 150 W
Regulatory Compliance: Listed to UL 1244; conform to IEC 348
Size: 198 mm W × 155 mm H × 316 mm D (7⅘₂ in × 6⅓₂ in × 12⅞ in)
Weight: 8.2 kg (18 lb)

Ordering Information

Option Description	Price
Opt 910 Additional Manual	$15

Accessories

HP 5060-8762 Rackmounting Kit for one or two units	$180
HP 5060-8760 Blank Filler Panel to be used with 5060-8762	$75

For off-the-shelf shipment, call 800-452-4844.

Specifications (at 0° C to 50° C, unless otherwise specified)

			HP 6825A	HP 6826A	HP 6827A
Output ratings	Volts		−5 to +5 V −20 to +20 V	−5 to +5 V −50 to +50 V	−10 to +10 V −100 to +100 V
	Amperes		0 to 2.0 A Both ranges	0 to 1.0 A Both ranges	0 to 0.5 A Both ranges
Ripple and noise	Voltage	rms	10 mV	6 mV	10 mV
		peak-to-peak	30 mV	35 mV	50 mV
	Current	rms	5 mA	0.8 mA	0.4 mA
		peak-to-peak	15 mA	5 mA	5 mA
Transient recovery	Time		100 μs	100 μs	100 μs
	Level		20 mV	50 mV	100 mV
Resolution	Voltage		40 mV	100 mV	200 mV
	Current		6 mA	3 mA	1.5 mA
Voltage gain	Fixed		1X 4X	1X 10X	2X 20X
	Variable		0 to 2X 0 to 8X	0 to 2X 0 to 20X	0 to 4X 0 to 40X
Frequency response (+1, −3 dB)	Fixed gain		dc to 40 kHz	dc to 40 kHz	dc to 30 kHz
	Variable gain		dc to 15 kHz	dc to 15 kHz	dc to 15 kHz
Distortion at full output	100 Hz		0.1% THD	0.1% THD	0.1% THD
	10 kHz		0.5%	0.5%	1%
Options available			910	910	910
Price			$3,400	$3,400	$3,400

- Manually operated voltage sources
- 0.025% output voltage accuracy
- Continuously variable current control

HP 6114A and 6115A Voltage Sources

These highly accurate, stable, and easy-to-use voltage sources are intended for use as low-cost calibrators, working voltage standards, system reference supplies, and high-performance lab supplies. The supplies automatically switch between their two voltage ranges. They can be remotely programmed using analog techniques.

The 4-digit push-button voltage control, with a fine-adjust knob, provides voltage resolution of 200 μV. The front-panel current control provides 2-mA resolution.

A built-in overvoltage protection circuit (SCR crowbar) monitors the output and reduces output voltage and current to zero whenever the preset voltage limit is exceeded. Using the front-panel control, the overvoltage limit is adjustable from 0.5 V to 10% over the output rating of the power supply.

Specifications

dc Output

HP 6114A: 0 to 20 V, 0 to 2 A
20 to 40 V, 0 to 1 A
HP 6115A: 0 to 50 V, 0 to 0.8 A
50 to 100 V, 0 to 0.4 A

Load Regulation: CV: 0.0005% + 100 μV
CC: 0.01% + 500 μA

Line Regulation: CV: 0.0005% + 100 μV
CC: 0.005% + 40 μA

Ripple and Noise: rms/peak-to-peak 20 Hz to 20 MHz
CV: 40 μV/200 μV
CC: 200 μA/1 mA

ac Input: 104 to 127 or 208 to 254 Vac (switchable), 48 to 440 Hz

- Manually operated current sources
- Useful to μA region
- High output impedance—no output capacitor

HP 6177C, 6181C, and 6186C Current Sources

These constant current- and voltage-limit power supplies offer exceptional regulation and stability. Typical applications include resistivity measurements, semiconductor characterization, and applications in electrochemistry and electromagnetics.

The output current is continuously variable from zero to full scale with the 10-turn control, while the decadial counts turns. Each model has three current ranges, providing resolution of 0.03% of range full scale. These sources can be remote-programmed using analog techniques.

Specifications

dc Output

	Full-Scale Current	Max. Voltage Compliance
HP 6177C	0 to 500 mA	0 to 50 V
HP 6181C	0 to 250 mA	0 to 100 V
HP 6186C	0 to 100 mA	0 to 300 V

Range A: 1% full-scale current
Range B: 10% full-scale current
Range C: 100% full-scale current
Load Regulation: 0.0025% + (5×10^{-6} × range full-scale current)
Line Regulation: 0.0025% + (5×10^{-6} × range full-scale current)
Ripple and Noise
HP 6177C and 6181C
rms: 0.00032 × range full-scale current
peak-to-peak: 0.008 × range full-scale current
HP 6186C
rms: 0.0002 × range full-scale current
peak-to-peak: 0.005 × range full-scale current
ac Input: 115 ±10% Vac, 48 to 63 Hz (for 230 Vac, see Option 028)

Ordering Information

	Price
HP 6114A, 6115A Precision Voltage Source	$2,750
HP 6177C, 6181C Precision Current Source	$2,490
HP 6186C Precision Current Source	$3,350
Opt 028 230 ±10% Vac Input (6177C, 6181C, 6186C)	$0
Opt 910 Extra Operating and Service Manual (HP 6177C, 6181C, 6186C)	$15
(HP 6114A, 6115A)	$10
HP 5060-8764 Rack Adapter for rack-mounting one or two HP 6177/81C Sources	$180
HP 5060-8530 Blank Filler Panel to be used with HP 5060-8764 for one power supply	$110
HP 5060-8762 Rack Adapter for rack-mounting one or two HP 6186C, 6114A, or 6115A units	$180
HP 5060-8760 Blank Filler Panel to be used with 5060-8762	$75

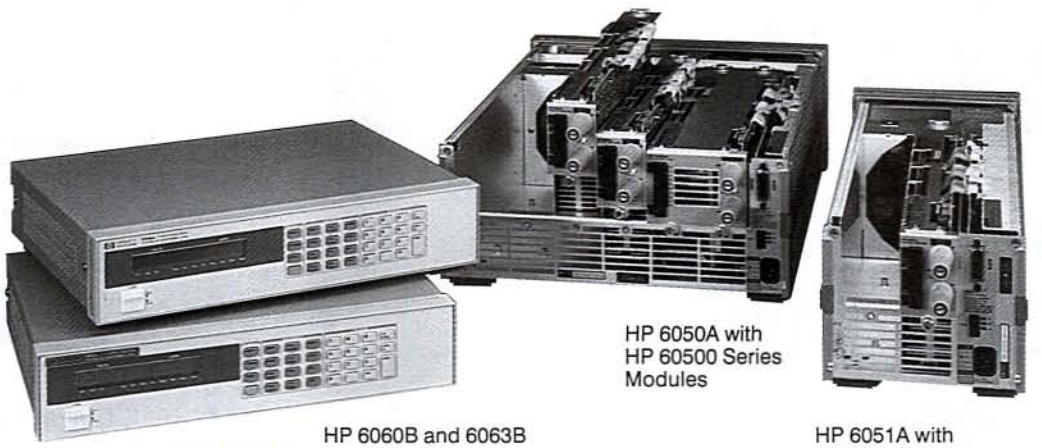
For the most current prices and product information, contact your local Hewlett-Packard sales office or agent.

dc ELECTRONIC LOADS

Electronic Load Family

HP 6050A – 6063B, 60501B – 60507B

- HP-IB control of current, voltage, and resistance
- HP-IB readback of current, voltage, and power
- Built-in pulse waveform generation with programmable amplitude, frequency, duty cycle, and slew rate
- Continuous and pulse modes
- Full protection from overpower, overtemperature, overcurrent, overvoltage, and reverse polarity
- Electronic calibration
- Trigger for external synchronization
- Analog voltage control in constant current mode
- Can parallel units in constant current mode
- Remote voltage sense in constant voltage mode
- Loads available for up to 240 V
- Standard three-year warranty



HP 6050A with HP 60500 Series Modules

HP 6060B and 6063B

HP 6051A with HP 60500 Series Module

DESIGNED FOR HP-IB SYSTEMS

Hewlett-Packard Instrument Drivers

HP dc Electronic Loads

HP dc electronic loads are ideal for the test and evaluation of dc power sources and power components and are well suited for applications in areas such as research and development, production, and incoming inspection.

The Hewlett-Packard One-Box Solution

HP single-input loads and load mainframes are equipped with standard HP-IB interfaces. This built-in IEEE-488 interface allows complete control of all load functions as well as readback of input voltage, current, power, and detailed operating status. Each HP standalone load or load module also includes programming inputs that allow control of load current via an analog control voltage. Other system features contributing to the one-box solution concept are internal voltage and current monitors and an internal transient generator with programmable amplitudes, frequency, duty cycle, and slew rate. The HP one-box solution saves space, cost, and time while making HP dc electronic loads easy to integrate into automated test systems.

Hewlett-Packard dc electronic loads are enhanced to optimally address a broad range of dynamic loading applications. The "B models" (HP 6060B, HP 6063B, and HP 60500B modules) accommodate a limited set of operating conditions where minimal load current overshoots could occur at maximum slew rate settings. This dynamically enhanced load family can achieve zero percent overshoot (typical specification) when slewing current up to 100 percent of full scale.

The programmable slew rate feature can be used to further tailor load performance for specific application needs. These enhanced models also include circuitry to optimize load operation when testing dc power supply output startup characteristics.

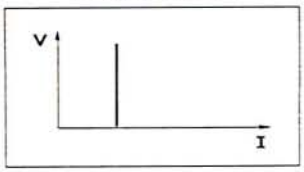
This family of loads are form, fit, and functional equivalents to the previous "A models" (HP 6060A, HP 6063A, and HP 60500A modules). Your existing software will run on these new modules, thus preserving previous resource investment in HP loads. In fact, the HP 60500B modules can be operated in the 6050A or 6051A mainframe with HP 60500A load modules.

Fully Compatible Operation

All HP dc electronic loads respond to instructions from the industry-standard SCPI command set. Moreover, the features of all HP dc electronic loads are fully compatible with one another. For example, test programs developed for an HP 6060B 300 W single-input electronic load or an HP 60502B 300 W single-input load module are interchangeable.

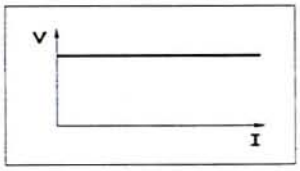
The HP dc electronic load family is also fully compatible with the HP 59510A relay accessory (see page 476). The HP 59510A provides physical isolation of the HP dc electronic load from the device under test or any other test instrument by switching power and sense leads. Capable of switching up to 60 A and 200 V dc, the HP 59510A can be controlled by rear panel signals on the HP electronic load.

Constant Current



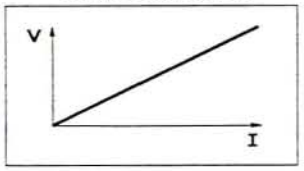
- Power Supply Load Regulation Testing
- Battery Capacity Testing
- Capacitor Discharging

Constant Voltage



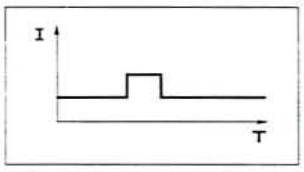
- Current Source Testing
- Current Limit Testing
- Shunt Regulator

Constant Resistance



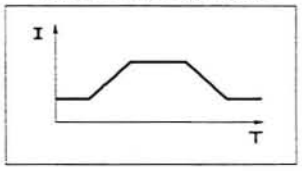
- Characterizing Power Supply Crossover
- Power Supply Start-Up Delay
- Power Resistor Emulation

Pulse and Dynamic Loading



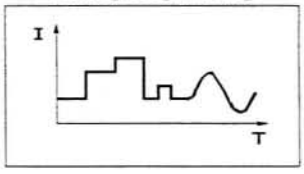
- Power Supply Load Transient Response
- Power Component Testing
- Pulse Electroplating

Programmable Slew Rate



- Power Supply Testing
- Power Component Testing
- Power Supply Load Transient Response

Analog Programming



- Battery Capacity Testing
- "Real-life" Load Simulation

dc Electronic Load Applications

System or Manual Applications

HP dc electronic loads are equally suitable for manual use on the bench. The front panel LCD meters indicate voltage, current, and power readings. The full-function front-panel keypad allows easy, repeatable, and reliable control of the load when it is used manually. Six volatile user-definable states allow you to easily save settings for later recall. An additional user-definable power-up state allows you to define settings that are remembered when the unit is switched off and then recalled when it is switched on again.

Specifying System Performance

Because Hewlett-Packard electronic loads feature an integrated HP-IB programmer, pulse generator, current shunt, DMM, and cabling, their performance is specified as a system. Specifications cover all the integrated functions as one unit, which eliminates the need to calculate the actual performance of the automated test system based on each component's specification. The HP one-box solution makes the integration and documentation of your test system fast and easy.

Single-Input Products

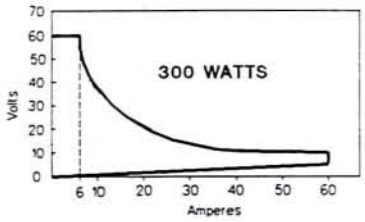
The HP 6060B and HP 6063B are single-input loads with standard rear-panel inputs. They are also available with optional front-panel inputs in addition to the rear-panel inputs. Front-panel inputs (Option 020) make input connections to the HP electronic load convenient for bench applications. These front-panel terminals are capable of handling the entire current rating of the load and can accept wire gauges up to AWG #4 (22 sq mm). They require no tools to tighten, making the connections quick and easy.

Mainframe Products

The HP 6050A 1800-W and HP 6051A 600-W electronic load mainframes accept the user-installable HP load modules for easy system configuration and future reconfiguration, if desired. The HP 6050A holds up to six HP 60501B, 60502B, and 60503B load modules or three HP 60504B and HP 60507B load modules, allowing up to 1,800 W of total maximum power. The HP 6051A holds up to two HP 60501B, 60502B, 60503B modules or one HP 60504B or HP 60507B module allowing up to 600 W of total maximum power. One HP-IB address is all you need for complete control and readback of all load modules within a single mainframe.

Operating HP Loads Below the Minimum Input Voltage Specification

HP electronic loads meet all specifications when operated above 3.0 V; however, the dc operating characteristics also extend below this minimum input voltage for static tests. Because of the FET technology used in the power input circuits, HP electronic loads have a low minimum input resistance allowing them to sink high currents even at low voltages.



HP 60502B Input Characteristics

The figure above shows the operating range of a typical HP dc electronic load. Notice that low-voltage operation, down to zero volts, is possible at correspondingly reduced current levels, depending on the minimum resistance of the load. HP electronic loads, therefore, can be used in many applications that previously required zero-volt loads.

Why Not Make Your Own Load?

Many load users have resorted to building their loads in-house when a commercially available electronic load with the right combination of features, power rating, performance, and purchase price could not be found. By making these loads in-house, users incur many hidden costs that can easily be overlooked. There are cost components associated with product development, parts procurement, manufacturing, product documentation, training, and product failure, maintenance, or replacement. In addition, the cost components increase as the design complexity changes from simply using resistors to more sophisticated designs addressing application needs for HP-IB programming, readback, and triggering schemes for measurement synchronization.

Equipment buyers with electronic load needs have realized that the purchase price of commercially available electronic loads can be relatively insignificant when compared to the overall cost of designing, manufacturing, and maintaining them in-house.

The HP electronic load family reduces your total cost of ownership by providing superior performance, features, reliability, and complete product documentation at a reasonable purchase price. These loads allow you to use fewer resources for your electronic load test system development, and more resources to remain successful and competitive in your particular industry. The standard three-year warranty can further reduce your maintenance costs.

The quality, performance, price, and Hewlett-Packard support will help you make an intelligent and economical purchase decision.

dc ELECTRONIC LOADS
Specifications

Specifications *(Data subject to change)*

Amperes	0 to 60 A	0 to 10 A	0 to 30 A	0 to 120 A	0 to 60 A
Volts	3 to 60 V	3 to 240 V	3 to 60 V	3 to 60 V	3 to 150 V
Maximum power (at 40°C)	300 W	250 W	150 W	600 W	500W
Hewlett-Packard model	HP 6060B, 60502B	HP 6063B, 60503B	HP 60501B	HP 60504B	HP 60507B
Constant current mode					
Ranges	0 to 6 A, 0 to 60 A	0 to 1 A, 0 to 10 A	0 to 3 A, 0 to 30 A	0 to 12 A, 0 to 120 A	0 to 6 A, 0 to 60 A
Accuracy	0.1% ±75 mA	±0.15% ±10 mA	0.1% ±40 mA	0.12% ±130 mA	0.1% ±75mA
Resolution	60-A range: 16 mA 6-A range: 1.6 mA	10-A range: 2.6 mA 1-A range: 0.26 mA	30-A range: 8 mA 3-A range: 0.8 mA	120-A range: 32 mA 12-A range: 3.2 mA	60-A range: 1.6 mA 6-A range: 1.6 mA
Temperature coefficient	100 ppm/°C ±5 mA/°C	150 ppm/°C ±1 mA/°C	100 ppm/°C ±3 mA/°C	120 ppm/°C ±8 mA/°C	120 ppm/°C ±5 mA/°C
Regulation	±10 mA	±8 mA	±10 mA	±10 mA	±10 mA
Constant voltage mode					
Accuracy	0.1% ±50 mV	±0.12% ±120 mV	0.1% ±50 mV	0.1% ±50 mV	0.1% ±125 mV
Resolution	16 mV	64 mV	16 mV	16 mV	40 mV
Regulation	±10 mV	±10 mV	±5 mV	±20 mV	±10 mV
Temperature coefficient	100 ppm/°C ±5 mV/°C	120 ppm/°C ±10 mV/°C	100 ppm/°C ±5 mV/°C	100 ppm/°C ±5 mV/°C	100 ppm/°C ±5 mV/°C
Constant resistance mode					
Ranges	0.033 to 1.0 Ω 1 to 1,000 Ω 10 to 10,000 Ω	0.20 to 24.0 Ω 24 to 10,000 Ω 240 to 50,000 Ω	0.067 to 2 Ω 2 to 2,000 Ω 20 to 10,000 Ω	0.017 to 0.5 Ω 0.5 to 500 Ω 5 to 5,000 Ω	0.033 to 2.5 Ω 2.5 to 2,500 Ω 25 to 10,000 Ω
Accuracy	1 Ω: 0.8% ±8 mΩ (with ≥6A at input) 1 KΩ: 0.3% ±8 mS (with ≥6V at input) 10 KΩ: 0.3% ±8 mS (with ≥6V at input)	24 Ω: 0.8% ±200 mΩ (with ≥1A at input) 10 KΩ: 0.3% ±0.3 mS (with ≥24V at input) 50 KΩ: 0.3% ±0.3 mS (with ≥24V at input)	2 Ω: 0.8%, ±16 mΩ (with ≥3A at input) 2 KΩ: 0.3% ±5 mS (with ≥6V at input) 10 KΩ: 0.3% ±5 mS (with ≥6V at input)	0.5 Ω: 0.8% ±5 mΩ (with ≥12A at input) 500 Ω: 0.3% ±16 mS (with ≥6V at input) 5 KΩ: 0.3% ±16 mS (with ≥6V at input)	2.5 Ω: 0.8% ±16 mΩ (with ≥6A at input) 2.5 KΩ: 0.3% ±5 mS (with ≥15V at input) 10 KΩ: 0.3% ±5 mS (with ≥15V at input)
Resolution	1 Ω: 0.27 mΩ 1 KΩ: 0.27 mS 10 KΩ: 0.027 mS	24 Ω: 6 mΩ 10 KΩ: 0.011 mS 50 KΩ: 0.001 mS	2 Ω: 0.54 mΩ 2 KΩ: 0.14 mS 10 KΩ: 0.014 mS	5 Ω: 0.14 mΩ 500 Ω: 0.54 mS 5 KΩ: 0.054 mS	2.5 Ω: 0.57 mΩ 2.5 KΩ: 0.10 mS 10 KΩ: 0.01 mS
Temperature coefficient	1 Ω: 800 ppm/°C ±0.4 mΩ/°C 1 KΩ: 300 ppm/°C ±0.6 mS/°C 10 KΩ: 300 ppm/°C ±0.6 mS/°C	24 Ω: 800 ppm/°C ±10 mΩ/°C 10 KΩ: 300 ppm/°C ±0.03 mS/°C 50 KΩ: 300 ppm/°C±0.03 mS/°C	2 Ω: 800 ppm/°C ±0.8 mΩ/°C 2 KΩ: 300 ppm/°C ±0.5 mS/°C 10 KΩ: 300 ppm/°C ±0.5 mS/°C	0.5 Ω: 800 ppm/°C ±0.2 mΩ/°C 500 Ω: 300 ppm/°C ±1.2 mS/°C 5 KΩ: 300 ppm/°C ±1.2 mS/°C	2.5 Ω: 800 ppm/°C ±0.8 mΩ/°C 2.5 KΩ: 300 ppm/°C ±0.3 mS/°C 10 KΩ: 300 ppm/°C ±0.3 mS/°C
Transient generator					
Frequency range	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz	0.25 Hz to 10 kHz
Resolution	4% or less	4% or less	4% or less	4% or less	4% or less
Accuracy	3%	3%	3%	3%	3%
Duty cycle range	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)	3 to 97% (0.25 Hz to 1 kHz) 6 to 94% (1 to 10 kHz)
Resolution	4%	4%	4%	4%	4%
Accuracy	6% of setting ±2%	6% of setting ±2%	6% of setting ±2%	6% of setting ±2%	6% of setting ±2%
Current level high range	60-A range:	10-A range:	30-A range:	120-A range:	60-A range:
Resolution	260 mA	43 mA	130 mA	520 mA	260 mA
Accuracy	0.1% ±350 mA	0.18% ±50 mA	0.1% ±200 mA	0.15% ±700 mA	0.15% ±350 mA
Current level low range	6-A range:	1-A range:	3-A range:	12-A range:	6-A range:
Resolution	26 mA	4 mA	13 mA	52 mA	26 mA
Accuracy	0.1% ±80 mA	0.18% ±13 mA	0.1% ±40 mA	0.15% ±160 mA	0.15% ±85 mA
Current temperature coefficient	100 ppm/°C ±7 mA/°C	180 ppm/°C ±1.2 mA/°C	100 ppm/°C ±5 mA/°C	150 ppm/°C ±10 mA/°C	150 ppm/°C ±5 mA/°C
Voltage level	3 to 60 V	3 to 240 V	3 to 60 V	3 to 60 V	3 to 150 V
Voltage level resolution	260 mV	1 V	260 mV	260 mV	650 mV
Voltage level accuracy	0.1% ±300 mV	0.15% ±1.1 V	0.1% ±300 mV	0.15% ±300 mV	0.15% ±750 mV
Voltage temperature coefficient	150 ppm/°C ±5 mV/°C	120 ppm/°C ±10 mV/°C	150 ppm/°C ±5 mV/°C	150 ppm/°C ±5 mV/°C	150 ppm/°C ±5 mV/°C
Programmable slew rate	60-A range: 1 A/ms to 5 A/μs 6-A range: 0.1 A/ms to 0.5 A/μs	10-A range: 0.17 A/ms to 0.83 A/μs 1-A range: 17 A/ms to 83 A/μs	30-A range: 0.5 A/ms to 2.5 A/μs 3-A range: 0.05 A/ms to 0.25 A/μs	120-A range: 2 A/ms to 10 A/μs 12-A range: 200 A/ms to 1 A/μs	60-A range: 1 A/ms to 5 A/μs 6-A range: 0.1 A/ms to 0.1 A/μs
Rise/fall time	12 μs to 8 ms	16 μs to 8 ms	12 μs to 8 ms	12 μs to 8 ms	36 μs to 8 ms

HP 6050A, 6051A Weight
Net weight: HP 6050A: 9.5 kg (21 lb)
HP 6051A: 5.5 kg (12 lb)
Shipping weight: HP 6050A: 13.6 kg (30 lb)
HP 6051A: 7.5 kg (17 lb)

Size:
HP 6050A: 425.5 mm W × 177 mm H × 624.7 mm D (16.75 in W × 7 in H × 24.6 in D)
HP 6051A: 213 mm W × 177 mm H × 624.7 mm D (8.4 in W × 7 in H × 24.6 in D)
HP 6060B, 6063B: 425.5 mm W × 88.1 mm H × 396 mm D (16.75 in W × 3.5 in H × 24.6 in D)

HP-IB Interface Capabilities

The following HP-IB functions are implemented: SH1, AH1, L4, SR1, DC1, DT1, and RL1.

Regulatory Compliance: Listed to UL 1244; certified to CSA 556B; conform to IEC 348; standalone models carry the CE mark
RFI Suppression: Standalone models comply with CISPR-11 Group 1 Class B

Specifications *(continued)*

	HP 6060B, 60502B	HP 6063B, 60503B	HP 60501B	HP 60504B	HP 60507B
Analog programming bandwidth	10 kHz (−3-dB frequency)	10 kHz (−3-dB frequency)	10 kHz (−3-dB frequency)	10 kHz (−3-dB frequency)	10 kHz (−3-dB frequency)
Analog programming accuracy Current (low range)	4.5% ±75 mA	3% ±8 mA	4.5% ±40 mA	4% ±200 mA	4% ±75 mA
Current (high range)	4.5% ±250 mA	3% ±12 mA	4.5% ±130 mA	4% ±400 mA	4% ±200 mA
Temperature coefficient	100 ppm/°C ±6 mA/°C	150 ppm/°C ±1 mA/°C	100 ppm/°C ±3 mA/°C	100 ppm/°C ±12 mA/°C	150 ppm/°C ±6 mA/°C
Voltage	0.8% ±200 mV	0.5% ±150 mV	0.8% ±200 mV	0.8% ±200 mV	0.8% ±375 mV
Temperature coefficient	100 ppm/°C ±1 mV/°C	120 ppm/°C ±10 mV/°C	100 ppm/°C ±1 mV/°C	100 ppm/°C ±1 mV/°C	120 ppm/°C ±12.5 mV/°C
Analog programming voltage	0 to 10 V	0 to 10 V	0 to 10 V	0 to 10 V	0 to 10 V
Readback specifications Current readback resolution	17 mA (via HP-IB) 20 mA (front panel)	2.7 mA (via HP-IB) 10 mA (front panel)	9 mA (via HP-IB) 10 mA (front panel)	32 mA (via HP-IB) 100 mA (front panel)	17 mA (via HP-IB) 20 mA (front panel)
Current readback accuracy	0.05% ±65 mA	0.12% ±10 mA	0.06% ±40 mA	0.1% ±110 mA	0.1% ±65 mA
Temperature coefficient	50 ppm/°C ±5 mA/°C	100 ppm/°C ±1 mA/°C	65 ppm/°C ±3 mA/°C	100 ppm/°C ±8 mA/°C	100 ppm/°C ±5 mA/°C
Voltage readback resolution	17 mV (via HP-IB) 20 mV (front panel)	67 mV (via HP-IB) 100 mV (front panel)	17 mV (via HP-IB) 20 mV (front panel)	16 mV (via HP-IB) 20 mV (front panel)	40 mV (via HP-IB) 100 mV (front panel)
Voltage readback accuracy[3]	0.05% ±45 mV	0.1% ±150 mV	0.05% ±45 mV	0.1% ±45 mV	0.1% ±90 mV
Temperature coefficient	50 ppm/°C ±1.2 mV/°C	100 ppm/°C ±8 mV/°C	50 ppm/°C ±1.2 mV/°C	100 ppm/°C ±2 mV/°C	100 ppm/°C ±5 mV/°C
Power readback accuracy	0.2% ±4 W	0.2% ±3 W	0.2% ±2 W	0.2% ±8 W	0.2% ±8 W
Analog monitor accuracy Current monitor (0 to 10 V out)	4% ±85 mA	3% ±10 mA	4% ±40 mA	4% ±170 mA	3% ±85 mA
Temperature coefficient	50 ppm/°C ±6 mA/°C	100 ppm/°C ±1 mA/°C	60 ppm/°C ±3 mA/°C	100 ppm/°C ±10 mA/°C	100 ppm/°C ±6 mA/°C
Voltage monitor (0 to 10 V out)	0.25% ±40 mV	0.4% ±240 mV	0.25% ±40 mV	0.4% ±60 mV	0.4% ±120 mV
Temperature coefficient	50 ppm/°C ±0.2 mV/°C	70 ppm/°C ±1.2 mV/°C	50 ppm/°C ±0.2 mV/°C	100 ppm/°C ±2 mV/°C	100 ppm/°C ±5 mV/°C
Remote sensing	5-Vdc maximum between sense and load input				
Minimum operating voltage	2 volts (1.2 V typical)	2 volts (1.2 V typical)	2 volts (1.2 V typical)	2 volts (1.4 V typical)	2 volts (1.4 V typical)
Programmable short	0.033 Ω (0.020 Ω typical)	0.20 Ω (0.10 Ω typical)	0.066 Ω (0.040 Ω typical)	0.017 Ω (0.012 Ω typical)	0.033 Ω (0.025 Ω typical)
Programmable open (typical)	20 kΩ	80 kΩ	20 kΩ	20 kΩ	20 kΩ
Drift (over 8-hour interval) Current	0.03% ±10 mA	0.03% ±15 mA	0.03% ±5 mA	0.03% ±20 mA	0.03% ±10 mA
Voltage	0.01% ±10 mV	0.01% ±20 mV	0.01% ±10 mV	0.01% ±10 mV	0.01% ±25 mV
Ripple and noise (20-Hz to 10-MHz noise) Current	4 mA rms 40 mA peak-to-peak	1 mA rms 10 mA peak-to-peak	2 mA rms 20 mA peak-to-peak	6 mA rms 60 mA peak-to-peak	4 mA rms 40 mA peak-to-peak
Voltage	6 mV rms	6 mV rms	5 mV rms	8 mV rms	10 mV rms
dc isolation voltage	±240 Vdc, between any input and chassis ground				
Digital inputs	V_{IL}=0.9 V max at I_{IL}=−1 mA V_{IH}=3.15 V min (pull-up resistor on input)				
Digital outputs	V_{OL}=0.72 V max at I_{OL}=1 mA V_{OH}=4.4 V min at I_{OH}=−20 μA				
Net weight (approx.)	6060B: 6.4 kg (14 lb) 60502B: 3.2 kg (7 lb)	6063B: 6.4 kg (14 lb) 60503B: 3.2 kg (7 lb)	3.2 kg (7 lb)	5.9 kg (13 lb)	5.9 kg (13 lb)
Shipping weight	6060B: 7.5 kg (17 lb) 60502B: 4.5 kg (10 lb)	6063B: 7.5 kg (17 lb) 60503B: 4.5 kg (10 lb)	4.5 kg (10 lb)	7.3 kg (16 lb)	7.3 kg (16 lb)

Notes:
1. Operating temperature range is 0 to 55° C. All specifications apply for 25° C ±5° C, except as noted.
2. Maximum continuous power available is derated linearly from 40° C to 75% of maximum at 55° C.
3. dc current accuracy specifications apply 30 seconds after input is applied.

Ordering Information

HP Model	Price	Options							
		Front panel inputs	ac Input			Rack Mount kit			Extra manuals
			100 Vac Japan only	220 Vac	240 Vac			With handles	
		020	100	220	240	800	908	909	910
6050A	$1,920	—	$0*	$0*	$0*	—	+$40†	+$100†	+$55*
6051A	$1,700	—	$0*	$0*	$0*	+$85†	+$80†	—	+$55*
6060B	$2,100	+$85*	$0*	$0*	$0*	—	+$35*	+$80*	+$35*
6063B	$2,500	+$85*	$0*	$0*	$0*	—	+$35*	+$80*	+$35*
60501B	$1,315	—	—	—	—	—	—	—	+$35*
60502B	$1,620	—	—	—	—	—	—	—	+$35*
60503B	$1,950	—	—	—	—	—	—	—	+$35*
60504B	$2,275	—	—	—	—	—	—	—	+$35*
60507B	$2,500	—	—	—	—	—	—	—	+$35*

† Options 908 and 909 for the HP 6050A, and Options 800 and 908 for the HP 6051A, require either the slide kit (p/n 1494-0059) or slide rails to support the weight of the load mainframe. Slide kits can be purchased using the above part number.
* This feature is available as an option.
— This feature is not available.

Option Descriptions

Opt 020 Front Panel Inputs (for HP 6060B and 6063B only)
Opt 100 87 to 106 Vac, 47 to 66 Hz (for Japan only)
Opt 220 191 to 233 Vac, 47 to 66 Hz
Opt 240 209 to 250 Vac, 47 to 66 Hz
Opt 800 Rack Mount Kit for two units (for HP 6051A) mounted side-by-side (HP p/n 5061-9694 and 5062-3978)
Opt 908 Rack Mount Kit (HP p/n 5062-3978 with an HP 6050A, HP p/n 5062-3960 with HP 6051A, and HP p/n 5062-3974 with an HP 6060B and 6063B)
Opt 909 Rack Mount Kit with Handles (HP p/n 5062-3984 when mounting an HP 6050A and HP p/n 5062-3975 when mounting an HP 6060B and 6063B)
Opt 910 Extra manual set, including one each of the operating manual, programming reference manual, and service manual. The programming manual is available with the mainframe, and therefore not with individual modules (operating manuals and programming manuals are shipped with standard units only).

FREQUENCY & TIME STANDARDS
General Information

Hewlett-Packard offers frequency standards and clocks that provide accurate frequency, time-interval, and timekeeping capabilities. HP standards provide means for comparing these quantities against national standards such as those of the U.S. National Institute of Standards and Technology (NIST) and the U.S. Naval Observatory (USNO).

A range of HP source products and systems components can be integrated into high-quality frequency and time applications. A choice of standards technologies can match desired accuracy and capabilities to varying tasks.

Frequency sources and systems manufactured by HP are used for control and calibration at observatories, national centers for measurement standards, physical research laboratories, missile and satellite tracking stations, communications systems, radio navigation systems, manufacturing plants, and radio-monitoring and transmitting stations.

Types of Frequency Standards

Hewlett-Packard currently offers frequency-standard products based on two types of technology. These are:

- The cesium atomic-beam–controlled oscillator
- The quartz crystal oscillator

Of these standards, the first is a primary frequency standard and the latter is a secondary frequency standard. A primary standard does not require any other reference for calibration; a secondary standard requires calibrations both during manufacturing and at intervals during use, depending on the accuracy desired.

Cesium-Beam Frequency Standard

Cesium-beam standards are in use wherever the goal is a very high accuracy primary frequency standard. In fact, the NIST frequency standard itself is of the cesium-beam type. The cesium-beam standard is an atomic resonance device that provides access to one of nature's invariant frequencies.

Quartz-Crystal Oscillators

Quartz oscillators are used in virtually every frequency-control application, including atomic standards. The excellent short-term stability and spectral purity of the quartz oscillators used in HP atomic standards contribute to the high quality of the output signal of these standards. For less demanding applications where some long-term drift can be tolerated, quartz oscillators are used as independent frequency sources.

Frequency Standards and Clocks

Frequency standards and clocks have no fundamental differences—they are based upon dual aspects of the same phenomenon. The basic unit of time, the second, is defined as the duration of 9,192,631,770 periods of transition within the cesium atom. Frequency is determined by counting the number of cycles over the period of a second.

Time Scale and Standards

The time interval of the atomic time scale is the International Second, defined in October 1967 by the Thirteenth General Conference of Weights and Measures. Since January 1972, the frequency offset between universal time coordinated (UTC) and atomic time has been zero and the UTC time scale is kept in synchronism with the rotation of the earth to within ±0.9 s by step-time adjustments of exactly 1 s, when needed (see HP Application Note 52-2).

The NIST provides the official basis for standard time for the United States. The UTC signal is broadcast from the NIST stations WWV and WWVB and by several other stations throughout the world. (See "HP Applications Note 52-1, Fundamentals of Time and Frequency Standards," for a list of stations broadcasting time signals.)

The master clock at the USNO, one of the world's most accurate clocks, is made of an ensemble of more than a dozen HP cesium-beam frequency standards. HP portable cesium standards, "flying clocks," are used periodically to check the synchronization between these stations and the master clock.

Hewlett-Packard House Standard

The Hewlett-Packard House Standard at the Santa Clara Division consists of an ensemble of five high-performance HP cesium-beam standards.

Time is maintained relative to the USNO and NIST master clocks to an accuracy of better than ±1.0 μs. This accuracy is verified using Loran C and GPS time-transfer techniques between HP Santa Clara Division, HP Geneva Calibration Lab, and the U.S. Naval Observatory. Both HP locations have been designated USNO time reference stations.

System Components

HP standby power supplies ensure continued operation despite line interruptions, and operate over a range of ac line voltage to supply regulated dc to operate frequency standards and frequency dividers and clocks. The batteries in the supplies assume the full load immediately when ac power fails.

Low distortion, excellent isolation, and versatile configurations of the HP distribution amplifier allow the outputs of high-quality frequency standards to be delivered to multiple channels. Modular construction tailors this component for a variety of system requirements.

Comparison of Frequency Standards

Standard	Principal construction feature	Principal advantages
Oscillator controlled with cesium atomic-beam resonator	Beam of free cesium atoms, spatially state-selected, is subjected to a microwave signal at resonance frequency.	• High intrinsic reproducibility and long-term stability • Primary standard for definition of time interval
Quartz crystal oscillator	Piezoelectrically active quartz crystal with electronic stabilization	• Very compact, light • Rugged • Inexpensive • Low phase noise

Frequency Standards: Specifications

	HP 5071A	HP 5071A Opt 001	HP 105B	HP 10811D/E
Type of standard	Cesium		Quartz	Quartz
Accuracy	$\pm 3 \times 10^{-12}$	$\pm 1.5 \times 10^{-12}$		
Reproducibility[1]	$\pm 5 \times 10^{-13}$			
Settability (frequency)	6.3×10^{-15} ($\pm 1.0 \times 10^{-9}$ range)		1 ppm (coarrse); 5×10^{-8} (fine)	$> \pm 1 \times 10^{-6}$ (10 Hz)
Long-term stability	$\leq 5.0 \times 10^{-14}$/30 days[1]	$\leq 2.0 \times 10^{-14}$/5 days[1]	5×10^{-10}/day	5×10^{-10}/day
Flicker floor (max)[1]	$\leq 5.0 \times 10^{-14}$	$\leq 2.0 \times 10^{-14}$		
dc magnetic field stability, frequency charge, any orientation in a 2-gauss field	$\pm 2.0 \times 10^{-13}$			< −90 dBc (1 gauss field)
Warmup time at 25° C	30 min		1×10^{-9}/30 min	5×10^{-9}/10 min
Tube warranty	5 years	3 years	Not applicable	
Sinusoidal outputs	1/5/10 MHz, 100 kHz		5 M, 1 M, 100 k, clock (1 M)	10 MHz
Output voltage	1 V into 50 Ω			1 V into 1000 Ω or 0.55 V into 50 Ω
Harmonic distortion (from rated output)	< −40 dBc			< −25 dBc
Nonharmonic distortion (from rated output)	< −80 dBc			< −100 dBc
Temperature, operating	0° to 55° C		0° to 50° C	0° to 71° C
Temperature, nonoperating	−40° to +70° C		−40° to 50° C	−55° to 85° C
Power, ac	100/120 vac ±10%, 45 to 440 Hz; 220/240 Vac ±10%, 45 to 66 Hz; 50 W (Opt 001, 56 W)		19 W (71 W warmup)	Not applicable
Power, dc	22 to 42 Vdc, 45 W	22 to 42 Vdc, 50 W	16 W (81 W warmup)	2.5 W (10 W warmup)
Dimensions (W × H × D): mm **in**	425.5 × 133.4 × 523.9 16.75 × 5.25 × 20.63		425.5 × 88.2 × 286 16.75 × 3.47 × 11.25	72 × 52 × 62 2.8 × 2 × 2.4
Weight (kg/lb)	30/65		10.9/24	0.31/0.69
Standby power-supply capacity at 25° C	45 min		6 h	

[1]This specification is guaranteed under laboratory conditions only (temperature: 25° C ±5° C; humidity, 45 ±10%).

Time Standard: Specifications

	HP 5071A and HP 5071A (Opt 001)
Clock display	Red LED, 24-hour time (h, min, s)
Clock 1-PPS outputs	
Connector type	BNC
Connector locations	1 on front, 2 on rear panel
Amplitude	≥ 2.4 V into 50 Ω (TTL)
Width	20 μs
Rise time	< 5 ns (slew rate > 10^9 V/s at 1.5 V)
Jitter	< 1 ns rms (pulse-to-pulse or pulse–to–10 MHz)
Manual clock synchronization	
Range	−0.5 to +0.5 s
Resolution	50 ns
Automatic clock synchronization	
Resolution	To within 50 ns of reference pulse
Sync pulse	2 independently armed inputs
Sync pulse amplitude	+2 to +10 V (max)
Sync pulse width	100 ns (min); 100 μs (max)
Sync pulse rise time	< 50 ns
Sync pulse input impedance	50 Ω (nominal)
Sync pulse time referencing	Rising edge
Connector type	BNC
Connector locations	1 on front, 2 on rear panel

FREQUENCY & TIME STANDARDS

Primary Standard

HP 5071A

- Accuracy: $\pm 1.5 \times 10^{-12}$
- Settability: $\pm 1.0 \times 10^{-9}$
- Flicker floor: $\leq 2.0 \times 10^{-14}$ ($\leq$ 5 days)
- Fast warmup
- No adjustments before or during operation
- Remote operation

HP 5071A

HP 5071A Primary Frequency Standard

The HP 5071A primary frequency standard delivers unsurpassed accuracy and stability for both laboratory and field applications. Its improved cesium-beam tube reduces the effects of Ramsey pulling. New beam optics use cesium more efficiently. The combined results—increased accuracy and stability, and increased tube life—ensure that your calibration lab services are available longer.

The HP 5071A is easy to use. Automatic startup is simple and requires no adjustments. A logical menu structure simplifies front-panel operations, selections, and status reporting.

The HP 5071A can be operated and maintained anywhere. All controls are programmable, status can be checked remotely, and no adjustments or alignments are necessary during operation. An internal battery provides 45 minutes of backup in case of ac power failure.

Unmatched Accuracy and Stability

The HP 5071A uses Cesium II technology to double the accuracy of its predecessor, the HP 5061B. Cesium II technology includes a new cesium tube and redesigned electronics. The improved accuracy ensures that any HP 5071A Option 001 can power up to within $\pm 1.5 \times 10^{-12}$ of the accepted standard for frequency. This is achieved under full environmental conditions in 30 minutes or less.

Cesium II technology brings a new level of stability to the cesium clock. The HP 5071A is the first cesium standard to specify its stability for averaging times longer than a day. It is the first standard to specify a *flicker floor*—the point at which the standard's stability does not change with longer averaging. Under laboratory conditions, the standard HP 5071A has a flicker floor better than 5 parts in 10^{14}, which is reached in an averaging time of 30 days or less.

Hewlett-Packard has been producing cesium frequency sources since 1964. The exceptional accuracy and stability of the HP 5071A are a result of this experience and are characterized by improved reliability. Backing up this reliability is a five-year warranty on the standard cesium tube and a three-year warranty for the optional high-performance tube.

Ease of Use

Startup and operation of the HP 5071A are extremely simple. Once connected to an ac or dc power source, the instrument automatically powers up to its full accuracy specifications. No adjustments or alignments are necessary during power-up or at any time during the lifetime of the cesium tube.

Intuitive menus logically report status and facilitate control of the instrument. These menus—Instrument State, Clock Control, Instrument Configuration, Event Log, Frequency Offset, and Utilities—are accessible via the front-panel LCD display and keypad.

High-Performance Tube: Option 001

For the most demanding operations, the HP 5071A Option 001 high-performance cesium-beam tube offers increased performance. Accuracy is two times better than the standard tube, and stability is superior as well. The high-performance tube allows a flicker floor of better than 2×10^{-14} within an averaging time of five days or less.

Frequency and Time Standards: Applications

Applications	Requirements	HP 5071A Solutions
Satellite communications	• Signal transmission and reception • Adjustment for satellite-to-satellite carrier-frequency differences • Secure communications (recovering encrypted data quickly) • Exact synchronization between receiver and transmitter during channel hops	• Stable primary and offset frequencies • Frequency flexibility • Precise synchronization • Frequency-agile signals; automatic synchronization to any external 1-PPS signal
Navigation and tracking systems	• Timing signal synchronization • Accurate, reliable, and stable standard in changing environments	• Remote and automatic synchronization of timing signals (lowers cost) • Excellent accuracy, HP reliability, and unsurpassed environmental stability
Telephone network synchronization	• Time synchronization and equal data rates between systems • Maximum system uptime	• Unit-to-unit frequency accuracy for preventing data loss • Unequaled HP reliability and quality

Specifications

Accuracy and Stability

Full Environmental Range

Conditions:
Temperature: 0° to 55° C
Humidity: 0 to 80% (40° C max)
dc magnetic field: 0 to 2 gauss
Accuracy: $\pm 3 \times 10^{-12}$ ($\pm 1.5 \times 10^{-12}$, Opt 001)
Warmup time (typical): 15 min to normal operating status
30 min to full specs
Settability:
Resolution: 6.3×10^{-15}
Range: $\pm 1.0 \times 10^{-9}$
Frequency change due to environment:
Temperature, 0° to 55° C: $\pm 5.0 \times 10^{-13}$
$\pm 3.0 \times 10^{-13}$ (Opt 001)
Humidity, 0 to 80% (40° C max): $\pm 3.0 \times 10^{-13}$
Magnetic field, frequency change, any orientation in a 2-gauss field: 2.0×10^{-13}

Laboratory Specifications

Conditions:
Temperature: 25° C ±5°
Humidity: 45 ±10%
Accuracy: $\pm 2 \times 10^{-12}$ ($\pm 1 \times 10^{-12}$, Opt 001)
Time domain stability, 5/10-MHz outputs:

Averaging times	HP 5071A	HP 5071A Opt 001
10^4 s	$\leq 5.6 \times 10^{-13}$	$\leq 8.5 \times 10^{-14}$
1 day	$\leq 2.0 \times 10^{-13}$	$\leq 3.0 \times 10^{-14}$
5 days	$\leq 1.0 \times 10^{-13}$	$\leq 2.0 \times 10^{-14}$
30 days	$\leq 5.0 \times 10^{-14}$	$\leq 2.0 \times 10^{-14}$

Flicker floor (maximum): $\leq 5.0 \times 10^{-14}$ in 30 days or less;
$\leq 2.0 \times 10^{-14}$ in 5 days or less (Opt 001)
Reproducibility: $\leq 5.0 \times 10^{-13}$

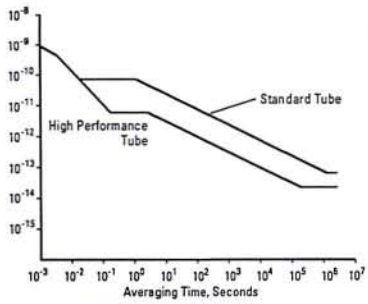
Sinusoidal Output Characteristics (all located on rear panel)

Parameter	Ports 1 & 2[2]	1 MHz 100 kHz
Amplitude into 50 Ω load	> 1 V rms	> 1 V rms
Isolation between ports	> 110 dB (typ)	not specified
Harmonic signals (typical)	< −40 dBc	< −40 dBc
Nonharmonic distortion	< −80 dBc	not specified
Connector type	N	BNC
Source impedance (nominal)	50 Ω	50 Ω

[2] Each output can be set to either 5 or 10 MHz from the front panel or by remote command.

Frequency Stability (5/10-MHz Outputs)

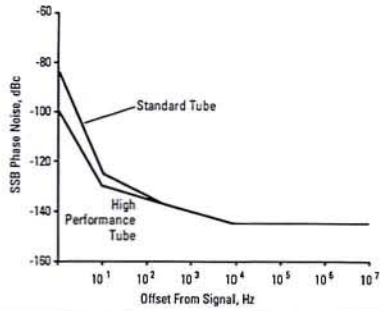
Time Domain Stability



Averaging time (seconds)	σy(2,τ) Standard cesium beam tube	σy(2,τ) High-performance cesium beam tube (Option 001)
10^{-2}	$\leq 1.5 \times 10^{-10}$	$\leq 1.5 \times 10^{-10}$
10^{-1}	$\leq 5.6 \times 10^{-11}$	$\leq 1.5 \times 10^{-11}$
10^{0}	$\leq 5.6 \times 10^{-11}$	$\leq 5.0 \times 10^{-12}$
10^{1}	$\leq 2.3 \times 10^{-11}$	$\leq 3.5 \times 10^{-12}$
10^{2}	$\leq 5.6 \times 10^{-12}$	$\leq 8.5 \times 10^{-13}$
10^{3}	$\leq 1.8 \times 10^{-12}$	$\leq 2.7 \times 10^{-13}$
10^{4}[1]	$\leq 5.6 \times 10^{-13}$	$\leq 8.5 \times 10^{-14}$
1 day[1]	$\leq 2.0 \times 10^{-13}$	$\leq 3.0 \times 10^{-14}$
5 days[1]	$\leq 1.0 \times 10^{-13}$	$\leq 2.0 \times 10^{-14}$

[1] Specified only under laboratory conditions.

Frequency Domain Stability



Offset from signal (Hz)	SSB Phase Noise dBc: Standard cesium beam tube	SSB Phase Noise dBc: High-performance cesium beam tube (Opt 001)
10^0	≤ −85	≤ −100
10^1	≤ −125	≤ −130
10^2	≤ −135	≤ −135
10^3	≤ −140	≤ −140
10^4	≤ −145	≤ −145
10^5	≤ −145	≤ −145

Time Standard

Refer to the specifications given on page 495.

Internal Standby Battery (Nominal Values)

Capacity: 45 min at 25° C from full charge
Charge Time: 16 h maximum from fully discharged state
Charge Source: ac input power only

Remote System Interface and Control

RS-232-C (DTE configuration): Complete remote control and interrogation of all instrument functions and parameters
Interface circuits: Optically isolated
Software command set: SCPI, version 1990.0
Connector: 9-pin male rectangular D subminiature type
Status Output: Logic output for externally monitoring normal and abnormal operation (user-defined)
Output: TTL open collector with internal pull-up resistor
Circuit sink capability: Up to 10 mA
Connector: BNC on rear panel

Environmental and Physical

Temperature
Operating: 0° to 55° C
Nonoperating: −40° to +70° C
ac Magnetic Field: < 2×10^{-13} change in frequency for 0.2-millitesla (2-gauss) peak for 50-, 60-, or 400-Hz fields
Power Requirements: See table on page 495.
Weight: 30 kg (65 lb)
Size: 425.5 mm W × 133.4 mm H × 523.9 mm D (16¾ in × 5¼ in × 20⅝ in)

Ordering Information

	Price
HP 5071A Primary Frequency Standard	$54,000
Opt 001 High-Performance Cesium-Beam Tube	+$12,000
Opt 0B2 Extra Operating and Programming Manuals	+$100
Opt 0BW Extra Assembly-Level Service Manual	Contact HP
Opt 0BV Component-Level Service Information Package	Contact HP
Opt 908 Rack Flange Kit (for use without handles included with HP 5071A)	+$85
Opt 913 Rack Flange Kit (for use with handles included with HP 5071A)	+$90
Opt W30 Extended Repair Service (see page 636)	+$795
Opt W50 Extended Repair Service (not available with Opt 001)	$1,590

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

FREQUENCY & TIME STANDARDS

Secondary Standards Phase Comparator

HP 105B, 10811D/E, K34-59991A

HP 105B

HP 105B Quartz Frequency Standard

The HP 105B quartz frequency standard provides excellent long- and short-term stability characteristics, spectrally pure output, unexcelled reliability, and the ability to operate under a wide range of environmental conditions. The HP 105B fills a need for a small and economical yet highly stable precision reference for frequency and time standards. The HP 105B can be operated from the ac line. It also has a built-in 6-hour standby battery for uninterrupted operation. The 5-MHz, 1-MHz, and 100-kHz buffered sinusoidal outputs have excellent short-term stability (1 part in 10^{11} rms for 1-second averaging time) and aging rate (< 5 parts in 10^{10} per day).

The HP 105B features rapid warmup. Typically, the standard will be within 5 parts in 10^9 of the final frequency in 15 minutes after an "off" period of less than 24 hours. The basis of this standard is an extremely stable quartz crystal oscillator. The crystal, oscillator, and AGC circuit are all enclosed in a proportional oven for reduced temperature effects on these components and circuits.

A spectrally pure 5-MHz output, when multiplied high into the microwave region, provides signals with spectra only a few Hertz wide. Spectra less than 1 Hz wide can be obtained in X-band (8.2 to 12.4 GHz). The 5-MHz output is suitable for Doppler measurements, microwave spectroscopy, and similar applications where the reference frequency must be multiplied by a large factor.

HP 105B Specifications

Outputs: 5 MHz, 1 MHz, 100 kHz; 1 V rms into 50-Ω front and rear connectors
Clock Output: 1 MHz; 0.5 V rms into 1-k Ω rear connector
Frequency Stability
Aging rate: $< 5 \times 10^{-10}$ per 24 h
Short-term stability: For 5-MHz output only

τ(s)	σΔf/f(2,τ)
10^{-2}	1.5×10^{-10}
10^{-1}	1.5×10^{-11}
10^{0}	1×10^{-11}

Temperature: $< 5 \times 10^{-9}$ total change 0° C to 50° C
Load: $< \pm 9 \times 10^{-11}$ open to short, 50-Ω R, L, or C load change
Supply voltage: $\pm 5 \times 10^{-11}$ for 22- to 30-V dc from 26-V dc reference and for 115/230 V ±10%
Warmup (at 25° C): To within 1×10^{-7} in 15 min, 1×10^{-8} in 20 min, 1×10^{-9} in 30 min of final value (24 h after turnon) if off less than 24 h.
Distortion (5 MHz, 1 MHz, 100 kHz) **Below Rated Output**
Harmonic: > 40 dB
Nonharmonic: > 80 dB
Frequency Adjustments
Fine: $\pm 5 \times 10^{-8}$ range with digital dial reading parts in 10^{10}
Coarse: $\pm 1 \times 10^{-6}$ front-panel screwdriver control
Phase locking: External +5 V to −5 V allows $> 2 \times 10^{-8}$ frequency control for locking to external source.
Temperature: 0° C to +50° C operating; −40° C to +50° C nonoperating (+75° C without standby battery storage)
Altitude: 15.24 km (50,000 ft)
Standby Supply Capacity: 6 h at 25° C ambient temperatures
Power Requirements: 115/230 V ±10%, Hz at 19 W (71-W warmup); 22 to 30 V dc at 16 W (81-W warmup)
Size: 425.5 mm W × 88.2 mm H × 286 mm D (16.75 in × 3.47 in × 11.25 in)
Weight: Net, 11 kg (24 lb); shipping, 14 kg (31 lb)

HP 10811D/E Oscillators

The HP 10811D/E crystal oscillators are oven-controlled, high-performance component oscillators. Both offer unmatched quality, high performance, and low cost. The low aging rate and fast warmup time reduce maintenance costs and downtime. Low power consumption gives the HP 10811D/E oscillators longer battery-backup time. Low phase noise translates to lower system phase noise when using HP oscillators.

The HP 10811D has a PCB connector for all external connections; the HP 10811E uses filter feedthrough terminals for power connections and oven monitor. The HP 10811E also has SMB snap-on RF connectors for the 10-MHz output and EFC input, and provisions for shock mounting. For specifications see page 495.

HP K34-59991A Phase Comparator

The HP K34-59991A broadband linear phase comparator accurately compares the phase relationship of the output signals of two frequency standards having the same nominal frequency. This will enable resolving extremely small differences between precision frequency sources. The phase comparator operates over a frequency range of 10 kHz to 50 MHz and input levels between 100 mV and 10 V rms. A linear dc-output voltage, proportional to the phase differences between the two standards, is available at both the front and rear panels and is suitable for driving a strip chart recorder.

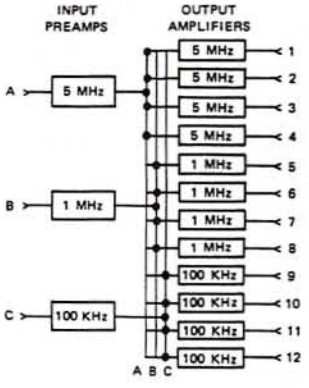
Ordering Information	Price
HP 105B Quartz Frequency Standard	$9,700
Opt 908 Rack Flange Kit	+ $120
Opt 910 Extra Manual	+ $30
HP 10811D 10-MHz Oscillator, PCB/Edge Connector	$1,050
HP 10811E 10-MHz Oscillator, SMB Connectors	$1,200
Options for HP 10811D or HP 10811E	
Opt 001 Low Aging Rate	+$500
Opt 002 Low Phase Noise	+$750
Opt 003 Integrated Opt 001 and Opt 002	+$2,500
Opt 100 Reduced Specifications	−$200
Note: Options are mutually exclusive; no mixing.	
Special Option HP K34-59991A Phase Comparator	$2,900

HP 5087A

HP 5087A Distribution Amplifier

The Hewlett-Packard 5087A distribution amplifier provides the isolation and flexibility required for distribution of the output of high-quality frequency standards. The distribution amplifier features plug-in modular construction, short-circuit isolation, exceptional phase stability, low noise and crosstalk, and switchover to standby dc if ac power fails.

Several configurations are available, and special combinations of input and output modules can be supplied. Amplifiers can be added or the configuration easily changed with the HP 10812A options.



HP 5087A with Option 031

HP 5089A Standby Power Supply

The HP 5089A standby power supply furnishes dc power to keep frequency- or time-standard systems operating during extended interruptions of ac line power. This unit is designed for use with Hewlett-Packard cesium-beam standards, quartz standards, and other equipment that will operate from 22 to 28 Vdc. No switching is used in transferring power from line to battery operation and back again, thus ensuring uninterrupted operation.

The HP 5089A is an extremely versatile unit. It was designed both as a portable power supply for "flying clocks" and as a standby supply for stationary applications.

HP 5087A Specifications

Inputs: Up to three, rear-panel BNC
- **Frequencies:** 10 MHz, 5 MHz, 1 MHz, or 100 kHz
- **Level:** 0.3 to 3.0 V rms, 50 Ω

Outputs: Up to 12 rear-panel BNC
- **Frequencies:** 10 MHz, 5 MHz, 1 MHz, or 100 kHz
- **Level:** 0 to 3 V into 50 Ω (screwdriver adjustment)
- **Harmonic distortion:** > 40 dB below rated output
- **Nonharmonic distortion:** > 80 dB below rated output

Isolation
- **Load** (open or short on any other channel):
  - **Amplitude change:** 0.1%
  - **Phase change:** < 0.1 ns at 5 or 10 MHz
    < 0.5 ns at 1 MHz
    < 5.0 ns at 100 kHz
- **Injected signal:** 1-V signal up to 50 MHz applied to any output except 10 MHz, will be down >60 dB in all other outputs; 10 MHz output channel will be down >50 dB.

SSB Phase Noise (5 MHz): >145 dB below signal in 1-Hz BW for frequencies >1 kHz from carrier

Short-Term Stability Degradation (5 MHz): $<1 \times 10^{-12}$ in 10-kHz bands (1-s average)

HP 5089A

Environmental
- **Temperature:** MIL-E-16400, class 4
- **Operating:** 0° to 50° C
- **Storage:** −62° to +75° C

Stability
- **Amplitude:** ±0.5 dB, 0° to 50° C
- **Phase:** <0.1 ns/° C, 5 and 10 MHz
- **Humidity:** 95% at 40° C
- **Altitude:** Up to 30,000 ft

General
- **Power:** 115 or 230 V ±10%, 48 to 440 Hz, 20 VA, maximum, or 22 to 30 V dc, 600 mA, maximum
- **Size:** 425 mm W × 88 mm H × 286 mm D (16.7 in × 3.5 in × 11.3 in)
- **Weight:** Typical, Opt 031: net 7 kg (15 lb)

HP 5089A Specifications

Input Voltage
- **ac charging:** 85 V to 130 V ac rms, 48 to 440 Hz, 300 VA maximum
  85 V to 255 V ac rms, 48 to 66 Hz, 300 VA maximum
- **dc operation:** 11 V to 30 V dc, 110 W maximum

Output Voltage: 22 V to 28 V dc (nominal), 2-A maximum
Standby Capacity: 15 AH at +25° C when fully charged
Recharge: Complete recharge in 24 h from ac line
External Low-Battery Voltage Alarm: Visible LED or audible

Environmental
- **Temperature:** 0° to 50° C operating; −40° to +65° C storage
- **Humidity:** Up to 95% at 40° C (with no internal condensation)
- **Altitude:** 12,000 m (40,000 ft), operating; 15,000 m (50,000 ft) storage
- **Size:** 425 mm W × 177 mm H × 416 mm D (16.7 in × 7 in × 16.4 in)
- **Weight:** Net weight 30.5 kg (67 lb)

Ordering Information	Price
HP 5087A Distribution Amplifier Mainframe	$3,300
Opt 908 Rack Flange Kit	+$120
Normal Configurations (input and output amplifiers)	
Opt 031 5-, 1-, 0.1-MHz Inputs; 4 Outputs at Each	+$2,600
Opt 032 Single 5-MHz Input and 12 Outputs	+$2,300
Opt 033 Single 10-MHz Input and 12 Outputs	+$2,300
Opt 034 Single 5-MHz Input, 4 Each; Outputs at 5, 1, and 0.1 MHz	+$2,700
Special HP 5087A Configurations	
Input preamplifiers (up to 3 total)	
Opt 004 Input Preamplifier (0.1 to 10 MHz)	+$150
Opt 005 5- to 1-MHz Input Divider	+$220
Opt 006 1- to 0.1-MHz Input Divider	+$370
Opt 011 5- to 10-MHz Input Doubler	+$360
Opt 013 10- to 5-MHz Input Divider	+$410
Opt 014 10- to 1-MHz Input Divider	+$370
Output amplifiers (up to 12 Total)	
Opt 001 5-MHz Output Amplifier	+$210
Opt 002 1-MHz Output Amplifier	+$220
Opt 003 0.1-MHz Output Amplifer	+$250
Opt 012 10-MHz Output Amplifier	+$220
HP 5089A Standby Power Supply (includes ac and dc input power cables, dc output cable, and extender board)	$8,800
Opt 001 Spare Board (HP 05089-60001)	+$1,500
Opt 908 Rack Mounting Adapter Kit	+$850
Opt 910 Extra Operating and Service Manual	+$270

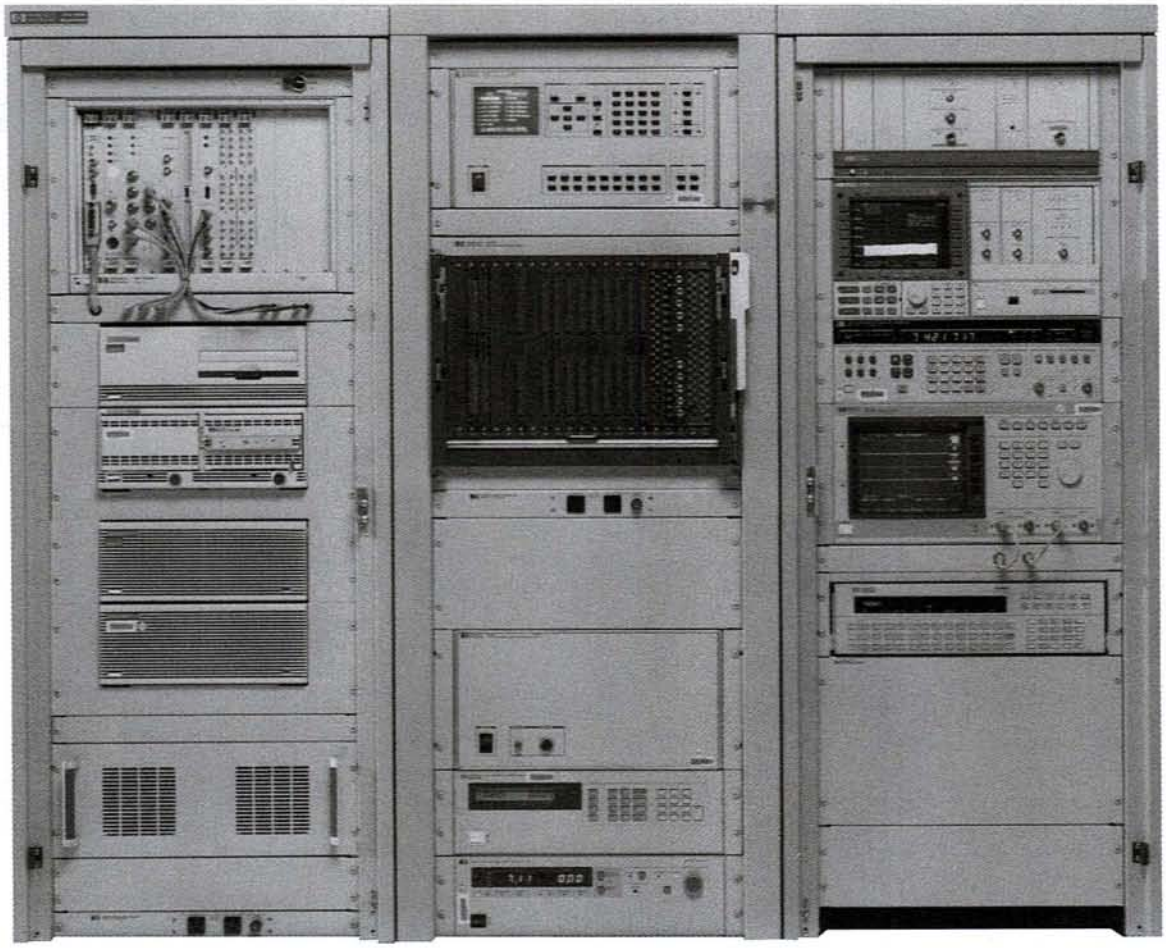
For the most current prices and product information, contact your local Hewlett-Packard sales office, see page 665.

AUTOMATIC TEST SYSTEMS

Systems Integration

HP ATS 2000+

- System design and integration
- Program management
- Custom hardware and software development



Introductory Overview

As a Hewlett-Packard systems integrator, the Integrated Systems Division (ISD) provides high-quality hardware and software integration services. HP is the only company in the world that makes high-quality computers and instrumentation—and has a dedicated, experienced team to handle the integration of a sophisticated mix of hardware and software products.

HP believes that a truly successful integrated solution must be carefully planned to provide optimum performance. A scope of work is one of the first steps taken to detail exactly what the HP team will deliver. HP engineers work closely, every step of the way, to configure a system that's exactly right for a customer's unique application. This includes determining exactly which products best meet the customer's needs—whether standard HP products, third-party, or custom products.

HP can provide a solution that's:

Cost effective. HP knows that controlling costs is a major concern. That's why it's important to remember that we work on a fixed-cost, fixed-delivery basis. As a result, a customer will always know up front what the costs are, without worrying about overruns or unwelcome surprises.

A proven performer. Why take chances with patchwork solutions when you can count on a company whose custom solutions set the standard for the industry? ISD has developed solutions in a number of businesses, including aerospace/defense, automotive, telecommunications, government, and multinational service companies. This means ISD has an extensive knowledge of automatic test systems, automotive test and diagnostic systems, automotive dealership information systems, online technical information systems, product platforms system integration, and more.

Fully integrated. Integrating a system the right way is more difficult than it looks. To do it successfully you have to be expert at everything from cooling and cabling, to hardware selection, ergonomics, and more. HP's open architecture, solidly based on accepted standards like IEEE-488, UNIX, VXI, and others, is another major advantage. It means a customer is never locked in and limited to what is in the box. Instead, a system can grow or adapt to meet changing needs.

Leverage off HP's Experience

Working with HP, a customer can benefit from our corporate depth and breadth of products and expertise. HP can draw on an unmatched variety of standard HP computer, data communication, and test and measurement instrumentation products. Other valuable HP resources are available too—HP Laboratories, Manufacturing Research Center, and state-of-the-art fabrication centers.

HP can also provide application feasibility studies, functional and design specifications, mechanical design studies, custom hardware and software design, system design and integration, training, field installation and warranty service, and program management.

Program Management

When developing and implementing a complex, integrated system, managing all phases of the project can be a challenging task. That's why our wide range of program management services is so important.

Our experienced professionals handle all the crucial details and take all the heavy responsibility off your shoulders. An HP Program Manager is responsible for coordinating and meeting all HP commitments. The Program Manager serves as a single, responsible contact point within HP for all project deliverables. These include all assigned tasks to be implemented by Hewlett-Packard or by a third party on HP's behalf.

Custom Product Manufacturing

When there is a need for low-volume, custom-tailored solutions, HP can help manufacture exactly what you need, and make sure that it comes up to our own high standards. Through a feasibility study, HP can help evaluate which technology and design alternative best meets the needs of the application. HP can help establish clear measures of success before a program is implemented.

HP ATS 2000+ Automatic Test Systems

HP's new automatic test systems offer a broad family of sophisticated instruments combined with powerful computers that are specially designed to control complex instrumentation. The result is that you get the high productivity and increased profitability that are so important to your organization.

A little background: When it comes to supplying integrated ATS systems for commercial and military testing applications, HP has more than 20 years of experience. With over 1000 installed systems, we've got the expertise needed to match advanced measurement technologies to a wide range of automatic test needs.

"Software Productivity" Is More Than a Buzzword

Cut development of test software. HP's unique test development environment (TDE) can cut the development of test software on the HP ATS 2000+ by up to 50 percent. TDE incorporates the use of iconic programming and serves as an easy-to-use graphics development environment as well as functioning as the test executive for the HP ATS 2000+. TDE provides users with a complete set of program development and execution tools.

Eliminate the need to write diagnostic software. Writing diagnostic software can account for 50 to 90 percent of a customer's entire software budget. HP Test Expert, an innovative software productivity tool, can eliminate the need for writing diagnostic software and significantly reduce costs. Based on expert systems technology, HP Test Expert uses its built-in intelligence to provide an accurate diagnosis of any faults found in the unit under test. And, it's easy to use.

Digital Testing: High Speed Saves You Time and Money

The HP ATS 2000+ digital test unit (DTU 82000) means you get a 50 MHz data rate and over 1000 channels. A graphical user interface simplifies the test development and run-time development process. The tester-per-pin architecture offers both high measurement accuracy and the flexibility for the individual pin timing and levels required for testing complex circuits.

Boeing

For years, HP has worked closely with Boeing, the world's largest manufacturer of commercial aircraft, to develop innovative solutions that meet the company's unique testing needs.

Testing modern, sophisticated commercial aircraft is a complex and demanding job. The analog instrumentation, relied on in the past, has been replaced, or augmented, by technically advanced digital instrumentation.

In order to test this new instrumentation in a timely and cost-effective manner, Boeing needed an automatic test system it could count on—one that could also be used by Boeing customers around the world to test their 757 and 767 airplanes. Boeing and their customers were looking for a test system that could:

- Match the same high standards Boeing sets for its aircraft
- Quickly and accurately identify problems or malfunctions
- Help save money and increase productivity

A key factor in the purchase decision for all airlines is reliability. Airlines need to know that they can have confidence in the test results the system provides. That's the reason so many airlines used the HP automatic test systems developed for Boeing. They know it makes good sense to use the same system that Boeing relies on in its own manufacturing and service process and to take advantage of the outstanding support that is a hallmark of the highly respected airplane manufacturer.

HP developed the nucleus of a system that Boeing uses to test 757 and 767 avionics. HP assembles and tests a "core" ATS station comprised of an HP controller, peripherals, instrumentation, switching, and digital test resources. Boeing then adds its complement of avionic test equipment and performs additional testing on customer cards, boards, and adapters before shipping to the airline customer.

There are many benefits that Boeing and their customers enjoy after making the HP automatic test system decision. Here are some of the most important:

- Significant time saving
- Greater airline control of operations
- Improved test consistency
- Reduced inventory levels
- HP and Boeing support
- Expandability
- Test software for major systems

HP's automatic test systems help the leading commercial airline manufacturer meet its goals of providing a cost-effective, reliable test system. To find how HP's ATS solutions can help your company gain a competitive edge, contact your local HP sales representative today.

AUTOMATIC TEST SYSTEMS

Board Test Equipment

HP 3070 Board Test Systems

- Flexible—compatibility, transportability, and reliability on a single platform
- Scalable—customize to meet your needs
- Upgradable—leverage your initial investment

Combinational and functional HP 3070 family members, with a pattern application rate up to 20MP/s, provide fast and efficient testing of even the most complex loaded circuit boards.

HP 3070 Board Test Family

The HP 3070 Board Test Family gives you what you need, when you need it.

Flexible

On a single platform, the HP 3070 board test family offers six different test systems for in-circuit, functional, combinational, and communications tests to fit your specific manufacturing test needs.

The in-circuit systems provide analog and digital testing capability, as well as analog functional testing capability. The high-performance, functional test systems provide superior fixturing technology, at-speed testing, and guaranteed accuracy specifications through the fixture to the Unit-Under-Test. The high-performance combinational systems provide the analog and digital in-circuit and analog and digital functional test capabilities to provide maximum flexibility to optimize test strategies. The communications test systems provide much faster test development time for functional serial tests.

Because these systems share the HP 3070's modular platform, they provide tests that are transportable, repeatable, and reliable: transportable because you can move programs and fixtures from system-to-system throughout the world; repeatable because you get consistent results every time you run a test; and reliable because you can trust the specifications and, therefore, the results. The outstanding reliability of the test systems, 3200 hours mean-time-between-failure, also translates into lower cost of ownership for you.

In addition, these systems all come standard with HP Test Visual User Environment (HP Test VUE) software that combines a graphical, mouse-driven programming environment with powerful test development tools that automate and simplify each step of the test development process.

Scalable

The HP 3070's scalable architecture allows you to add test solutions at any time without buying a new test system. These solutions include HP 3070 VXI tools, boundary scan, panelized board testing, communications testing, concurrent-test–environment (CTE), automation, and increased throughput.

HP 3070 VXI

The HP 3070 VXI board test system products speed integration of VXI and external instruments and reduce instrument programming time through easy-to-use front panels.

Boundary Scan

In-circuit boundary scan software, that generates boundary scan device tests in minutes, comes standard on each HP 3070 system. HP InterconnectPlus software provides comprehensive interconnect, TAP integrity, and silicon nail tests.

Panelized Board Testing

The HP PanelTest software enables the test system to test boards in panels and lowers production testing costs by reducing test development time, improving test throughput, and solving common panel testing problems.

Communications and Serial Testing

The HP communications test platform allows you to emulate serial bitstreams without complex fixture electronics. Completely flexible, the system can also manipulate bits in any serial stream and respond to non-deterministic information in real time. The system tests multiple serial bitstreams in parallel for highest possible throughput.

CTE

The CTE products provide complete integration to Mentor Graphics, allowing you to take full advantage of your design simulation.

Automation

The HP 3070 Express Fixturing System was designed as an integral part of the HP 3070 systems and provides a solid foundation for test workcell automation.

Increased Throughput

The HP Throughput Multiplier software provides up to four independent test modules within a single test system allowing the parallel testing of two, three, or four identical boards.

Upgradable

The 3070 family's modular architecture allows you to select node count, pattern application rate, and any additional software and hardware capability required to meet today's test needs. Upgrade to higher performance, higher node counts, and new technologies to meet tomorrow's needs.

Upgrade your functionality from 6 MP/s to 12 MP/s to 20 MP/s depending on your performance needs. Purchasing a 6 MP/s system now does not lock you out of higher performance; simply add what you need, when you need it.

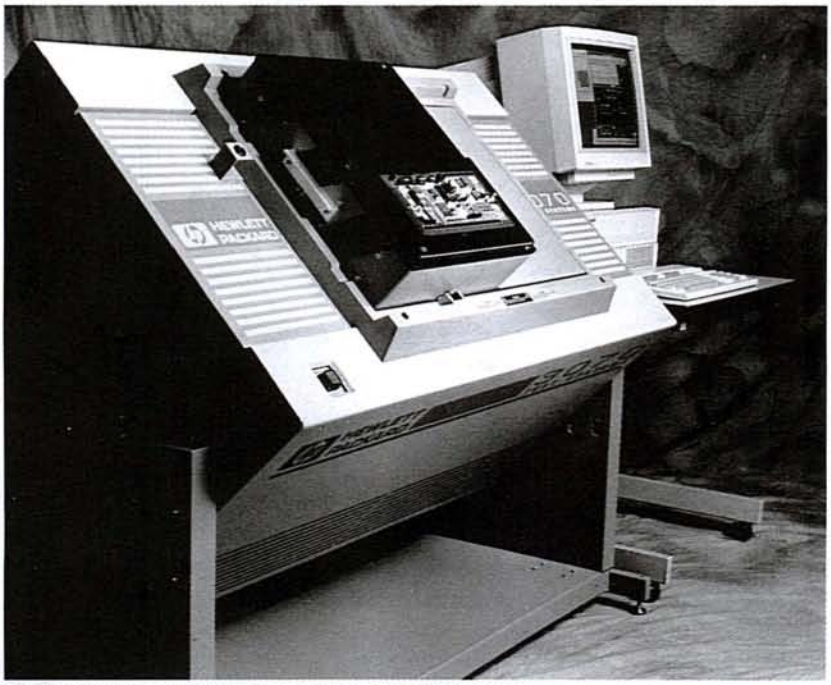
Begin with in-circuit capability now and upgrade to full combinational capability at a later date. Upgrading from functional to combinational tests is also an available option.

The system's modular architecture provides up to four test modules with up to 2592 individually programmable pins, allowing you to expand node count as you need it.

Ordering Information	Price
Systems	
HP 3065 Board Test Systems	start under $100,500
HP 3173 Low-Cost Test System	starts under $100,000
HP 3073 Advanced In-Circuit Test System	starts under $140,000
HP 3175 High-Performance Combinational Test System	starts under $155,000
HP 3074 Functional Test System	starts under $325,000
HP 3075 High-Performance Combinational Test System	starts under $350,000
HP 3079CT Communications Test System	starts under $120,000
Upgrades	
Combinational/Functional Test Upgrade	$25,050
Combinational/In-Circuit Upgrade	$30,000
Hardware*	
HP HybridPlus-6 Card	$9,150
HP HybridPlus-12 Card	$12,050
HP HybridPlus-20 Card	$15,050
HP ChannelPlus Card	$12,450
HP AnalogPlus Card	$4,160
HP AccessPlus Card	$7,115
HP Serial Test Card	$45,050
HP ControlPlus Card	$27,000
Applications	
HP 3070 VXI Tools**	
HP CTE Tools**	
HP Communications Test Tools**	
HP Throughput Multiplier Software	$25,000
HP PanelTest Software	$15,000
HP InterconnectPlus Boundary Scan Software	$35,000

*Trade-in credit is available for some of these products.
**See your HP Sales Representative for option and pricing information.

For Fixturing information, see the *Fixturing Catalog*.
All prices subject to change.



The HP 3070 family offers comprehensive test systems.

POWER-SUPPLY TEST SYSTEMS

Power-Supply Test System

HP E3650B

- Customized for specific applications
- Easy to use
- Standard test packages
- Includes installation, training, and support
- Windows 3.1 software
- HP Vectra 486 PC
- VXI
- Proven reliability of HP instruments

HP E3650B Power-Supply Test System

Each HP E3650B is a complete power-supply test system tailored to the specific needs of a particular application. Each system is custom-built from HP's broad array of rack-mountable instruments. Systems range in size from half-height single bays to three bays wide. The flexible software and hardware architecture of the HP E3650B system allows HP to offer custom solutions for your special test requirements. And with over 25 years of experience building and testing power supplies, HP offers broad expertise in designing power-supply test systems.

A system consists of an HP Vectra 486 PC with HP-IB interface card; software; and one or more racks of instruments that quickly test single or multiple output dc power sources and dc-to-dc converters. The HP E3650B system serves in manufacturing, R&D, and vendor qualification.

The software includes programs for testing a wide array of standard power-supply parameters. These programs minimize or eliminate the need for custom programming. To develop a test for a particular model of power supply, the operator simply enters its characteristics and specifications (voltage and current, for example) into the database tables.

Simple Operation

To execute the test, an operator uses a mouse to select the model from a pull-down menu, chooses the desired operation, and clicks the Run option. All test results are stored in standard format files that can be accessed by a wide variety of data analysis programs. An interconnect panel makes quick, easy, and reliable connections between your product and the test system.

In addition, test-program source files are provided and documented so, if needed, you can customize them. Test programs can also be written using Microsoft Visual Basic or Quick-C. Where necessary, third-party instruments can also be included.

Installation, Training, Support

When your system arrives, it is set up and tested by HP personnel. Two days of training are included so you can begin testing your power products as quickly as possible. Training includes information on how to use the standard software tools, how to edit test specifications, and how to create custom programs and reports. After the training, your system is backed by a one-year on-site warranty and HP's worldwide support network.

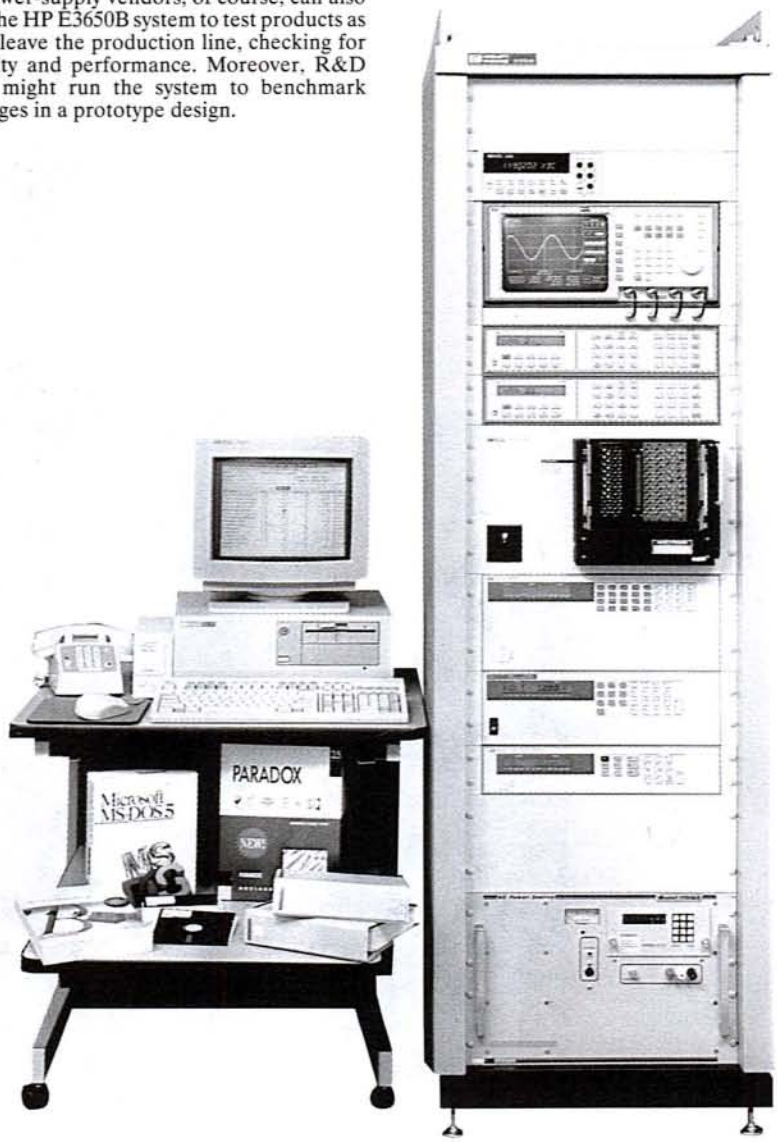
Applications

The value of the HP E3650B power-supply test system extends beyond power-supply manufacturers to any facility that uses power supplies in its product. With the HP E3650B, for example, a user of power supplies can evaluate the units of various vendors to select the best one for the user's own product. Once that choice is made, the user could apply the system to inspect incoming shipments. Or, for manufacturers that build their own power supplies, the test system can check units for quality and performance.

Power-supply vendors, of course, can also use the HP E3650B system to test products as they leave the production line, checking for quality and performance. Moreover, R&D labs might run the system to benchmark changes in a prototype design.

Good Economic and Technical Sense

Buying an HP E3650B power-supply test system is a sound economic and technical choice. Compared to competitors' systems, HP offers the high reliability of instruments that are proven over time. One alternative, building a comparable system, would take time, technological expertise, and internal resources. Although some people do choose to build their own test system, HP can do it faster—and without the uncertainty incurred by building it yourself.



Key Features (Typical System)

- Checks switch-mode and linear power supplies
- Can test several outputs, up to 240 V each
- Monitors digital I/O lines
- Makes differential peak-to-peak noise measurements
- Contains safety interlock
- Windows 3.1 software
- Includes flexible run-control options
- Installed and supported by HP
- Accompanied by two-day training
- Provides for modem-based remote support by HP experts

Hardware List (Typical One-Bay System)

HP 34401 multimeter
HP 54503A oscilloscope
HP 1141A differential probe
HP 665xA power supply
HP 6050A load mainframe
HP 82335A HP-IB interface card
HP Vectra 486 PC with VGA display
Programmable ac source
9600-baud modem
Equipment rack

Software List

HP Power Supply Test Executive
HP Power Supply Test Algorithms
MS-DOS 5.0
Windows 3.1
Microsoft Visual BASIC
Remote-console support software

Specifications (Typical System)

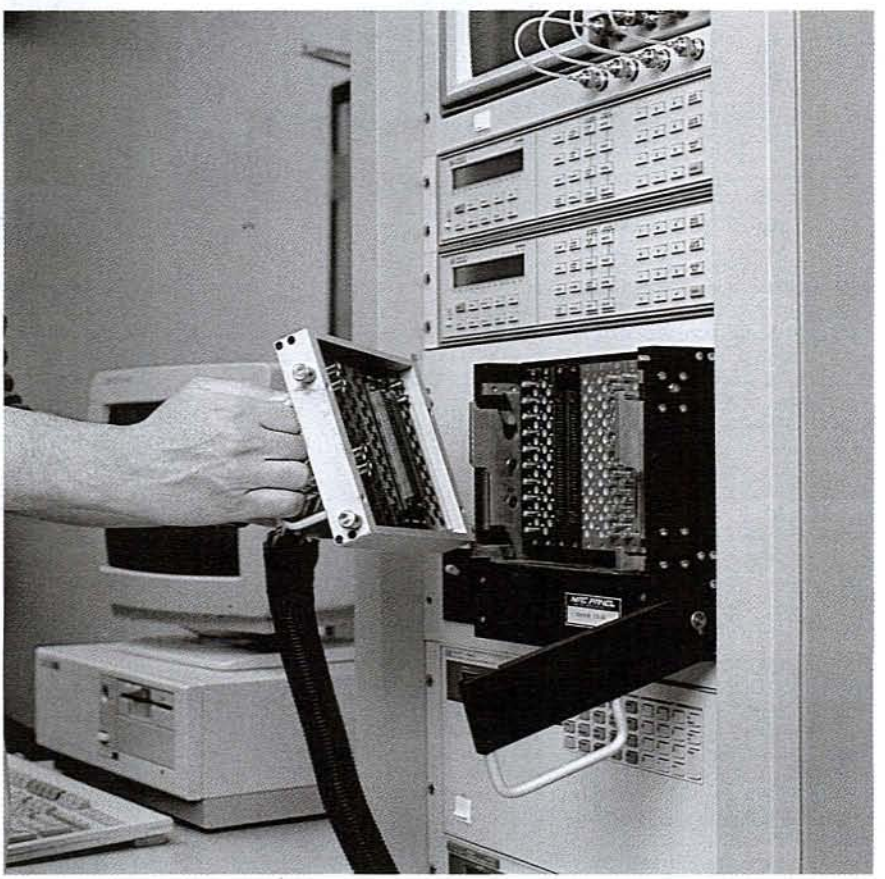
Peak-to-Peak Noise Measurement:
Bandwidth 15 Hz to 50 MHz, ±3 dB
Noise floor (20-MHz BW): 2 mV, typical
General-Purpose Measurements
Cable BW: dc to 2 MHz ±3 dB, typical
Accuracy: Instrument specifications, ±3 μV
Temperature: 0° to 35° C
HP 54503A Oscilloscope
Channels: 4
Repetitive bandwidth (−3 dB): dc to 500 MHz
Sample rate: 20 Msamples/s
Sensitivity: 1 mV/div
HP 1141A Differential Probe
Bandwidth (−3 dB): dc to 200 MHz
Gain: Unity
CMRR: 3000:1 at 1 MHz
HP 34401A Multimeter
dc accuracy: ±0.005%
ac measurements: True rms, 3 Hz to 300 kHz

HP 6050A Load Mainframe
6 slots, 1800 W total
Available modules:
60 V, 30 A, 150 W
60 V, 60 A, 300 W
60 V, 120 A, 600 W (2 slots)
150 V, 50 A, 500 W (2 slots)
240 V, 10 A, 250 W
dc Power Supplies (wide range of models available)
Maximum power output: 25 to 2,000 W
Maximum voltage output: 7 to 500 V
Maximum current output: 0.5 to 220 A
Features: CV and CC operation, V and I readback

ac Power Source
(several models available)
Power output: 1,750 to 4,500 VA
Features: Dual-range output; programmable V, I limit and frequency; cycle drop-out; V, I, and P readback

Ordering Information

For a quotation on an HP E3650B power-supply test system, contact your HP sales representative.



SEMICONDUCTOR TEST SYSTEMS

Test Systems for IC Evaluation, Mixed Signal, and Production Testing

HP 82000 Models D400, D200, D100X, D100, D50

- Up to 400 MHz vector rate
- Up to ±200 ps edge placement accuracy
- Up to 768 channels
- Tester-per-pin architecture
- Automatic functional test generation
- Automatic ac/dc characterization

HP 82000 Maxiframe configuration

DESIGNED FOR HP-IB SYSTEMS

HP 82000 Test Systems

A Family of Compatible Systems

With the HP 82000, Hewlett-Packard offers systems to satisfy the IC evaluation requirements of both IC manufacturers and end users. To address a wide range of applications, four models are available: Model D400 for a maximum vector rate of 400 MHz, and Models D200, D100, and D50 for maximum rates of 200 MHz, 100 MHz, and 50 MHz, respectively.

Model D50

The HP 82000 Model D50 is the ideal choice to test mainstream CMOS devices. ASICs with up to 768 bidirectional signal pins can be verified and characterized with up to ±500 ps accuracy. Critical turnaround times are reduced with the Model D50's automated characterization software, which is also compatible with the other models.

Model D100/D100X

The HP 82000 Models D100 and D100X are designed to test BiCMOS and fast CMOS devices of up to 100 MHz. The edge placement accuracy is ±250 ps (D100: ±350 ps) on up to 512 I/O channels.

Model D200

The HP 82000 Model D200 offers 200 MHz speed and ±250 ps edge placement accuracy on up to 512 I/O channels. It is designed for manufacturers, design centers, and ASIC system designers with fast BiCMOS and bipolar devices.

Model D400

The HP 82000 Model D400 is intended for applications with the most demanding speed requirements. These are typically high-speed bipolar and GaAs devices. The D400 I/O boards can also be mixed and used with D200 boards, thus allowing great application flexibility.

Application Examples

The Standard HP 82000—IC Characterization

To optimize design throughput, Hewlett-Packard developed automatic characterization functions as standard with every system. There are numerous test functions, which provide test patterns and appropriate system setups, and automatically sweep test parameters for complete characterization tests. Measurements of ac and dc characteristics, such as hold time or leakage current, are started quickly from menus and are completed instantly.

HP 82000M—Mixed Signal Testing

The HP 82000M Mixed Signal Test system combines the powerful digital test capabilities of the HP 82000 with state-of-the-art analog test equipment based on VXI. The result is a test solution that reduces the time needed to characterize and test today's complex mixed signal ICs—in audio, video, telecommunications, or computer peripheral applications.

The HP VEE-Test software uses visual "objects" to represent the VXI instrumentation, and thus simplifies the test development process. Pre-written DSP-based test objects allow you to perform many common analog tests (such as INL/DNL, THD, and SNR) with just a few mouse clicks.

You can select from a wide range of HP VXI instrumentation modules to build a system that fits your exact needs, and your budget.

HP 82000P—Production Testing

The HP 82000P production version consists of external testheads, special I/O boards with increased memory depth, and dedicated production software—Production Test Shell. The resulting system reduces test program development time for at-speed testing of complex parts, and reduces test costs.

The Production Test Shell software offers a macro test language capable of setting up test flows, and a hierarchical structure that provides self-documentation. At the same time, an operator can become comfortable with the system in a matter of hours.

The excellent accuracy of the HP 82000P provides tight guardbands for high yield. Up to 2 M vectors behind each pin together with the speed and pincount of the standard HP 82000 guarantee at-speed testing of even complex devices.

Tester-per-Pin Architecture

Timing and level capabilities are provided for every channel without sharing resources. Each channel also has dedicated memory for masking information and can have its own data format (RZ, R1, DNRZ, and so on). All tester channels can be calibrated individually at the device-under-test (DUT) pin. For best results, you can calibrate using the actual test parameter set—giving an edge placement accuracy of ±200 ps for Model D400, ±250 ps for Model D200, ±350 ps for the Model D100, and ±500 ps for Model D50. This is useful when performing fast go/no-go tests, for example, in production.

Best Time-to-Test with Windows System Software

Productivity is increased by a highly interactive user interface based on the X Window standard. The mouse-operated software is used to enter and modify parameters for pin timing and levels, and to modify the vector data. Thanks to the tester-per-pin architecture, parameters can be defined and changed for each channel individually without limitations through shared resources. Error maps, timing diagrams and shmoo plot displays show results in a graphic form familiar to the engineer.

Automatic Test Program Generation

The LAN provides fast access to design workstations from vendors such as Daisy, Mentor, Valid, and HP, and to FACTOR and VERILOG files. Other formats can be adapted by the user during the translation process or with the EDA programming toolkit. The computing power of a 32-bit workstation, and translation programs optimized for speed, maintain high throughput in the automatic test program generation.

Software fully supporting the testers' hardware resources generates a functional device test without user programming. Test vectors, timing setup, and pin setup are generated automatically.

Test Control Includes Scan-Path Testing

To support "design for testability," a scan-path testing mode is integral to the system. The memory of up to 256 tester channels can be serialized via a software command, increasing vector depth on user-selected channels. A programmable vector sequencer has functions such as vector repeat, looping, and branching on real-time test results or external events.

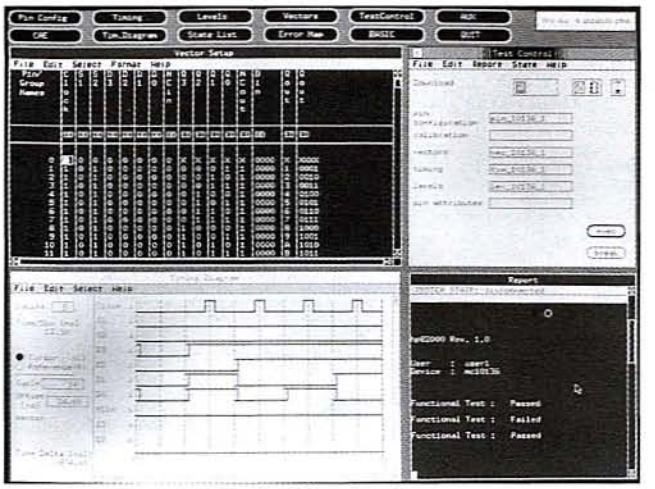
Minimum DUT Wiring

"Instant-wired" DUT boards for the popular pin layouts reduce the time for I/O wiring to zero and are available in various sizes to allow you to optimize board size and cost for the pin count of your DUT. A controlled impedance environment from the testers' I/O circuits to the DUT provides excellent signal fidelity up to 400 MHz. To cover special IC packages, HP also offers boards that provide maximum flexibility for user wiring.

Cost-Efficient Configurations

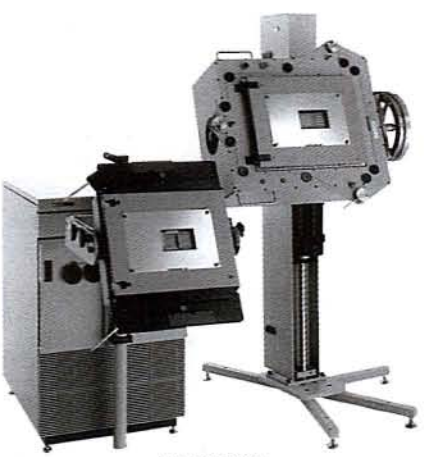
For applications requiring a maximum of 80 I/O pins (160 I/O pins on the model D50), there is a compact benchtop alternative to the standard and maxiframe systems. The system components, including DUT boards, are compatible for upgrades to higher channel counts. With built-in self-test and calibration, on-site board exchange is easy. Expansion to maximum-channel-count systems with uncompromised speed and accuracy is made possible by adding extra mainframes.

For ordering and technical information, technical data sheets and application notes, please contact your nearest HP sales office.



Standard User Interface

HP 82000M



HP 82000P

HP 82000 System Characteristics

	Model D400	Model D200	Model D100X	Model D100	Model D50
Vector rate	400 MHz	200 MHz	100 MHz	100 MHz	50 MHz
Vector depth	1024/K	2048/K	1024/K	1024/K	1024/K
Max. I/O pin count	512	512	512	512	768
Timing resolution	50 ps	50 ps	50 ps	50 ps	100 ps
Edge placement accuracy					
at standard calibration	±500 ps	±500 ps	±500 ps	±600 ps	±800 ps
at calibrated user settings	±200 ps	±250 ps	±250 ps	±350 ps	±500 ps
Level range	−4 . . +8 V −4 . . +5 V (400 MHz RZ channels)	−4 . . +8 V	−4 . . +8 V	−4 . . +8 V	−2 . . +7 V

Architecture: Tester-per-pin with individual timing and level resources, including per-pin formatting, compare mode (edge/window), tristate, masking, and channel modes.

PMUs: Available as plug-in boards, 1 pair per card cage.

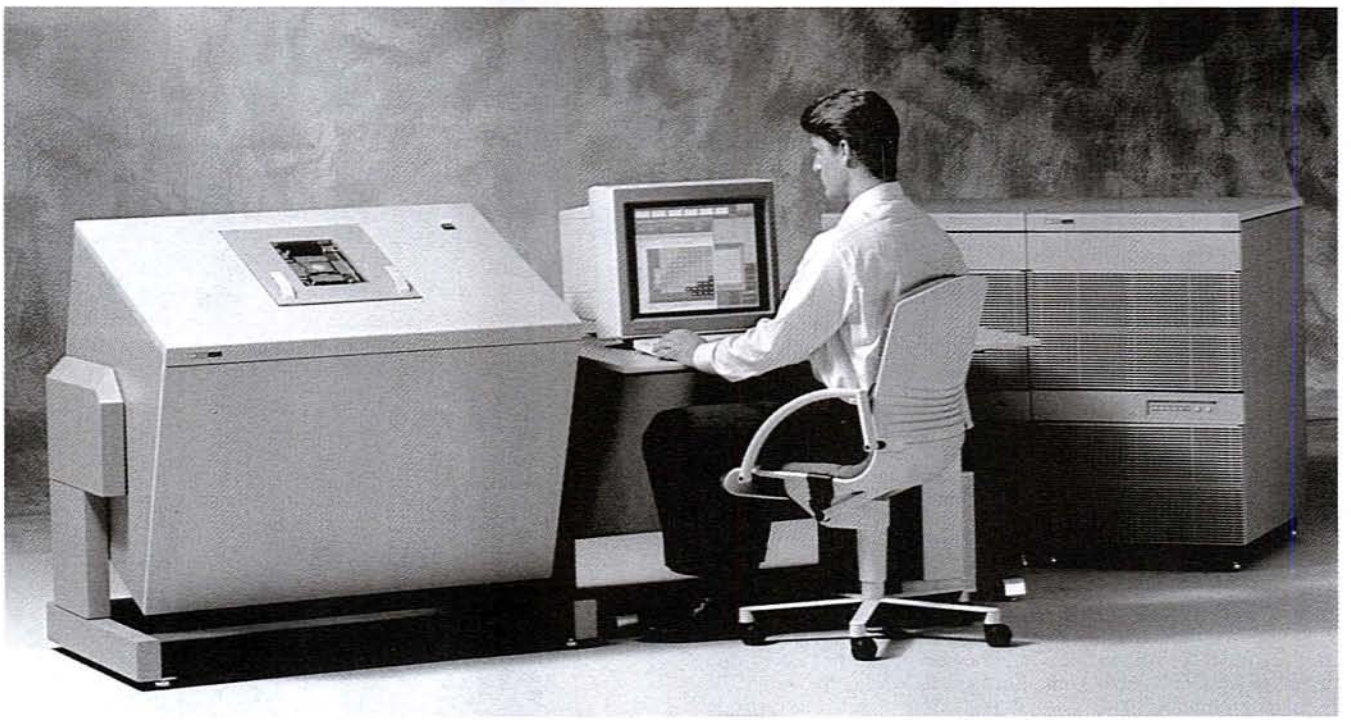
Software: Interactive X Window environment, automatic tests and ac/dc characterization, color graphics result windows.

SEMICONDUCTOR TEST SYSTEMS

Digital Test System

HP 83000 Model F660

- Speed of 660 MHz
- Pincount up to 1024
- Accuracy of ±50 ps
- Vector memory of 1 M/4 M



HP 83000 Model F660

NEW

DESIGNED FOR HP-IB SYSTEMS

HP 83000: Meeting Today's Testing Challenges

New technologies accelerate the development of new designs. Competition forces faster "time-to-market" and leads to shortened design cycles, which make top-performance test equipment essential. In addition, the increasing frequency, complexity, and pincount of digital devices increase the need for testing to the limits. Meanwhile, the economics of the marketplace oblige you to keep capital cost and cost of ownership as low as possible.

Top Performance at the Right Price

The HP 83000 Model F660 digital test system provides a means of meeting these challenges.

- The system's 50 ps measurement accuracy gives you confidence in test results.
- The system's 660 MHz, true tester-per-pin architecture, and 512 pins, allow most technologies to be driven to the limits in applications designed for prototype verification characterization failure analysis production testing.
- The system is cost effective.

Shorten Design Cycle

The system's X Window-based software offers a complete set of debugging tools that let you easily check any design. A wide range of automatic test functions provides a fast and convenient way of measuring parameters. The system intuitive user interface creates easily production flows.

Reduce Test Cost

The system's fast optical interface and data compression techniques reduce loading time. 4 MB memory, together with change timing, levels, and formats during test, maintain device throughput. The high 50-ps measurement accuracy allows you to set tighter guardbands and in this way increase yield.

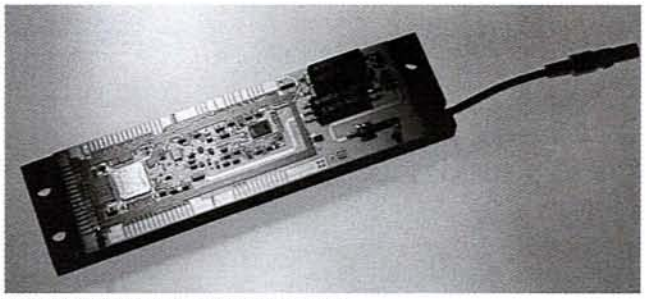
The Future Built In

Use of the latest technology, modular I/O design, liquid cooling, memory upgrades, and expansion to 1024 pins ensures high reliability, optimizes return on investment, and gives you a long-term commitment to staying on the leading edge.

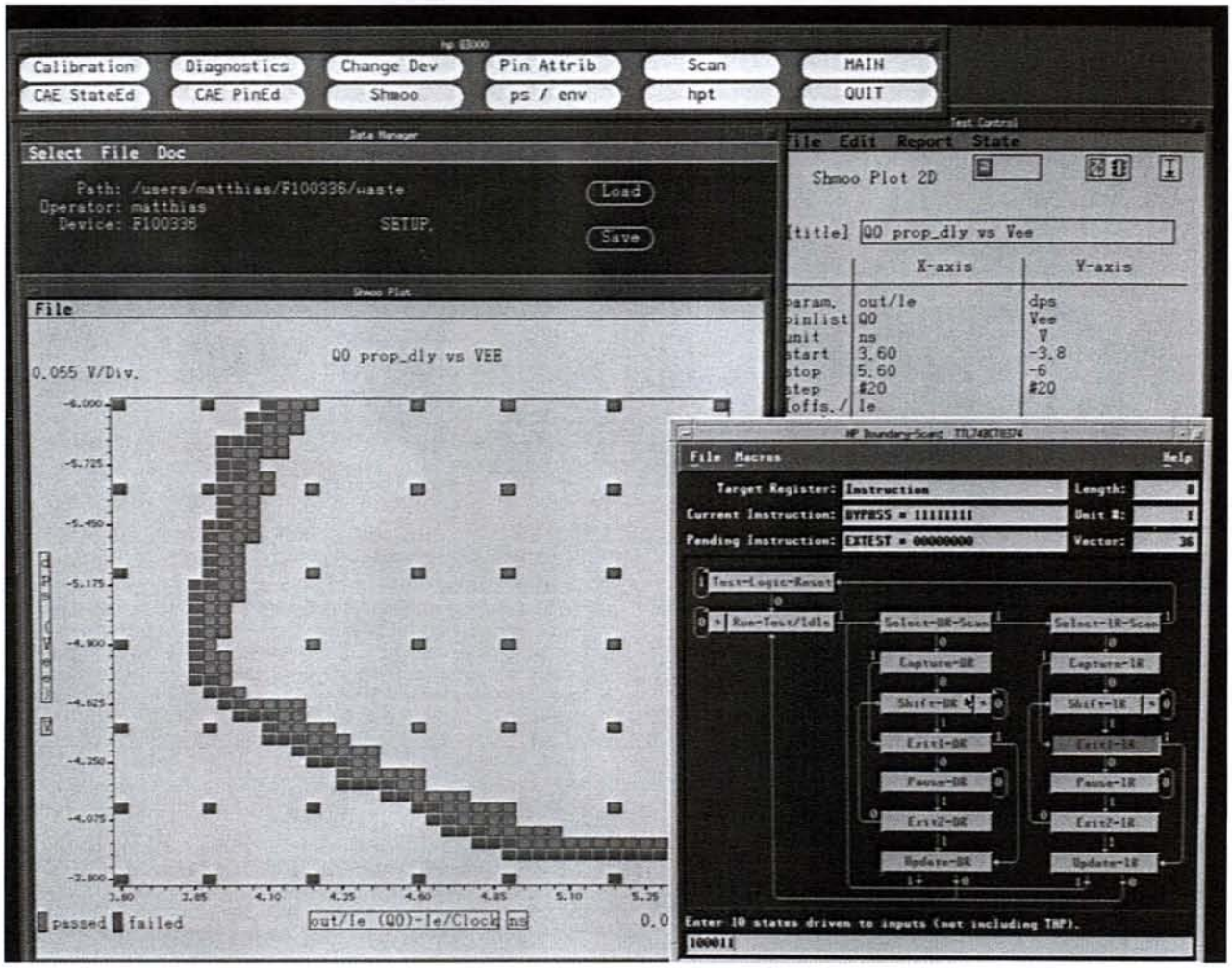
Expertise and Commitment

The compatibility of HP 82000 and HP 83000 systems in existing setups, test functions, and DUT boards provides security for current users and a growth path for the future.

Hewlett-Packard offers a total solution with a range of services including telephone support, user training, hardware support, and a variety of financial and consultation services to fit any budget.



Hybrid of driver with pin electronics



Multiwindow environment

HP 83000 Model F660 System Characteristics

50-ps accuracy
660 MHz
10-ps resolution
Up to 512 pins
1-M or 4-M vectors
Tester-per-pin architecture
X Window user interface

For technical information, brochures, datasheets, and application notes, contact your nearest HP sales and support office.

SEMICONDUCTOR TEST SYSTEMS

Power Mixed Signal Test System

HP 9472 Series

- Menu-driven software
- C program development environment
- ± 1500 V
- ± 100 A
- 32-channel analog cross-point matrix
- 32-digital I/O at 10 MHz, with ±600 V fault protection
- Low-level measurement capability (< 5 μV, < 1 pA)
- Time ± 1 ns (100-ps resolution)

HP 9472 test system with TH-200 and TH-300 test heads

HP 9472 Test System

The HP 9472 is a general-purpose modular and field-configurable test system. The system can be configured to test a host of power mixed signal, hybrid, and analog device types including motor drivers, automotive circuits, medical electronics, high-side switches, voltage regulators, power supply controllers, analog switches, op-amps, timers, and comparators. It can handle voltages up to ±1500 V and currents up to ±100 A. The system supports up to 32 analog channels and up to 32 digital I/O pins, and features low leakage measurement capability (pA), inductive load testing, instrument-level diagnostics, networking, time measurement, and menu-driven software with compiled C language test libraries.

Benefits

- Immediate production solutions • High throughput
- Versatile, reconfigurable linear architecture • Low cost of test

HP 9472 System Overview

The HP 9472 is designed to provide quality production testing at an economical cost. The system controller, an 80386/25-MHz PC with a high-speed instrument control bus, is complemented by RS232C and optional IEEE-488 and Ethernet interfaces. The mainframe houses four-quadrant, 16-bit voltage/current (VI, force/measure) resources, an NIST traceable calibration standard, and high-voltage relay matrix. All mainframe resident resources are 3-wire Kelvin connected (force, sense, and driven guard) through the 1000 V/2 A cross-point matrix to one or two test heads. For additional capability, the system can be easily expanded with a second bay.

Operating System

- Interactive hardware debugger with soft curve tracer
- Context-sensitive help
- Offline program development
- Built-in statistical analysis
- Compiled macro language for user interface control
- Optional networking

Configurable Test Head

The TH-300 Test Head integrates power, high voltage, small signal, time measurement, and flexible digital test capability in one compact test head environment. Up to 14 instrumentation modules can be located close to the DUT for improved accuracy, high-throughput, and single-pass testing. Both precision analog and digital options are available. The test head is designed to allow straightforward interfacing to external instruments. It is also designed for easy field reconfiguration. Signals of all types can be connected to the DUT via a modular DUT interface that may be configured as demanded by the application.

Low-Cost, Dedicated Test Head

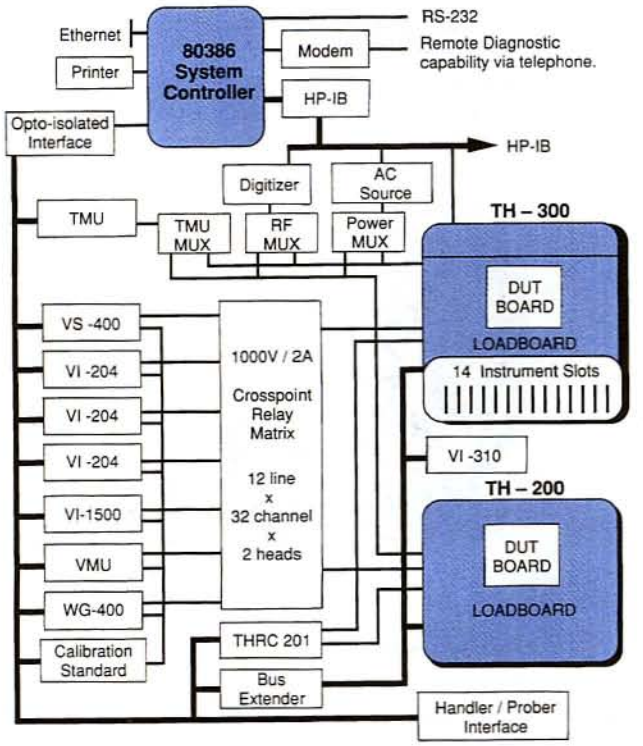
For high-volume, lower complexity applications, the TH-200 test head can provide an economical solution. The TH-200 supports 16 mainframe analog channels (1000 V/2 A), 16 relay control lines for user-configurable circuitry, and standard loadboard power supplies (±5V, ±15V, +12V). Many versatile loadboards and DUT interfaces are available.

Menu-Driven Software

An interactive menu-driven environment affords an efficient approach to program generation and debugging. The main menu allows the user to quickly select operating modes, such as program generation, program debug, system operation, system diagnostics, real-time report generation, and utilities, all of which offer context-sensitive help.

Device Types Tested

Power mixed signal devices tested include power conversion devices, offline and monolithic power supplies, automotive circuits, industrial control devices, and high side switches. Standard linear devices are also tested, including op-amps, comparators, voltage regulators, low side switches, and analog switches.



System architecture, shown with available options

HP 9472 Basic System

• Single bay cabinet • 80386 system controller • 80387 math co-processor • Choice of printers • Color monitor • 84-MB hard disk • Floppy disk • Opto-isolated interface • Handler interface • System interface • Test head control (32 relay drivers, 32 static digital drivers/receivers per test head) • Differential voltmeter (16-bit, 1000-V range) • NIST traceable autocalibration • Optional IEEE-488 • Menu-driven system software • Instrument level diagnostics • Program libraries • Choice of test heads • Documentation • Optional networking • Installation

Optional Mainframe Resources

VI-204: Four quadrant force, clamp, measure VI, 16 bits up to ±50 V, ±2 A
VI-310 EP: Four-quadrant, floating, programmable pulsed, high-current up to ±100 A, at up to ±20 V
VS-400: Four-quadrant, programmable ±50 volt outputs, 2 channels at 2 A max, 2 channels at 500 mA max
VI-1500: High-voltage programmable four-quadrant VI, up to ±1500 volts, up to ±200 mA
RM-201: Cross-point relay matrix, 12 input by 8 output channels; each channel has force, sense and driven guard, 1000 V/2 A rated
WG-400: Dual source arbitrary waveform generator, 2 megasamples per second, 64 K of memory per channel
IEEE-488: HP-IB interface and software for additional instruments

Optional Time Measurement Instrumentation

TMU-100: Time measurement unit, ±1.0 ns accuracy
WD-200: Waveform digitizer, real-time viewing, storage, and analysis of wide bandwidth complex signals

Optional Test Head Resident Instrumentation

Analog
TMM: 16-channel time measurement unit signal conditioner
HVPA: High-voltage, low-current VI source (±110 V, ±10 nA to ±10 mA)
OPA: High-performance op-amp loop card
FPT: Floating time measurement probe with ±1000-V float range and 50-V pulse generator
FVI: Floating ±36V/±500 mA VI with ±1000 V float range

Digital
PPG: 100-MHz pulse pattern generator
OPE: 8 channel 10 MHz digital, octal pin electronic drivers (±15 V)
Power Digital: 10 MHz digital, expandable in groups of four to 32 I/O, (−5 V to +20 V) pin electronics, fault-protected up to ±600 V

Ordering Information

Please call your local HP sales office for a data sheet, prices, and application assistance.

Power Discrete Test System

HP 9470 Test System

- Lower-cost alternative
- Up to 16 channel 1000 V/2 A relay matrix
- ±1500 V VI force/measurement instrument
- ±100 A VI force/measurement instrument
- Power switching time test capability

Device Types Tested

• Bipolar transistors • MOSFETs • IGBTs • Opto-couplers • Photo logic • Photo-interrupters • Rectifiers and bridges • SCRs, triacs • Diacs • Sense FETS • Solid-state relays • Switch mode controllers • Voltage regulators

HP 9470 System Overview

The HP 9470 uses a linear test system architecture and is driven by an 80386 controller with a math coprocessor running MS-DOS; 4 MB of RAM; and choice of line printer, hard disk, floppy disk, serial port, and parallel port. It also includes a real-time test operating system with menu-driven program generation. Using the concept of a program library, a new program can be generated in less than an hour. The HP 9470 test system is easily configured for today's applications in the low-cost electronic test marketplace with expandability.

TH-200 Test Head

For high-volume, lower-complexity applications, the TH-200 provides an effective solution. The TH-200 supports 16 mainframe analog channels (1000 V/2 A), 16 relay control lines for user-configurable circuitry, and standard loadboard power supplies (±5 V, ±15 V, +12 V). Many loadboards are available.

HP 9470 System Features

• One or two test heads • Single bay cabinet • 4 to 16 analog channels (force, sense, and driven guard) • Low-leakage 1000 V/2 A cross-point matrix • Voltages up to 2000 V • Currents up to ±100 A • 16 static digital drivers/detectors and 16 relay drivers per test head • Differential voltmeter (16-bit, 1000-V range) • NIST traceable autocalibration • Powerful binning and branching capability • Handler/prober interface • Instrument-level diagnostics • Report generation • Menu-driven software • Turnkey device libraries • Installation • Optional IEEE-488 • Optional networking

Optional Mainframe Resources

VI-204: Four-quadrant force, clamp, measure VI, 16 bits up to ±50 V, up to ±2 A
VI-310 EP: Four-quadrant, floating, programmable pulsed, high-current force, clamp, measure VI, up to ±100 A, up to ±20 V
VI-1500: High-voltage programmable four-quadrant VI, up to ±1500 volts, up to ±200 mA
RM-200: Cross-point relay matrix, 12 input by 4 output channels, each channel has force, sense, and driven guard, 1000 V/2 A rated
TMU-200: Time measurement unit, ±1.0 ns accuracy
IEEE-488: HP-IB interface and software for additional instruments
Networking: Optional

Ordering Information

Please call your local HP sales office for a data sheet, prices, and application assistance.

SEMICONDUCTOR TEST SYSTEMS

Isolation Voltage Testers

HP 9460 and 9464

HP 9464 integrated with a tube-to-tube DIP handler

- UL isolation voltage testing with HP 9460
- VDE-0884 isolation voltage testing and partial discharge detection with HP 9464
- 0 to 7.00 kVac with programmable test times
- 0 to 9.99 kV peak with programmable test times
- 0 to 50.0 μA leakage threshold
- 0 to 50 picocoulomb (pC) partial discharge threshold

HP 9460 or HP 9464 manual configuration

HP 9460 Isolation Voltage Tester

The HP 9460 Series testers are isolation voltage testers for UL-approved testing. They are designed to test the input-to-output and lead-to-case isolation voltage of opto-couplers (DIP) and isolated case power packages (isolated TO-220) used in the power semiconductor industry.

Complete Operator Control

Controls are provided for device leakage and high-voltage/low-limit thresholds. LEDs indicate PASS/FAIL and the type of failure. Safety interlocks protect the operator from contact with the high test voltages.

Leakage Detection

The testers sense excessive leakage currents in the device under test. The HP 9460 is in compliance with Underwriters Laboratories (UL) test methods leakage testing.

Nondestructive Testing

The HP 9460 prevents destruction of a device if leakage at a given voltage causes the discharge of stored energy. The test circuitry features negligible stored energy and a current-limiting design that prevents damage to devices that fail. Voltages are applied to the DUT at the ac zero crossings and a solid-state switch cuts off the test voltage.

Bench Top Version

The manual version is ideal for incoming inspection, sampling, and laboratory analysis.

Multiple Handler Options

For production applications, the testers can be factory integrated with an automatic handler. Typical throughput is 2000 to 2400 units per hour with one-second programmed test time.

Specifications

Voltage Range: 0 to 7.00 kVac
Voltage Accuracy: 2%
Leakage Threshold: 0.0 to 50.0 μA
Current Accuracy: 2%
Open Socket Leakage: <1 μA at 7.00 kVac

Ordering Information

Please call your local HP sales office for a data sheet, prices, and application assistance.

HP 9464 Isolation Voltage and Partial Discharge Tester

The HP 9464 Series testers are isolation voltage and partial discharge testers for VDE-0884 approved testing. They are designed to test the input-to-output isolation voltage and partial discharge of opto-couplers.

Complete Operator Control

Controls are provided for device leakage, partial discharge, and high-voltage/low-limit thresholds. LEDs indicate PASS/FAIL and the type of failure. Safety interlocks protect the operator from contact with the high test voltages.

Leakage and Partial Discharge Detection

The testers sense both excessive leakage current and partial discharge in the device under test. The HP 9464 is in compliance with VDE-0884 test methods for partial discharge testing.

Nondestructive Testing

The HP 9464 has an optional nondestructive mode that prevents destruction of a device if leakage at a given voltage causes the discharge of stored energy.

Automated Production

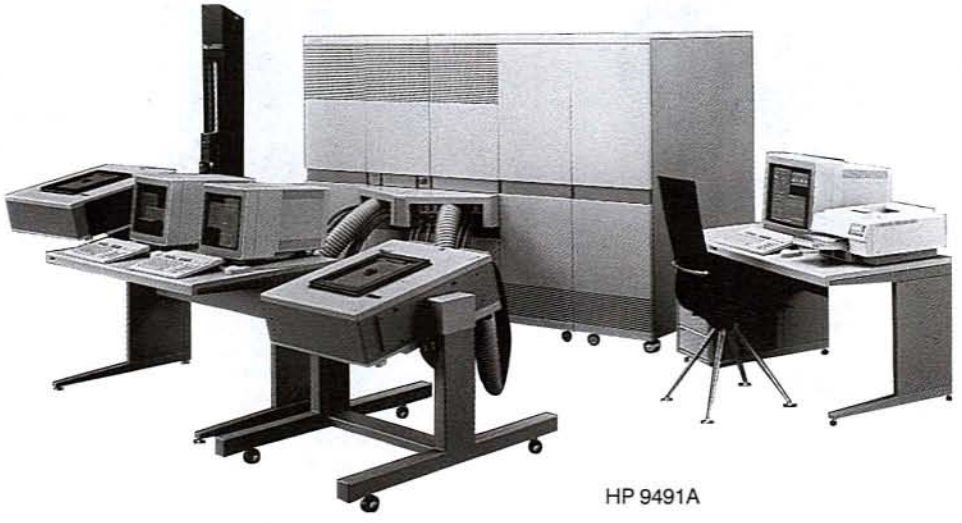
For production applications, the testers can be factory integrated with an automatic handler. Typical throughput is 2000 to 2400 units per hour with 1-second programmed test time. An automation kit allows the user to interface the voltage isolation tester to the auto-handler or robotics of his choice. The kit includes an HP 9464, an opto-isolated handler interface, a verification fixture, 24-in cable set, and optional 5-pC calibrator (required for VDE-0884 testing). The front panel is reversible to allow the system to be mounted in either a horizontal or vertical position.

Specifications

Voltage Range: 0 to 7.00 kVac, 9.99 kV peak
Leakage Threshold: 0.0 to 50.0 μA
Open Socket Leakage: <1 μA at 7.00 kVac
Partial Discharge Delay: 0.1 to 9.9 seconds
Partial Discharge Threshold: 0 to 50 pC
PDC710V Partial Discharge Calibrator
Range: 0 to 9 pC at up to 4.00 kVac
Resolution: 1 pC

HP 9490 Series

- Tester series for engineering and production use
- Mixed-signal control function
- Real-time digital signal processing
- High throughput via per-pin dc and dual CPU architecture
- Test vector generator per-pin digital test capability
- Application-oriented software



HP 9491A

HP 9490 Mixed-Signal LSI Test System

Mixed-signal devices promise to become an important segment of the semiconductor world. Due to advances in communications and computer technologies, for example, these devices make it possible to realize smaller and more convenient phone systems, advanced television systems, and multimedia systems.

The HP 9490 Mixed-Signal LSI Test System series provides tester capability to achieve full mixed-signal test coverage with a series of systems: HP 9491A and HP 9492A.

Series Concept

To develop complex test applications for mixed-signal devices is usually a very time-consuming process. After the test program has been developed for device evaluation, it can then be modified for production testing, which also requires time. The HP 9490 uses the series concept to reduce both of these times, thus providing the best solution to shorten time-to-market and reduce test costs.

With the HP 9490 series, you can use the high-end tester to accelerate new device development, then you can transfer the test program to the production tester, without changes. The HP 9491A has a wider frequency and a more dynamic range than the HP 9492A, making the HP 9491A a good fit for engineering design and device evaluation. The HP 9492A features a small footprint and lower system cost, which is important for production testing. These two HP 9490 series systems share a common architecture, so the test programs and DUT boards are completely compatible.

System Architecture

The HP 9490 Mixed-Signal LSI Test System series combines not only high-performance digital and analog test functions, but also complex mixed-signal control functions. Using Synchro-Pipe to control complex mixed-signal event synchronization, digital and analog modules can trigger each other, even under asynchronous timing conditions set by dual master clocks.

Real-time digital signal processing can modify or analyze signals, without consuming a huge amount of waveform memory. The testheads can support a maximum of 128 digital input/output channels with per-pin test vector generation. With the dual CPU architecture, test development and device testing can be performed concurrently.

The HP 9490 Series maintains a consistent, advanced architecture from the higher-performance HP 9491A to the cost-effective HP 9492A. Even with full system functionality, the HP 9492A system cabinet footprint is only 1.21 m^2 (3.97 ft^2) for a 64-pin system.

Event Synchronization

Recently, mixed-signal devices have become increasingly complex, making them difficult to test without event synchronization technology. For example, testing some telecommunications devices without event synchronization technology means that the tester cannot control device signals adequately.

The HP 9490 Series solves this testing issue by using HP's advanced Synchro-Pipe architecture combined with a dual master clock architecture. In this architecture, the master sequencer executes a sequence program to control events, such as the input/output of analog and digital signals. Each event is synchronized with a particular clock provided by the test system or the device. In brief, Synchro-Pipe is a trigger and flag highway that acts as a control path between modules.

Real-Time Digital Signal Processor (DSP) Architecture

Additional mixed-signal test challenges demand advanced hardware to test devices such as ISDN or Modem ICs. In the HP 9490, the real-time DSP architecture realizes the tests of these ICs easily.

Real-time DSP modules are available for arbitrary waveform generators (AWGs), digitizers, and digital functions. For example, a real-time DSP module used with a digitizer can analyze extremely long digitized analog waveforms, including jitter. After the waveform is digitized by the digitizer, the real-time DSP module processes the data immediately. The real-time DSP function not only emulates the actual operating conditions of the device, but also reduces the required waveform memory and test time.

Mixed-Signal Testing

Digital Test Functions

The HP 9490 series provides system pin counts up to a maximum of 128 digital pins to test ICs.

To simplify links with a CAE system, the HP 9490 adopts a per-pin architecture. To store long test patterns, each test vector generator (TVG) has a maximum 1-megaword (8-bit word) pattern memory. For capturing high-speed digital signals, each TVG provides a maximum 1-megaword (2-bit word) capture memory.

Each TVG has six timing edges for waveform control. The system is designed to allow flexible generation of digital test patterns with various formats.

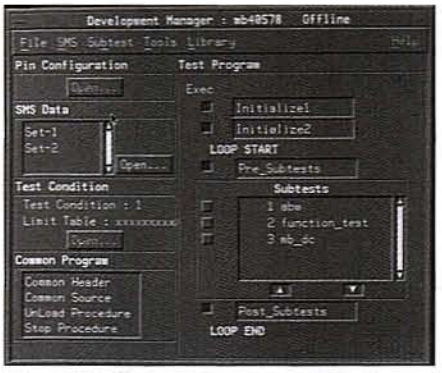
To evaluate mixed-signal devices, the required data rates sometimes exceed 100 MHz, especially for high-frequency video or data communications devices. The HP 9491A's maximum 128-MHz data

SEMICONDUCTOR TEST SYSTEMS

Mixed Signal LSI Test System (cont'd)

HP 9490

HP 9492A



Development Manager Window

rate is ideal for device design and evaluation; the HP 9492A's maximum 32-MHz data rate is optimized to address most production applications.

For high-speed converter testing, the pure clock generator (PCG) of the HP 9491A can generate a 128-MHz clock with low jitter.

Analog Test Functions

Based on high-speed transient waveform measurement experience, Hewlett-Packard developed a sampler system for accurate sampling of HF to VHF signals and has applied this expertise to the HP 9490 Series. The sampler has 12-bit resolution and a 1-GHz bandwidth.

The 16-bit digitizers and 16-bit and 18-bit AWGs provide low-distortion test capability at lower frequencies. These modules are useful for testing audio, telecom, and generic low-frequency mixed-signal ICs.

To generate high-speed analog signals, HF and VHF AWGs with 12-bit resolution are available. For complex devices used in advanced TV or video systems, a 12-bit AWG with 128-MHz maximum data rate can address the majority of applications.

Each AWG and digitizer module has deep waveform memory (up to 1 megaword) to generate or capture complex, modulated signals. To fit the test needs, the system provides low-cost analog modules, such as 12-bit 30-MHz AWGs, 16-bit 100-kHz digitizers, and 12-bit samplers with 128-MHz bandwidth.

With the HP 9490, system noise has been minimized by using low-noise power supplies and optical data links. All analog test functions have been carefully selected to meet the needs of mixed-signal device testing now and in the future.

dc Test Functions

To improve yield, a greater number of dc test items are required. So, accelerating the dc test throughput is a critical issue. The HP 9490's dc test-function architecture provides per-pin voltage source/current measure and per-pin current source/voltage measure. These functions increase test speed via parallel dc setting and measurement. For other dc test needs, more capability is available through the universal dc test unit (40-V range) and the wide-range dc test unit (200-V range).

Advanced Test Development and Execution Environment

Shorter test development times make a significant contribution toward reducing test costs. The HP 9490's advanced environment for test development and execution is a total, applications-oriented environment designed to minimize test costs.

Application Development Environment

To allow efficient development of mixed-signal device test applications, software with an advanced visual user interface is necessary. The HP 9490 application development environment (ADE) provides an interactive, structured, and application-oriented approach to test development. Keyboard-free operation allows rapid test development for a variety of mixed-signal devices.

Over one dozen powerful tools—including various monitors, editors, and debuggers—are available. For example, the Development Manager supervises the creation and flow of test programs in a logical, straightforward manner. The Synchro-Monitor displays analog and digital signal relationships graphically. The Intrinsic Panel offers an approach to create test programs that require minimal typing and minimal reference to manuals. Even if a user is not familiar with the operating system or programming language, these tools can shorten the program development cycle.

Offline development reduces the hardware cost of a test system. Hardware and device simulation capabilities provide a virtual test system environment. Data created by the Waveform Editor or previously captured data can be used to simulate actual device output for offline program debugging.

Test Execution Environment (TEE)

On the production line, the test operator oversees the test process while the production engineer must report the test results. The HP 9490 provides a total, consistent environment for test execution.

The HP 9490's series concept means that the same DUT board and test program can be used on the HP 9491A and the HP 9492A. This saves engineering costs, because applications do not need to be modified when they are transferred to the production line. After the test program has been transferred, the HP 9490 Test Execution Manager can be used to select the desired subtests and to change test limit values, data log conditions, and prober or handler settings, without any changes in the main test program.

The Snapshot Test Report can be used to neatly summarize test data for the production line. For system maintenance, the HP 9490 offers diagnostic software and tools to perform system checks and calibration, which can isolate faulty modules quickly.

Network Capability

For improving productivity, the construction of a tester network is considered critical. The standard HP 9490 system has a dual CPU architecture: a user interface processor (UIP) and a tester controller (TC). The UIP is used for user interface activities and supervising other test systems. In addition, by using basic network functions, the UIP can be a gateway to CAE or data management systems.

System Specification Summary

HP 9490 Series

Maximum 128 digital I/O channels
1-megaword memory (max) for each pin
12-bit/128-MHz, 18-bit/1-MHz AWGs
12-bit/30-MHz, 16-bit/500-kHz AWGs
16-bit/1-MHz, 12-bit/20-MHz digitizers
16-bit/100-kHz digitizer
1-GHz bandwidth/12-bit, 128-MHz bandwidth/12-bit samplers
Synchro-Pipe (mixed-signal control line)
Per-pin dc test
ADE, TEE software

HP 9491A Mixed-Signal LSI Test System

128-MHz maximum data rate for digital testing

HP 9492A Mixed-Signal LSI Test System

32-MHz maximum data rate for digital testing

- 128-MHz analog and digital synchronized testing
- 1-GHz bandwidth, 1-ps sampling resolution
- ac testing at the wafer level
- Digital Signal Processing (DSP)-based system
- High test throughput modules
- Flexible modular architecture
- Powerful debugging tools
- Distributed workstation environment

HP 9480 Analog LSI Test System

The HP 9480 Analog LSI Test System integrates powerful test hardware and software to perform precise high-frequency signal measurements. You can use the HP 9480 to test and characterize a wide variety of devices, from mixed signal devices such as flash ADCs, video DACs, telecommunication devices, and so on, to purely analog or purely digital ICs. The HP 9480 provides full data sheet test coverage in a single insertion, thus eliminating the problem of time-consuming and costly multiple insertion testing. The HP 9480 can also perform high-frequency ac tests on wafers.

The HP 9480's modular architecture allows you to combine many state-of-the-art hardware and software features into a configuration that best suits your measurement needs. The system can generate digital stimulus patterns and analog stimulus waveforms up to 128 MHz and it can capture DUT digital response patterns up to 128 MHz. For analog DUT response, the system offers 16- and 12-bit real-time waveform digitizers and 1-GHz bandwidth samplers with 1-ps resolution. The system also offers 18-, 12-, and 10-bit arbitrary waveform generators. Digital patterns, dc voltage, and dc current can be input or output to up to 128 pins. Analog signals can be input or output using up to four channels each. Digital Signal Processing (DSP) allows complex waveform generation and high-speed signal analysis via a full floating point array processor. The HP 9480's system software is based on the HP-UX operating system. Powerful debugging tools, including an offline debugger, virtual panel, and virtual scope, significantly minimize debugging time. Furthermore, HP 9480 software is easy to operate because it incorporates menus, a user-friendly multiwindow environment, and mouse capability. These features increase test throughput and minimize time spent on program development.

SEMICONDUCTOR TEST SYSTEMS

Analog LSI Test System (cont'd)

HP 9480

Hardware

Device Testing Under In-Circuit Conditions

The HP 9480's analog and digital signal test capability enables you to test the dynamic parameters of devices under their true operating conditions. The HP 9480 can also perform high-frequency tests on wafers because of its coaxial cable environment and very low system noise.

For ac signal stimulus, the HP 9480 generates low-distortion sine waves (up to 128 MHz), arbitrary waveforms with 12-bit resolution (up to 128-MHz clock rate), and arbitrary waveforms with 18-bit resolution (up to 1-MHz clock rate). For recording high-frequency signals up to 1 GHz, with 12-bit resolution, the system offers four sampler channels that sample a signal with 1-ps resolution. For recording signals in real time, the system offers two choices—20-MHz/12-bit and 1-MHz/16-bit digitizers. For digital testing, the system offers up to 128 I/O pins, and features 64 kword memory for each pin. The system can generate digital stimulus patterns and clocks, and it can analyze response patterns from the test device at a data rate of 128 Mwords/s with 100-ps resolution. And because the HP 9480 can synchronize analog waveforms with digital signals and automatically execute timing adjustments, you can perform precise tests on mixed signal devices under actual operating conditions.

Digital Signal Processing (DSP) Technology

The HP 9480 uses digital signal processing to generate and analyze analog and digital signals.

For example, you can easily and quickly modify and create waveforms in the frequency domain by using FFT commands. The HP 9480 can easily synchronize analog signals with system clocks because the waveform data is recorded into system memory. Multiple parameters such as THD, SNR, differential nonlinearity, etc., can be extracted from the recorded data without running the test again. A 32-bit full floating point array processor minimizes system controller loading by performing complex matrix computations for digital signal processing. DSP technology shortens test times by allowing multiple parameter extraction from a single test, and it minimizes hardware costs because analog and digital processing are performed by the same modules.

Modular Architecture

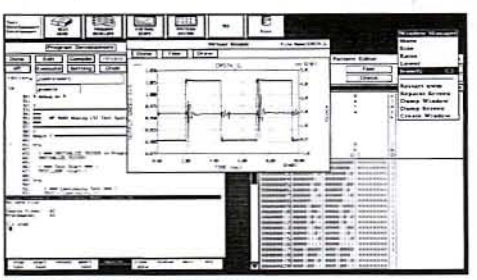
The modular system architecture of the HP 9480 allows easy adaptability to your changing test needs. This means that the system's usefulness and value are maintained well into the future because system upgrades and enhancements are easy and cost-effective. Also, maintenance costs are minimized because only faulty modules need to be repaired or replaced in the event of a system malfunction.

High Test Throughput

In addition to the high-speed testing resources, the dual test head system contributes to increased test throughput. For an ADC characteristic test, the Histogram Accelerator is available to reduce the test time by a factor of 60.

Software

HP 9480 software is based on the HP-UX operating system and operates on HP 9000 Series 300 engineering workstations. HP-UX is fully compatible with standard UNIX systems and incorporates an advanced multiwindow system with a mouse and pop-up menus. This provides graphics-oriented test development, testing, and data analysis environments, which facilitate smooth and efficient operation.



Multi-Window Environment

You can easily set up conditions and values for test execution and data analysis with the HP 9480's fill-in-the-blanks format. You simply enter the appropriate information into the mask fields displayed on the screen.

Test Development

The HP 9480 features two debugging modes and three useful tools for you to use the test hardware effectively and reduce the amount of time spent on test program development.

The debugging modes available are offline and the standard online debugging. A hardware simulator is used with offline debugging. Therefore, offline debugging and device test execution can be performed at the same time because the test hardware is not used for offline debugging. This guarantees efficient system utilization.

Available tools are the symbolic debugger, virtual panel, and virtual scope. The symbolic debugger offers a number of features that enable the user to debug at the source code level. The symbolic debugger decreases debugging time because it allows you to modify test conditions without program recompilation. The virtual panel displays the hardware settings and output conditions in real time when debugging, thereby allowing you to confirm program measurement conditions. The multiwindow function displays hardware information on a module-by-module basis. The virtual scope displays the stimulus waveform or pattern data specified in the program and the response waveform output from the test device. These tools minimize the test development time and maximize engineering productivity.

Testing

The HP 9480 provides easy operation in the test execution environment. The test conditions are set in a fill-in-the-blanks format displayed on the screen, and tests start by the press of a function key or the start button on the operator console. The operator console is a compact terminal to control test execution, such as test start, retest, and test stop.

For monitoring tests quickly, the virtual scope and summary logging are useful tools. The virtual scope displays waveform output from the test device. The summary logging collects data during device testing, and makes test summary, bin summary, and lot summary reports.

Data Analysis

The HP 9480's software capabilities are complemented by a comprehensive set of data analysis functions. These functions allow you to make effective use of all test data collected during device testing. The following reports can be set up and displayed so that you can easily analyze measurement results: tabular reports, scatter diagrams, control charts, wafer maps, X-Y graphs, Shmoo plots, and bar charts.

Tester Workstations (sold separately)

The HP 9000 Series 300 computer, the HP 9480 system controller, can connect directly to the Ethernet/IEEE802.3 local area network (LAN).

When networked, HP 9480 tasks can be distributed between workstations in the network. This increases system efficiency because tasks previously managed by one computer are now distributed between workstations. For example, you can use a test development station (TDS) as a standalone workstation for test program development, such as editing, compiling, and offline debugging, while testing, without degradation of test performance.

Application Support for Rapid Start Up

HP Semiconductor System Centers (SSCs) offer quality application support for quick start up of your HP 9480 system. Application support packages include consultation with expert HP personnel and the tailoring of test program software and hardware to your specific test requirements.

System Specification Summary

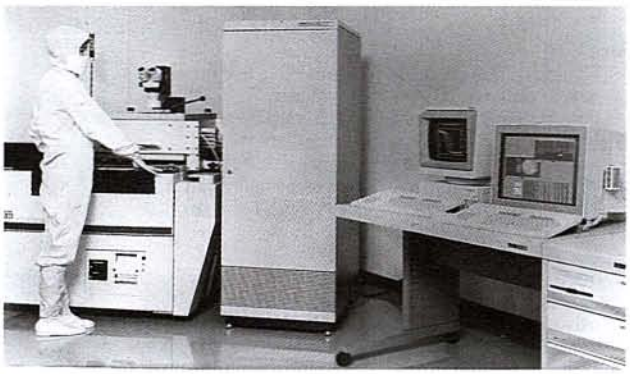
128-Pin I/O, 128-MHz (1 μHz resolution) Clock Rates

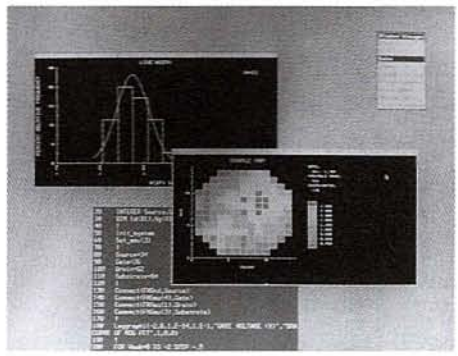
Analog signals analysis:
16-bit (1-MHz)/12-bit (20-MHz) real-time digitizer
1-GHz (12-bit) high-frequency sampler

ac signal stimulus: 18-bit (1-MHz)/12-bit (128-MHz)/10-bit (128-MHz) AWG

Digital test: 64-Kword (128-MHz) WG/WM; dc test per pin

- High-speed and wide measurement range
- Standard networking
- Interactive Measurement and Analysis Software
- Multiuser and multitasking
- Multiwindowing
- Off-line debugger





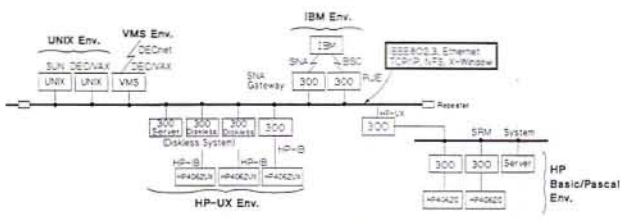
HP 4062UX Semiconductor Process Control System

The HP 4062UX Semiconductor Process Control System is the high-end system of the HP 4062 Semiconductor Parametric Test System family. The HP 4062UX satisfies all of the requirements of the Integrated Circuit Manufacturers for both process monitoring and process development. Since the HP 4062UX uses the same measurement hardware as the HP 4062C, it maintains the same highly accurate and reliable measurement capabilities as the HP 4062C, such as high-speed measurements over a wide measurement range. For example, a typical connect-connect-force-measure sequence (resistance) measurement takes less than 17 ms, and measurements can range from 20 fA to 1A and 4 μV to 200V. Refer to the HP 4062C description on page 519 for more information about the high-speed measurements and wide measurement range that are also possible with the HP 4062UX.

In addition to the sophisticated hardware of the HP 4062C, the HP 4062UX provides powerful software capabilities with the HP BASIC/UX operating environment. HP BASIC/UX combines the most powerful instrument control language, HP BASIC, with all the elements of HP-UX, the Hewlett-Packard implementation of the AT&T System V UNIX* operating system. HP Interactive Measurement and Analysis (IMA) Software makes measurements interactively by providing a softpanel user interface.

Networking

You can easily link the HP 4062UX to other test systems or computers over standard Local Area Networks (LANs). Access to IEEE 802.3/Ethernet using ARPA/Berkeley services, to DECnet using NS/VAX, or to SNA using an SNA gateway, is easily accomplished with the HP 4062UX. The HP 4062UX system controller can be integrated into test-area or factory-level management systems. A diskless cluster configuration allows for the sharing of file storage disks and printing peripherals, resulting in low-cost test-area design.



* UNIX is a U.S. registered trademark of AT&T in the U.S.A. and in other countries.

Multitasking and Windowing

The HP BASIC/UX environment brings multitasking and windowing to process control. While a test is running in one window, you can analyze measurement data in another window. Or use the Virtual Front Panel (VFP) in one window to monitor tests running in a second window. These features increase productivity and efficiency.

Interactive Measurement and Analysis

HP Interactive Measurement and Analysis (IMA) software turns the HP 4062UX into an automatic semiconductor analyzer. You can make measurements without having to program by an interactive, softpanel user interface.

Off-Line Debugger

The HP 4062UX contains a unique off-line debugger that lets you write and debug test programs without having to access the measurement hardware. With the multitasking capability, you can create test programs at the same time that you are testing wafers.

IC-MS: Test Shell for HP 4062UX

The integrated Circuit Measurement System (IC-MS) is software for the HP 4062UX used to develop and execute parametric wafer tests for semiconductors.

IC-MS provides the flexibility needed in a research and development environment for generating parametric test plans and maintains high test execution performance. The user interface is designed to assist the novice user without sacrificing the accessibility of advanced features needed by a sophisticated user. An open interface lets the user integrate data into a preferred database and analysis package. The algorithm used in the test definition can be written in either BASIC/UX or C language.

Specifications

Measurement Functions: I, V, I-V, C-G-V, C-G-t, Pulse I/V, Pulse I-V, Analog Search

Switching Matrix—Number of pins (to DUT):
12 pins to 48 pins (48-pin matrix)
24 pins to 96 pins (96-pin matrix)

Number of Ports (to instrument): 9 ports (optionally 17)
High-resolution source/monitor unit: 1 port
High-power source/monitor unit: 1 port
Source/monitor units: 2 ports
Ground unit: 1 port
Auxiliary: 4 ports (optionally 10)

Maximum Voltage at Each Port: ±200V (SMU ports)
±100V (aux. ports)

Maximum Current Through Ports to Pins: ±1.6A (GNDU port)
±1A (SMU ports)

dc Source/Monitor Units (SMUs):

SMU for high resolution port: 1 unit	
V: ±40 μV to ±100V	Basic accuracy: ±0.05%
I: ±20 fA to ±100 mA	Basic accuracy: ±0.2%
SMU for high current port	
V: ±40 μV to ±200V	Basic accuracy: ±0.05%
I: ±2 pA to ±1A	Basic accuracy: ±0.2%
SMUs: 2 units—Kelvin	
V: ±40 μV to ±100V	Basic accuracy: ±0.05%
I: ±2 pA to ±100 mA	Basic accuracy: ±0.2%

SEMICONDUCTOR TEST SYSTEMS

Process Control System (cont'd)

HP 4062UX

*V force resolution is 100 μV, I force resolution is 50fA (high res SMU) and 5pA (other SMUs)
Ground unit (GNDU): 1 unit
±1.6A Accuracy: ±1mV
Voltage sources (VSs): 2 units
±1 mV to ±40V Basic accuracy: ±0.1%
Voltage monitors (VMs): 2 units
±40 μV to ±40V Basic accuracy: ±0.05%
*Differential voltage can be measured with 4μV resolution

All SMUs can function as a dc voltage source/current monitor or current source/voltage monitor. Pulse measurements can be made with SMUs and VSs.

Capacitance-Conductance Measurements

HP 4280A

Test frequency: 1 MHz, ±0.01%
OSC level: 30 mVrms ±10%, and 10 mVrms ±10%
Measurement range (maximum resolution to full scale):
C: 0.001 pF to 1.2 nF Basic accuracy: ±0.5%
G: 0.01 μS to 12 mS Basic accuracy: ±1.5%
dc bias voltage (for capacitance measurements): ±100V

HP 4284A

Test frequency: 1k, 10k, 100k, 1 MHz ±0.01%
OSC level: 30 mVrms ±10%
Measurement range:

C: 0.001 pF to 1.2 nF	G: 0.01 μS to 12 mS (at 1 MHz)
C: 0.001 pF to 10 nF	G: 0.01 μS to 100 mS (at 100 kHz)
C: 0.001 pF to 100 nF	G: 0.01 μS to 1000 mS (at 10 kHz)
C: 0.01 pF to 100 nF	G: 0.1 μS to 1000 mS (at 1 kHz)

dc bias voltage for capacitance measurements: ±40V (optional)

System Controller

Supported controller: HP 9000 Series 300 Model 330, 332, 350, 360, 370, 375, 380, or 382. HP 9000 Series 300 Model 318M, 319C+, 340, and 345 are supported as a diskless cluster node.
Required main memory: 8 MB
Recommend: 16 MB
Required hard disk memory:
Test execution environment: 150 MB with 15-MB swap
Test execution and development environment: 300 MB with 20-MB swap
Required HP-HIL Device: HP 46084A ID module

Software

Operating system: HP-UX 8.0
Programming language: HP BASIC/UX 6.2 (optionally C language)
Programming utilities: TIS (test instruction set)
PARA (parameter extraction)
PPG (probing pattern generator)
PCL (prober control library)
Off-line debugging: TIS for offline debugging
VFP (virtual front panel)
Data processing: FCL (file creation library)
XYGRAPH (XY graphics)
MAP (wafer map)
Basic statistics and data management
Interactive Measurement and Analysis (IMA) software
Integrated Circuit Measurement System (IC-MS) software
Available networking: NS, ARPA, Berkeley, NFS, SNA

Prober Interface

Automatic wafer probers used with the HP 4062UX must be equipped with HP-IB capability. Hardware for mounting the switching matrix on the prober is also required. Contact the prober manufacturer for details concerning necessary mounting hardware. Control software for Electrogras 1034X/2001X and TSK APM6000/7000 probers is furnished.

Reference Data (typical)

Command execution time
Connect (relays): 4 ms
dc source/monitor[1]: Force (current or voltage): 4 ms, measure (current or voltage): 5 ms, analog search[2]: 25 ms

[1]When integration time is short and range is not 1 nA/10 nA. Excludes wait time set by user.
[2]Analog search controls the output of one SMU to set the output of another to a given value.

General Specifications

Operating temperature: 5° C to 40° C, 55% to 70% RH
Permissible temperature change: ≤3° C after calibration
Air cleanliness: Class 100,000 or higher clean room required
Power requirements: 100V (90V to 110V), 120V (108V to 127V), 220V (198V to 242V), 240V (216V to 252V), 48 Hz to 66 Hz, 1150 VA maximum

Size

Cabinet: 1600 mm H × 600 mm W × 800 mm D
48-pin matrix: 210 mm H × 406 mm W × 380 mm D
96-pin matrix: 250 mm H × 620 mm W × 600 mm D

Weight

Cabinet with instruments: approx. 230kg
48-pin matrix: approx. 22 kg (48-pin configuration)
96-pin matrix: approx. 55 kg (96-pin configuration)

HP 4142B Power Limitation: 32 W

Ordering Information

	Price
HP 4062UX Semiconductor Process Control System (consists of system cabinet, a license to use the HP 4062UX software, system documentation library, and software installations of HP-UX, HP BASIC/UX, and HP 4062UX)	$40,500
Opt 022 ¼-in Tape Media	+$4,350
Opt 032 C Language Media	$710
Opt 050 50-Hz Power Line Frequency	$0
Opt 060 60-Hz Power Line Frequency	$0
48-Pin Matrix Options	
Opt 310 Add HP 4085B 48-Pin Matrix with 12 Pins (and HP 4085B/16066A/16075A/16076A)	+$28,700
Opt 311 Add 1 Pin (HP 16320B) to HP 4085B	+$660
Opt 312 Add Test Fixtures for Packaged Devices (add HP 16067A through HP 16070A)	+$3,240
Opt 313 Add HP 16077A Extension Cable Fixture	+$1,350
Opt 314 Add HP 16071A Universal Fixture	+$405
Opt 315 Add HP 16071B Universal Fixture (Kelvin)	+$455
Opt 316/Opt 317 Add HP 16072A Personality Board	+$220
Opt 318/Opt 319 Add HP 16072B Personality Board (Kelvin)	+$250
Opt 340 Add Port Expander for HP 4089B	+$3,450
96-Pin Matrix Options	
Opt 330 Add HP 4089A 96-Pin Matrix with 24 Pins (add HP 4089A/16370A/16355A/16356A)	+$62,100
Opt 331 Add 1 pin (HP 16320C) to HP 4089A	+$690
Opt 332 Add Test Fixtures for Packaged Devices (add HP 16371A through 16375A)	+$6,900
Opt 333 Add HP 16378B Extension Cable Fixture	+$4,410
Opt 334 Add HP 16376A Universal Fixture	+$550
Opt 335 Add HP 16376B Universal Fixture (Kelvin)	+$550
Opt 336 Add HP 16377A Personality Board	+$550
Opt 337 Add HP 16377B Personality Board (Kelvin)	+$550
Measuring Instruments	
Opt 400 Add HP 4142B Modular dc Source/Monitor	+$16,200
Opt 405 Field Installation Kit for HP 4142B	+$4,100
Opt 410 Add HP 41420A 200V/1A SMU	+$4,730
Opt 411 Add HP 41421B 100V/100mA SMU	+$3,910
Opt 414 Add HP 41424A VS/VM Unit	+$3,500
Opt 415 Add HP 41425A Analog Feedback Unit	+$1,900
Opt 450 Add HP IMA Software Package	$5,590
Opt 451 Add HP IMA License-to-Use	$4,730
Opt 510 Add HP 4280A 1-MHz C meter	+$15,800
Opt 515 Field Installation Kit for HP 4280A	+$3,010
Opt 520 Add HP 4274A LCR Meter (100 Hz to 100 kHz)	+$14,200
Opt 521 Add ±35V Bias (Opt 001-4274A)	+$1,040
Opt 522 Add ±100V Bias (Opt 002-4274A)	+$950
Opt 525 Field Installation Kit for HP 4274A	+$3,230
Opt 530 Add HP 4284A LCR Meter	+$15,600
Opt 531 Add 40V Bias (Opt 001-4284A)	+$1,220
Opt 535 Field Installation Kit for HP 4284A	+$4,200

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- 25 ms Vth/hFE extraction (typical)
- ±20 fA to ±1 A precise wafer measurements

HP 4062C

DESIGNED FOR HP-IB SYSTEMS

(System controller, printer, and tables are sold separately.)

HP 4062C Semiconductor Parametric Test System

The HP 4062C semiconductor parametric test system is a high-throughput, high-resolution, computer-controlled system for measuring the dc voltage and current and the 1 MHz capacitance and conductance parameters of wafer-state devices, as well as discrete and packaged devices. Based on its predecessor, the HP 4062B, this enhanced system will enable you to significantly improve IC yield and quality and increase efficiency during new-process development.

Precise 20 fA, 4 μV, and 1 fF measurements to ±200 V and ±1 A are possible through the 4062C's low-noise, reliable switching matrix, which you can configure with up to 96 device-under-test (DUT) pins, and specifications are guaranteed at all DUT pins. The heart of the HP 4062C, the high-speed HP 4142B modular dc source/monitor, provides fast throughput over a wide measurement range—without sacrificing resolution—for wafer process monitoring and evaluation. Highly reliable wafer measurement results can quickly be fed back to design and process engineers to improve IC yield and quality.

The HP 4062C's language system is the simple, yet powerful, HP BASIC. The HP 4062C can be controlled with the HP Vectra PC and HP 82324B Measurement Coprocessor (HP 4062PC, optional). The HP 4062PC provides customers with benefits of a superior instrument control environment while retaining easy access to MS-DOS® software. For inexpensive but efficient data analysis, Lotus® 1-2-3® can be used with the HP 4062PC. Parameter measurements, such as threshold voltage and current gain, can be performed with a simple 2-line program, thanks to the HP 4062C's measurement utility subprograms. In addition, HP Interactive Measurement and Analysis (IMA) makes the measurements interactively, using the HP 4062C or HP 4062PC.

High-Speed Measurements, Wide Measurement Range

In production environments where measurement speed is a prerequisite, the HP 4062C comes through. The HP 4062C's DC measurement subsystem provides high-speed device/process parameter extractions while maintaining measurement resolutions down to 20 fA and 4 μV. For example, by using the dc measurement subsystem's Analog Feedback Unit (AFU), such key device parameters as threshold voltage (Vth) and forward current gain (hFE) can be obtained in as little as 25 ms: roughly 4 times faster than the HP 4062B.

The HP 4062C's switching matrix subsystem enables reliable measurement results by virtually eliminating the effects of environmental noise while minimizing leakage current and stray capacitance. The expanded measurement range of ±20 fA to ±1 A and ±4 μV to ±200 V is guaranteed to the tip of each switching matrix DUT pin. These exacting standards ensure precise, reliable semiconductor parameter measurements through the switching matrix for each system instrument.

MS-DOS® is a U.S. registered trademark of Microsoft Corporation. Lotus® 1-2-3® are U.S. registered trademarks of Lotus Development Corporation.

Easy to Program

The HP 4062C's Test Instruction Set (TIS) software makes programming easy, and the fast execution of TIS programs ensures high-speed measurements. By using the furnished measurement library, you can quickly create and execute programs. For example, to perform a Vth or hFE measurement requires only 1 or 2 program lines.

Specifications

Hardware

Same as HP 4062UX

Software

Operating system: HP BASIC 6.2 or later
Programming language: HP BASIC
Programming utilities:
TIS (Test Instruction Set)
PARA (Parameter Extraction)
PPG (Probing Pattern Generator)
PCL (Prober Control Library)
Data processing:
FCL (File Creation Library)
XYGRAPH (XY Graphics)
Basic Statistics and Data Manipulation

HP Interactive Measurement and Analysis (IMA) Software System Controller

Supported controller: HP 9000 Series 300 Models 310, 320, 330, 332, 340, 345, 350, 360, 362, 370, 375, 380, and 382
Required main memory: 2 MB
Required HP-HIL device: HP 46084A ID module
Required interface: In addition to internal HP-IB I/O, 2 extra HP-IB I/Os (98624A) are required.

Ordering Information

	Price
HP 4062C Semiconductor Parametric Test System (Consists of HP 4142B modular dc source/monitor, 48-pin matrix with 48 pins, HP 4280A 1 MHz C meter, system cabinet, system software, system library, and system software installation.)	$147,200
Opt 050/060 For 50/60 Hz Line Frequency	$0
Opt 100/120/220/240 For 100/120/220/240V Line Voltage	$0
Opt 001 12-Pin Configuration of 48-Pin Matrix	−$23,760
Opt 002 24-Pin Configuration of 48-Pin Matrix	−$15,840
Opt 003 36-Pin Configuration of 48-Pin Matrix	−$7,920
Opt 004 Add Spare Pin Board of 48-Pin Matrix	+$660
Opt 012 24-Pin Configuration of 96-Pin Matrix	+$12,800
Opt 013 36-Pin Configuration of 96-Pin Matrix	+$21,030
Opt 014 48-Pin Configuration of 96-Pin Matrix	+$29,280
Opt 015 64-Pin Configuration of 96-Pin Matrix	+$40,300
Opt 016 72-Pin Configuration of 96-Pin Matrix	+$45,820
Opt 017 84-Pin Configuration of 96-Pin Matrix	+$54,100
Opt 018 96-Pin Configuration of 96-Pin Matrix	+$62,280
Opt 019 Add Spare Pin Board of 96-Pin Matrix	+$690
Opt 102 Delete HP 4280A	−$12,800
Opt 110 Delete Package Fixtures for 48-Pin Matrix	−$4,390
Opt 115 Delete Package Fixtures for 96-Pin Matrix	−$7,500
Opt 130 Delete System Rack	−$3,900
Opt 1BE Replace 1.6 m rack with 1.0 m rack	$0
Opt 340 Add Port Expander	$3,450
Opt 405 HP 4062C System Software Right-to-Copy	−$2,310
Opt 450 Add HP IMA/WS Software Package	+$4,410
Opt 451 Add HP IMA/WS License-to-Use	+$3,760
Opt 910 Extra System Library	+$345
Opt PC5 License-to-Use HP 4062PC and 5¼-in disks	$0
Opt PC7 License-to-Use HP 4062PC and 3½-in disks	$0
Opt P55 IMA/PC LTU, manual, and 5¼-in disks	+$4,410
Opt P57 IMA/PC LTU, manual, and 3½-in disks	+$4,410

For the most current prices and product information, contact your local Hewlett-Packard sales office. see page 665.

SEMICONDUCTOR TEST SYSTEMS

Semiconductor Parameter Analyzer

HP 4145B

- Fully automatic, high-speed dc characterization of semiconductor devices.
- High-resolution, wide-range sourcing and measurement I: 50 fA to 100 mA; V: 1 mV to 100 V
- Maximum 1140 measurement and display points for precise measurement and analysis
- Flexible graphic analysis functions for quick parameter extraction
- Built-in 3½-inch disk drive for storage of 240 user programs or 105 measurement results

HP 4145B

DESIGNED FOR HP-IB SYSTEMS

HP 4145B Semiconductor Parameter Analyzer

Designed for production-line and laboratory use, the HP 4145B is the electronics industry's first standalone instrument capable of complete dc characterization of semiconductor devices and materials. It stimulates voltage-and current-sensitive devices, measures the resulting current and voltage responses, and displays the results in a user-selectable format (graph, list, matrix, or schmoo) on a built-in CRT display. An on-board programmable calculator provides real-time calculation of voltage/current-dependent parameters, such as the current gain (h_{FE}) and transconductance(g_m) of transistors, which can also be displayed on the CRT. A number of powerful graphic analysis tools—marker, cursor, line function, and interpolation—enhance the HP 4145B's basic capabilities and provide fast, accurate analysis of semiconductor devices, leading to increased production yields and improved device quality.

Four built-in source monitor units (SMUs) are the heart of the HP 4145B. Each SMU can be independently programmed to function as either a voltage source/current monitor or a current source/voltage monitor. Thus a bipolar transistor, for example, can be completely characterized in common-base, common-emitter, and common-collector configurations without changing connectionsøonly changing the SMUs' operating modes is required. The HP 4145B is also equipped with 2 voltage sources and 2 voltage monitors for measurements on devices having more than 4 terminals, such as ICs.

The HP 4145B can be controlled from the front panel via the HP-IB (standard), or by measurement setups stored on diskettes.

Displayed information—measurement setups, auto-sequence programs, measurement results—can be dumped directly onto an external graphics plotter to obtain publication-quality hard copies. A built-in 3-½-inch disk drive enables you to store measurement setups and measured data, which can be accessed by another compatible HP disk drive for further processing.

Auto Sequence Programs

Measurement programs stored on a HP 4145B 3½-inch disk can be linked by an auto-sequence program, making it possible to perform a series of measurements with just one keystroke.

Four User-Selectable Display Formats to Suit the Evaluation

Measurement results can be displayed in one of four display formats: Graphics, list, matrix, or schmoo. After measurement has been made and the results displayed, the softkeys can be used to access various analysis functions for complete device evaluation. These functions include MARKER for numeric readout of measured value at any point along a plotted curve, CURSOR for numeric readout of value at any graphic point and for line positioning, STORE /RECALL for overlay comparisons, AUTO SCALE for optimum graphic scaling, and LINE FUNCTION for direct readout of line gradient and X-Y axis intercept values.

Specifications

Measurement

Source/Monitor Unit (SMU): Four SMUs are built into the HP 4145B. Each SMU can be programmed either to source voltage and monitor current or to source current and monitor voltage. Each SMU can also be programmed to COM mode. This sets voltage at 0 V and current compliance at 105 mA.
Output/Measurement Resolution: Voltage, 4½ digits; current, 4 digits
Voltage Measurement Input Resistance/Current Source Output Resistance: $\geq 10^{12}\ \Omega$
Maximum Capacitive Load: 1000 pF
SMU Voltage Range, Resolution, and Accuracy

Voltage Range	Resolution	Accuracy[1,2]	Max. Current
±20 V	1 mV	±(0.1% + 10mV + 0.4 × Io)	100 mA
±40 V	2 mV	±(0.1% + 20mV + 0.4 × Io)	50 mA
±100 V	5 mV	±(0.1% + 50mV + 0.4 × Io)	20 mA

*Io is SMU output current in amps.

SMU Current Range, Resolution, and Accuracy

Current Range	Resolution	Accuracy[1,2]	Max. Voltage
±100 mA	100 μA	±(0.3% + 100 μA + 2 μA × Vo)	20 V(>50 mA)
			40 V(>20 mA)
±10 mA	10 μA	±(0.3% + 10 μA + 200 nA × Vo)	100 V (≤20 mA)
±1000 μA	1 μA	±(0.3% + 1 μA + 20nA × Vo)	
±100 μA	100 nA	±(0.3% + 100 nA + 2 nA × Vo)	
±10 μA	10 nA	±(0.3% + 10 nA + 200 pA × Vo)	
±1000 nA	1 nA	±(0.5% + 1 nA + 20 pA × Vo)	
±100 nA	100 pA	±(0.5% + 100 pA + 2 pA × Vo)	
±10 nA	10 pA	±(1% + 15 pA + 200 fA × Vo)	
±1000 pA	1 pA	±(1% + 6 pA + 20 fA × Vo)	

*Vo is SMU output voltage in volts.
**50 fA resolution in current monitor mode.

[1] Accuracy specifications are given as ±% of reading or setting value ±% of range.
[2] Accuracy tolerances are specified at 25° C ±5° C, after a 40-minute warmup time, with AUTO CAL on, and specified at the rear panel connector terminals referenced to SMU common. Tolerances are doubled for the extended temperature range of 10° to 40° C.

SMU Voltage/Current Compliance

Maximum Voltage Compliance: 20 V, 40 V, or 100 V, depending on the output current range
Maximum Current Compliance: 20 mA, 50 mA, or 100 mA, depending on the output voltage range
Compliance Setting Resolution: Same as current and voltage output/measurement resolution. Maximum current compliance resolution, however, is 50 pA.
Compliance Accuracy: Voltage compliance accuracy is the same as voltage output/measurement accuracy. Current compliance accuracy is current output/measurement accuracy ± (1% of range + 10 pA).

Voltage/Current Sweep Characteristics

Output from up to 3 SMUs or voltage sources can be swept in one of three modes: VAR1, VAR2, or VAR1′.
VAR1: Linear or log staircase sweep
VAR2: Linear staircase sweep. Output from the VAR2 source is incremented after completion of each VAR1 sweep.
VAR1′: Output from the VAR1′ source is synchronized with VAR1, but at levels proportional to a user-selectable ratio or offset relative to VAR1.
Ratio: ±0.01 to ±10
Offset: Any value that will not cause VAR1′ to exceed maximum allowable output.
Hold Time: 0 to 650 s, ±(0.5% + 9 ms) with 10 ms resolution
Delay Time: 0 to 6.5 s, ±(0.1% + 5 ms) with 1 ms resolution
No. of Measurement Steps: 1024 for a single VAR1 sweep, 1140 for a multiple sweep

Voltage Sources (Vs) Characteristics

Number of Sources: 2
Output Resistance: ≤0.2 Ω
Maximum Capacitive Load: 1000 pF

Voltage Output Range, Resolution, and Accuracy

Voltage Output Range	Resolution	Accuracy	Max. Output Current
±20 V	1 mV	±(0.5% of setting + 10 mV)	10 mA

Voltage Monitors (Vm) Characteristics

Number of Monitors: 2
Input Resistance: 1 MΩ ± 1% shunted by 100 pF ± 10%
Voltage Measurement Range, Resolution, and Accuracy

Voltage Measurement Range	Resolution	Accuracy
±2 V	100 μV	±(0.5% of reading + 10 mV)
±20 V	1 mV	±(0.2% of reading + 10 mV)

Characteristics Common to SMUs, Voltage Sources, and Voltage Monitors

Maximum Allowable Terminal Voltage: 100 V peak across SMU and V_m input terminals, or SMU and V, output terminals, or between those terminals and guard; and 42 V maximum from Common to Ground.

Display

CRT Size and Screen Resolution: 152.4 mm (6 in) diagonal; 2048 × 2048 points
Display Modes: Graphics, Schmoo, List, Matrix, and Time Domain
External CRT Analog Output: X, Y, and Z outputs of 0 to 1 Vdc into 330 Ω (X and Y) and 240 Ω (Z)

Analysis

Calculation: Two user functions can be input and keyboard calculations can be done using the following 11 operators: +, −, *, /, $\sqrt{\ }$, EXP, LOG, LN, ** (power), ABS (absolute) and Δ (differential).
Constants Available on the Keyboard
q: Electron charge (1.602189×10^{-19} coulomb)
k: Boltzmann's Constant (1.380662×10^{-23} J/°K)
e: Dielectric constant of vacuum (8.854185×10^{-12} F/m)
Analysis Functions: Overlay comparison with STORE/RECALL, Marker, Interpolate, Cursor, Auto scale, Zoom function (←→, →←, ↑↓, ↓↑, Line and Move Window

General Specifications

Operating Temperature Range: +10° C to +40° C; ≤70% RH at 40° C, permissible temperature change ≤1° C/5 min
Power: 100/120/220 V, ± 10%; 240 V, −10% + 5%; 48 to 66 Hz; 270 VA max
Size: 426 mm W × 235 mm H × 612 mm D (16.75 in × 9.06 in × 24.1 in)
Weight: 27 kg (59 lb) approximately

Reference Data

SMU Measurement Time: Measurement time = response time + ranging time + integration time
SMU Response Time

Current Range	Setup/Settling Time	SMU Wait Time
100 nA to 100 mA	2.7 ms	0.2 ms
1 nA and 10 nA		47.5 ms

Ranging time: Varies from 4 ms to 74 ms
Integration time: Short, Med., and Long

	Short	Med.	Long
50 Hz	3.6 ms	20 ms	320 ms
60 Hz		16.7 ms	267 ms

Accessories Furnished

HP 16058A Test Fixture
HP 04145-61502 System Disc
HP 04145-60001 Connector Plate
HP 04145-61622 Triaxial Cable (3m), 4 ea.
HP 04145-61630 BNC Cable (3m), 4 ea.
HP 04145-61623 Shorting Connector

Ordering Information

	Price
HP 4145B Semiconductor Parameter Analyzer	$27,500
Opt 050/060 50Hz/60Hz Line Frequency	$0

For the most current prices and product information, contact your local Hewlett-Packard sales office.

SEMICONDUCTOR TEST SYSTEMS

Modular DC Source/Monitor

HP 4142B

- Flexible, modular architecture
- Wide measurement range with high resolution
  V: ±4 μV to ±1000 V, 0.05%
  I: ±20 fA to ±10 A, 0.2%
- Pulse measurement capabilities
  Pulse width 1 ms to 50 ms, 100 μs resolution
- High-speed measurement (typical)
  Sourcing or monitoring: 4 ms
  Vth, hFE extracting: 12 ms
- Internal memory
  Program memory: >2000 commands (typical)
  Data memory: 4004 measurement points

HP 4142B

DESIGNED FOR HP-IB SYSTEMS

HP 4142B Modular DC Source/Monitor

Offering a wide measurement range and excellent sensitivity, the HP 4142B modular dc source/monitor is a system-use dc measurement instrument especially designed for high-throughput dc semiconductor testers. A completely user-definable system component, the HP 4142B features modular architecture that allows you to build a custom configuration to suit your measurement needs.

Eight plug-in module slots can accommodate any combination of the 5 presently available modules; as new modules become available, you can upgrade your measurement capabilities with ease. Choose from 2 types of source/monitor units (SMUs) to force or measure up to ±200 V and ±1 A: a high current source/monitor unit (HCU) up to ±10 A; a high voltage source/monitor unit (HVU) up to ±1000 V, a voltage source/voltage monitor unit (VS/VMU), and an analog feedback unit (AFU). The HP 4142B's instrument command and measurement data-storage capabilities, coupled with the high-speed HP-IB interface, minimize computer loading, enhance throughput, and simplify systemization.

Versatile SMUs and Reliable Measurement

For general-purpose dc or pulsed measurement, use the HP 41421B source monitor unit. The equivalent of 4 instruments, this precision module forces voltage up to ±100 V and simultaneously measures currents down to 20 fA. It can also force currents up to ±100 mA while measuring voltage down to 40 μV.

If you test high-power components or desire a wider measurement range, use the HP 41420A source monitor unit. This versatile SMU can source ±200 V or ±1 (14 W, dc or pulsed) and still maintain a measurement resolution of 40 μV and 20 fA. Both SMU's include a compliance feature that limits output voltage, current, or power to prevent damage to your device. Each SMU (HP 41420A or HP 41421B) acts as either a voltage source/current monitor or current source/voltage monitor. These complementary operating modes let you change the stimulus on a device without modifying the physical connections. This versatility reduces test time and eliminates instabilities caused by changing connections at the DUT.

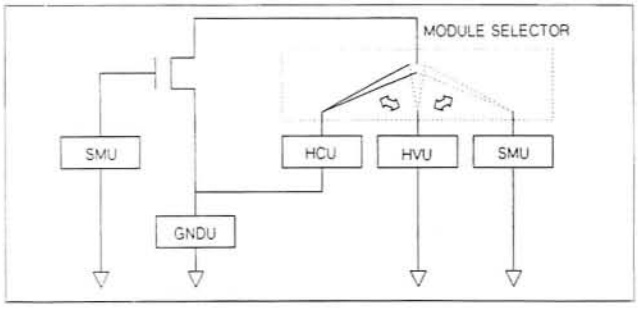
Test Power Devices to 10 A and 1000 V

The HP 41422A HCU and the HP 41423A HVU expand the measurement range of the HP 4142B to 10 A and 1000 V. They dramatically expand the HP 4142B's ability to test power devices, such as power transistors, power MOSFETs, GaAs FETs, and smart ICs. Using a combination of the two units, measurements of up to 20 A and 2000 V are possible.

Using the HCU, fast pulse testing (100 μs minimum pulse width) at high current increases test reliability by minimizing the effects of thermal drift.

Quasi-pulsed measurements by the HVU are effective for measuring breakdown voltage by minimizing the duration of the breakdown condition.

The HP 16087A module selector is a scanner that lets you remotely control the connection of the HP 41420A/41421B SMUs, the HP 41422A HCU, or the HP 41423A HVU to a test pin. It contributes to automatic testing for high-power devices with high breakdown voltage. The built-in module selector can be specified as an option of the HP 16088B test fixture.

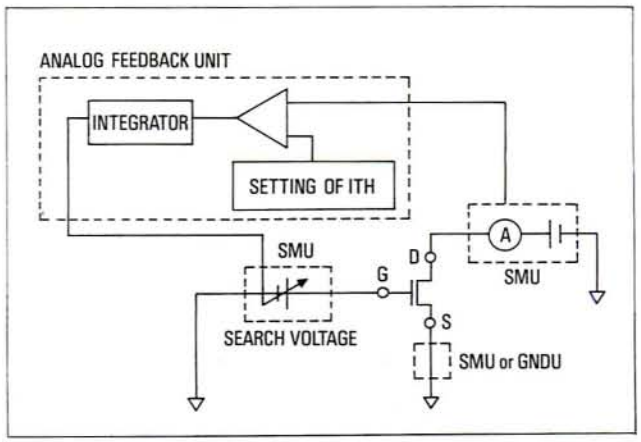


High-Speed Parameter Extraction by Analog Feedback Technique

To find important parameters that are specified at a given voltage or current, such as Vt or hFE, connect the HP 41425A AFU to 2 SMUs. The AFU modulates the output voltage of one SMU while monitoring the current or voltage of the other. Target currents and voltage are found with great speed (12 ms). This unique analog feedback network rapidly measures Vt, hFE, ΔL, or ΔW: parameters that would require excessive test time on other parametric testers.

You can also use the AFU to bias and test microwave devices. It can be integrated into the network analyzer system.

By using the AFU, you can eliminate the effect of device thermal drift and can hold the initial setting bias for ac measurement time.



Specifications

4142B Modular dc Source Monitor

Ground Unit (GNDU):
Use as measurement ground
0 V, Kelvin connection
Offset voltage: ±500 μV max
Current voltage: ±1.6 A
Maximum cable resistance:
FORCE terminal: ≤1 Ω*
SENSE terminal: ≤10 Ω*
Maximum capacitive load: 10 μF max*
Spot Measurements: Source and monitor DC current or voltage
Swept Measurements:
- One channel can sweep current or voltage while up to 8 channels measure current or voltage
- A second sweep channel can be slaved to the first sweep channel (dual synchronous sweep)

Sweep modes: Linear or logarithmic
Single or double staircase
Sweep parameters: Start, stop, number of steps, or steps per decade
Maximum number of steps: 1000
Hold time: 0 to 655.35 s, 10 ms resolution
Delay time: 0 to 65.535 s, 1 ms resolution
Setting accuracy: 0.5% + 1 ms*

Measurement Unit

HP 4142B Modules

Model Number	Slots Req'd	Voltage Range	Current Range	Measurement Resolution	Accuracy V	Accuracy I
HP 41420A SMU[1]	2	±100 μV to ±200 V	±50 fA to ±1 A	40 μV 20 fA	0.05%	0.2%
HP 41421B SMU[1]	1	±100 μV to ±100 V	±50 fA to ±100 mA	40 μV 20 fA	0.05%	0.2%
HP 41422A HCU[1]	2	±200 μV to ±10 V	±500 μA to ±10 A	40 μV 20 μA	0.5%	0.5%
HP 41423A HVU	2	±10 mV to ±1000 V	±50 pA to ±10 mA	2 mV 2 pA	0.5%	1%
HP 41424A VS/VMU	1	±1 mV to ±40 V	±20 mA ±100 mA	4 μV[2] 20 μA	0.05%	3%
HP 41425A AFU	1	Searches for a specified current or voltage on one SMU by controlling the voltage output of another SMU.				

[1] Provides Kelvin connections (remote sensing).
[2] Differential measurement mode (40 μV resolution in normal mode).

SMU Range, Resolution and Accuracy (at 18° to 28° C)

Voltage Range	Set Res.	Meas. Res.	Accuracy	Max. Current
±2 V	100 μV	40 μV	±0.05% ±1 mV	1 A
±20 V	1 mV	400 μV	±0.05% ±10 mV	1 A(V≤14 V)
				0.7 A(V>14 V)
±40 V	2 mV	800 μV	±0.05% ±20 mV	350 mA
±100 V	5 mV	2 mV	±0.05% ±50 mV	125 mA
±200 V	10 mV	4 mV	±0.05% ±100 mV	50 mA

Current Range	Set Res.	Meas. Res.	Accuracy	Max. Voltage
±1 nA	50 fA	20 fA	±1% ±(0.1+0.2×Vo/100)% ±5 pA	200 V
±10 nA	500 fA	200 fA		
±100 nA	5 pA	2 pA	±0.5% ±(0.1×0.2×Vo/100)%	
±1 μA	50 pA	20 pA		
±10 μA	500 pA	200 pA	±0.2% ±(0.1+0.2×Vo/100)%	
±100 μA	5 nA	2 nA		
±1 mA	50 nA	20 nA		
±10 mA	500 nA	200 nA		
±100 mA	5 μA	2 μA		200 V (I<50 mA)
				100 V (I>50 mA)
±1 A	50 μA	20 μA	±0.5% ±(0.1+0.2×Vo/100)%	200 V (I≤50 mA)
				100 V (125 mA ≥I>50 mA)
				40 V (350 mA ≥I>125 mA)
				20 V (0.7 A ≥I>350 mA)
				14 V (I>0.7 A)

* Note: Vo is the SMU output voltage, in volts.

Pulsed Measurements (SMU)
Force and measure pulsed current or voltage
Ranges: 2 V range: 10 nA to 1 A range
20 V to 200 V range: 100 μA to 1 A range
V pulse: 2 V range: 1 compliance ≥ 2 nA
20 V to 200 V range: 1 compliance ≥ 20 μA
I pulse: 10 nA to 10 μA range: V compliance ≤ 2 V
100 μA to 1 A range: V compliance ≤ 200 V
Pulse width: 1 to 50 ms, 100 μs resolution
Pulse period: 10 to 500 ms, 100 μs resolution
Setting accuracy: 0.5% + 100 μs*

Pulsed Sweeps
- Sweep and measure pulsed current or voltage
- Sweep dc current or voltage while pulsing current or voltage. Use Pulse and Sweep specification

Memory
Program memory: Stores approximately 2000* HP-IB commands, which can be grouped into 99 subroutines.
Data memory: 4004 measurement points (binary)
1001 points (ASCII format)

General Specifications

Auto Calibration: Automatically calibrates the offset errors in each measurement unit every 30 minutes*
Environmental Information
Operating temperature: 5° to 40° C
Allowable temperature drift: ±3° C*
Operating humidity: 5% to 80% RH
Storage temperature: −40° to 65° C
Storage humidity (at 65° C): ≤90% RH
Operating inclination: ±20° from horizontal
Power: 100/120/220 V, ± 10%; 240 V 10% + 5%; 48 to 66 Hz, 750 VA max.
Size: 426 mm W × 235 mm H × 676 mm D
Weight
HP 4142B: Approximately 23 kg
HP 41420A/41422A/41423A: Approximately 3 kg
HP 4142B/41424A/41425A: Approximately 2 kg
Recommended Computer
HP 9000 Series 300
BASIC operating system (Version 3.0 or later)
Software
Parameter measurement library: Current Gain, Breakdown Voltage (2), Drain Current, Threshold Voltage (3), and Resistance
Test instruction set: Initialize, Force, Measure, Pulse, Graphics, and Data Storage

* Reference data only.

Ordering Information

	Price
HP 4142B Modular DC Source/Monitor	$12,100
Opt 300 Install Control Unit for Module Selector	$430
Opt 302/303 Control Cable	$130/110
Opt 400 Install 41420A (needs 2 slots)	$4,730
Opt 402/403 Quadraxial Cable for 41420A	$600/500
Opt 410 Install 41421B (needs 1 slot)	$3,910
Opt 412/413 Quadraxial Cable for 41421B	$600/500
Opt 420 Install 41422 A (needs 2 slots)	$5,000
Opt 422/423 Dual Coaxial Cable for 41422A	$540/490
Opt 430 Install 41423A (needs 2 slots)	$6,500
Opt 432/433 Triaxial/BNC Cable for 41423A	$580/510
Opt 440 Install 41424A (needs 1 slot)	$3,560
Opt 442/443 Coaxial Cable for 41424A	$340/320
Opt 450 Install 41425A (needs 1 slot)	$1,900
HP 41420A Source/Monitor Unit	$4,730
Opt 402/403 Quadraxial Cable	$600/500
HP 41421B Source/Monitor Unit	$3,910
Opt 412/413 Quadraxial Cable	$600/500
HP 41422A High-Current Source/Monitor Unit	$5,000
Opt 422/423 Dual Coaxial Cable	$540/490
HP 41423A High-Voltage Source/Monitor Unit	$6,500
Opt 432/433 Triaxial/BNC Cable	$580/510
HP 41424A Voltage Source/Voltage Monitor Unit	$3,560
Opt 442/443 Coaxial Cable	$340/320
HP 41425A Analog Feedback Unit	$1,900
HP 16087A Module Selector	$1,300
HP 16088B Test Fixture	$4,300
Opt 010 Module Set for Power Devices	$690
Opt 300 Add Module Selector	$650

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

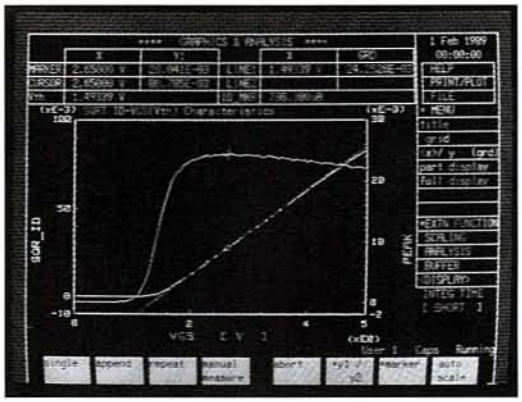
SEMICONDUCTOR TEST SYSTEMS

Softpanel Interactive Measurement and Analysis Software

HP 16276B/16277B/16278B

- Full-feature parameter analyzer
- Menu-driven softpanels

- Powerful graphics analysis for quick parameter retrieval
- Automatic measurement and analysis with HP BASIC subprogram library



HP Interactive Measurement and Analysis Software

HP interactive measurement and analysis (IMA) software makes semiconductor measurements interactively, using the HP 4142B dc source/monitor. The IMA software turns the HP 4142B into a fully automatic semiconductor dc parameter analyzer by providing an interactive softpanel user interface.

There are three versions of HP IMA software: IMA/WS (HP 16276B) is for HP BASIC/WS, IMA/UX (HP 16277B) for HP BASIC/UX, and IMA/PC (HP 16278B) for an HP Vectra PC with a high-performance measurement coprocessor.

Now you can use the HP 4142B like the HP 4145B semiconductor parameter analyzer, with the addition of the higher speed, wider dynamic measurement range, and more flexible module configuration of the HP 4142B, and with the enhanced capabilities of IMA software.

Easy-to-Use Softpanels

The IMA software provides easy-to-use softpanels. You use the mouse to reduce the measurement setup to a simple fill-in-the-blanks operation. The mouse is also used to control the graphics analysis routines, output formats, and file management of the IMA.

Automatic Measurement and Analysis

You can perform most semiconductor analysis functions using the HP IMA softpanels. For automation or customization of measurement and analysis, use the unique Analysis Instruction Set (AIS). The AIS is the subprogram library of HP BASIC and an interface with the HP BASIC program; the softpanel is the interactive user interface.

Setting up softpanels, triggering measurements, analyzing graphics, extracting data from and sending data to the graphics page, and managing files are made easy using the HP BASIC programming feature of the IMA software. By using the IMA softpanels, you can monitor and analyze program execution and manually reset parameters.

HP 4145B Compatibility

Data-file upward compatibility with the HP 4145B is maintained for graphics and list data.

Specifications

Products supported by HP IMA:

HP 4142B Modular DC Source/Monitor Unit
HP 41420A 200 V/1 A Source Monitor Unit (SMU)
HP 41421B 100 V/100 mA Source Monitor Unit (SMU)
HP 41422A 10 V/10 A High-Current SMU
HP 41423A 1000 V/10 mA High-Voltage SMU
HP 41424A Voltage Source/Voltage Monitor Unit

Measurement Characteristics

Voltage/current sweep parameters

Var 1: Main sweep, single or double sweep; selectable linear or logarithmic
Var 2: Subordinate linear staircase sweep
Var 1': Staircase sweep synchronized with the Var 1 sweep
Time domain sweep: Selectable time domain when Var 1 is not set
Pulse: Every source unit can be set as a pulse source
Constant: Every source unit can be set as a constant voltage or current source
Measurement modes: Single, append, repeat, or manual
Integration Time: Short, medium, or long
Display modes: Graphics or list

Analysis Capabilities

User functions: Up to 4 user functions can be defined
User display functions: Up to 2 functions can be defined as numeric expressions with the marker, cursor, or line analysis data; results are displayed in real time.
Marker function: Interpolation, marker → min/max, or direct marker
Cursor functions: Cursor → marker, regression line, tangent line, line, fix line, or erase line
Scaling functions: Auto scale, move, zoom, init. scale, change scale, revise scale, and reset display
Buffer function: Four buffers are available: store, recall, recall off, and exchange.
Display functions: Title, grid/tick, part display, full display, and auto retrieve

System Requirements

Computer: HP 9000 Model 310, 320, 330 or 362 (HP 16276B)
Model 332, 340, 345, 350, 360, 370, 375, 380 or 382 (HP 16276B/16277B)
HP Vectra PC with HP 82324A High-Performance Measurement Coprocessor (HP 16278B)
Memory: 4 MB (HP 16276B/16278B)
8 MB (HP 16277B)
Language System: HP BASIC 6.2 or later (16276B)
HP BASIC/UX 6.2, HP-UX 8.0 or later (16277B)
HP BASIC 5.14 or later (16278B)

Ordering Information

	Price
HP 16276B HP IMA/WS License-to-Use and Manual	$3,750
Opt 007 Media, 3½-in 2HD	$650
HP 16277B HP IMA/UX License-to-Use and Manual	$4,750
Opt 022 Media, ¼-in Tape	$850
HP 16278B HP IMA/PC License-to-Use and Manual	$3,750
Opt 005 Media, 5¼-in 2HD	$650
Opt 007 Media, 3½-in 2HD	$650

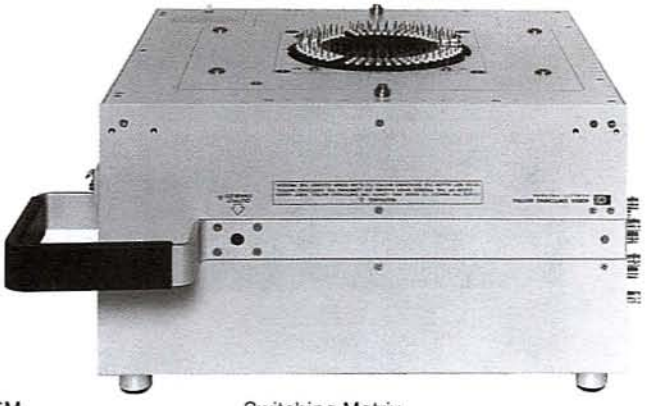
For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- 48 pins with 1 pA resolution
- Easy programmable switching

DESIGNED FOR HP-IB SYSTEMS

Switching Matrix Controller

HP 4085M



Switching Matrix

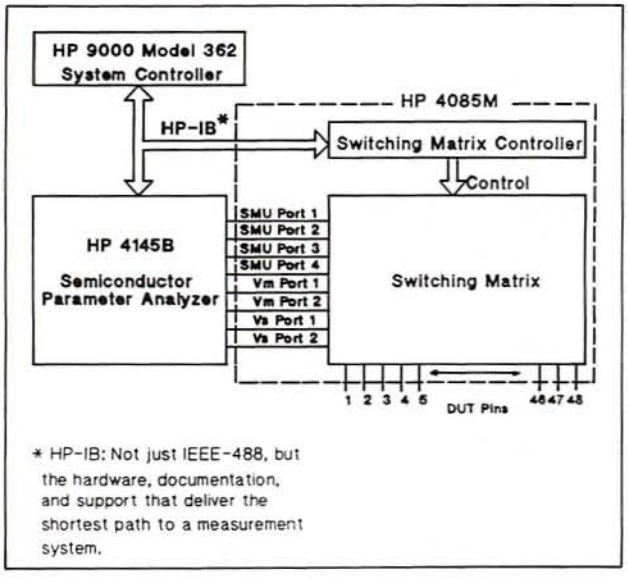
Description

Combining the HP 4085M switching matrix with the HP 4145B semiconductor parameter analyzer produces a 1 pA, 1 mV switching system capable of 48-pin high-resolution semiconductor testing.

A design that minimizes both noise and leakage current means exceptional built-in dc measurement capabilities and the realization of 1 pA resolution measurements at any of the 48 pins.

The software included with the system makes it possible to freely switch any of the 8 instrument ports to any of the test pins from the system controller. A number of fixtures are available for wafer and various packaged device measurements. The HP 4085M retains the HP 4145B's full measurement capabilities to obtain highly reliable wide-range dc parameter measurements.

System Configuration Example



* HP-IB: Not just IEEE-488, but the hardware, documentation, and support that deliver the shortest path to a measurement system.

Switching Matrix Specifications

DUT Pins: From 12 to 48 pins can be installed
Instrument Ports:* Eight instrument ports are included

Low-leakage SMU port:	1 ea. (Port 1)
SMU ports:	3 ea. (Ports 2 through 4)
Vs ports:	2 ea. (Vs Ports 1 and 2)
Vm ports:	2 ea. (Vm Ports 1 and 2)

Maximum Voltage Between Instrument Ports: ±220 Vdc
Maximum Current at Each DUT Pin: ±500 mA dc

*SMU: Source measurement unit
Vs: Voltage source
Vm: Voltage monitor

General Specifications

Operating Temperature: 10° to 40° C; ≤70% RH at 40° C
Air Cleanliness: Class 100,000 or higher clean room required.
Power Requirements: 100, 120, 220V ± 10%; 240V +5% −10%; 48 to 66 Hz, 130 VA max
Size: Switching matrix, 406 mm W × 210 mm H × 380 mm D; switching matrix controller, 426 mm W × 134 mm H × 432 mm D
Weight: Switching matrix, approximately 25.3 kg; switching matrix controller, approximately 8 kg

System Controller

Required Controller: HP 9000 Series 200 Model 216S, 236A or 236S, or Series 300 Model 310, 330, 332, 350, 360, 362, 370, 380 or 382
System Language: BASIC 2.0 or later version
Memory Size: ≥ 320 Kbytes

Ordering Information

	Price
HP 4085M Switching Matrix (does not include controller)	$58,900
Opt 001 12-Pin System	−$23,760
Opt 002 24-Pin System	−$15,840
Opt 003 36-Pin System	−$7,920
Opt 004 Add One Pin	+$660
Opt 016* For HP 9000 Model 216A/S Controller	$0
Opt 030* For HP 9000 Model 310 Controller	$0
Opt 036* For HP 9000 Model 236 A/S Controller	$0

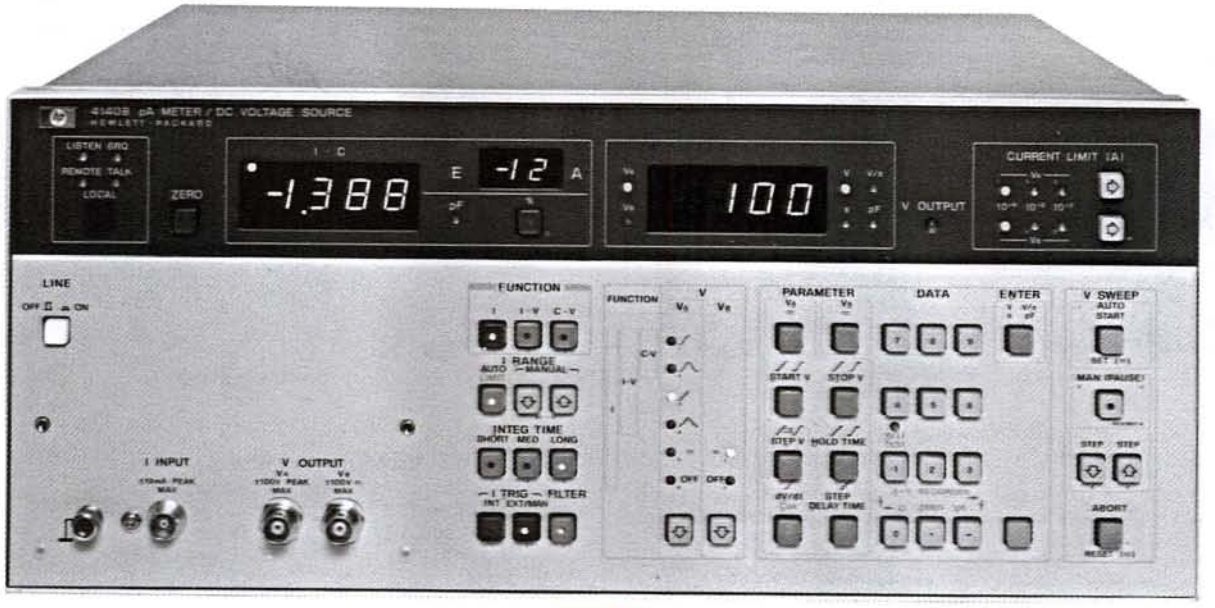
*Opt 016, 030 or 036 must be selected according to the system controller used.

SEMICONDUCTOR TEST SYSTEMS

pA Meter/dc Voltage Source

HP 4140B

- 3 basic semiconductor measurements: I, I-V, and quasi-static C-V
- Two programmable voltage sources
- Basic accuracy: 0.5%
- High resolution: 0.001 × 10^{-12} A
- HP-IB standard



HP 4140B

DESIGNED FOR HP-IB SYSTEMS

HP 4140B pA Meter/dc Voltage Source

The HP 4140B pA meter/dc voltage source is part of component-measurement instrumentation. It consists of an extremely stable picoampere meter and two programmable dc voltage sources, one of which operates as a ramp and staircase generator as well as a dc source. These features make the HP 4140B ideal for making dc-characteristic measurements such as leakage current, current-voltage characteristics, and quasi-static C-V measurements, required by the semiconductor industry for new-product development and for improving production yields. It is equally useful in measuring electronic components and materials to determine leakage currents or insulation resistances.

The HP 4140B can contribute to the development, production, and quality control of semiconductor devices and to improvements in the reliability of electronic components and equipment.

Stable pA Measurements

Stable pA measurements can be made with the HP 4140B with a maximum resolution of 10^{-15}A. This is made possible by a measurement technique in conjunction with an offset current capability, low-noise test leads, and an electrostatic and light-shielded test fixture. These features provide both stable and fast measurements.

This measurement technique is very useful in making small leakage-current measurements and determining dc parameters of semiconductor devices, or measuring the insulation resistance and leakage current for dielectric absorption measurements necessary in the analysis of capacitors or insulation materials.

Synchronized I-V Measurements

The HP 4140B makes automatic, synchronized current-voltage measurements that have required a large instrumentation system in the past.

The two voltage sources in the HP 4140B operate over a range of −100 V to +100 V with a maximum resolution of 10 mV. One operates only as a stable dc source, while the other generates a staircase voltage, a precise ramp, or a stable dc level.

Precise, programmable timing capability allows fast, accurate I-V and C-V measurements. Device stabilization times (time between the applied voltage and the subsequent current measurement) can now be programmed from the front panel of the HP 4140B or via the HP-IB bus.

Quasi-Static C-V Measurements

Automatic quasi-static C-V measurements are easily accomplished by the ramp voltage capability of the HP 4140B. This measurement is highly significant in evaluating basic semiconductor characteristics.

The HP 4140B operates over a capacitance range of 0.1 pF to 1999 pF, with a dc voltage ramp rate of 1 mV/s to 1 V/s in 1 mV/s increments. Capacitance, which is calculated from the measured current divided by the ramp rate, can also be provided as a percentage of the capacitance of the oxide film (Cox) over a range of 0.0 to 199.9%. By providing the output voltage at each capacitance-measurement point, we have the dc (quasi-static) C-V characteristics of the device under test.

HP-IB Capability

Interfacing the HP 4140B with an HP-IB system improves measurement efficiency and takes advantage of its high-speed (approx. 5 ms) measurement rate. Such a system minimizes measurement time for dc parameters of semiconductors and the insulation resistance and leakage current of electric components and materials. This allows rapid feedback to production for fast evaluation of a new device in the development stage.

Specifications

Measurement Functions: I, I-V, and C-V

Voltage Sources: 2 separate sources (V_A and V_B)

V_A: ±100 V programmable source/function generator

V_B: ±100 V programmable dc voltage source

Measurement Function/Source Selection

Function	V_A	V_B
I	⎍ ⎍ ⎍ ⎍ ⎓ (dc)	⎓ (dc)
I-V	⎍ ⎍ ⎍ ⎍	
C-V	⎍ ⎍	

Voltage Sweep: Auto or manual (pause)

Current Measurements

Displays: Current, 3½ digits with 2-character annunciator. Voltage, 3½ digits.

Measurement range: $\pm 0.001 \times 10^{-12}$ A to 1.000×10^{-2} A full scale in 11 ranges.

Overrange capability: 99.9% on all ranges

Range selection: Auto (lowest current range is selectable) and manual

Measurement Accuracy/Integration Time

Range	Accuracy* ± (% of rdg. + counts)	Integration time**(ms) Short	Medium	Long
10^{-2} – 10^{-9}	0.5 + 2	20	80	320
10^{-10}	2 + 2			
10^{-11}	5 + 3	80	320	1280
10^{-12}	5 + 8	160	640	2560

* Accuracy for long integration time. 23° C ± 5° C. humidity ≤ 70%. For short and medium integration times, see reference data section.

** Integration times specified at 50 Hz. For 60 Hz operation, multiply time by ⅚.

Zero offset: Cancels leakage current of test leads or test fixtures.

Offset range: 0 to $\pm 100 \times 10^{-15}$ A

Trigger: INT, EXT and HOLD/MAN

Input terminal: Triaxial

Capacitance-Voltage (C-V) Measurement

Measurement ranges: 0.0 pF to 100.0 pF and 200 pF to 1000 pF full scale in 2 ranges; 99.9% overrange

Ranging: Auto

%C: Capacitance change of device under test is displayed as a percent of the set value of the oxide capacitance (Cox = 100%).

%C range: 0.0% to 199.9%

Cox setting ranges (2 ranges): 0.1 pF to 199.9 pF and 200 pF to 1999 pF

Capacitance calculation accuracy: Accuracy is dependent on accuracy of both the current measurement and the ramp voltage.

Zero offset: Cancels stray capacitances of test fixtures and test leads

Offset range: 0 to 100 pF

High-speed I data output: Available with HP-IB interface only. Outputs current measurement data at 4 ms intervals (max rate).

dc Voltage Sources

Output Modes, V_A and V_B

Function	V_A	V_B
I	⎍ ⎍ ⎍ ⎍ ⎓ (dc)	⎓ (dc)
I-V	⎍ ⎍ ⎍ ⎍	
C-V	⎍ ⎍	

Voltage Ranges (V_A and V_B): 0 to ±10.00 V and 0 to ±100.0 V in 2 ranges, auto range only

Maximum Current: 10 mA, both sources

Voltage Sweep: Auto and manual (pause), up/down step in manual (pause) mode. Sweep abort standard

Operating Parameter Setting Ranges

Start voltage and stop voltage: 0 to ±10.00 V, 0.01 V steps; 0 to ±100.0 V, 0.1 V steps

Step voltage: 0 to ±10.00 V, 0.01 V steps; 0 to ±100.0 V, 0.1 V steps

Hold time: 0 to 199.9 seconds in 0.1 s increments; 0 to 1999 seconds in 1.0 s increments

Step delay time: 0 to 10.00 seconds in 0.01 s increments; 0 to 100.0 seconds in 0.1 s increments

Ramp rate (dV/dt): 0.001 V/s to 1.000 V/s in 0.001 V/s increments.

Accuracy (at 23° C ±5° C)

Output voltage: ±10 V, ±(0.07% + 11 mV); ±100 V, ±(0.09% + 110 mV)

Linearity: Typically 0.5%, 0 to ±10 V; <5 %, >10 V

Current limit: 100 μA, 1 mA and 10 mA, ±10% (V_A and V_B).

Output terminals: BNC; L-GND

Reference Data

Current Measurement

Current Measurement Accuracy*

Range	Integration time Short	Medium
10^{-2} to 10^{-8}	0.5 + 3	0.5 + 2
10^{-9}	0.5 + 3	0.5 + 3
10^{-10}	2 + 4	2 + 3
10^{-11}	5 + 10	5 + 4
10^{-12}	5 + 20	5 + 10

* ± (% of rdg. + counts), 23° C

Current Ranging Times:* 20 ms to 7.76 s (longer ranging time needed for large changes in input signal level, especially on lowest current ranges.)

Warmup Time: ≥1 hour

Common Mode Rejection Ratio: ≥120 dB (≤2 counts)

*When FILTER is on, current ranging time increases 60 ms (50 Hz power line) or 50 ms (60 Hz power line).

Analog Output I, C and V_A

Accuracy: ±(0.5% + 20 mV)

Low-Pass Filter: 3 position: OFF, 0.22 s ±20% and 1s ±20% applied to both V_A and I/C data outputs

Pen Lift Output: TTL low level (≤0.8V) during sweep period in I-V and C-V functions

Recorder Output Scaling: Pushbutton scaling of lower left and upper right limits of X-Y recorder

HP-IB Interface

Remote-Controlled Functions: Measurement function, current range, integration time, I data output trigger, voltage sweep controls, current limit, V_A and V_B voltages, zero (offset), self-test and parameter settings (voltages, sweep/hold/delay times)

Data Output

Measured data (I, C and V_A)
Voltage setting (V_A and V_B)
Parameter settings

General Information

Power: 100, 120, 220 V ±10%, 240 V +5% –10%; 48 to 66 Hz, 135 VA max

Size: 426 mm W × 177 mm H × 498 mm D (16.5 in × 7 in × 19.6 in)

Weight: 14.4 kg (31.7 lb)

Accessories Furnished

HP 16053A Test Leads: Consists of 1 triaxial cable, 2 each BNC-BNC cables and 1 connection plate with mating female panel-mount connectors. Cables are 1 m in length.

HP 16055A Test Fixture: For general device measurements. Provides electrostatic and light shielding for stable pA measurements.

Accessories Available

HP 16054A Connection Selector: Provides a simple method to select appropriate connection of low lead for the pA meter section.

HP 16056A Current Divider (10:1): For use only on the 10 mA range to extend the measurement capability to 100 mA.

Ordering Information

	Price
HP 4140B pA Meter/dc Voltage Source	$12,100
Opt 907 Front Handle Kit (HP p/n 5061-0090)	$76
Opt 908 Rack Flange Kit (HP p/n 5061-0078)	$42
Opt 909 Rack and Handle Kit (HP p/n 5061-0084)	$106
Opt 910 Extra Manual	$110
Opt W30 Extended Repair Service (see page 636)	

Accessories

HP 16054A Connection Selector	$405
HP 16056A Current Divider (10:1)	$214

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office, see page 665.

SEMICONDUCTOR TEST SYSTEMS

1 MHz C Meter/C-V Plotter

HP 4280A

- Built-in sweepable dc bias source and timer for C-V (capacitance-voltage)/C-t (capacitance-time) measurements
- High-speed C-t measurements with minimum measurement interval of 10 ms (10 μs if an external pulse generator is used)
- Basic C measurement accuracy: 0.1%
- Test lead extension up to 5 m
- 51/2-digit display resolution (option) for C measurement

HP 4280A

DESIGNED FOR HP-IB SYSTEMS

HP 4280A MHz C Meter/C-V Plotter

The HP 4280A 1 MHz C Meter/C-V Plotter measures the capacitance and conductance of semiconductor devices and materials as functions of applied voltage (C-V) or time (C-t). The HP 4280A consists of a precision 1 MHz C-G meter, a programmable dc bias source that can be swept in staircase fashion, and accurate timing control.

The HP 4280's internal dc bias source has a range of 0 V to ±100 V with 1 mV resolution on the most sensitive range. Various measurement parameters for C-V and C-t measurements can be manually set from the front panel, or these parameters can be set under program control via the HP-IB. Settable range for C-t measurement interval is 10 ms to 32 s with a best-case resolution of 10 μs. If an external pulse generator is used, however, measurement intervals as short as 10 μs can be set. Up to 9,999 readings can be set for a C-t measurement. These capabilities make it possible for the HP 4280A to measure the C-t characteristics of virtually any device.

The HP 4280A can measure either floating or grounded devices. Thus, it can be connected to a wafer prober and still provide stable, accurate C and G measurements.

Specifications (See data sheet for complete specifications.)

C Measurement

Test Signal
Frequency: 1 MHz ±0.01%.
OSC level: 30 mV rms or 10 mV rms ±10%.
Measurement Range: C: 1 fF to 1.9 nF
G: 10 nS to 12 mS
Basic Accuracy/Display: 0.1%, 4½ digits max. (with Opt 001, C: 5½ digits max)
Measurement Terminals: 2-terminal-pair configuration (High, Low, and Guard).
Connection Mode: Sets connection configuration between DUT (floating/grounded) and measurement circuit.
Error Compensation
Cable length: 0 m, 1 m or 0 to 5 m. The standard cable (HP p/n 8120-4195) up to 5 m can be internally compensated.
Zero open: Compensate stray capacitance and conductance at the test fixture.
Trigger: Internal, External or Hold/Manual.
Internal dc Bias Mode: Off or ⎓ (dc).

C-V Measurement

Function: Measures C-V, G-V, or C and G-V characteristics using internal staircase bias.

C-t Measurement

Function: Measures C-t, G-t or C and G-t characteristics using internal and/or external pulse bias source.

dc Bias Source

Output Mode: ⎍, ⎍, ⎍, ⎓ (dc) or Off
Output Voltage Range/Resolution: ±1.999 V, 1 mV resolution
±19.99 V, 10 mV resolution
±100.0 V, 100 mV resolution
Output Voltage Basic Accuracy: 0.1%
Staircase Sweep Parameter Settings (C-V basic function only)
Start/stop voltage: 0 V to ±100 V (max. 1 mV resolution)
Step voltage: 0 v to 200 V (max. 1 mV resolution)
Hold/step delay time (th/td): 3 ms to 650s (max. 1 ms resolution)
Pulse Bias Parameter Settings (C-t basic function only)
dc/pulse/measurement voltage: 0 V to ±100 V (max. 1 mV resolution)
Number of readings: 1 to 9,999
Hold time (th): Max 10 μs resolution
Internal bias: 10 ms to 32 s
Ext bias slow: 50 μs to 32 s
Ext bias fast: 10 μs to 32 s
Delay Time (td): 10 μs to 32 s (max 10 μs resolution)

Other

HP-IB: Not just IEEE-488, but the hardware, documentation, and support that delivers the shortest path to a measurement system.

General Specifications

Operating Temperature Range: 0° to 55° C; 95% RH at 40° C
Power: 100/120/220 V, ±10%; 240 V, + 5% − 10%; 48 to 66 Hz, 140 VA max
Size: 426 mm W × 177 mm H × 498 mm D (16.5 in × 7 in × 19.5 in)
Weight: 15.3 kg (33.7 lb)

Accessories Furnished

HP 16080A: Direct Coupled Test Fixture

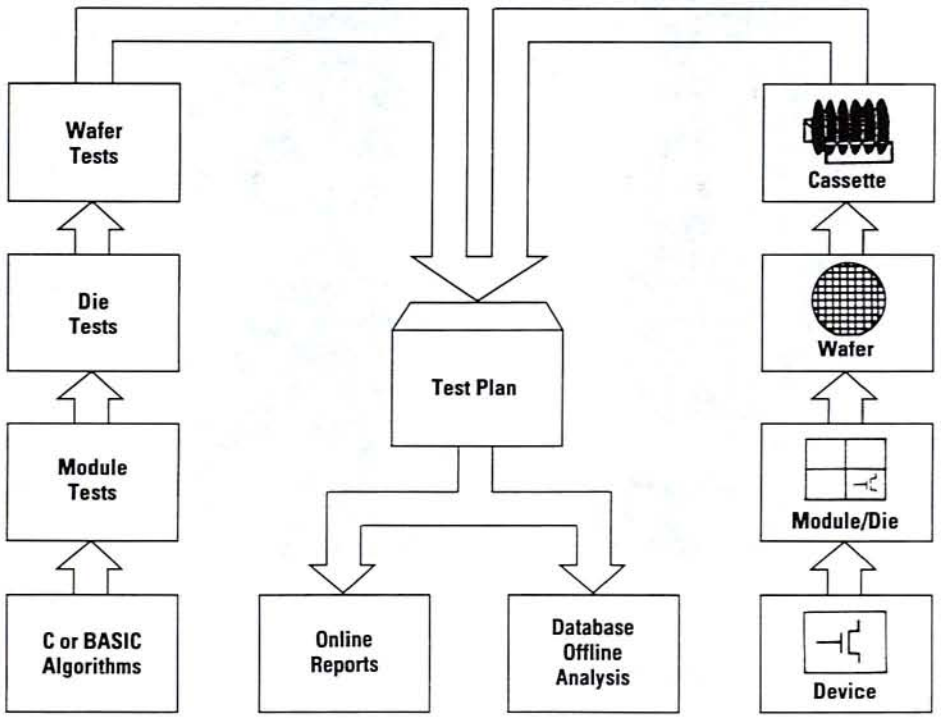
Ordering Information

	Price
HP 16081A Test Leads, 2 m, Double-Shielded, BNC	$760
HP 16082A Test Leads, 1 m, BNC	$260
HP 16083A Pulse Bias Noise Clipper	$415
HP 4280A 1 MHz C Meter/C-V Plotter	$12,200
Opt 001 C High Resolution (not field-installable)	$470
Opt W30 Extended Repair Service (see page 636)	

For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Substantially reduce parametric test development time
- Standardize on IC-MS for all your test development and execution needs
- Generate test plans for use in research and development and production



IC-MS is the ideal test manager for development and production environment.

Impact of VLSI on Parametric Testing

Demands of a rapidly changing VLSI environment have placed great emphasis on a highly flexible and automated manufacturing process. This in turn has led to the evolution of high-speed parametric testers with intelligent instrumentation to perform thousands of measurements routinely. Different phases of VLSI development require using special test structures and corresponding test plans to provide the final evaluation of the myriad interactions between materials and processing that occur during the IC manufacturing sequence.

A Powerful Test Shell for Process Monitoring/Development Needs

IC-MS is implemented on the HP 4062UX semiconductor process control system. It is a test shell that will help you generate and execute parametric test plans with ease and with the least amount of programming. Test plans generated by the IC-MS are used throughout the IC manufacturing process from development to production process monitoring.

IC-MS in Development Environment

Semiconductor technology development process requires a sophisticated parametric test environment in order to gain maximum information from the experimental wafer lots. In such an environment, test plans are constantly generated and modified to meet the demands of increasingly complex tests. Designing a test plan with IC-MS involves two steps: defining the physical structures, and defining the algorithms used to test those structures. The only programming involved is creating test algorithms. Once the reference information about the physical structure of the wafer is entered, generating a test plan involves sequencing, devices, and dies and test algorithms using the X-window–based user interface. This approach offers the maximum flexibility, which is the primary requirement of testing at this stage.

IC-MS in Production Environment

IC production environment requires a parametric test shell that is easy to operate and generates robust test plans. IC-MS takes care of all the nonapplication specific portions of the software, including the user interface. It includes many powerful features to allow for secure and error-free operation in the production mode. IC-MS is optimized for throughput and allows for maximum use of the test hardware.

Powerful Turnkey Features

IC-MS provides many unique features to simplify the process of developing a parametric test plan. These features include on-line reporting capability for quick reports on the status of your process, open interface to allow automatic entry of the reference data, and open access to test plan data for easy integration into the popular databases. User-written algorithms are supported in both HP BASIC/UX and C.

Ordering Information

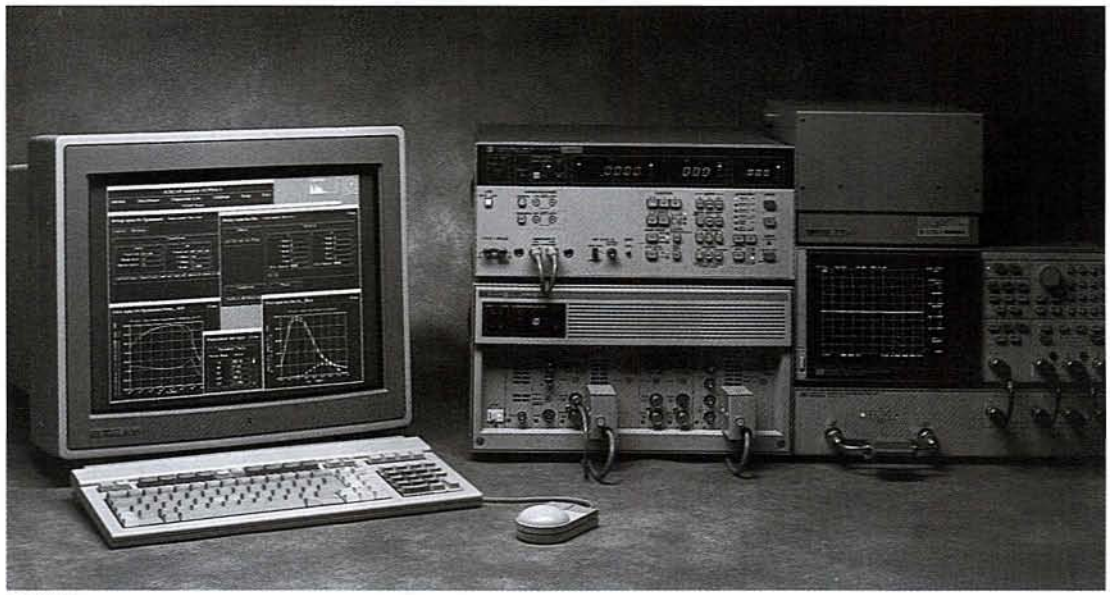
IC-MS software product number is E3330A. It can also be ordered for a site wide installation using E3331A. IC-MS is covered by HP's Basic/ResponseLine support services. We recommend subscription to Software Material Update Service in order to keep current with the IC-MS enhancements.

SEMICONDUCTOR TEST SYSTEMS

Circuit/Device Modeling

IC-CAP

- Minimize design iteration cycle
- Optimize the IC performance
- Create new device models and circuit macromodels with ease
- Use Unified Modeling/Parametric Test enviroment to obtain maximum performance from an IC process



IC-CAP

IC-CAP Circuit/Device Modeling Software

New Approach to Modeling

Over the last decade, semiconductor technology has gone through rapid advancements resulting in dramatic improvement in the performance of ICs. State-of-the-art IC technologies use devices that require careful attention to modeling the parasitics and second-order effects. Parasitics must be included as subcircuits formed around the transistors. Analytically solving a set of device equations is inadequate for most of the semiconductor technologies.

Subcircuit Characterization and Modeling

The success of an IC technology is rooted in its ability to achieve the desired performance while maintaining high product yield. Accurate prediction of the performance of an IC relies on the simulation models used and the capability to accurately extract device parameters as well as subcircuit component values for these models.

Simulating a Device or Subcircuit

IC-CAP provides a direct link to SPICE circuit simulator through an open interface and uses it for analysis and optimization of device or subcircuit performance. Direct use of SPICE also eliminates any discrepancy between modeling and simulation tools.

Extracting Parameters

IC-CAP's powerful extraction, optimization, and advanced utilities, coupled with SPICE simulator, will help you generate the most accurate device parameters or circuit element values for your designs.

Macromodeling

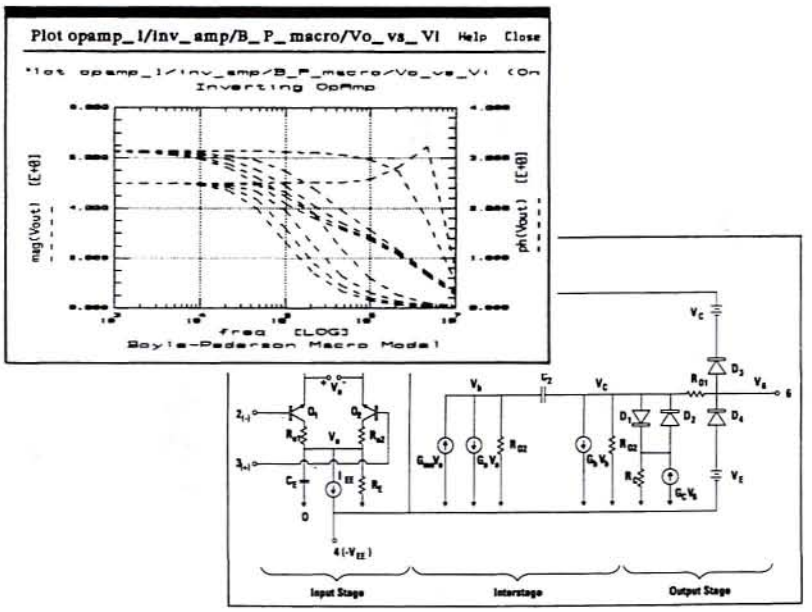
Macromodels are simplified versions of complex circuits that are used for efficient simulation of circuits or systems. The user describes the topology of the macromodel in the form of a subcircuit to IC-CAP. IC-CAP performs the analysis and measurements based on the inputs and finds the optimum component or device parameter values for the best performance.

Unified Modeling/Parametric Test Environment with IC-CAP, IC-MS, and HP 4062UX

Obtaining the maximum performance out of an existing process or a newly developed process requires that the model parameters accurately represent the device characteristics and their variations. Capturing these variations requires gathering a significant amount of model data. This in turn requires the use of high-speed parametric testers for data collection, parametric test software for building process monitoring and modeling test plans. With the advances in framework techniques, it is possible to offer an environment where the modeling and parametric test software can interact and cooperate. IC-CAP and IC-MS offer such a unified environment. The modeling software (IC-CAP), in connection with the high-speed parametric test hardware (the HP 4062UX process control system) and the parametric test software (IC-MS), capture the impact of process-induced variations on device models.

Complete Characterization Solution with TECAP and IC-CAP

TECAP and IC-CAP cover a wide range of characterization needs for the semiconductor industry. All TECAP measurement and extraction files are compatible with IC-CAP. This allows a smooth migration path for present and future TECAP users as they move from single device extraction to device and subcircuit modeling.



IC-CAP circuit-modeling capability is a valuable aid in macromodel development.

IC-CAP Utilities

PEL: Parameter Extraction Language, with an HP BASIC–like syntax, was developed to implement proprietary user-defined extraction routines. This capability is in addition to those of the online Parameter Extraction Library.

TAM: Task Automation Macro language was developed to automate modeling tasks. Instead of using multiple menus and the mouse, TAM allows users to initiate routine or complex modeling tasks by executing a TAM command.

OMI: Open Measurement Interface was developed in response to users' needs to easily add the latest measuring instruments to their system. This capability enhances IC-CAP's comprehensive instrument-driver library.

OSI: Open Simulator Interface offers the same comprehensive tools as OMI to link IC-CAP to any user simulator. In addition to the standard SPICE, HSPICE™, and Saber™ simulator interfaces, some users want to use their in-house simulator, which contains proprietary models; without disclosing the proprietary model equations to the modeling software vendor. OSI allows a direct link to the simulator and protects users' proprietary models.

Random/hybrid optimizers: IC-CAP offers three optimizers to tackle the most challenging characterization tasks. In addition to the commonly used Levenberg-Marquardt optimizer, which may find only the local minimum, the random optimizer continues the search until it converges to the global minimum. The hybrid optimizer uses a combination of Levenberg and random optimizers to quickly achieve the most accurate set of model parameters.

Training and Support

Hewlett-Packard offers free training for every purchase of one of the IC-CAP modeling systems. IC-CAP is covered by HP BasicLine and ResponseLine software support services. We recommend subscription to *Software Material Update* to stay current with the IC-CAP software.

IC-CAP Framework

Configuring a modeling system requires the IC-CAP framework. It must be ordered with all new systems. Adding new models or measurement drivers for an existing system requires the purchase of the particular module only. For example, you can start with a MOS modeling system, and later on add bipolar models and ac measurement drivers to address BiCMOS characterization needs.

IC-CAP Modeling System Configuration

IC-CAP is the product of choice to perform characterization and modeling on the device and subcircuit level for various technologies. IC-CAP runs on HP 9000 Series 300, 400, and 700 computers running under HP-UX, as well as Sun SparcStations. IC-CAP is available with floating license for maximum flexibility in networked installations.

MOS Modeling System
- E3300A IC-CAP Framework
- E3301A dc measurement drivers
- E3302A LCRZ measurement drivers
- E3304A Time Domain (TD) drivers
- E3305A Analysis Module
- E3306A SPICE MOS model parameter extraction
- E3307A SPICE BSIM model parameter extraction

Note: IC-CAP supports both BSIM 1 and 2, levels 2 and 3 of UCB SPICE models. You have the option to select either one or both. We also recommend the E3304A in order to characterize and validate transient performance of selected circuits.

Bipolar Modeling System
- E3300A IC-CAP Framework
- E3301A dc measurement drivers
- E3302A LCRZ measurement drivers
- E3303A ac measurement drivers
- E3304A Time Domain (TD) driver
- E3305A Analysis Module
- E3308A SPICE Bipolar model parameter extraction

GaAs Modeling System
- E3300A IC-CAP Framework
- E3301A dc measurement drivers
- E3302A LCRZ measurement drivers
- E3303A ac measurement drivers
- E3304A Time Domain (TD) driver
- E3305A Analysis Module
- E3309A GaAs model parameter extraction (includes Raytheon and Curtice models)

Ordering Information

Please call your local HP sales office (see page 665) for a data sheet, prices, and application assistance.

SEMICONDUCTOR TEST SYSTEMS

Device Modeling Software

TECAP Characterization System

- Shorten IC design time
- Improve circuit designs
- Lower chip costs
- Maximize yields
- Accurate circuit simulations
- Device ac and dc measurements

TECAP software is fully compatible with a wide range of standard HP-IB instrumentation.

TECAP Lets You Design New ICs in Less Time—With Less Cost

The TECAP Characterization System shortens your IC design cycles and lowers design costs. TECAP—Transistor Electrical Characterization and Analysis Program—provides fast, reliable analysis of device behavior. Model parameters generated with the TECAP system will improve your circuit simulation and IC designs.

TECAP Extracts Model Parameters in Seconds

TECAP software can automatically extract UCB MOS Level 1, 2, 3, or 4; UCB Bipolar; or GaAs model parameters in seconds. These models can simulate second-order effects, such as channel-length modulation, and offer direct compatibility with the UCB SPICE circuit simulator developed at the University of California, Berkeley.

The TECAP system can also extract parameters for your new transistor models. Newly implemented models have the same parameter extraction, optimization, and simulation capabilities as standard TECAP models. You can even add a custom extraction module to the program to fully automate parameter extraction for your model.

Best/Worst Case Modeling

Using TECAP's statistical tools, you can accurately determine worst case performance of your process using those dominant parameters. TECAP gives you the vehicle to construct worst case models, which will allow you to increase the performance of your process with minimal process development and lower cost.

Develop and Understand New Device Models

You can implement your own transistor models into TECAP to be completely compatible with proprietary circuit simulation programs or emerging new semiconductor technologies. You can use the versatile simulation tools to develop and test new model equations.

TECAP Is Easy to Use

TECAP provides both ease of use for the occasional user and advanced features and capabilities for the expert user.

To measure a device, extract model parameters, or simulate device performance, you select the appropriate command. If the system needs more information from you, it will supply a diagram or table for you to edit. Every table is already furnished with default values or configurations. The table entry method allows you to have immediate access to all of your characterization routines so that you can use the design tools more productively.

Configure System Hardware to Satisfy Your Price and Performance Requirements

The TECAP system works with a wide range of standard Hewlett-Packard computers and HP-IB instrumentation, allowing you to choose the equipment that meets your exact needs. TECAP supports the HP 4145B and HP 8753B, as well as newer instruments such as the HP 4142B, HP 8720A, and HP 4284A. You can build an entry-level system to start with. Then, as your requirements expand, you can add the latest in high-performance measurement tools to fit your changing situation.

TECAP Software Specifications

Operating System: Pascal Workstation language system, Version 3.25

Measurement: Voltage, current, capacitance, and 2-port ac parameters vs. bias and frequency

Model Parameter Generation

Extraction:

- Direct extraction from measured data
- Predefined routines for automatic extraction
- Interactive parameter extraction mode
- User-definable extraction routines

Optimization:

- Numerical fine tuning of extracted parameters using integrated SPICE-like simulator for highly accurate fits
- Compatible with user defined models
- Levenberg-Marquardt algorithm for nonlinear, least-squares fit
- Constrained optimization

Simulation: Voltage, current, capacitance, and 2-port ac parameters vs. bias and frequency

Available Models:

- UCB MOS Levels 1, 2, 3, and 4 (BSIM)
- UCB Bipolar (Gummel-Poon, Ebers-Moll)
- Curtice GaAs MESFET Levels 1 (quadratic) and 2 (cubic)
- UCB GaAs MESFET
- Yaeger-Dutton GaAs HEMT
- UCB JFET
- Diode
- PN Junction Capacitance
- MOS Gate Capacitance
- Classical MOS
- Up to seven user-definable models

TECAP Data Sheets

MOS Modeling with TECAP—p/n 5956-4220
BSIM Modeling with TECAP—p/n 02-5956-4217
GaAs Modeling with TECAP—p/n 02-5956-4216
UCB Bipolar Modeling—p/n 5956-4218

Ordering Information

Please call your local HP sales office listed on page 665 for a data sheet, prices, or applications assistance.

Test Solutions for Data Communication and Telecommunication Networks

Communication networks carry the voice and data information that has become essential to businesses and individuals. Network operators and managers face the challenge of continuously expanding and improving the network while keeping it operating at peak efficiency. The pace of change is accelerating as new technologies are introduced and user demands increase.

Hewlett-Packard offers a wide selection of data communication and telecommunication test equipment designed to test, monitor, troubleshoot, and eliminate problems on your network, no matter what its size. Complete and integrated solutions are available that combine instruments, software, and computers to meet your rapidly evolving needs.

All HP communication test instruments incorporate the latest, most appropriate technology and are easy to use, portable, and rugged enough to stand up to years of use in the field. Rigorous environmental testing ensures that measurement specifications are met or exceeded. All products are backed by a warranty that underlines their proven quality and reliability. In addition, HP's efficient repair and calibration services, available worldwide, enable you to maintain your network's quality of service and uptime—and to enjoy a low overall cost of ownership.

Service, Support, and Training

With every HP communication network test product, you get the added benefit of HP's commitment to service and support.

- Lock in maintenance cost savings at the time you purchase your instrument. Options for support beyond original warranty deliver quality repair or calibration services for extended periods of time.
- Solve your problems fast, in the office or in the field. HP has a worldwide staff of knowledgeable engineers to provide you with technical support and repair services.
- Take advantage of training programs designed to give your work force the skills and information necessary for accurate testing. On-site seminars; computer-based training in networking technologies such as frame relay, T1/E1, X.25, and LAN; and video-based training products for local area network or wide area network tests are only a few of your options.

Digital Transmission Testers

	North American Standards										Both Standards		International Standards							
	HP 3784A Option 008	HP 3787B	HP 3789B	HP 37701A	HP 37702A	HP 37704A	HP 37711A	HP 37741A	HP 37743A	HP 37744A	HP 71603B	HP 75000 Series 90	HP 3764A	HP 3784A	HP 37721A	HP 37722A	HP 37724A	HP 37729A	HP 37730A	HP 37732A	HP 37742A
Datacom					●		●													●	
DDS		●			●																
64 kb/s		●		●			●	●								●				●	●
n × 64 kb/s or FT1				●	●		●	●								●				●	●
1.544 Mb/s (T1)	●	●	●	●	●	●	●	●	●												
2.048 Mb/s (E1)													●	●	●	●	●	●	●	●	●
8, 34 Mb/s													●	●	●			●	●		
44.736 Mb/s (DS-3)	●	●			●	●			●	●											
140 Mb/s													●		●			●	●		
3 Gb/s											●										
STS-1, 3, 12						●				●		●									
OC-1, 3, 12						●						●									
STM-1, 4												●					●				
OC-48; STM-16											●	●									
ATM												●									
Jitter	●	●	●		●	●						●	●	●							
Framing		●	●	●	●	●	●	●	●	●		●				●	●	●	●	●	●

TELECOMMUNICATIONS & DATA COMMUNICATIONS TEST
General Information (cont'd)

Data Communication Testers

Workgroup Networks

Portable Test Solutions			
Product	**Description**	**Model**	**Page**
LAN Media Scanners	Troubleshoots 4 or 16 Mb/s Token Ring networks	Ring Scanner	543

Campus Networks

Portable Test Solutions			
LAN Media Scanners	Automated pair scanners	HP 340 Scanner	543
Network Advisor	Problem-solver for Ethernet and Token Ring LANs Decode: TCP/1P, DECnet, Novell, NETBios, 3Com, SNA, AppleTalk, Banyan, IBM PC	HP 4980AS HP 4981AS HP 4982AS	535 535 535
FDDI Network Advisor	For 100 Mb/s fiber distributed data interface networks Passive monitoring or participation as SMT	HP 4983AS	544
WAN Protocol Analyzers	RS-232C, v.24, v.35, RS-449 interfaces; miniature interfaces for ISDN BRI and PRI, X.21 Supports ISDN, X.25, SNA, X.21, frame relay, CCS#7, SDLC, HDLC, IPARS, BSC, DDCMP, async, most character sync protocols	HP 4957A HP 4957PC HP 4959A High Speed	535 535 535
PC-Based Remote Troubleshooter Software	Eavesdrops on remote WAN protocol analyzers PC file transfer, advanced decoding, statistical capabilities	HP 18275A	535
Distributed Network Test Solutions			
LanProbe Network Monitors (DOS platform)	Automatic segment mapping Continuous network monitoring RS-232C, Ethernet, modem interfaces Runs HP ProbeView Software	HP 4991A HP 4996A	546 546
LAN Protocol Analyzer	For Ethernet, IEEE 802.3, StarLAN Supports TCP/IP, DECnet, Novell, NSF, XNS, ISO	HP 4972A	543

Enterprise Networks

Portable Test Solutions			
T1/Datacom Test Set	For T1 leased lines Pinpoint burst errors, phase jitter	HP 37701A, 37711A HP 37702A	548 552
Telecom/Datacom Analyzer	For 2 Mb/s/E1 applications Tests terminals, data circuits using sync. or async. transmission	HP 37732A	548
DS1 Tester	Extensive T1 signal generation and analysis; simplified T1 line and path test	HP 37741A	553
2 Mb/s Test Set	Handheld installation and maintenance of digital leased lines	HP 37742A	551
Transmission Impairment Measuring Sets (TIMS)	For analog datacom and DDS Measure IEEE 743 and CCITT specs	HP 4934A HP 4947	547 547
Distributed Network Test Solutions			
LanProbe Network Monitors (UNIX platform)	Continuous network performance monitoring Supports SNMP and RMON MIB Probe manager runs on HP OpenView platform	HP 4995A	546
In-Service TIMS (ITIMS)	Non-intrusive test of voice-grade leased-lines, North American and CCITT	HP 4948A	547
WAN and ISDN Protocol Testers	Verify network equipment X.25, ISDN, SS#7 automated conformance test suites Flexible script-writing environment Multiple configurations, multiple interfaces X.25, ISDN, SS#7, frame relay, SNA, BSC, group 4 fax	HP PT300/PT500	537
2 Mb/s Protocol Testers	Identifies protocol problems quickly in X.25, SMDS, and frame relay links Auto frame relay emulation	HP PT302/PT502	537
Rate Adaption Tester	Rate adaption test of CCITT Simultaneous ISDN basic-rate and WAN interfaces	HP PT510	537
4-Port WAN Tester	Tests X.25 MLP and gateways	HP PT540	537

HP 4957A, 4957PC, and 4959A Portable WAN Protocol Analyzers

HP's selection of portable, field-service WAN protocol analyzers offers you the testing capabilities you need today, plus the extensibility you may need to solve future problems.

The HP 4957A is a rugged, portable unit weighing only 13 lb. This instrument is ideal for field use where proven reliability in a harsh environment is a must.

The HP 4957PC is a full-length (can be shortened to ⅔ size) PC card that operates in an 80286 or more powerful PC. If your organization already uses portable PCs, the HP 4957PC is the ideal way to obtain uncompromised protocol analyzer performance and to avoid the higher cost of dedicated test equipment.

The HP 4959A is a rugged, stand-alone analyzer based on MS-DOS with a hard disk for plenty of data and program storage. A spare, full-sized, low-profile PC-AT card slot offers expandability to higher speeds and other applications.

Features and Benefits

An Easy-to-Use Testing Environment

- Toolkit provides application management features so you can execute tests that isolate datacomm problems with a single keystroke (HP 4957PC and HP 4959A)
- Auto-configure determines line parameters within seconds
- Softkey-driven menus guide you through the appropriate selections for any given field

A Complete Set of Measurement Tools

- Cursor timing facilitates quick timing measurements between characters or frames
- Monitor menu provides intelligent analysis of collected data. It can:
  - Count events, such as bad frames; 5 counters with a maximum count of 65,535
  - Highlight events for easy location
  - Effortlessly make timing measurements; 5 timers run for up to 65,535 seconds
  - Store data only when relevant information is found on the line
- Simulate menu gives you the ability to replace a node of the network. It includes all programming features of the monitor menu and sends valid and invalid data to test network response.
- Statistics for frame relay, ISDN, X.25, and SNA allow you to easily determine the efficiency and status of the network
- User-definable decodes for frame relay, ISDN, X.25, SNA, and SS#7 let you customize the display to show only information of interest to you
- Bit-error rate testing identifies line quality problems, such as:
  - Standard BERT results (errored seconds, bit and block errors) and G.821 results on the same screen (HP 4957PC and HP 4959A)
  - Block size: 511, 1000, 2047
  - Pseudo-random sequence patterns: 63, 511, 2047, 4095
  - User-definable patterns and FOX message (HP 4959A and HP 4957PC)
  - Character framing: 5, 6, 7, or 8 bits/character plus parity
  - Inject errors: single error or burst of 10 errors
  - Flow control (HP 4959A and HP 4957PC)
- Data filter and selective storage functions let you pinpoint problems faster by limiting the volume of data in the buffer
- Hard disk accommodates storage of large data files so you can capture intermittent problems (HP 4957PC and HP 4959A)
- Supports a full range of protocols and data codes, which allows you to easily isolate configuration and protocol mismatch problems

Additional Functionality Built-In for Convenience

- Support for an external printer lets you quickly communicate test results with printouts of data and menus
- VT-100 terminal emulator eliminates the need for a separate equipment configuration terminal
- Built-in interfaces for RS-232, V.35, and RS-449 provide a complete testing solution under one handle (HP 4957A and HP 4959A)
- PC and protocol analysis capability give you a full-feature protocol analyzer with access to any needed PC functions, all in one package (HP 4957PC and HP 4959A)

Remote Testing (HP 18275A)

With the PC-based Remote Troubleshooter software, you can bring a specialist to the remote problem site instantly, without travel, thus solving problems in a timely and cost-effective manner. The Remote Troubleshooter application allows you to control a remotely-located HP protocol analyzer from your PC with the following features:

Virtual Remote Control: In this mode, the PC's screen and keyboard function like the remote protocol analyzer so you can control the analyzer completely.

- A graphical screen updates information faster than most PC remote control applications
- A "chat" window facilitates communication with remote-site personnel to relay critical information, while enhancing on-the-job training (HP 4959A and HP 4957PC)

TELECOMMUNICATIONS & DATA COMMUNICATIONS TEST

Protocol Analyzers (cont'd)

HP 4957A, 4957PC, and 4959A

File Transfer: Data and menus can be exchanged between the controlling PC and the protocol analyzer, eliminating the need for a separate file transfer application.

- Save data analysis time by capturing data on the remote analyzer, then uploading the data to your local PC for in-depth analysis
- Easily distribute customized monitor and simulate menus to field personnel

PC Data Analysis (HP 18276A thru HP 18279A): In this mode, data captured on the remote analyzer and uploaded to a local PC can be analyzed thoroughly—you no longer depend on the phone or network link to the remote protocol analyzer.

- Pinpoint problems quickly with powerful search and filter functions
- Determine line quality, congestion, or connection problems with statistical displays
- Integrate key protocol information into reports with the print-to-file capability
- Focus on data of interest with flexible display format selection
- A full range of standard protocol decodes (X.25, SNA, bit-oriented, and character-oriented), plus optional decodes (frame relay, ISDN, X.400, and DASS/DPNSS) are available.

Ordering Information

	Price
HP 4957A	$7,190
HP 4957PC	$2,990
HP 4959A	$10,995
HP 18275A Remote Troubleshooter Software	$990
HP 18258A Frame Relay Data and Performance Analysis Software	$790
HP 18280A thru HP 18286A ISDN Solutions	$2,000 to $3,000
HP 18282T T1 Single-Channel Interface	$2,500
HP 18259A X.25 and SNA L2 and L3 Performance Analysis	$600
HP 18261A SNA Analysis Package	$450
HP 18263A 3270 Installation and Maintenance Software	$450
HP 18266A and HP 18267A X.25 Troubleshooting	$600
HP 18273A SS#7 Testing	$600
HP 18291A RS-232C/V.24 Interface Pod (for HP 4957PC)	$610
HP 18292A RS-449 Interface Pod (for HP 4957PC)	$590
HP 18293A V.35 Interface Pod (for HP 4957PC)	$1090
HP 18294A X.21 Interface Pod and Software	$790

Software Applications

With the robust feature sets of the protocol analyzers, plus the additional protocols and features supported via software accessories, a solution can be fine tuned easily to meet your specific needs.

Solutions Matrix

	Frame relay	ISDN	X.25/HDLC	SNA/SDLC	X.21	SS#7	DDCMP	G.821
Layer 2 decode	X	X	X	X	X	X	X	
Layer 3 decode		X	X	X		X		
Layer 4 decode						X		
Layer 2 statistics	X	X	X	X				
Layer 3 statistics			X	X				
Address filter	X	X	X					
Layer 2 emulation		X	X	X				
Partial layer 3 emulation		X	X					
Simulation	X	X	X	X	X	X	X	
Softkey-assisted data entry			X	X				
Bit-error rate tests								X

Choosing the Protocol Analyzer that Is Right for You

	HP 4957A	HP 4957PC	HP 4959A
Size	16.0 × 27.9 × 34.3 cm (6.3 × 11.0 × 13.5 in)	Full-length, 33.4-cm (13.15-in); low-profile, 9.92-cm (3.9-in) PC card. May be shortened to 28.0 cm (11.0 in)	15.0 × 36.3 × 42.7 cm (5.9 × 14.3 × 16.8 in)
Weight	5.8 kg (12.8 lb)	0.3 kg (0.6 lb)	11.4 kg (24 lb)
Hard disk	None	Dependent on PC	86 MB standard 172 MB optional
MS-DOS–based	No	Yes	Yes
Packaging	Portable, rugged, compact package	⅔ or full-length, low-profile AT card	Portable, rugged compact package
Data rate	256 kb/s monitor (opt) 64 kb/s simulate	256 kb/s monitor 64 kb/s simulate	256 kb/s monitor 64 kb/s simulate future: T1/E1, n × 56 kb/s, n × 64 kb/s
User interface	Softkey-driven	Toolkit & softkey-driven	Toolkit & softkey-driven
Interfaces	Built-in: RS-449, V.35, RS-232/V.24 Optional: X.21, basic & primary rate ISDN, single-channel T1	Optional: RS-449, V.35, RS-232/V.24, X.21, basic and primary rate ISDN, single-channel T1	Built-in: RS-449, V.35, RS-232/V.24 Optional: X.21, basic & primary rate ISDN, single-channel T1
Extensibility	Optional software for additional software support	Same as HP 4957A *Plus* runs on DOS, which supports additional applications	Same as HP 4957PC *Plus* spare card slot for higher speed (2 Mb/s) testing
Display	High resolution 12-cm (5-in) monochrome	Utilizes PC display	10.4 in LCD VGA flat panel; monochrome (standard); color active-matrix (opt)

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

The R&D Protocol Tester Series

Whether you are building networking products or designing a new network, you need to manage the protocols at your fingertips. Unlike general-purpose protocol analyzers, the Hewlett-Packard PT Series is designed specifically for laboratory testing—with a flexible development environment full of tools to let you do programming and custom testing with the least amount of effort.

Unlike typical analyzers, these HP testers are designed for combination passive and active testing, including simulation of complex protocols. The multiport configurations allow you to simulate a real network environment with multiple protocols and interfaces. Different models of the HP PT Series support different protocols, such as ISDN, ISDN rate adaption, X.25, frame relay, SMDS, X.75, X.21, Group 4 Fax, and SS#7. For certification and conformance testing, a library of executable test suites is available. Please see the product chart on the next page and check with your local HP sales office for the latest product information.

Flexible Programming

The comprehensive protocol routine library is one of the main elements that make your customization work easier. The protocol emulation package includes high- and low-level routines of the protocol it emulates. You can run the automatic emulation as is, or send frames via menu while the program is running. Sample test scripts are included. Building a script for the higher layers could be as simple as modifying the existing script with a different built-in key word that describes the task. While the script is running, the rest of the emulation for the lower layers automatically does its part. There is no need to read or write in hex—unless you prefer hex, of course. You can use the tester to simulate a live network, or do end-to-end testing, or the like—there is very little that the tester cannot do via test scripts.

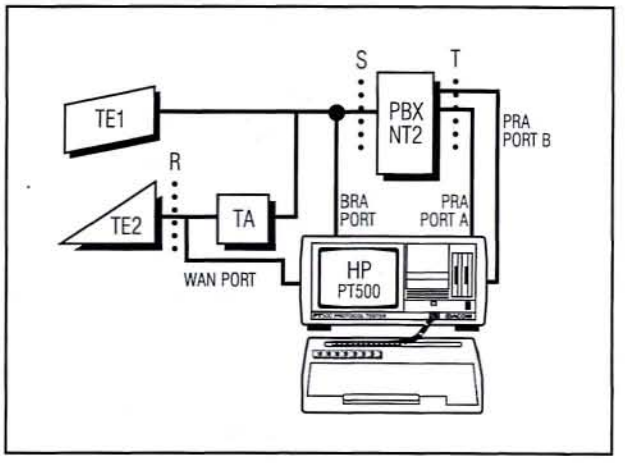
HP PT500 WAN and ISDN Protocol Tester

The HP PT500 is a powerful multiport test engine with an extensive library of software for WAN and ISDN. Besides the automatic emulation programs, the PT500 supports these conformance test suites: DDN, FIPS100, NET2, ISO8882, CTS-WAN, NET31, NET3, CTS2, ACT23, NI-1, VN2, 1TR20, NET5, AT&T CPE, and CCITT Q.781. For design testing, the conformance test suites can be executed case by case so that pieces of software codes may be tested incrementally before systems integration.

ISDN Multiport Application: PABX Development

One of the key advantages of this HP series is true multiport functionality—each port in the protocol tester can operate independently, allowing simultaneous monitoring and/or full emulation of different protocols over different interfaces. The PT500 can have up to three ports, and each port may support up to three channels.

In this example, a manufacturer of PABX equipment is able to use the PRA/BRA/WAN configuration to fully test all network and user functions simultaneously by simulating and monitoring all voice and data calls. The primary-rate (PRA) port is used to simulate the network on the primary-rate interface by generating incoming and outgoing calls and B-Channel (DS0) switched data (for example, X.25) or voice traffic to the PABX. The basic-rate (BRA) port is used to monitor the resulting traffic on two channels: D-Channel signal protocol and data on B Channel is on the basic-rate side of the switch. The WAN port is used to monitor or simulate the communications at the DTE interface with X.21, X.25, Async, Group 4 FAX, and so on.



Accreditation

The HP PT500 with the CTS-WAN X.25 conformance test suite is a registered harmonized test tool recognized by the OSTC and used for X.25 testing service by some PTTs in Europe. It is also a registered test tool for the US GOSIP program running the ISO 8882 test suite.

HP PT502/PT302 2-Mb/s Protocol Testers

The HP PT502 and PT302 are 2-Mb/s protocol testers for frame relay, SMDS, and high-speed X.25. Network managers and developers can find protocol problems quickly with the error identification feature. The HP PT502 is the lab tester. The HP PT302 is its service partner for deployment at the tier-2 level. Both testers share the same software program and user interface, handling existing X.25 links as well as high-speed frame relay and SMDS links. Automatic frame relay emulation, statistics, load generation, SMDS monitor, and SMDS simulation are application software that give you maximum power and flexibility.

HP PT510 Rate Adaption Tester

The HP PT510 is specifically designed for rate adaption testing of CCITT V.110 and CCITT V.120. The dual port (BRA/WAN) configuration supports simultaneous testing of ISDN basic-rate and WAN interfaces. Data streams are synchronized so that you can see traffic going in from the R interface and the same traffic stream coming out at the S/T interface. High-level decoding lets you see the transactions in meaningful explanations in the same order as they happen. Conformance test suites verify correct operation of D-channel signaling and the X- and V-series connection.

HP PT540 4-Port WAN Tester

The HP PT540 is a 4-port WAN tester designed specifically for testing X.25 MLP and gateways between different protocol implementations. This tester can generate background traffic/load to the switching equipment while testing on one, two, or three specific connections, and then measure the performance of the switching equipment.

TELECOMMUNICATIONS & DATA COMMUNICATIONS TEST

R&D Protocol/Conformance Testers (cont'd)

HP PT300/PT500, PT302/PT502, PT510, PT540

HP X.25 Testing

HP X.25 software for HP PT Series protocol testers is designed for R&D applications. The software provides automated high-level test functions that can be used as is or customized. This is only possible with some very special tools: intelligent monitor, automatic reference emulation, built-in high- or low-level routines, sample test scripts, a display system that allows different levels of detail decoding, multiport capability, and a user-definable combination of filters and triggers.

X.25 Emulation and Simulation

The reference emulation program fully emulates the X.25 layer-2 and layer-3 protocol, according to 1980, 1984, and 1988 CCITT recommendations. It supports simultaneous emulation of up to 255 logical channels.

With a dual-port WAN configuration, you can use an HP PT to simulate a switch, emulate dual DTEs, or test a protocol converter on both sides. Each port is independent and capable of emulating while monitoring its own emulation. The tester can automatically synchronize all the ports when you load the test program. Traffic from all ports is time-stamped and recorded as it happens.

To track intermittent problems, set the unit to record the traffic directly to the hard disk. The filters and triggers can be used to set off an alarm when the problem occurs. The search features will help you find the important events leading up to the problem.

Optimizing Your X.25 Network: Dual-Port Testing

Use the X.25 Load Generator to stress-test your X.25 equipment and network. It can generate traffic up to eight logical channels (LCNs) per port. If you have a dual-port WAN unit, you can use both WAN ports simultaneously; with one, you can pinpoint inefficiencies within the network by collecting statistics with the X.25 Network Performance package. This package will automatically collect and display statistics, for both the link and packet layer, on all active or user-selected logical channels.

ISDN Testing

ISDN is a complex protocol, and implementing new features requires a flexible testing environment. The HP PT500 and HP PT510 protocol testers are specifically designed for ISDN development testing. The powerful emulation program, built-in high- and low-level protocol routines, message-building facility, built-in test scripts, and a full test script development facility for customizing scripts are some of the reasons developers choose the HP PT500. A comprehensive library of national and vendor-specific message sets is supported.

Intelligent Monitoring

Optimize your network with statistics analysis. Identify ISDN problems quickly with multiprotocol, multichannel monitoring. High-level decoding, a variety of menu-selected displays, and a multilevel filter system let you see the important events you need to see. You can even set triggers to beep or start test programs when specific events occur.

Comprehensive Emulation and Simulation

Automatic emulation for layer 2 supports up to 8 logical links at a time. You can control layer-3 events via the menu-guided Message Builder or through simulation scripts. The Message Builder simplifies the generation of the complex simulation. The layer-3 simulation can maintain the data associated with 8 separate calls simultaneously. It saves you from having to encode or decode cryptic hexadecimal sequences.

Switch Simulation

Use the HP PT500 to simulate an ISDN switch—such simulation provides an inexpensive alternative to purchasing a live switch for testing. The unique 5-port configuration for simultaneously accessing and testing basic-rate, primary-rate, and WAN protocol provides a real-world ISDN testing environment.

ISDN Research

The HP ISDN Customization Toolkit is designed for research and development of the ISDN protocol. By modifying existing source files for layer-3 messages, IEs, and parameters, you can create a new proprietary message variant. Once this source file is compiled, the new variant will be seamlessly integrated into the ISDN software to provide decoding and display, encoding (building) of protocol data units, filter and trigger recognition, and simulation capabilities. This allows the developer to test the new proprietary ISDN implementation as if the HP software were specifically written to test this new variant.

Once a new message is built or another variant loaded, checking messages received from the device under test for the proper parameters is easy. There are two types of messages: illegally formatted messages and correctly formatted messages, which may contain unexpected but valid parameters. When adapting equipment designed for one country or vendor's standard to another, some IEs might be illegal in different standards. For example, although CCITT's *Blue Book* (1988) specification for Q.931 defines a FEATURE ACTIVATION information element, this IE is treated as illegal and is not implemented in Telecom Australia's ISDN standard TPH1856. The PTs automatically display illegal protocol components in a red banner, so you can find the illegal messages quickly.

To check for expected value of parameters inside any particular information element, use the comprehensive programming library. An analysis script can be built. For example, again, both the CCITT *Blue Book* and the Australian national standards require a bearer-capability IE within a SETUP message in the user-to-network direction. However, the national standard in Australia restricts the "information transfer rate" to only 64 Kb/s; CCITT allows five different values from 64 Kb/s up to 1920 Kb/s. You can build a script to verify conformance to this standard, without using hex coding. First, the script determines the individual parameters within ITs, and then it compares values of those parameters against the expected value.

Conformance Testing

The HP PT500 is also an ISDN conformance test system for product acceptance, compliance, certification, permission-to-connect, and quality-assurance testing. A wide range of automated, executable test suites based on test standards is supported. You can test the myriad of complicated protocol features with these test suites. Available test suites are NI-1(L2, L3 BCC, L3SS), NET3, ACT23, AT&T CPE, CTS2 BRA, VN2 BRA TE, VN2 BRA NT, VN2 PRA TE, VN2 PRA NT, ITR20 MGK, and ITR20 MGK.

	HP PT300/PT500	HP PT302/PT502	HP PT510	HP PT540
Mass storage	40 MB hard disk (standard) 85 MB hard disk (optional) PT300: 1 × 800 KB 3½-in floppy disk drive PT500: 2 × 800 KB 3½-in floppy disk drives	80 MB hard disk PT502: 2 × 800 KB 3½-in floppy disk drives PT302: 1 × 800 KB 3½-in floppy disk drives	40 MB hard disk (standard) 80 MB hard disk (optional) 2 × 800 KB 3½-in floppy disk drives	40 MB hard disk (standard) 80 MB hard disk (optional) 2 × 800 KB 3½-in floppy disk drive
Ports and physical test channels	Up to 3 ports, 6 test channels	Up to 2 ports, 2 test channels	Up to 2 ports, 3 test channels	Up to 4 ports, 4 test channels
Configurations	BRA D channel, WAN, BRA (2B + D), PRA, WAN/WAN, BRA/WAN, PRA/WAN, BRA/BRA, PRA/BRA/WAN	WAN, Dual WAN, T1-E1 and WAN, Dual T1-E1 and WAN	BRA/WAN	4 ports WAN
Physical interface	WAN: RS-232-C/V.24, V.35, RS-449/V.36, V.11/X.21 ISDN BRI: RJ-45, TAE8 + 4C ISDN PRI: RJ-45 & Bantam, DB-9, RJ-14 Voice, serial remote-control DB-25, DB-15 external B Channel access, serial and parallel printer port	T1: RJ-48 and mini Bantam E1: DB-9 and adapter cables WAN: V.35/V.11 or RS-449/422/423/V.11	WAN: RS-232-C/V.24, V.35, RS-449/V.36, V.11/X.21 ISDN BRI: RJ-45, TAE8 + 4C	RS-232-C/V.24, V.35, RS-449/V.36, V.11/X.21
Operating speeds	Up to 256 Kb/s per test channel	Up to 2.048 Mb/s per test channel	Up to 256 Kb/s per test channel	Up to 256 Kb/s per test port
Remote testing	Remote test pack for Frame Relay, X.25, X.25/QLLC, ISDN	Remote test pack for Frame Relay and X.25 monitoring on WAN interface		
Protocols	Frame Relay, X.25, X.25/Q(QLLC/BRPAD/DSP), ISDN, LAPD/X.36 (D Channel), SS#7, SDLC/SNA, X.75, X.21, Group 4 Fax, V.120, BSC 3270, Universal (Sync, BOP, COP, Async)	Frame Relay, X.25, SMDS, ISDN	ISDN, V.110, V.120, X.25, Universal (Sync, BOP, COP, Async)	ISDN, X.25, Universal (Sync, BOP, COP, Async), X.32, X.28, X.29, SDLC/SNA, BSC, X.75, Frame Relay
Programming	Custom-test script generation via finite-state machine concept. Access to an extensive run-time library for all protocols supported. Simulation via function keys.	Custom-test script generation via finite-state machine concept. Access to an extensive run-time library for all protocols supported. Simulation via function keys.	Custom-test script generation via finite-state machine concept. Access to an extensive run-time library for all protocols supported. Simulation via function keys.	Custom-test script generation via finite-state machine concept. Access to an extensive run-time library for all protocols supported. Simulation via function keys.
Conformance testing	Available executable test suites: **X.25:** DDN, FIPS100, CTS-WAN, NET2, Facility, ISO8882 (US GOSIP) **ISDN:** NET3, ACT23, VN2 BRA, VN2 PRA, CTS-WAN L3, ISO8882 L3, NET2 L3, CTS2 BRA, 1TR20, NET5, AT&T CPE, NI-1, CTS2 bis V.120, VN3 **SS#7:** Q.781 **Group 4 Fax:** NET31 (T.64) **SDLC/SNA:** Verification **CTS2:** X.32 **CTS2:** Triple X	Available executable test suites: **Frame Relay:** ITD proprietary verification test, ACT FR **X.25:** CTS-WAN, NET2, ISO8882	Available executable test suites: **V.110:** CTS2 bis V.110, CTS2 bis NET7 **V.120:** CTS2 bis V.120	

V.110 and V.120 Rate Adaption Testing

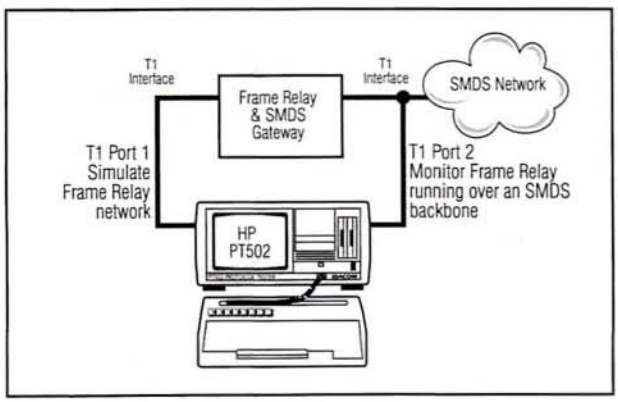
The HP PT510 ISDN Rate Adaption Tester provides a complete testing environment for ISDN terminal adapters. You can increase the reliability of rate-adapted ISDN equipment before it is brought to the market or hooked up to a live network. The CTS2 bis V.110, CTS2 bis NET7, and CTS2 bis V.120 are automated conformance test suites to help you identify interoperability problems. The software works with ISDN D-Channel and WAN applications so that you can see how the rate adapter handles D-Channel signaling and what the traffic looks like from its WAN interface. The V.110 software will decode asynchronous data and HDLC-CCITT frames within V.110 frames. The V.120 software will decode all layer-2 frames and layer-3 messages. The simulation supports building layer-2 frames, including header and control state octets, and layer-3 messages. The V.120 software is also available for the HP PT500 and PT300.

Applications: Identifying a Frame Relay problem

The requirements for testing high-speed networks, when the data goes faster than the eye can see, are unique. You need a tester that can filter a greater number of important events than usual and can decode to a specific level of detail so you can see specifically what you want to see. An HP protocol tester organizes the data for you in a logical format. Easy-to-understand English descriptions enable you to pinpoint the problem quickly.

When you have a network full of routers and it doesn't work, how do you identify the problem? You would probably guess that it was a router configuration problem because traffic on some TCP/IP addresses worked and on others it didn't. Which router was at fault? The local one or the remote one? Use the HP PT502 to record a correct terminal session and a malfunctioning one. The clearly decoded data will show exactly what was wrong with the traffic and which router needs fixing.

Users report that the most common kinds of problems are physical cabling problems and layer-1 faults. Often, these errors are not visible until errors in the higher layers are ruled out or identified. For example, at a trial network there was a nonfunctioning Frame Relay link. When a cabling problem was suspected, a BERT tester was used on the line, but no problem could be identified. When the protocol tester was connected, the wrong kind of traffic was seen on the line. With the detailed decoding, the operator could understand the traffic immediately and the fault was identified: The cable was connected to the wrong jack.



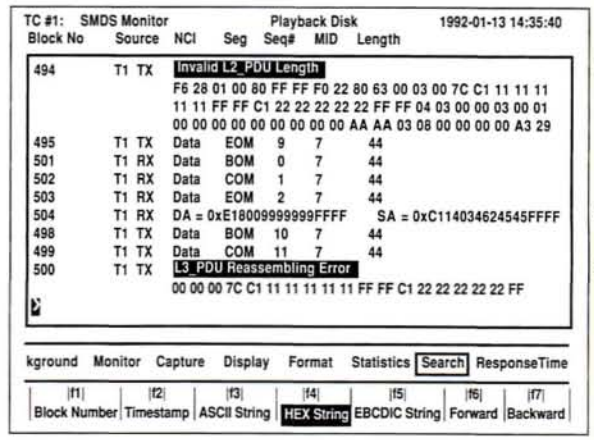
A fully automatic Frame Relay emulation for Q.922 LAPF handles up to eight LAPF channels on any DLCI, with heartbeat polling, and so on. This is invaluable for active testing when you need to check the device for correct operation before you release it to your network. You can send frames via menu while the emulation is running. Built-in protocol routines save you a lot of scripting effort when you need to handle unplanned testing situations. You can use the dual-port configuration to emulate on one port and monitor the resulting traffic on the other port. Traffic is correlated and events are presented in the order they occurred on the line.

The frame relay monitor includes a package that can gather statistics at over 80,000 frames per second, with 100% line utilization at 2.048 Mb/s (with varying frame sizes).

SMDS Testing

The HP PT502 2 Mb/s protocol tester helps SMDS implementors find protocol problems quickly. It will fully decode SIP levels 1, 2, and 3 and highlight errors in red. The level-3 reassembly engine can reassemble up to four level-3 PDUs simultaneously. Traffic is decoded into English descriptions. Intelligent filtering lets the user filter the high-speed recordings and see only what is required. Intermittent SMDS events can be identified by using triggers. Statistics capabilities let you analyze utilization and error rate on the line.

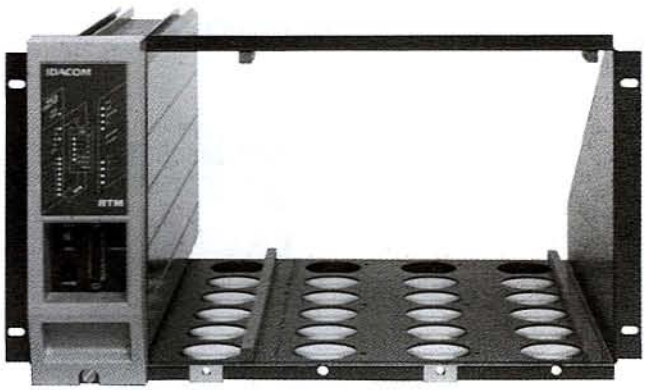
The PT502 screen below shows how errors are highlighted. (On an actual screen, the highlighting is red.) The first error, ①, shows an invalid protocol data unit (PDU) length. The second error, ②, shows a level-3 reassembling error. Reassembled L3 PDUs, ③, will be decoded to show the destination address.



SMDS Simulation

You can simulate SMDS SIP level-2 or level-3 traffic as the customer premise equipment (CPE) or Switching System (SS). With the PDU builder, you can construct a correct or incorrect level-2 or level-3 PDU. The constructed PDUs can be saved to a pool file on disk for later use. Level-3 PDU information fields longer than the maximum size of 9188 octets can be constructed for error testing. The SMDS application supports user-created higher-layer decoding and display. A TCP/IP decoding test script is included.

The application diagram on the left shows the PT502 testing a Frame Relay/SMDS gateway with the dual-port T1 configuration. It simulates Frame Relay on one port by doing Frame Relay load generation; then the second port monitors the same traffic over an SMDS link.



Remote Transparent Monitor (RTM)

HP's RTM is a remote test access system that transports live data, clocks, and control lead information from a remote test site back to a Network Control Center (NCC). At the NCC, the circuit being tested is regenerated in real-time with full data integrity and with the same time correlation between events as occurred originally. When a network user has a problem, experts at a NCC can now use local equipment to analyze a network problem without locating to a remote site.

RTM equipment operates in pairs. Monitor equipment at the remote site and regeneration equipment at the local site are connected via a dedicated or a switched circuit. The RTM units are interchangeable between remote and local sites. With the flip of a switch they can be reconfigured to operate as a monitor or a regeneration unit.

Features

Protocol Independent: The circuit being tested and monitored by the RTM can be any protocol to 19.2 KB/s asynchronous and to 64 KB/s synchronous in selected speed increments. Since the RTM is protocol independent, circuits using modified or emerging protocols can be analyzed also.

Maintains Time Correlation: The data, clocks, and control leads are regenerated at a NCC in the same sequence as they occur on the circuit being tested.

Link Error Detection: The RTM is a smart pipeline—a revolutionary data transport system with built-in error detection. It accommodates to normal noise that may occur over the link, making the regenerated data an accurate and link-error-free reproduction of the circuit being tested. The regeneration RTM signals the operator at a NCC if major link disturbances occur.

Lead States and Transitions: The RTM transmits lead transitions of up to 8 leads with 100 transitions per second, maintaining time correlation between the lead transition and data.

Automatic Clock Adjustments: The RTM automatically adjusts to synchronous clock rates. It also recognizes asynchronous circuits and provides its own internal clock to sample the data at a suitable rate.

Voice Channel: Direct phone communications over the link is provided between the remote and central sites.

Test and Analysis Channel: This port acts as a transparent asynchronous communication link between the remote and central test sites.

Command Channel: Using the command port, the operator can run diagnostics, obtain reports on link statistics, and reset link error counters.

Size		26.5 W × 8.6 H × 45.7 D cm 10.5 × 3.4 × 18 in
Weight		4.1 kg (9 lb)
Modes of operation		Monitor or regenerator Maintains data integrity, ensuring time correlation
Protocols		Protocol independent, any sync or async
Circuit under test **Output to test equipment**	Sync (with clock):	2.4, 4.8, 9.6, 19.2, 56.0, 64.0 KB/s
	Async:	0.3, 1.2, 2.4, 4.8, 9.6, 19.2 KB/s
	Leads:	Up to 8 leads, 100 lead transition/sec
	Monitor:	DB-25 (female) RS-422 or DB-25 (male) RS-232-C
	Regeneration:	DB-25 (female) RS-422
Link	Sync (network clock):	Up to 256 KB/s
	Protocol:	HDLC (requires passive link)
	Physical Interface:	34-pin Winchester V.35
Command channel	Async:	9.6 KB/s
	Modes of operation:	Communication to local RTM Communication to remote RTM Transparent between local and remote sites
	Physical interface:	DB-25 (female) RS-232-C
Test and analysis channel	Async:	9.6 KB/s
	Mode of operation	Transparent between local and remote sites
	Physical interface:	DB-25 (male) RS-232-C
Voice channel	Mode of operation:	Phone (front panel) PBX (rear panel) Off hook detect Ring detect Transparent connection
	Physical interface:	2-wire RJ-14

TELECOMMUNICATIONS & DATA COMMUNICATIONS TEST

Signaling Test Set

HP 37900D

- Multilink tester for network signaling (No. 7 and ISDN)
- Message sequence tracing
- Text decoding of level-2, level-3, and level-4 data
- Optional programmable emulation to network devices

HP 37900D

HP 37900D Signaling Test Set

This high-performance, multilink network signaling tester is used to test Signaling System No. 7 and ISDN protocols simultaneously. It provides slots for four 2.048-Mb/s, GSM TRAU, 1.544-Mb/s, V.35/DS-0/DS-0A, or BRI signaling interface cards [or for two RS-232-C plus RS-449 (422) signaling and interface card pairs].

The base HP 37900D signaling test set provides No. 7 monitor-only capabilities on up to two signaling interfaces. Options allow control of up to four signaling interfaces, addition of ISDN and emulation capabilities, and monitoring of the interaction between an HP 8922G and a GSM mobile under test.

Features

The HP 37900D is a portable test set capable of monitoring up to four bidirectional links simultaneously or emulating up to eight links.

Monitoring

The monitoring capabilities allow signaling events to be followed as they happen or signaling data to be recorded for later in-depth analysis.

Real time

- Activity and customizable message-decoding displays
- Triggers, filters, or tracing facilities control data collection

Post logging

- Data management facilities (searches, selective views, replays, statistics, and message sequence traces)
- Text decoding of data on levels 2, 3, and 4 for No. 7 or ISDN

Emulation

The emulation capabilties allow the HP 37900D signaling test set to test the response of signaling equipment to specified messages or message sequences. Following user-written tests the HP 37900D can generate and receive No. 7 and/or ISDN messages. For each test, users can define up to 300 specific messages plus real-time message modifications. All signaling events (including unexpected events) during a test are time-stamped and recorded in a test log. Additionally, a test sequencer allows unattended testing.

HP 37900D: A Versatile Tester

This portable, multilink test set is an ideal troubleshooter for maintaining signaling equipment and software for networks. Optional capabilities allow the HP 37900D to simplify design verification or cross-switch testing. It is also used for conformance, compatibility, or regression testing.

Specifications

Size: 370 mm W × 190 mm H × 480 mm D (14.5 in × 7.5 in × 18.9 in)
Weight: Net, 13 kg (27 lb); shipping, 22 kg (46 lb)

Basic Characteristics

RAM buffer for logging: 2 MB (expandable to 6 MB)
Built-in hard disk: 52 MB
Flexidisk drive: 3½ in (1.44 MB)
Level-1 status: Front-panel LEDs (plus alarm analysis in software)

Monitor

Capture performance: 100% MSUs per link (each direction)
Time stamp for logged data: 1-ms accuracy
Triggers, filters, traces: Include triggering on data on levels 2, 3, or 4 and erroneous SUs and filtering of specified SUs or events (filtering of PCR links also available)
Text decodes (No. 7): *CCITT Red Book* and *Blue Book*, No. 7 national variants and applications, GSM, NMT 900
Text decodes (ISDN): Q.921 and Q.931 (Blue Book), Abis, ISDN national variants

Emulation

Message generation performance: 100% MSUs
Real-time message manipulation: Yes
Time-stamped test log: Yes
Text decoding of test log: Yes

Ordering Information

Please contact your local Hewlett-Packard sales and support office. See page 665.

HP 4972A LAN Protocol Analyzer

The HP 4972A is a protocol analyzer for Ethernet, IEEE 802.3, and StarLAN local area networks (LANs). The analyzer captures and displays frames integral to communication between networked systems and devices. Statistical measurements provide information on fundamental parameters that instantly characterize network performance. Messages can also be transmitted to test system responses or simulate heavily loaded network conditions.

Features

- Trends and statistics
- Network performance analysis
- Protocol interpreters
- Background traffic generation
- Programmable messages, tests
- Simultaneous transmit, receive

Trends and statistics of media-access layer parameters are monitored easily by the HP 4972A. Key measurements include utilization, errors and collisions, and station activity. The background traffic generator is user-configurable for stress testing networked systems and devices.

Network performance analysis applications measure network and transport layer parameters for TCP/IP and DECnet networks. System activity by IP or DECnet address, and a distribution of frames by port or message type are tabulated. Graphs of throughput, retransmissions, response time, and packet length analyze conversations at the transport layer.

Protocol interpreter applications present protocol header information in an easily understood manner and highlight common error conditions. Interpreters are available for TCP/IP, DECnet, Novell's NetWare, Sun Microsystem's NFS, XNS, and ISO protocols.

Specifications

Size: 430 mm W × 270 mm H × 570 mm D (17 in × 11 in × 22 in)
Weight: Net, 21 kg (46 lb); shipping, 27 kg (60 lb)

Ordering Information	Price
HP 4972A LAN Protocol Analyzer	$21,000
Opt 001 RGB Color Output	$1,500
Opt 002 RS-232/V.24 Remote Interface	$600
Opt 005 StarLAN Interface	$500
HP 18221A TCP/IP Protocol Interpreter	$960
HP 18222A TCP/IP Network Performance Analysis	$960
HP 18223A XNS Protocol Interpreter	$960
HP 18224A DECnet Protocol Interpreter	$960
HP 18225A DECnet Network Performance Analysis	$960
HP 18226A ISO Protocol Interpreter	$960
HP 18227A NetWare Protocol Interpreter	$960
HP 18228A NFS Protocol Interpreter	$960

LAN Media Scanners

Hewlett-Packard offers two handheld, battery-powered local area network media scanners for isolating wiring problems on LANs quickly. For Token Ring shielded twisted pair (STP) or unshielded twisted pair (UTP), 10Base-T, Ethernet thick- or thin-LAN, ARCNET, or almost any LAN, these easy-to-use products are designed to find the most common LAN faults.

HP J2201A HP 340 Scanner

The J2201A HP 340 Scanner provides automatic testing of LAN cabling systems in an easy-to-use instrument. Compatible with UTP, STP, and coaxial LANs, the HP 340 Scanner is designed to help installers and network managers certify LAN cabling systems for Ethernet, 10BASE-T, 4 or 16 Mbps Token Ring, and ARCNET networks.

With the scan time-domain reflector (TDR) measurement, the HP 340 Scanner pinpoints the exact location of any fault or break in the cable. For certification of new or existing LAN cabling systems, the HP 340 Scanner measures signal attenuation and near-end crosstalk (NEXT) from 256 KHz to 20 MHz. The autotest mode automatically runs the appropriate tests for the network type selected and instantly reports any deviation from expected results.

When used with the optional Cable Management System software package, the HP 340 Scanner allows you to access up-to-date records on the physical parameters of every part of your LAN.

HP J2196A Ring Scanner

The J2196A Ring Scanner was designed exclusively for troubleshooting Token Ring LANs. At a fraction of the cost of more complex Token Ring testing products, the HP Ring Scanner will detect faults quickly in Token Ring lobe wiring, isolate defective MSAUs, and verify proper installation and operation of both 4 and 16 Mb/s Token Ring networks.

When used together with the HP 340 Scanner, the HP Ring Scanner will display the instantaneous network traffic level graphically, and will record data activity over time to pinpoint traffic congestion problems.

Each HP scanner is backed by a full three-year hardware warranty (parts and labor), and is serviced and supported by Hewlett-Packard worldwide.

Specifications

Size: 10 cm W × 19 cm H × 2.5 cm D (4.0 in × 7.5 in × 1.0 in)
Weight: 0.5 to 0.9 kg (1 to 2 lb)

Ordering Information	Price
HP J2201A HP 340 Scanner	$3,495
HP J2196A Ring Scanner	$1,295
HP J2203A Cable Management System Database Software	$195

Contact your local Hewlett-Packard sales office for information on the availability of different options, including test kits for specific network types and ac battery chargers for various destination countries.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

TELECOMMUNICATIONS & DATA COMMUNICATIONS TEST

LAN Protocol Analyzers

HP Network Advisors

- Network performance analysis
- Network protocol decoding
- Node statistics and node discovery
- Network commentators for Token Ring, Novell, IBM LAN Manager, ICMP, and FDDI
- Traffic generation capability
- Stimulus/response testing
- Filtering
- Expert system technology for network problem solving
- Custom network acquistion hardware
- FDDI, Token Ring and Ethernet network interfaces
- Industry standard MS-DOS operating system
- Lightweight, integral package

HP Network Advisor

The HP Network Advisor combines a complete measurement set with multitasking to provide a powerful tool for stress testing applications and isolating and solving problems on local area networks (LANs). The HP Network Advisor also defines a new class of LAN troubleshooting tool. Other analyzers provide good protocol decoding tools, allow stimulus/response testing, or offer statistical performance measurements. But, no other analyzer offers all of these capabilities and more in the same instrument.

The HP Network Advisor has a powerful, multitask operating system, which allows various measurements to be executed simultaneously. For example, the network advisor allows you to run statistical performance measurements and capture frames, or simulate a network load and observe its effect on the performance of a server or an individual conversation. You can verify station connectivity (ping) actively while still monitoring the performance of the overall network.

The HP Network Advisor's graphical display makes measurement results very easy to interpret. The VGA resolution display system instantly provides graphs, pie charts, bar charts, or gauges to help clarify results of statistical performance measurements. With the optional 16-color display, the results are color-coded, and alert conditions are apparent visually.

Intelligent protocol decodes automatically follow each conversation and report on errors or deviations from expected protocols. The HP Network Advisor then reduces hundreds of captured data frames to a short list of significant network events, and interprets the significance of these events. This capability is incorporated into a feature called a Network Commentator.

The HP Network Advisor's Fault Finder expert system observes your network's behavior, forms hypotheses on possible problems, performs tests to prove or disprove the hypotheses, and finally reports on its findings. The Fault Finder takes advantage of powerful statistical performance measurements not found on any other product in its class, making fault diagnosis much more comprehensive. Active stimulus/response tests are used to actually prove conclusively the existence of each suspected fault. This automatic, active fault-finding capability is unique to the HP Network Advisor.

A context-sensitive, on-line help system is built into the HP Network Advisor, virtually eliminating the need for operating manuals when you troubleshoot. The help system provides complete explanations of all measurements as well as tutorials on various networking topics and troubleshooting suggestions.

Network Performance Analysis

The HP Network Advisor provides the most comprehensive set of statistical measurements available on any protocol analyzer. The network summary statistics, or "dashboard" display, combines the most important information about the network's overall health on a single screen. Included are network utilization over time, errors, protocol mix, and traffic activity by node. The dashboard provides an instant indication that there is a problem on the network, and what that problem is.

Critical Ethernet measurements—such as utilization, collisions, errors, and protocol distribution—are distilled onto a single screen. For Token Ring networks, the HP Network Advisor takes advantage of the MAC layer network management functions to tell you even more about your network. Beacons, claim tokens, and a complete breakdown of report soft-error contents, along with utilization, are plotted simultaneously. The trends feature allows you to graph four predefined or user-selected network parameters in graphical or tabular format. You can draw your own correlation from either 20 Ethernet or 43 Token Ring continually measured parameters.

When network performance exceeds network norms, key indicators turn red to alert and notify you automatically. Details of these potentially problematic events are posted to the Event Log. Each screen of information can be exported to a standard PC spreadsheet program for further analysis or report generation.

Protocol Decodes

When it becomes necessary to examine the contents of frames, the HP Network Advisor provides a complete set of decodes, which can be used at run time or for post processing. The HP Network Advisor has decoding capability for every major protocol stack including TCP/IP, Novell, 3COM, AppleTalk, Banyan VINES, DECnet, XNS, IBM PC LAN, SNA, ISO, and many others.

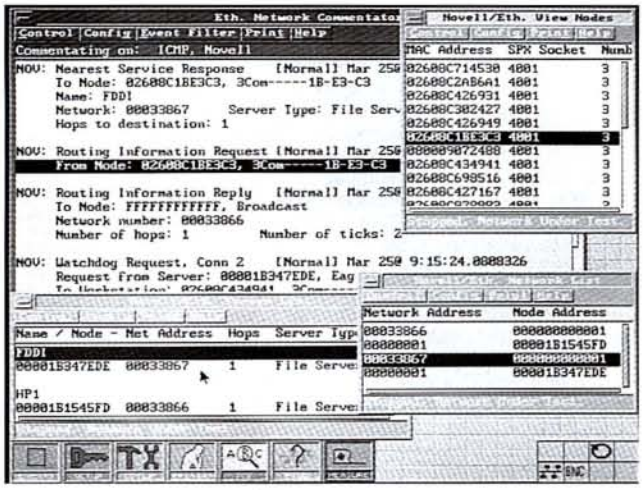
Decoding can be performed in three modes. The Network Stack Decodes provide a global view, frame-by-frame, of all the data traffic on your network. Protocol Stack Decodes allow you to zoom in on a specific protocol stack. Protocol Layer Decodes let you focus still further on individual conversations at any protocol level within the stack.

In addition to displaying the contents of each frame, the decodes can also follow the protocol of each individual conversation and point out the significance of the data you decode. Protocol violations—such as checksum, length field, and sequence number errors—are brought to your attention.

Node Statistics and Node/Station Discovery

With the node statistics capability, the HP Network Advisor can perform conversational analysis on nodes using multiple sorting criteria. For example, possible sorting criteria are: errors, frames sent, and frames received. This information can be displayed in tabular, pie chart, or graphical format.

The node/station discovery feature allows you to create a node list consisting of observed or user-defined nodes. By monitoring all traffic and comparing it with a node list, the HP Network Advisor can tell you which stations are observed (seen on the network and match an entry in the node list), new (seen on the network and do not match an entry in the node list), and inactive (appear on the node list and are not seen on the network).



Network Commentators

Isolating a LAN problem can often mean searching through hundreds or thousands of captured frames, most of which are insignificant or irrelevant. Commentators will increase your productivity and save you time by automating this process. You can think of commentators as expert troubleshooters that monitor data traffic, follow protocols, and reduce hundreds of frames to a handful of significant events (events that are potential preludes to performance degradation or network failure). Commentators sift automatically through data traffic and identify problems for you. They provide a sequenced list of network events for important protocols, including Token Ring, Novell (on Ethernet or Token Ring), IBM LAN Manager, ICMP, and FDDI.

Trafffic Generation

The traffic generator is an extremely powerful and flexible tool. You can use it to load your network with added traffic to observe its behavior. As a development tool, it is very useful for characterizing and qualifying network devices during development and before installation. Hardware limits or protocol device implementation—such as bridges, gateways, and routers—can be determined by increasing traffic to these devices or introducing perturbations on the network. Protocol stacks can be exercised by passing different types of messages through them. The traffic load can be configured easily by utilization, frames per second, or interframe spacing. Traffic can be generated on the Ethernet/802.3, Token Ring/802.5, or the FDDI interface.

Errored frames can be created to evaluate a network's sensitivity to errors. Very often it is necessary to generate a particular sequence of data packets or errors, or to create a specific traffic load to recreate a fault. The traffic generator provides 32 user-configurable messages for this purpose. These messages can be entered by the user directly, copied from the capture buffer, or chosen from a list of template messages such as ARP Request, XID Request, or Echo Request. These messages can be transmitted a specified number of times, or continuously. With the HP Network Advisor, you can recreate most any network condition.

Stimulus/Response Testing

With the HP Network Advisor, both active and passive testing can be accomplished using predefined, easily configurable measurements. The active tests allow you to: query a station for its address, send a "ping" message to verify connectivity, find the nearest Novell server, list all bridges, and list all active stations. Since the network advisor can multitask, any of the active stimulus/response tests can be executed while simultaneously monitoring the effect on the network.

Filtering

The HP Network Advisor will capture every frame no matter what the traffic level—sometimes exactly what you need. But with data filtering, you can zero in on exactly the frames you need to see. You can filter by MAC level station addresses, by frame attributes, by frame type, or by any user-specified data field. Multiple filters can then be defined and enabled simultaneously to capture several different kinds of frames. Filter criteria can be used to capture frames, to exclude frames, or to stop data capture when a frame occurs. The filters examine every frame in real time as they occur on the network.

Fault Finder

Fault Finder is the expert-system–based troubleshooting program that diagnoses problems on Ethernet and Token Ring networks automatically. It monitors the network watching for significant events, and then forms and reports the most likely hypothesis from its observations. It will prove or disprove that hypothesis using an extensive array of preconfigured active stimulus/reponse tests, comprehensive time-correlated statistical performance measurements, and a host of other powerful measurement tools.

For every problem found, Fault Finder will define the problem, explain the reasoning used to determine the problem's cause and suggest actions that could be taken to correct the fault. Hundreds of common faults are diagnosed quickly on Ethernet, TCP/IP, Token Ring, Novell, and IBM LAN Manager networks. If a problem is not found conclusively, the HP Network Advisor will list possible problems and leave a detailed record stating what it has learned about your network.

Fault Finder can also be used on healthy networks where there is no problem. By measuring utilization and error levels when the network is healthy, the HP Network Advisor can establish a baseline level of normal network performance. Whenever a problem does occur, Fault Finder will use this baseline performance level as its reference when looking for probable problem causes.

Convenient System Platform

The HP Network Advisor is contained in a lightweight, portable package, which makes it easy to dispatch to a problem site. The display and keyboard are hinged to facilitate rackmount and floor standing as well as desktop operation. An optional, state-of-the-art, VGA resolution flat-panel color display greatly enhances the instrument's user interface. The network advisor runs on a 20 MHz 386SX or 33 MHz 486DX base platform, and can be used to run standard MS-DOS applications when not used for network troubleshooting.

Specifications

Size: 363 mm W × 150 mm H × 427 mm D (14.3 in × 5.9 in × 16.8 in)
Weight: 11.4 kg (25 lb)

Ordering Information (typical configurations)	Price
Basic Unit	$15,000
HP4980AS Combination Ethernet and Token Ring Network Advisor Series 486 with Color Display	$29,800
HP 4981AS Ethernet Network Advisor Series 386 with Monochrome Display	$15,000
HP 4982AS Token Ring Network Advisor Series 486 with Color Display	$23,500
HP 4983AS FDDI Dual Attached Network Advisor Series 486 with Color Display	$37,500
HP 4983AS FDDI Single Attached Network Advisor Series 486 with Color Display	$28,500
Opt 002 16-MB Extended Capture Buffer	+$1,000
Opt 003 32-MB Extended Capture Buffer for FDDI	+$1,600
Opt AMJ Replace 52-MB Hard Disk with 105-MB Hard Disk	+$500
Opt ADW Replace Monochrome Display with Color Display	+$4,500

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

TELECOMMUNICATIONS & DATA COMMUNICATIONS TEST

Distributed LAN Analysis System

HP 4990A, 4995A, 4996A, 4997A, 4998A

HP 4995A and 4996A

Ethernet LAN Monitoring Systems

The HP LanProbe family of products provides instrument-quality monitoring for Ethernet local area networks for both MS-DOS* and HP-UX platforms. In the HP-UX application, the HP 4997A or HP 4998A OpenView Probe Manager runs with HP's OpenView network management platform and integrates information by using the new RMON MIB in the HP 4995A LanProbe II. In the MS-DOS–based application, HP ProbeView runs under MS Windows and provides data by using the HP 4991A LanProbe segment monitor and the HP 4996A LanProbe II. HP ProbeView provides linkage to SNMP-based systems via SNMP traps.

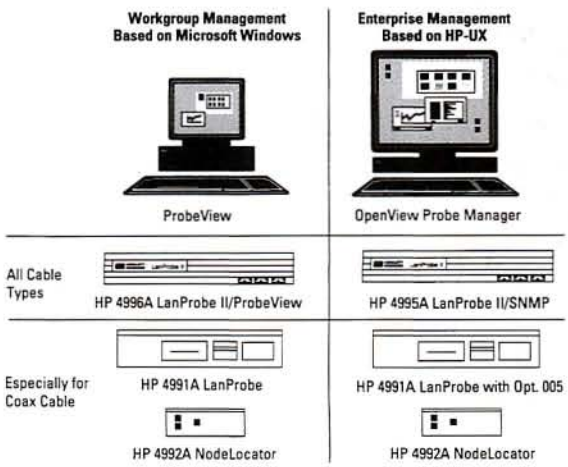
HP OpenView Probe Manager and HP 4995A LanProbe

HP Probe Manager extends the capability of HP OpenView to capture and display Ethernet events from remote segments. It provides distributed packet capture, protocol analysis, and Ethernet statistics. Decoding capabilities extend to TCP/IP, DECnet, AppleTalk, Banyan, XNS, and Novell Netware.

The HP 4995A LanProbe II/SNMP is a second-generation probe providing a complete implementation of the RMON MIB. It can be managed by HP's OpenView Probe Manager and other management applications supporting RMON devices. The HP 4995A comes in three different memory configurations—1, 4, and 8 MB—to provide a dynamic feature range for differing network demands.

HP ProbeView, the HP 4991A LanProbe, and the HP 4996A LanProbe II

HP ProbeView runs on any IBM PCAT, PS/2, or compatible Intel 386* PC with Windows 3.0 or later. Data collected by the HP 4991A LanProbe or the HP 4996A LanProbe II is graphically displayed. Provided features include statistics, echo tests, user-configurable thresholds with alarms, unattended data collection and exporting, and tracing with filters. An optional protocol-analysis feature allows decoding of TCP/IP, DECnet, AppleTalk, Banyan, XNS, and Novell. The HP 4991A LanProbe I offers internal modem and cable testing with node location for coaxial cabling. HP ProbeView requires HP ARPA Services 2.1 for Ethernet connectivity (HP p/n D1812B Opt 001).



Ordering Information

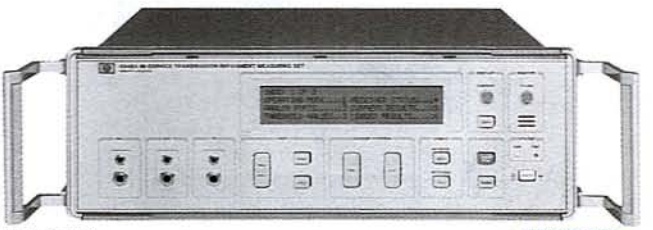
	Price
DOS Products	
HP 4990A ProbeView Manager Software	$5,000
Opt 100 Adds ProbeView Observer	+$950
Opt 200 Adds Protocol Analysis	+$2,000
Opt 300 Adds HP ARPA Services	+$450
Opt 400 Adds MS Windows	+$187
Opt ABJ Adds Japanese Manual	$0
Opt ABF Adds French Manual	$0
HP 4991A LanProbe Segment Monitor	$3,995
Opt 001 Deletes Cable Test, BNC Connector, and Node-Locator Capability	−$775
Opt 002 Deletes Modem	−$225
Opt 003 Deletes Cable Test, BNC Connector, Internal Modem and Node-Locator Capability	−$1,000
HP 4992A NodeLocator (optional)	$975
HP 4993A ProbeView Console	$10,730
Vectra Intel 386/25 with 4 MB of memory and 3½-in floppy disk drive. Has VGA monitor, HP mouse ThinLAN card, and HP mouse. Comes with ProbeView, HP ARPA Services, and MS Windows installed.	
Opt 003 Adds additional 2 MB of memory	+$559
Opt 004 Adds additional 4 MB of memory	+$1,198
Opt 005 Deletes ProbeView Manager, adds ProbeView Observer	−$4,050
Opt 006 Adds 5¼-in Floppy Disk Drive	+$275
Opt 007 Deletes ThinLAN, adds Ethertwist	−$55
Opt 008 Adds Protocol-Analysis Option	+2,000
HP 4996A LanProbe II/PV with Ethertwist MAU	$2,755
Opt 100 Deletes HP Ethertwist MAU	−$160
Opt 101 Substitutes HP ThinLAN MAU	+$79
Opt 102 Substitutes Fiber-Optic MAU	+$339
UNIX Products	
HP 4995A LanProbe II/SNMP, 4 MB, Ethertwist MAU	$3,095
Opt 001 Substitutes 1 MB of memory for std 4 MB	−$340
Opt 002 Adds add'l 4 MB of memory for 8 MB total	+$500
Opt 100 Deletes HP Ethertwist MAU	−$160
Opt 101 Substitutes HP ThinLAN MAU for Ethertwist	+$79
Opt 102 Substitutes Fiber-Optic MAU for Ethertwist	+$339
HP 4997A OpenView Probe Manager/300/400	$0
Opt OAK License to Use OpenView Probe Manager	+$3,995
Opt AAO ¼-in Cartridge Tape and Documentation	+$100
Opt AAH DDS Cartridge Tape and Documentation	+$100
Opt ABJ Adds Japanese Manual	$0
Opt ABF Adds French Manual	$0
HP 4998A OpenView Probe Manager 600, 700, or 800	$0
Opt OAK License to Use OpenView Probe Manager	+3,995
Opt AAO ¼-in Cartridge Tape and Documentation	+$100
Opt AAH DDS Cartridge Tape and Documentation	+$100
Opt ABJ Adds Japanese Manual	$0
Opt ABF Adds French Manual	$0

Please see the LanProbe family brochure (HP p/n 5091-3127E) for details on product specifications and support options.

*Intel 386 is a U.S. trademark of Intel Corporation.
Microsoft® is a U.S. registered trademark of Microsoft Corporation.
MS-DOS® is a U.S. registered trademark of Microsoft Corporation.

- Complete analog testing to North American and CCITT standards
- Testing of voice-grade data circuits, program circuits, metallic digital circuits
- Wide choice ranging from rugged portables to systems instruments, including unique in-service TIMS

HP 4934A


HP 4948A

DESIGNED FOR HP-IB SYSTEMS

HP 4934A TIMS

The HP 4934A transmission impairment measuring set (TIMS) increases installation and maintenance productivity for telephone companies and service providers through its ease of use, portability, and ruggedness. Measurements are to IEEE 743 specifications:

- Level/frequency up to 110 kHz
- Noise and noise-to-ground
- Noise-with-tone and signal-to-noise ratio
- Three-level impulse noise
- P/AR

Optional battery with typical 6 hours of operation

HP 4934A J01/J02 TIMS

The HP 4934A TIMS Option J01 and J02 are versions of the instrument with measurements for installation and maintenance of voice frequency or wideband leased lines to CCITT specifications. Option J01 is for countries with 820 Hz holding tone and Option J02 is for countries with 1020 Hz holding tone.

Measurements are to CCITT specifications:

- Level/frequency to 110 kHz
- Circuit noise
- Noise-with-tone and signal-to-noise ratio
- Three-level impulse noise (quiet or tone)

Optional battery with typical 6 hours of operation

Ordering Information	Price
HP 4934A TIMS, including Front-Panel Cover, Power Cord, 2 HP 15513A Test Cords (with WEC0 310 jack plugs)	$3,545
Opt 001 Battery Pack with Built-In Charger	+$440
Opt 010 Deletes Test Cords	−$105
Opt J01 Replaces North American Features and Connectors with CCITT; 820 Hz Holding Tone: Deletes Test Cords	+$665
Opt J02 Same as J01, except 1020 Hz Holding Tone	+$665

Accessories

HP 15513A 1 m Cable, WECO 310 Jack Plug Each End	$165
HP 18134A Vinyl Carrying Case	$160
HP 18182A 1.5 m Cable, WECO 310 Jack Plug to Alligator Clips	$70

HP 4948A In-Service TIMS

The HP 4948A TIMS provides unique in-service measurements (North American and CCITT) on voice-grade modem circuits using the live traffic signal. It is ideal for preventive maintenance and use in network monitoring systems. The HP 4948A measures:

- Level/frequency
- Signal-to-noise ratio
- Phase and amplitude jitter
- Dropouts, gain hits, phase hits
- Impulse noise
- Attenuation and delay distortion

HP 4947A TIMS

The HP 4947A is a fully featured TIMS with HP-IB remote control for use in installation, maintenance, and manufacturing. The HP 4947A TIMS provides measurements to IEEE 743 (North American) standards, supplemented by a special option for a psophometric noise filter, and level/frequency to 5 kHz.

Ordering Information	Price
HP 4947A TIMS	$15,385
Opt 908 19-in Rack Mount Kit	+$41
HP 4948A In-Service TIMS	$16,705
Opt 006 14.4 kb/s V 33 Capability	+$1,165
Opt 908 19-in Rack Mount Kit	+$35

TELECOMMUNICATIONS & DATA COMMUNICATIONS TEST

Telecom/Datacom Test Sets

HP 37732A, 37711A

- Combined telecom and datacom testing in one analyzer; no need for separate test sets or plug-ins
- Eight interfaces in one analyzer
- Powerful results storage without using printer
- Rugged, portable, easy to use

HP 37732A

HP 37732A Telecom/Datacom Analyzer

The HP 37732A is a lightweight, field-portable, and rugged test set that combines the full telecom testing capability of the HP 37722A digital telecom analyzer (see page 549) with datacom testing. The HP 37732A telecom/datacom analyzer consists of the HP 37722A and the HP 15901A Option 001 datacom module.

The HP 37732A provides testing at V.24, V.35, V.11/X.21-leased interfaces at rates up to 2 Mb/s. It also provides a full range of BER/BLER measurements; control-circuit timing analysis with transitions diagrams on the screen; a built-in V.24 breakout box; and an internal synthesizer. It offers 80 days' results storage in text and graphic form.

The HP 37732A reduces test time and speeds problem resolution by simplifying test setup. It presents results in easy-to-read and easy-to-record ways that make it easy to pinpoint the cause of a problem.

Applications

- Installation of digital telecom circuits and services
- Long-term network monitoring
- Maintenance and troubleshooting

Specifications

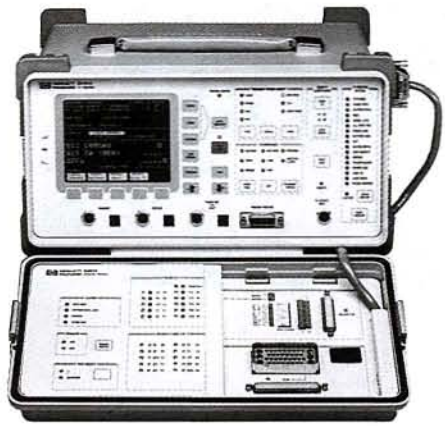
Telecom testing, remote control, power supply, and size specifications as HP 37722A (see page 549).

Datacom Interfaces: V.24, V.35, V.11/X.21-leased
Data Rates: 50 b/s to 2.048 Mb/s (synchronous: built-in synthesizer); 50 b/s to 19.2 kb/s (asynchronous)
V.24 Breakout: Patch points, monitors, voltage sources, and switches
V.11/V.35: Activity indicators on data, clock, and control circuits
Test Patterns: 63-bit, 511-bit, 2047-bit, $2^{15}-1$, $2^{20}-1$, all 1s, all 0s, 3 to 16-bit user-definable word, FOX word
Measurements: Errors, BER, blocks, block-errors, BLER, error seconds, % EFS, Tx and Rx frequency, alarm seconds, clock slips, alarms, G.821 analysis
Control-Circuit Timing: Measures times between selectable start/stop events; timing range 100 ms, 1s, 10s
Transition Diagrams: For RTS, CTS, DTR, DSR and DCD
Weight: 5.9 kg (12.5 lb)

Ordering Information

	Price
HP 37732A Telecom/Datacom Analyzer	$8,280
Opt 002 8 Mb/s (unframed)	+$340
Opt 003 704 kb/s (framed and unframed)	+$560
Opt 004 Small Siemens Connectors	$0
Opt 005 Sub-Rate Testing, Timeslot Access and Tones	+$1,330
Opt 006 Timeslot Access and Tones	+$945

- Combined T1, fractional T1, and datacom testing up to 1.5 Mb/s; no need for separate testers or plug-ins
- Four datacom interfaces in one test set
- Powerful results storage without using printer
- Rugged, portable, easy to use



HP 37711A

HP 37711A T1/Datacom Test Set

The HP 37711A tests at T1 (DSX and line), RS-232, RS-449 (balanced), and V.35 interfaces. The instrument consists of the HP 37701A T1 tester (see page 552) plus the HP 15901A datacom module (available separately for existing HP 37701A users). In addition to a full range of BER tests, the HP 37711A performs timing analysis on interface control leads, with transition diagrams on the screen, and it has results storage and histogram alarm/results presentation on the screen.

Applications

- T1 and datacom installation
- Long-term network monitoring
- Troubleshooting and service restoration

Specifications

T1 remote control, power supply, and size specifications as HP 37701A (see page 552).

Datacom Interfaces: RS-232, RS-449, V.35, DTE, or DCE
Data Rates: 600 b/s to 1.544 Mb/s (synchronous: built-in synthesizer); 50 b/s to 19.2 kb/s (asynchronous)
RS-232 Breakout: Patch point, monitors, voltage sources, and switches
RS-449/V.35: Activity indicators on data, clock, and control circuits
Test Patterns: 63, 511, 2047, $2^{15}-1$ PRBS, QRSS, (all invertible); all 1s, 1010 ..., 24-bit word, FOX message
Measurements: Errors, BER, blocks, block errors, BLER, error seconds, % EFS, clock slips, alarms, Tx and Rx frequency, G.821 analysis
Control-Circuit Timing: Measures times between selectable start/stop events; timing range 1s, resolution 0.1 ms
Transition Diagrams: For MON, RTS, CTS, DTR, DSR and DCD
Weight: 6 kg (13 lb)

Ordering Information

	Price
HP 37711A T1/Datacom Test Set	$8,365
Opt 001 Pulse Shape and Wander/Clock Slips Measurements	+$595
Opt 002 Built-in Battery Operation	+$810
Opt 004 n × 56/n × 64 kb/s T1 Measurements	+$1,260

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Complete range of in- and out-of-service telecom installation and maintenance measurements in one tester
- Low-cost, rugged, easy to use
- Adaptable to future requirements—no need to buy new test sets
- Powerful results storage and analysis without using printer

HP 37722A

- Bit and code error testing at 704 kb/s, 2, 8, 34 & 140 Mb/s
- In-service frame alignment signal (FAS) testing
- Portable, lightweight, rugged
- Text and graphic results on large display
- Remote control, frequency offset and measurement, multiple outputs, binary interfaces

HP 37721A

DESIGNED FOR HP-IB SYSTEMS

HP 37722A Digital Telecom Analyzer

The HP 37722A digital telecom analyzer is an easy-to-use, lightweight, field-portable test set for in- and out-of-service bit error and signal measurements on CEPT digital circuits and services. The HP 37722A provides framed pattern generation and measurements at 704 kb/s and 2 Mb/s. Also, it offers many other features to help increase productivity and network uptime: 80 days' results storage in text and graphic form; n × 64 kb/s testing; timeslot monitor including all signaling bits display; and timeslot access. Options provide unframed 8 Mb/s, framed/unframed 704 kb/s, 64 kb/s timeslot access and sub-rate processing (X.50 divisions 2 and 3, and X.58).

The HP 37722A is easily upgraded to the HP 37732A telecom/datacom analyzer. See page 548.

Applications

- Installation of digital telecom circuits and services
- Long-term network monitoring
- Maintenance and troubleshooting

Specifications

Full Transmit and Receive Capability
Interfaces: 64 kb/s codirectional, 704 kb/s, 2.048 Mb/s, 8448 Mb/s
Measurements: Bit errors, code errors, frame errors, CRC errors, REBEs (E bits), slips, round trip delay
Error Analysis: G.821 standard, user-defined and Annex D.
Timeslot Access: External drop/insert of 64 kb/s timeslot to VF ports or n × 64 kb/s (n = 1 to 6) to X.21 datacom port: internal tone generation/measurement and talk/listen
RS-232 Remote Control and Printer Interface
Universal ac Power Supply
Size: 340 mm W × 190 mm H × 208 mm D (13.4 in × 7.7 in × 8.2 in)
Weight: 4.5 kg (10 lb)

Ordering Information

	Price
HP 37722A Digital Telecom Analyzer	$6,100
Opt 002 8 Mb/s (unframed)	+$340
Opt 003 704 kb/s (framed and unframed)	+$560
Opt 004 Small Siemens Connectors	$0
Opt 005 Sub-Rate Testing, Timeslot Access and Tones	+$1,330
Opt 006 Timeslot Access and Tones	+$945
Accessories	
HP 15901A Opt 001 Datacom Module With V.24, V.11/X.21-Leased, V.35 Interfaces	$2,100

HP 37721A Digital Transmission Analyzer

The HP 37721A digital transmission analyzer is a portable, lightweight, rugged test set providing bit, code, and FAS error testing at the European CEPT rates of 704 kb/s, 2, 8, 34 and 140 Mb/s. It measures error performance to CCITT Recommendation G.821, with interfaces to G.703.

A key feature of the HP 37721A is its ease of use: the autosetup facility automatically configures the test set to the incoming data; nine stored setups ensure that required test parameters are instantly available; graphic display of results snows error counts, error seconds, and alarms at a glance; and a range of logging options to an internal or external printer provides customized hard-copy proof of results.

Option 001 provides remote control via RS-232 and HP-IB interfaces and adds the ability to log results to an HP ThinkJet. Multiple outputs in Option 002 enable simultaneous loading of four channels of a multiplexer or digital radio with only one test set. With Option 003, up to 100 ppm of frequency offset is provided at all rates to evaluate clock-recovery circuits. Option 004 provides binary TTL/ECL interfaces with external clock input for telecom and general-purpose applications. Option 005 fully checks frame signals in-service at 140, 34, 8 and 2 Mb/s.

Applications

- Maintenance of digital networks (PTTs, other network operators)
- Installation of digital networks (PTTs, network operators, manufacturers)
- Long-term unattended monitoring with error performance analysis based on CCITT Recommendation G.821

Ordering Information

	Price
HP 37721A Digital Transmission Analyzer	$8,500
Opt 001 Remote Control	+$715
Opt 002 Multiple Outputs	+$1,900
Opt 003 Frequency Offset	+$1,190
Opt 004 Binary Interfaces	+$2,000
Opt 005 FAS Error Testing	+$2,780

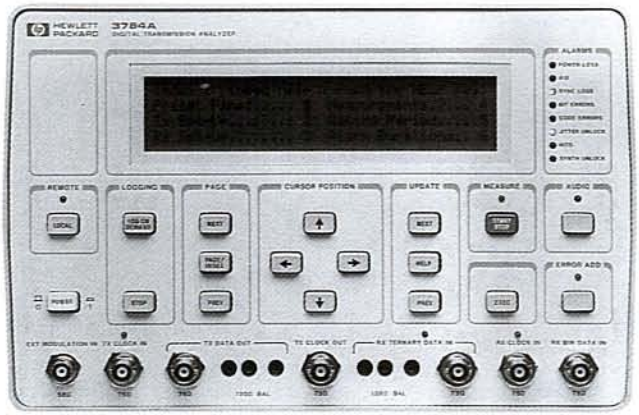
For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

TELECOMMUNICATIONS & DATA COMMUNICATIONS TEST

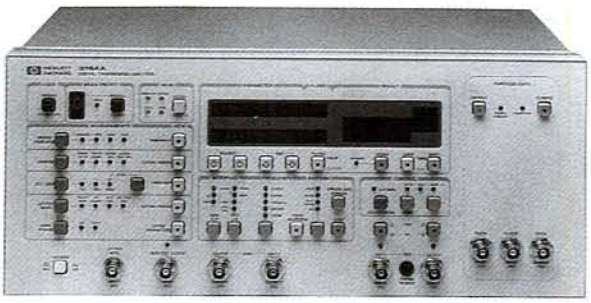
Digital Transmission Analyzers

HP 3784A, 3764A

- G.821 error analysis at 704 kb/s, 2, 8, and 34 Mb/s
- Optional jitter generation and measurement at 2, 8 and 34 Mb/s
- Clock synthesizer for rates between 1 kb/s and 50 Mb/s
- Optional error and jitter measurements at DS1, DS1C, DS2, and DS3
- Error and jitter measurements at 140 Mb/s or error measurements at 704 kb/s, 2, 8, 34, and 140 Mb/s
- Internal synthesizer for measurements from 1 kb/s to 170 Mb/s at binary interfaces
- Powerful data logging to internal or external printer
- Fast, easy measurement setup using stored presets



HP 3784A



HP 3764A
Option 007

DESIGNED FOR HP-IB SYSTEMS

HP 3784A Digital Transmission Analyzer

The HP 3784A is a portable error performance/jitter test set, offering standard telecom interfaces at 704 kb/s, 2, 8 and 34 Mb/s, with the option of DS1, DS1C, DS2, and DS3 for testing at North American rates, replacing the standard rates. In addition, it has binary TTL/ECL interfaces for measurements up to 50 Mb/s, using the internal clock synthesizer. A special option for SONET is available for error and jitter measurements at STS1, DS3, DS1C, and DS1.

The HP 3784A is easy to use with measurement presets, automatic receiver setup and error performance pass/fail thresholds. Automatic jitter tolerance and transfer plotting routines are provided for fast accurate testing up to and beyond CCITT limits. Through-data mode allows jitter to be added to a structured signal for jitter tolerance testing of demultiplexers.

Applications

- Automated production test of transmission line and terminal equipment
- Development and test of digital circuits that transport or store data
- Long-term monitoring of digital transmission equipment in the field

Measurement Summary

Error Analysis: All measurements are made simultaneously and in accordance with CCITT Recommendation G.821.
Jitter Analysis: Peak-to-peak amplitude, jitter-hit count, jitter-hit and hit-free seconds or deciseconds.

Ordering Information

	Price
HP 3784A Digital Transmission Analyzer	$11,890
Opt 002 Jitter Measurements	+$6,750
Opt 006 64 kb/s Measurement and V.11 Interfaces	+$1,230
Opt 008 Error and Jitter Measurements at DS1, DS1C, DS2, and DS3	+$7,725

Note: Options 002 and 006 cannot be ordered together.

HP 3764A Digital Transmission Analyzer

HP 3764A digital transmission analyzer is available in a number of different versions to cover a wide range of telecom and general-purpose test applications. Each one offers pattern generation and error detection at coded and binary interfaces, and an HP-IB port for remote control operation.

A version of the HP 3764A with combined error and jitter performance measurements at 140 Mb/s is ideal for production test of telecom equipment. It can be enhanced further with a through-data mode to allow jitter to be added to any 140 Mb/s signal passing through the instrument.

Versions of the instrument with CEPT rates from 704 kb/s to 140 Mb/s offer a test solution for manufacturing and installation of digital network equipment. Other versions, including a clock synthesizer, offer data generation and error detection at binary interfaces at rates up to 170 Mb/s. A special option for SONET/SDH is available for error and jitter measurements at STS3 and STM1.

Applications

- Production testing of digital transmission equipment
- Installation and maintenance of digital networks
- Demultiplexer testing using through-data mode to add jitter to a structured signal
- Long-term unattended monitoring with error performance analysis based on CCITT Recommendation G.821

Measurement Summary

Error Analysis: All measurements are made simultaneously and in accordance with CCITT Recommendation G.821.
Jitter Analysis: Peak-to-peak amplitude, jitter-hit count, jitter-hit seconds, jitter-hit-free seconds. Internal filters to CCITT Recommendation 0.171 are available for performing selective jitter measurements. Where a greater degree of selectivity is required, a demodulated jitter output allows connection of external equipment such as a spectrum analyzer.

Ordering Information

	Price
HP 3764A Digital Transmission Analyzer	$14,210
Opt 002 Jitter Generation and Measurement at 140 Mb/s	+$4,195
Opt 006 Error Performance at 704 kb/s, 2, 8, 34, and 140 Mb/s Plus Clock Synthesizer	+$3,040
Opt 007 Jitter Generation and Measurement at 140 Mb/s with Through-Data Mode Plus Clock Synthesizer	+$7,980

Note: Options 002, 006 and 007 cannot be ordered together.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- Full-capability transmitter and receiver
- 2 Mb/s and n × 64 kb/s
- 6-h battery operation
- Remote control and printer output

HP 37742A

NEW

HP 37742A 2M Test Set

The HP 37742A is a handheld 2-Mb/s test set with all the features normally found only in larger instruments. It is easy to use, with full 2-Mb/s transmission and reception, compatibility with CRC4 frame formats, and built-in monitor speaker. The HP 37742A is used by telephone companies, utilities, and end users for installation and maintenance of 2-Mb/s circuits.

Applications

The HP 37742A is used for the installation and maintenance of 2-Mb/s circuits at:

- Telephone exchanges
- Repeater interfaces
- Customer premises

Measurement Summary

Measurements: Level, line attenuation, bit errors, code errors, frame errors, CRC errors

G.821 Analysis: For bit and frame-bit errors; error seconds, error-free seconds, severely errored seconds, degraded minutes, available seconds, unavailable seconds

Alarm Detection: Signal loss, AIS, frame loss, multi-frame loss, pattern loss, remote frame loss, remote multiframe loss, error ratio threshold exceeded

Transmitter

Framing: PCM31, PCM30 (CAS), with or without CRC4 multi-frame, unframed

Test patterns: PRBS; 2^9, 2^{11}, 2^{15}, normal and inverted, fully programmable 8-bit word

Error add: Bit, code, frame, CRC; alarm generation, signaling, and overhead bits setup

Receiver

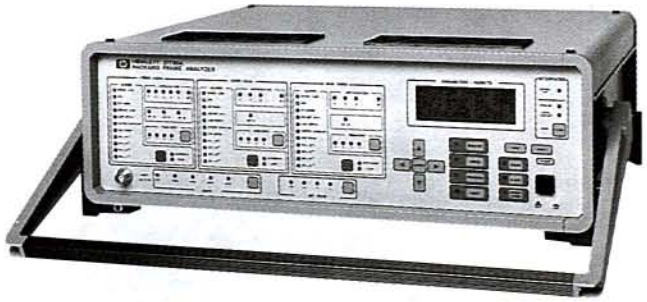
Time slot map and time slot display

Ordering Information

	Price
HP 37742A 2M Test Set, (including wrist strap, shoulder strap, soft carrying pouch with shoulder strap and carrying handle, ac adapter, VF cable, and operating manual)	$4,775
Accessories	
HP 15730A Thermal Printer (230 V)	$420
HP 15733A Thermal Printer (110 V)	$420

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

- In-service identification and diagnosis of faults
- Full network performance analysis
- All 1984 channels checked



HP 37730A

NEW

HP 37730A Frame Analyzer

The HP 37730A is an in-depth analysis tool for CCITT rates from 2 Mb/s to 140 Mb/s. It provides accurate and immediate identification of in-service network problems. A quick check of the analyzer's bright front-panel LEDs clearly shows the status of network alarms. "Fast-scan" diagnoses framing bits and alarms at all hierarchical levels in less than 2 s. The HP 37730A's capabilitities also include G.821 analysis to Annex D, frequency measurement, and full audio and signaling diagnosis.

Applications

The HP 37730A frame analyzer offers:

- In-service maintenance of 2 to 140 Mb/s circuits
- Manufacturing test of multiplexers

Measurement Summary

At 8, 34, and 140 Mb/s: Signal loss, AIS, frame alignment, distant alarm, justification, FAS, reserved bits, justification control bits

At 2 Mb/s: Signal loss, AIS, frame alignment, multiframe alignment, FAS, CRC

At 64 kb/s: Level, peak code, offset, signaling, BER

NEW

HP 37729A Frame Generator

The HP 37729A frame generator is a companion product to the frame analyzer. It is a complete solution to structured test-signal generation from 2 Mb/s to 140 Mb/s. Framed signals can be constructed with a large variety of payloads and error conditions for testing network equipment.

Applications

The HP 37729A frame generator offers conformance and acceptance testing of multiplexers.

Specifications

Patterns: 2^{15}-1, 2^{23}-1, all ones, all zeros, external signal, AIS, from a lower hierarchy

Error Add: Bit, FAS bit and sequence, justification, alarms, service bits, CAS, CRC, offset clocks, external clocks

64 kb/s: Tone, word, 2^{11}-1, external digital, external analog

Ordering Information

	Price
HP 37730A Frame Analyzer with Remote-Control and 48-V Operation	$17,760
HP 37729A Frame Generator with Remote-Control and 48-V Operation	$22,200
Accessories	
HP 15730A Thermal Printer	$420

TELECOMMUNICATIONS & DATA COMMUNICATIONS TEST

T1 and Digital Data Test Sets

HP 37702A, 3787B, 37701A

- Combined T1, FT1, DDS, and datacom testing up to 1.5 Mb/s; no need for separate plug-ins
- Powerful results storage and analysis without using a printer

HP 37702A

NEW

- Complete range of T1 installation and maintenance measurements in one tester
- Low cost, rugged, easy to use
- Fractional T1 BER and configuration measurements
- Powerful results storage and analysis without using a printer

HP 37701A

HP 37702A Digital Data Tester

The HP 37702A combines T1, fractional T1 (FT1), DDS, and datacom testing in one small, light, and portable tester. A built-in multiplexer allows internal test patterns/tones, or external tones or data (up to 384 kb/s) to be inserted into, or extracted from, individual timeslots or subrate channels. Measurements range from simple BER tests to full error analysis, as well as signal measurements such as level, pulse shape, and slips.

Applications

- Installation and troubleshooting by service providers
- Long-term network monitoring

Specifications

Full transmit, receive and through capability
Interfaces: T1 (D4, ESF), DS0-A, RS-232, RS-449, and V.35
DDS:
Access points: 64 kb/s or from within T1
DS0 timing: Bit/byte or composite clock
Testing: Meets TS-TSY-000476 (TA55)
T1: Refer to HP 37701A specifications on this page
Datacom: Refer to HP 37711A specifications on page 548

HP 3787B Digital Data Test Set

The HP 3787B combines T1/T1C and DDS (DS0 A/B) testing in one portable test set. A built-in multiplexer/demultiplexer allows test patterns, control codes, or external data to be inserted into, or extracted from, individual timeslots, subrates, and overhead channels. Measurements range from simple BER tests to full error analysis, as well as signal level and optional DS1 jitter measurements.

Ordering Information	Price
HP 37702A Digital Data Tester	$9,240
Opt 001 Pulse Shape and Wander/Clock Slips Measurement	+$600
Opt 002 Adds Datacom Interfaces and Measurements	+$2,100
HP 3787B Digital Data Test Set	$11,340
Opt 001 DS1 Jitter Measurements	+$1,105
Opt 002 DC Operation (48V)	+$715
Opt 003 Channel VF Output	+$455

Special options are available to give 32 or 64 additional DSX outputs and DS0 operation with a composite clock signal.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 37701A T1 Tester

The HP 37701A performs bit-error and signal measurements on T1 circuits in central offices, at outside locations, and on the users' premises. Built-in CSU emulation allows circuits to be proven before user equipment is connected. Autoconfigure, "trouble scan," and prestored setups, together with clear simple controls, make the tester easy to use. The HP 37701A T1 tester is easily upgraded to the HP 37711A T1/datacom test set (see page 548).

Applications

- Leased T1 circuit installation and maintenance
- T1 circuit monitoring in central offices
- Acceptance testing and maintenance by T1 users
- Testing fractional T1 services

Specifications

Full transmit and receive capability.
Receiver Range: +6 to −36 dB DSX with equalization
Framing: D4, ESF, SLC-96
Line Codes: AMI, B8ZS
Test Patterns: 2^{23}, 2^{20}, 2^{15} PRBS; QRSS, 3 in 24, 1:1, 1:7, 55 octet, 1024-bit word
Measurements: Error performance based on BPVs, logic, frame, and pattern errors; frequency, pattern slips, simplex current, level, round trip delay, pulse shape, clock slips, and channel mapping
Channel VF output including internal loudspeaker
RS-232 remote control and printer interface (HP-IB available)
Size: 340 mm W × 190 mm H × 208 mm D (13.4 in × 7.5 in × 8.2 in)
Weight: 4.5 kg (10 lb)

Ordering Information	Price
HP 37701A T1 Tester	$5,500
Opt 001 Pulse Shape and Wander/Clock Slips Measurement	+$605
Opt 002 Built-In Rechargeable Battery and Charger	+$825
Opt 003 Graphic Results Presentation, Result Storage, and G.821 Performance Analysis	+$765
Opt 004 n × 56/n × 64 kb/s Measurements	+$1,295
Accessories	
HP 15513A 1 m WECO 310—WECO 310 Cable	$165
HP 18182A 1.5 m WECO 310—Crocodile Clip Cable	$70
HP 15710A Soft-Fabric Carrying Case	$220

DS3 Test Set, DS1 Tester

HP 37743A, 37741A

- Comprehensive DS3 analysis and alarm monitoring
- DS3 generation and test on M13, C-bit and unframed formats
- Simultaneous in-service DS1 and DS2 alarms and analysis
- Full capability transmitter and receiver
- Five hours battery operation
- Remote control and printer output

HP 37743A

NEW

HP 37741A

NEW

HP 37743A DS3 Test Set

The HP 37743A is a DS3 test set with built-in multiplexer and demultiplexer to DS1. It offers both in-service and out-of-service tests. Front-panel LEDs give the status of the circuit at a glance. C-bit parity is included for testing the most modern links. A large range of patterns helps find the more difficult faults and analysis gives a measure of long-term performance.

Applications

Installation and maintenance of DS3 circuits at:
- Telephone exchanges
- Customer premises

Measurement Summary

Measurements: Bit, code, parity, frame, C-parity, FEBE
DS3 Alarm LEDs: Loss of signal, code error, parity error, frame error, frame loss, bit error, pattern loss, AIS, idle, X-bit
At DS1: CRC and frame errors
DS1 Alarm LEDs: Frame error, CRC error, frame loss, yellow alarm, AIS, ESF

Ordering Information

	Price
HP 37743A DS3 Test Set	$7,500

Accessories

HP 15710A Soft Carrying Case	$220
HP 15733A Thermal Printer	$420

HP 37741A DS1 Tester

The HP 37741A is a handheld T1 test set with all the features normally found only in larger instruments. It is easy to use, with full T1 transmit and receive capability, compatibility with all frame formats, and a built-in monitor speaker. It is used for installation and maintenance of T1 circuits in telephone operating companies, but also has features such as CSU emulation and code frame format conversion that will appeal to manufacturers.

Applications

Installation and maintenance of T1 circuits at:
- Central offices
- Repeater interfaces
- Customer premises

Measurement Summary

Line Measurements: Level, frequency, simplex current, code errors, slips, excess zeros, ones density, loopback detect
Path Measurements: Signal loss, AIS, frame loss, pattern loss, yellow alarm; frame, CRC, bit, G.821 errors; COFA, OOF; signaling bits, peak codes
Transmitter
Frame format: D4, ESF, ZBTSI, SLC-96, D1D, D2, unframed
Line codes: AMI, B8ZS
Test patterns: 2^{15}-1, 2^{20}-1, QRW, 2^{23}-1, all ones, all zeros, 1010 . . . , 1 in 8, 2 in 8, 3 in 24
Loop codes, CSU, NI, and payload loop-up and loop-down
Thru mode: Retransmits signal with or without change of framing coding, alarm status, or payload

Ordering Information

	Price
HP 37741A DS1 Tester, with Carrying Pouch, ac Adapter, Bantam Cables, and Operating Manual	$3,600

Accessories

HP 15727A Thermal Printer	$360

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

TELECOMMUNICATIONS & DATA COMMUNICATIONS TEST

ATM Analyzer, SONET/SDH Analyzer

HP 75000 Series 90

- Combined ATM and SONET/SDH test capability
- Single solution for B-ISDN testing
- Compliance with latest CCITT recommendations
- Flexible modular architecture and software upgradability
- Supports both SONET and SDH standards
- Operates at 52-, 155-, 622-, and 2488-Mb/s line rates
- Flexible modular architecture and software upgradability
- Embedded overhead and mapped payload testing

HP 75000 Series 90

DESIGNED FOR HP-IB SYSTEMS

Hewlett-Packard Instrument Drivers

NEW

HP 75000 Series 90 ATM Analyzer

The HP 75000 Series 90 155-Mb/s asynchronous transfer mode (ATM) analyzer generates and analyzes cell streams within a SONET/SDH framing structure. It offers comprehensive analysis of both the ATM cell stream and the SONET/SDH overhead.

The ATM analyzer is based on industry-standard VXIbus hardware (see page 84 of this catalog). It consists of a C-sized VXI mainframe; a series of C-sized VXI modules; and a Windows-based, PC user interface that simplifies the operation and creation of test suites.

Applications

The HP 75000 Series 90 155-Mb/s ATM analyzer meets the needs of telecom equipment manufacturers in research and development, conformance, and production, as well as telecom service providers during field trials, installation, and maintenance of broadband ISDNs (B-ISDNs).

The ATM analyzer provides comprehensive ATM cell generation and analysis within a SONET/SDH frame structure. Multiple ATM virtual channels can be generated in a variety of different cell distributions to simulate a B-ISDN network. Users can measure ATM performance parameters—such as error rate, cell loss, cell delay, and cell-delay variation—to verify ATM switch performance and congestion control.

Features

Generator: The generator offers the following features:

- STS-3c or STM-1 ATM mapping
- ATM cell-stream generation
- Type-1 SAR-PDU support
- Up to nine independent ATM channels
- Channel bandwidth control
- Periodic and burst-cell distribution
- Cell PRBS generation
- Comprehensive ATM error add
- SONET/SDH overhead generation

Receiver: The receiver offers the following features:

- STS-3c or STM-1 ATM mapping
- Type-1 SAR-PDU support
- VP and VC channel selection
- Measurements of HEC errors; SAR-PDU seq. no. errors; channel bandwidth; and cell-loss, cell-delay, cell-PRBS errors
- 512-ATM cell snapshot
- SONET/SDH overhead analysis

Ordering Information	Price
HP 75000 Series 90 155-Mb/s ATM Analyzer	$68,800–$109,000

Please contact your local Hewlett-Packard sales office for details.

HP 75000 Series 90 SONET/SDH Analyzer

The HP 75000 Series 90 modular SONET/SDH analyzer meets the varied test requirements in development and manufacture of synchronous network equipment conforming to both SONET and SDH standards. Capable of operating at 51.84, 155.52, 622.08, and 2,488 Mb/s, the analyzer provides the functionality to rigorously test a wide range of network elements—including add-drop multiplexers, line-terminal multiplexers, digital cross-connects, and regenerators.

Based on industry-standard VXIbus hardware (see page 84 of this catalog), the HP 75000 Series 90 consists of a series of C-sized VXIbus modules and a PC user interface. Each module addresses a specific aspect of SONET/SDH testing. The modular architecture enables the Series 90 to be exactly tailored to match the application. Example configurations include 52/155-Mb/s analyzer; 52-/155-/622-Mb/s analyzer; and 52-/155-/622-/2488-Mb/s analyzer.

A full range of optical, coded electrical, and binary interfaces is provided for connection to equipment under test.

Applications

For telecom equipment manufacturers, the analyzer's real-time generation and analysis support in-depth testing in both development and production. The comprehensive test suite includes:

- Frame-alignment stress tests
- Payload mapping/demapping tests
- Pointer stress tests
- Pointer analysis
- Error performance monitoring (B1, B2, B3, BIP-2, FEBE)
- Alarm testing
- Clock-recovery stress tests
- Protection switching tests
- DCC access

Test applications requiring manual control of the analyzer are supported by a PC user interface. This powerful yet easy-to-use interface meets the needs of a wide range of applications—from in-depth R&D tests requiring byte access to any location in the synchronous frame to manual production tests that need fast, repeatable measurements.

The HP 75000 Series 90 is fully programmable via HP-IB, enabling it to be integrated easily into production-line ATE systems. An automatic code generation facility simplifies the development of ATE software. Using this capability, software designed to control the analyzer's measurement hardware can be created quickly and accurately without reference to Series 90 programming manuals.

Specifications

Frame Formats: STS-1, STS-3, STS-3c, STS-12, STS-48 to ANSI T1.105 and TA-253; STM-1, STM-4, STM-16 to CCITT G.708
Mappings: DS1 (all VT1.5 modes) and DS3 to ANSI T1.105 and TA-253; 2 (all TU12 modes), 34, and 140 Mb/s to CCITT G.709
Test Interfaces:
Optical: 52, 155, 622, and 2488 Mb/s (1310 nm)
Coded electrical: 52 Mb/s (B3ZS) and 155 Mb/s (CMI)
Binary: 52, 155, 622, 2488 Mb/s (ECL, NRZ)
Measurements: EC, ER, and ES on mapped payload; B1, B2, B3, BIP-2, FEBE
Pointer Control: Set pointer to any value (with or without NDF); pointer movement sequences as T1X1.6 and CCITT G.783.

Ordering Information	Price
HP 75000 Series 90 Modular SONET/SDH Analyzer (single, transmitter/receiver configuration)	$35,000–$136,000

Please contact your local Hewlett-Packard sales office for details.

SONET/SDH Test Sets

HP 37704A, 37744A, 37724A

- Combined SONET/DS3 and DS1 test solution
- Field-portable and robust unit
- Easy to use
- Overhead and mapped payload testing

HP 37704A

DESIGNED FOR HP-IB SYSTEMS

HP 37704A SONET Test Set

The HP 37704A is a comprehensive, field-portable, SONET, DS3, and DS1 test set for applications up to 622 Mb/s (STS-12). It provides generation and analysis of VT (DS1) and DS3-mapped SONET signals, with full control of section, line, and path overhead bytes. Plug-in modules provide connection to a range of optical and electrical interfaces. Errors, alarms, and T1X1 pointer movement sequences are generated to stress equipment up to and beyond ANSI standards.

Applications

The HP 37704A is a rugged, portable test set well suited to installation, acceptance testing or commissioning, and maintenance of SONET, DS3, and DS1 network equipment. In addition, its comprehensive test suite covers many applications in R&D and production.

Specifications

Frame Formats: DS1, DS3, STS-1, STS-3, and STS-12
Mappings: DS1 (all VT1.5 modes) and DS3 to ANSI T1.105 and Bellcore TA-TSY-000253
Test Interfaces
Optical: 51.84, 155.52, and 622.08 Mb/s (1310 nm)
Coded electrical: 1.544 (B8ZS), 44.736 (B3ZS), 51.84 (B3ZS), and 155.52 (CMI) Mb/s
Size: 340 mm W × 190 mm H × 420 mm D (13.9 in × 7.8 in × 17.2 in)
Weight: 10 kg (22 lb)

HP 37744A SONET Tester

The HP 37744A is a small, rugged, and easy-to-use SONET tester for applications up to 155 Mb/s. It provides a low-cost solution for the generation and analysis of the section line and path overhead on structured 52-Mb/s or 155-Mb/s SONET signals. The tester is intended for applications in SONET circuit installation and maintenance, as well as for circuit monitoring in central offices.

Specifications

Frame Formats: STS-1 and STS-3
Test Interfaces: Optical, 51.84 Mb/s and 155 Mb/s (1310 nm); coded electrical, 51.84 (B3ZS) and 155.52 (CMI) Mb/s
Size: 340 mm W × 190 mm H × 208 mm D (13.4 in × 7.5 in × 8.2 in)
Weight: 4.5 kg (10 lb)

Ordering Information

	Price
HP 37704A SONET Test Set	$19,900
Opt 001 Frequency Offset	+$3,000
Opt 002 VT Capability	+$7,200
HP 37744A SONET Tester	$9,900
Accessories	
HP 37771A STS-3 Electrical Interface	$3,000
HP 37772A Optical Interface 52/155 Mb/s (STM-1)	$14,500
HP 37776A Optical Interface 622 Mb/s (STM-1/4)	$25,500

- SDH testing at 155 Mb/s (STM-1) and 622 Mb/s (STM-4)
- PDH testing at 2 Mb/s and 140 Mb/s
- Comprehensive, single-unit test solution
- Field-portable and robust unit

HP 37724A

NEW

DESIGNED FOR HP-IB SYSTEMS

HP 37724A SDH/PDH Test Set

The HP 37724A is a comprehensive, field-portable SDH/PDH test set for applications up to 622 Mb/s (STM-4). It provides generation and analysis of TU-12 (2 Mb/s) and 140-Mb/s mapped SDH signals, with full control of regenerator section, multiplexer section, and path overhead bytes. Plug-in modules provide connection to a range of optical interfaces. Errors, alarms, and G.783 pointer movement sequences are generated to stress equipment up to and beyond CCITT standards.

Applications

The HP 37724A is a rugged, portable test set well suited to installation, acceptance testing or commissioning, and maintenance of SDH network equipment. In addition, its comprehensive test suite covers many applications in R&D and production.

It provides a wide range of tests for verifying SDH equipment such as line systems, add-drop multiplexers, digital cross-connects, and line-terminal multiplexers.

Specifications

Frame Formats: STM-1 and STM-4
Mappings: 2 Mb/s (all TU-12 modes) and 140 Mb/s to CCITT G.709
Test Interfaces
Optical: 155.52 and 622.08 Mb/s (1310 nm)
Coded electrical: 2.048 (HDB3), 139.264 (CMI), and 155.52 (CMI) Mb/s
Add/drop: 2 Mb/s, 140 Mb/s, STM-1, and overhead DCC channels
Overhead: Standard and user-programmable section, line, and path overhead bytes
Size: 340 mm W × 190 mm H × 420 mm D (13.9 in × 7.8 in × 17.2 in)
Weight: 10 kg (22 lb)

Ordering Information

	Price
HP 37724A SDH/PDH Test Set	$25,530
Opt 001 Frequency Offset	+$3,000
Opt 002 TU Capability	+$4,000
Opt 003 Small Siemens 1.6/5.6 mm replace all BNC	$0
Accessories	
HP 37772A Optical Interface 52/155 Mb/s (STM-1)	$14,500
HP 37776A Optical Interface 155/622 Mb/s (STM-1/4)	$25,500

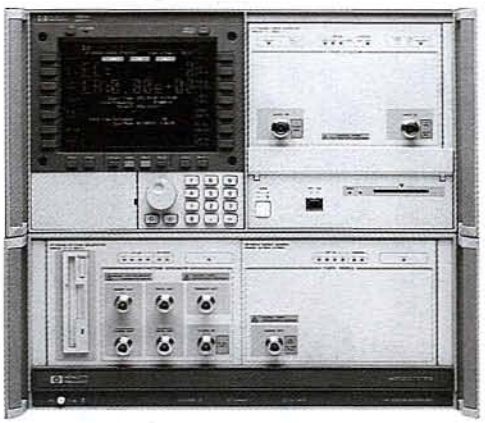
For the most current prices and product information, contact your local Hewlett-Packard sales

TELECOMMUNICATIONS & DATA COMMUNICATIONS TEST

Gigabit Error Performance Analyzer and Pattern Generator

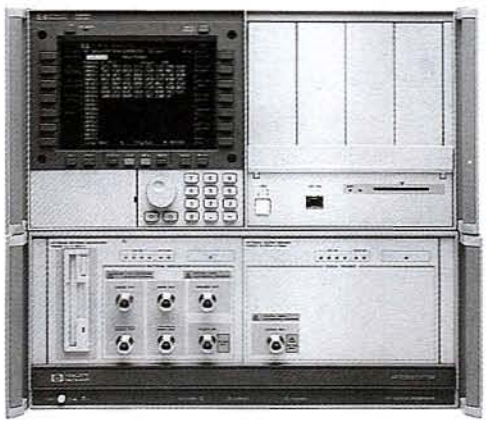
HP 71603B, 71604B

- Low-phase-noise clock source
- User-programmable patterns up to 4 Mbits with screen-based editor
- Seamless switching between two programmed patterns
- Trigger anywhere in pattern
- True complementary outputs
- Automatic setting of clock/data phase and data-decision point
- High-resolution setting of decision threshold and phase alignment
- Simultaneous detection of errored ones and errored zeros
- User-formattable results



DESIGNED FOR HP-IB SYSTEMS

HP 71603B



DESIGNED FOR HP-IB SYSTEMS

HP 71604B

HP 71603B Error Performance Analyzer

The HP 71603B error performance analyzer consists of pattern generator, synthesized clock source, and error detector modules configured in the HP 70000 modular measurement system (MMS). The HP 71603B covers the range from 100 Mb/s to 3 Gb/s and features automatic clock/data alignment for rapid set-up of the error detector. The HP 71603B makes BER measurements on waveforms badly distorted by noise, jitter, and intersymbol interference through the high resolution setting of decision threshold and phase adjustment. The HP 71603B also features the simultaneous counting of errored ones and errored zeros to locate the source of pattern-dependent errors. Error distribution is analyzed by counting errored and error-free intervals between one second and one millisecond.

Applications

The HP 71603B works with any application that involves serial movement of data at gigabit rates. Some of these applications are listed below.

- Components: Gallium-arsenide and high-speed silicon; optical
- Modules/systems: SONET and SDH; broadband video and ATM; submarine cable; high-speed LAN and computer peripheral communication; general lightwave

Specifications

Bit Rate: 100 Mb/s to 3 Gb/s
Patterns and Data Outputs: As for pattern generators
Data Input: 0.5 V to 2 V p-p amplitude
Decision Threshold Range: +1 to −3 V, resolution 1 mV
Termination Voltage: Selectable 0 V or −2 V nominal
Clock/Data Delay: ±1 ns; resolution 1 ps
Errors Detected: Errored ones, zeros, and all logic errors
Measurements: Error count, ratio, errored seconds, deci-seconds, centi-seconds, milliseconds and G.821 analysis
Results Logging: Time-stamped events logged to external printer

Ordering Information

	Price
HP 71603B 100 Mb/s to 3 Gb/s Error Performance Analyzer	$110,000
Individual modules can be ordered for configuring custom-designed systems:	
HP 70311A 3 GHz Signal Generator Module	$24,500
HP 70841B 100 Mb/s to 3 Gb/s Pattern Generator Module	$36,900
HP 70842B 100 Mb/s to 3 Gb/s Error Detector Module	$33,900
HP 15680A RF Accessory Kit	$1,600

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 71604B Pattern Generator

The HP 71604B pattern generator consists of pattern generator and synthesized clock source modules configured in the HP 70000 modular measurement system (MMS). The HP 71604B covers the range from 100 Mb/s to 3 Gb/s and features standard pseudo-random test patterns up to $2^{31}-1$ bits long. Users can program and run variable length test patterns from 1 bit to 4 Mbs long or create two equal length patterns up to 2 Mbs long and switch seamlessly between them. User-programmable patterns are created using the screen-based editor or are transferred to the pattern generator on an MS-DOS format, 3½-in floppy disk. dc-coupled, closely-matched complementary clock and data outputs simplify connection to high-speed logic devices.

Applications

The same as HP 71603B error performance analyzer shown on this page.

Specifications

Bit Rate: 100 Mb/s to 3 Gb/s; resolution 1 Hz
Rise Time (20% to 80%): <90 ps
Patterns: $2^{31}-1, 2^{23}-1, 2^{15}-1, 2^{10}-1, 2^{7}-1$; zero substitution variable mark density patterns; variable length user patterns from 1 bit to 4 Mbits
Data and $\overline{\text{Data}}$ Outputs: ECL or variable 0.25 V to 2 V p-p amplitude into 50 Ω, high level +1 V to −3.75 V
Clock/Data Delay: ±1 ns; resolution 1 ps

Ordering Information

	Price
HP 71604B 100 Mb/s to 3 Gb/s Pattern Generator	$76,000
Individual modules can be ordered for configuring custom-designed systems:	
HP 70311A 3 GHz Signal Generator Module	$24,500
HP 70841B 100 Mb/s to 3 Gb/s Pattern Generator Module	$36,900
HP 15680A RF Accessory Kit	$1,600

HP 3586A Selective Level Meter (CCITT)

DESIGNED FOR HP-IB SYSTEMS

HP 3336A Synthesizer/Level Generator (CCITT)

HP 3586A/B Selective Level Meter and HP 3336A/B Synthesizer

The HP 3586A/B selective level meter and HP 3336A/B tracking synthesizer offer the high performance necessary to meet demanding requirements in the design, manufacture, commissioning, and maintenance of frequency division multiplex (FDM) systems. Features of the HP 3586A/B selective level meter include wideband power measurements and telephone impairment measurement of impulse noise, phase jitter, noise with tone, and signal-to-noise with tone ratios. The wide frequency coverage to 32.5 MHz allows measurements at both voice channel and carrier frequencies.

The HP 3336A/B synthesizer/level generator is an excellent precision tracking signal source for the HP 3586A/B. When the selective level meter (SLM) and synthesizer are in the tracking mode, the frequency of the synthesizer is automatically set to the frequency of the SLM. The HP 3586A and HP 3336A models meet CCITT requirements, and the HP 3586B and HP 3336B models meet North American (Bell) standards.

HP 3586A/B Specifications

(See data sheet or manual for complete specifications.)

Frequency

Frequency range

Signal input	HP 3586A	HP 3586B
75 Ω Unbalanced	50 Hz to 32.5 MHz	
124 Ω Balanced	—	4 kHz to 10 MHz
135 Ω Balanced	—	4 kHz to 1 MHz
150 Ω Balanced	4 kHz to 1 MHz	—
600 Ω Balanced	100 Hz to 108 kHz	

Center frequency accuracy: ±10 ppm/year

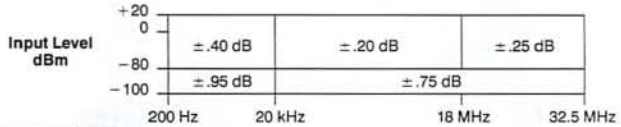
Frequency counter accuracy: Center frequency accuracy +1.0 Hz

Selectivity

3 dB bandwidth: 20, 400, 1740 Hz ±10%

Noise weighting: Psophometric (3586A) C-message (3586B)

Amplitude Accuracy: (75 Ω input)



Dynamic Range

Noise floor (full scale setting −35 to −120 dBm)

Frequency	Bandwidth	Noise level
100 kHz to 32.5 MHz	3100, 1740, 2000 Hz	−116 dBm
	20 Hz, 400 Hz	−120 dBm
10 kHz to 100 kHz	All	−105 dBm

Harmonic distortion: 70 dB below full scale >4 kHz on 75 Ω and 600 Ω inputs, low distortion mode

Intermodulation distortion: Two-tone second and third order, separation 7 kHz to 1 MHz, 75 dB below full scale. Either tone ≥ 10 MHz, −70 dB.

Nonharmonic spurious signals: >1600 Hz offset, −80dBc

General

Power: 100/120/220/240 V, +5%, −10% 48 to 66 Hz, 150 VA

Weight: Net, 23 kg (50 lb); shipping, 30 kg (65 lb)

Size: 425.5 mm W × 177 mm H × 466.7 mm D (16.75 in × 7 in × 18.38 in)

HP 3336A/B Specifications

Frequency Range

Signal output	HP 3336A	HP 3336B
75 Ω Unbalanced	10 Hz to 20.999 999 999 MHz	
124 Ω Balanced	—	10 kHz to 10.999 999 999 MHz
135 Ω Balanced	—	10 kHz to 2.099 999 999 MHz
150 Ω Balanced	10 kHz to 2.099 999 999 MHz	—
600 Ω Balanced	200 Hz to 109.999 999 kHz	

Amplitude

Range: 75 and 600 Ω outputs: − 72.99 to +7.00 dBm; 124, 135 and 150 Ω outputs: − 78.23 to + 1.76 dBm

Accuracy: 75 Ω output, 10 Hz - 20.9 MHz (−3 to +7 dBm) ±.15 dB Opt. 005 ±.12 dB

Spectral purity

Phase noise: < − 72 dB for a 3 kHz band, 2 kHz either side of a 20 MHz carrier.

Harmonic level: − 35 dB, 10 Hz to 30 Hz; −50 dB, 30Hz to 50 Hz; −60 dB, 50 Hz to 1 MHz; −55 dB, 1 MHz to 5 MHz; − 50 dB, 5 MHz to 20.9 MHz.

Spurious: All non-harmonically related signals will be more than 70 dB below the fundamental or −100 dBm (−115dBm with option 005 except 150/600 Ω), whichever is greater.

Phase Offset: ± 719.9° with respect to arbitrary starting phase or assigned zero phase.

Frequency Sweep: Linear, logarithmic

Flatness: ±0.15 dB, 10 kHz −20 MHz

Modulation: External AM or PM

General

Power requirements: 100/120/220/240 V, +5%, −10%, 48 to 66 Hz, 60 VA, (100 VA with all options), 10 VA standby

Size: 132.6 mm H × 425.5 mm W × 498 mm D (5¼ in × 16¾ in × 19⅝ in)

Weight: Net, 10 kg (22 lb); shipping, 15.5 kg (34 lb)

Ordering Information

	Price
HP 3586A Selective Level Meter (CCITT)	$12,700
Opt 001 1.6/5.6 mm 75 Ω Connector	+$103
Opt 004 High-Stability Frequency Reference	+$775
HP 3586B Selective Level Meter (North American)	$12,700
Opt 001 75 Ω connector mates with WECO 358A and 124 Ω connector mates with WECO 372A	+$103
Opt 004 High-Stability Frequency Reference	+$775
HP 3336A Synthesizer/Level Generator (CCITT)	$5,920
Opt 001 1.6/5.6 mm 75 Ω Connector	+$105
Opt 004 High-Stability Frequency Reference	+$685
Opt 005 High-Precision Attenuator	+$685
HP 3336B Synthesizer/Level Generator (North American)	$5,920
Opt 001 75 Ω WECO 358A, 124 Ω WECO 372A	+$105
Opt 004 High-Stability Frequency Reference	+$685
Opt 005 High-Precision Attenuator	+$685

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

DIGITAL MICROWAVE RADIO TEST EQUIPMENT

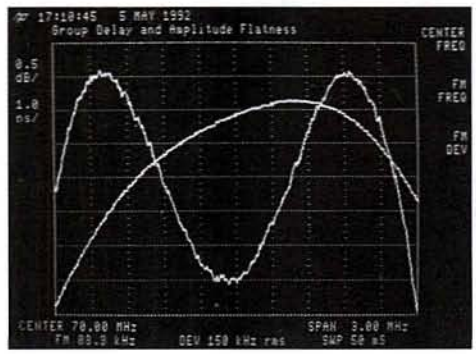
Digital Radio Test System, Group Delay and Amplitude Flatness, Multipath Fading Simulator

HP 11758V, 11768A, 11757B

- Now has group delay
- Performs important installation and maintenance measurements
- Easy-to-use
- Portable

HP 11758V

- An economical way to add high-performance, end-to-end group delay measurements to your spectrum analyzer
- Ideal for digital radio, satellite, and cable testing
- Measures any two-port device between 300 kHz and 2.9 GHz



HP 11768A displaying group delay and amplitude variation

HP 11758V Digital Radio Test System

The HP 11758V combines several popular HP instruments into one portable system. This combination provides you with an all-in-one portable system that is ideal for the installation and maintenance of microwave radios, and is especially suitable for work in rugged terrain or remote areas.

The HP 11758V can be configured to have all your necessary measurement functions available during radio installation and maintenance. The spectrum analyzer can even control other HP-IB instruments to automate measurements for quicker and more reliable results.

Test Functions

Spectrum Analysis: 50 kHz to 22 GHz (26 GHz optional)
Swept Source: 300 kHz to 2.9 GHz (options to 26 GHz)
Group Delay Analyzer: 300 kHz to 2.9 GHz
Multipath Signature Test Set: 40 MHz to 90 MHz (options to 190 MHz)
Power Meter: 10 MHz to 18 GHz (options to 26 GHz)
Frequency Counter: 50 kHz to 22 GHz (options to 26 GHz)
Intermodulation Test Signal: 70 and 140 MHz bands available and more.

See data sheet 5091-4651E for more information.

HP 11768A Group Delay and Amplitude Flatness

Accurately adjusted group delay and amplitude response is critical to the proper performance of virtually every wideband digital or analog communication network. The HP 11768A adds group delay and amplitude flatness measurement capabilities to the HP 11758V (or any HP 8590E Series spectrum analyzer with a tracking generator). This makes it ideal for testing digital and analog terrestrial radios as well as other broadcast and transmission media like satellite and cable networks.

Installed in a spectrum analyzer, the HP 11768A is far more portable than any previous solution and yet maintains the ease-of-use features you expect from standalone test equipment. Adding the HP 11768A to a spectrum analyzer with a tracking generator gives you important microwave link analysis functions at a significantly lower cost than separate pieces of test equipment. DADE and return loss measurements can also be made with the optional switch and bridge.

See data sheet 5091-4652E for more information.

HP 11757B

- Automatic multipath signature measurements
- Measures and prints static M-curves, dynamic M- and S-curves, recovery signatures, recovery times, and dispersive fade margin
- High-performance, lightweight, and economical

HP 11757B Multipath Fading Simulator/Signature Test Set

The HP 11757B characterizes the equalizers in modern digital microwave radios by introducing a precisely controlled notch in and around the radio's transmission bandwidth. This allows precise measurements of the equalizers' ability to compensate for multipath fading. The HP 11757B records the measurement automatically on a built-in printer.

See data sheet 5091-1052 for more information.

For more information on these and other HP instruments designed to test digital radios, see application note 355-1, "Tools for Digital Microwave Radio Installation and Maintenance" #5091-4653.

HP 11757B

HP 3708A
- Carrier tracking maintains accurate & repeatable C/N & C/I conditions
- Fast, alternative residual BER measurement
- Accurate simulation of radio system interference

HP 3708A

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HP 3708A Noise and Interference Test Set

The HP 3708A provides an accurate method of assessing performance of microwave radio and satellite modem systems by providing the Carrier to Noise (C/N) and Carrier to Interference (C/I) conditions necessary to make C/N & C/I vs Bit Error Ratio (BER) measurements. Accurate and repeatable C/N and C/I ratios can be maintained even in the presence of severe signal variations.

The HP 3708A is equally at home in manufacturing, commissioning, or maintenance. Its measurement accuracy allows small changes in performance to be identified with confidence. The instrument is designed for easy access to the IF section of the radio system. The carrier level is monitored and calibrated levels of interference and Gaussian noise are added to stress the system in a controlled way.

The HP 3708A has the flexibility to accommodate a wide variety of radio designs, a selection of calibrated internal filters giving accurately specified Carrier to Noise ratios in any noise bandwidth. The interference facility allows the addition of a wide variety of interference signals to accurately simulate the effects of radio interference on system performance. Connectors are 75 Ω unbalanced, and standard 70 MHz and 140 HMz reference tones are provided.

Options

Standard: 75 Ω unbalanced connector. Reference tone oscillator frequency is 70 to 140 MHz.
001: 50 Ω unbalanced connector.
Special Options: Reference tone oscillator frequencies, specifically for portable application of the HP 3708A in determining residual BER, are available on a special order basis.

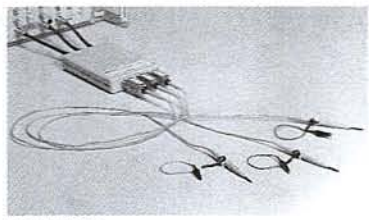
Ordering Information

	Price
HP 3708A Noise and Interference Test Set	$23,975
Opt 001 50 Ω Unbalanced Connectors	+$235

HP 3709B
- For troubleshooting, fine-tuning and preventive maintenance
- Identifies digital radio impairments
- Analyzes magnitude of distortions

HP 3709B

DESIGNED FOR HP-IB SYSTEMS



HP 15709A

HP 3709B Constellation Analyzer

The HP 3709B is used to characterize the performance and condition of digital radios both in-service and out-of-service by analysis of constellation patterns. In addition to displaying constellation patterns, the HP 3709B measures the linear and nonlinear distortions revealed by the patterns, and can provide a formatted report containing the pattern and measurement results on a ThinkJet printer.

Measurements

Constellation: Amplitude, closure, lock- and quad-angle errors, non-linear distortion (rms, am-am, am-pm)
Modulation Schemes: QPSK, 16QAM, 64QAM, 256QAM, 9QPR, 25QPR, 49QPR, 81QPR

Monitor Points

I and Q Signals: Any of the above schemes with signal levels in the range 30 to 400 mV p-p across the constellation. (dc offset must be no more than 0.5 × signal amplitude).
Clock: 1 MHz to 80 MHz (100 mV to 1 V p-p)
Impedance Level: All HP 3709B inputs are 75 Ω terminated.

Options

001: 50 Ω unbalanced input connectors
003: Siemens series 1.6/5.6 mm input connectors
130: High Impedance Interface Kit. Contains 1 x HP 15709A High Impedance Interface and 3 x HP 10435A 1 metre 10:1 probes
Special Options: A low bit rate version (0.1 – 8 MHz) is available to special order.

HP 15709A High Impedance Interface

This specially designed accessory provides three high impedance, filtered inputs which allow the HP 3709B to be connected to radios without protected 75 or 50 Ω monitor points, using standard oscilloscope passive probes (e.g., HP 10435A 10:1, 1 metre probe).
Gain: × 5 (= overall × 0.5 gain when used with 10:1 probes)
Impedance: 1 MΩ

Ordering Information

	Price
HP 3709B Constellation Display	$16,870

DIGITAL MICROWAVE RADIO TEST EQUIPMENT

Digital Radio Constellation Analyzer, Vector Signal Generator

HP 8780A, 8981B, 8782B, 11736B

HP 8780A

- 10 MHz to 3 GHz synthesizer
- BPSK, QPSK, 8PSK, 16QAM, Optional 64QAM
- Burst digital modulation

HP 8981B

- Analyzes coherent phase and amplitude modulation
- 350 MHz I vs. Q bandwidth
- Markers for measuring phase, amplitude, and time
- Displays magnitude and phase at time marker or magnitude and phase versus time
- 12-bit digitizing for HP-IB measurements
- 50 MHz to 200 MHz I/Q demodulator
- $<0.5°$ quadrature error and <0.1 dB amplitude imbalance

HP 8780A

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HP 8981B

DESIGNED FOR HP-IB SYSTEMS

HP 8780A Vector Signal Generator

The HP 8780A Vector Signal Generator is a synthesized source with exceptional modulation for modern digital microwave radio and satellite communications testing. The Vector Signal Generator offers a wide variety of modulation using both digital and analog inputs. It generates standard formats from BPSK to 64QAM and traditional modulation like FM, AM, and pulse, as well as sophisticated complex modulation.

HP 8981B Vector Modulation Analyzer

The HP 8981B Vector Modulation Analyzer is a two-channel X-Y sampling oscilloscope designed to analyze the in-phase (I) and quadrature phase (Q) components of modern digital microwave radio signals such as QPSK, 16QAM, and 256QAM. The HP 8981B has a 50 MHz to 200 MHz demodulator. Other demodulator frequencies available as special options.

Applications

The vector signal generator and vector modulation analyzer are well suited to testing modern terrestrial and satellite receivers and transmitters.

The HP 8780A standard modulation patterns—BPSK, QPSK, 8PSK, 16QAM, and 64QAM (with Option 064)—are easily generated using standard data generators. Asynchronous TDMA modulation can be simulated using the Burst feature along with one of the PSK modulations. A coherent carrier output simplifies quadrature and gain alignment of vector (I/Q) demodulators.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 8782B

- BPSK, QPSK, 8PSK, 16QAM, 256QAM, digital modulation and burst
- Internal pseudo random binary sequence (PRBS) generator
- AM/SCALAR modulation to simulate flat fading
- Coherent carrier output
- 100 MHz calibrated baseband analog I&Q inputs
- Optional 1 GHz unmodulated 10 output for upconversion to 0.750 to 1.25 GHz

HP 8782B

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HP 8782B Low-Cost Vector Generator

The HP 8782B low-cost vector signal generator offers a wide range of built-in digital modulation from BPSK to 256QAM for microwave terrestrial and satellite communication applications. The 1 MHz to 250 MHz range covers most of the IF frequencies in commercial receivers. An internal pseudo-random bit sequence (PRBS) generator allows digital modulation without external digital data. The HP 8782B provides economical IF signal generation for research and development and manufacturing. The cost is substantially lower than the cost of the HP 8780A Vector Signal Generator.

Applications

Use the HP 8782B to align digital radios in manufacturing. The HP 8782B can be used to provide calibrated digital modulations with extremely low quadrature error and amplitude imbalance. It can be used to simulate transmitter impairments, and to test receiver performance margins.

For more information about the HP 8780A, HP 8782B, and the HP 8981B, refer to the Signal Generator and Signal Analyzer section of this catalog.

HP 11736B I/Q Tutor

The HP 11736B I/Q Tutor was written to train engineers, technicians, and engineering managers. I/Q Tutor consists of interactive training software and a user manual. It covers all the major blocks of a complete digital communications system, from the analog input through modulation, transmission, demodulation, and conversion, back into analog.

I/Q Tutor's presentation of fundamental principles followed by simulations and examples is a powerful learning tool. The user manual teaches fundamentals of phase and magnitude and employs laboratory exercises to help you explore the effects of real-world interactions of C/N ratios, data errors, multipath fades, filter factors, modulation types, and so forth.

Subjects covered include phase and magnitude, practical digital modulation techniques, BPSK, QPSK, 16QAM, Offset QPSK, and Offset 16QAM, multipath fading, high power amplifier nonlinearities, theory of I/Q modulation and demodulation, Nyquist filters, and some aspects of regulation.

Ordering Information

Price

HP 11736B Runs on HP Vectra and most IBM PC-compatible computers (PC/XT/AT) with a monochrome or color graphics card. $125

To order, phone 1-800-227-8164.

Lightwave Selection Chart

Lightwave multimeter	**HP 8153A**		
Power sensor modules			
Wavelength range	450 to 1700 nm		
Power range	+10 to −110 dBm		
Accuracy (at reference cond.)	±2.2%		
Laser source modules			
Wavelengths	850, 1310, 1550, 1310/1550 nm		
Stability	±0.003 dB to ±0.01 dB		
LED source modules			
Wavelengths	850, 1300 nm		
Stability	±0.003 dB		
Return loss module			
Wavelength range	1250 to 1600 nm		
Return loss range	0 to 65 dB		
Sources	**HP 8167A**	**HP 8168A**	**HP 83424A/5A**
Wavelength range	1280 to 1330 nm	1500 to 1565 nm	1300 to 1550 nm (DFB)
Output power	> −4 dBm	> −4 dBm	> +3 dBm
Side mode suppression ratio	>40 dB	>40 dB	
Optical attenuators	**HP 8158B**	**HP 8157A**	
Wavelength range	600 to 1650 nm	1200 to 1650 nm	
Linearity (single-mode)	±0.4 dB	±0.2 dB	
Return loss	14 dB	45 dB	
Optical isolators	**HP 81210LI**	**HP 81310LI**	
Wavelength range	1290 to 1330 nm	1530 to 1570 nm	
Peak isolation	60 dB	60 dB	
Lightwave converters	**HP 11982A**	**HP 83440B/C/D**	
Wavelength range	1200 to 1600 nm	1200 to 1600 nm	
Bandwidth (optical)	dc to 15 GHz	dc to 6/20/34 GHz	
Conversion gain	300 V/W nominal	35/35/25 V/W nominal	
Lightwave signal analyzers	**HP 71400C**	**HP 71401C**	**HP 83810A**
Wavelength range	750 to 870, 1200 to 1600 nm	750 to 870, 1200 to 1600 nm	1200 to 1600 nm
Modulation bandwidth	100 kHz to 22 GHz	100 kHz to 2.9 GHz	9 kHz to 22 GHz
Sensitivity (optical)	−62/−66 dBm	−62/−66 dBm	−4 dBm
Optical spectrum analyzer	**HP 71450A**	**HP 71451A**	
Wavelength range	600 to 1700 nm	600 to 1700 nm	
Sensitivity	−85 dBm	−85 dBm	
Dynamic range	−55 dB @ 0.5 nm offset	−55 dB @ 0.5 nm offset	
Resolution	0.08 to 10 nm	0.08 to 10 nm	
Lightwave component analyzers	**HP 8702B**	**HP 8703A**	**HP 83420A**
Wavelengths	850, 1300, 1550 nm	1300, 1550 nm	1300, 1550 nm
Modulation bandwidth	300 kHz to 6 GHz	130 MHz to 20 GHz	130 MHz to 20 GHz
Precision reflectometer	**HP 8504A**		
Wavelengths	1300, 1550 nm		
Return loss range	0 to 75 dB		
Measurement span	1 mm to 40 cm (air)		
Two-event resolution	25 μm (air)		
Lightwave polarization analyzer	**HP 8509A/B**		
Wavelength range	1200 to 1600 nm		
Optical time domain reflectometer	**HP 8146A**		
Wavelengths	1310, 1550, 1310/1550 nm	850, 1300, 850/1300 nm	
Dynamic range	up to 30 dB	up to 28 dB	
Attenuation deadzone	30 m	20 m	
Hand-held optical loss test set	**HP 8140A**		
Power sensor modules			
Wavelength range	400 to 1700 nm		
Power range	+10 to −70 dBm		
Accuracy (at reference cond.)	±5%		
LED source modules			
Wavelengths	850, 1300, 1550 nm		
Stability (15 min)	±0.03 dB		

LIGHTWAVE TEST EQUIPMENT

Lightwave Multimeter

HP 8153A

- User-exchangeable plug-in modules for tailor-made measurements
- Traceable to NIST and PTB for accurate absolute power measurements
- Installed application software for standard measurements without external controller
- Dump to printer and dump to plotter for easy documentation
- Measurement of absolute power, insertion loss, and return loss
- Solutions for parallel-beam, unpackaged-chip, connectorized, and bare-fiber measurements

DESIGNED FOR HP-IB SYSTEMS

HP 8153A

HP 8153A Lightwave Multimeter

High Flexibility through Modular Design

The HP 8153A lightwave multimeter mainframe offers two slots for plug-in modules. Since modules can be combined in any configuration, the instrument can be used as a 1/2-channel power meter, as a 1/2-channel light source, as a loss test set, or even as a return-loss test set.

Power Sensor Modules with High Accuracy and Sensitivity

Four different power sensor modules, with different sensitivities from −70 dBm down to −110 dBm, cover the 450 nm to 1700 nm wavelength range. Each is individually calibrated over its entire wavelength range and is traceable to NIST and PTB for precise optical power measurements. Their excellent linearity and the high stability of the source modules provide the basis for precise determination of optical insertion loss for both single-mode and multimode components.

Stabilized Laser- and LED-Source Modules

The source modules offer very good short-term and long-term stability. The high output power can be internally attenuated by up to 6 dB. All sources output CW or pulse-modulated light (internal modulation at 270 Hz, 1 kHz, or 2 kHz).

Return-Loss Measurements with Unsurpassed Accuracy

By calibrating directly at the connector under test using the HP 81000BR reference reflector, an exceptional accuracy is achieved: ±0.4 dB for return-loss measurements over a dynamic range of 50 dB (±0.65 dB between 50 dB and 60 dB). The reference reflector is a gold-plated connector capable of providing a 96 percent reflection with just ±2 percent uncertainty. Unwanted reflections in front of the DUT can also be calibrated and compensated for. Both steps require just the push of a button.

Built-In Software for Advanced Applications

Without the need for an external controller, long-term power, insertion loss, or return-loss monitoring up to 100 hours can be performed. For easy documentation, the measured curves can be dumped to the HP ThinkJet or to any HP-GL plotter. Automatic loss measurements can be made simultaneously at 2 wavelengths. Procedures to maximize the amount of coupled light are supported as well.

Optical Heads Featuring Large-Area Detectors

The HP 81520A and HP 81521B optical heads and their various accessories offer elegant solutions for every sophisticated measurement. They can be used for high-precision power measurements in both parallel-beam and connectorized applications. Together with the HP 81230FL attenuating lens adapter, they can easily be used to perform calibrated absolute power measurements on unpackaged laser chips or LED chips. The HP 81000BA bare-fiber adapter facilitates interfacing to a fiber pigtail with a typical repeatability of less than 0.02 dB. For A/B relative power measurements or power monitoring during a bit error rate test, the HP 81000BS optical power splitter offers both low insertion loss and low polarization sensitivity. For more detailed information about accessories and specification, see the *Lightwave Test and Measurement Catalog.*

Sensor Module Specifications

	HP 81530A	HP 81536A	HP 81531A	HP 81532A	HP 81533A + 81520A	HP 81533A + 81521B
Sensor element	Si	InGaAs			Si	Ge
Wavelength range	450 to 1020 nm	800 to 1700 nm			450 to 1020 nm	900 to 1700 nm
Power range	+3 to −110 dBm	+3 to −70 dBm	+3 to −90 dBm	+3 to −110 dBm	+10 to −100 dBm	+3 to −80 dBm
Display resolution (dB)	0.001 dBm, 0.001 dB (0.0001 dB/dBm on printout)					
Display resolution (W)	0.01 pW	100 pW	1 pW	0.01 pW	0.1 pW	10 pW
Applicable fiber type	9/125 to 100/140 μm, (NA ≤0.3)				Parallel beam, 9/125 to 100/140 μm (NA ≤0.3)	
Accuracy (at ref. cond.)	±2.5% (600 to 1020 nm)	±2.5% (1000 to 1650 nm)			±2.2% (600 to 1020 nm)	±2.2% (1000 to 1650 nm)
Total uncertainty	±5% ±0.5 pW (600 to 1020 nm)	±5% ±50 pW (1000 to 1650 nm)	±5% ±1.5 pW (1000 to 1650 nm)	±5% ±0.5 pW (1000 to 1650 nm)	±4% ±0.5 pW (600 to 1020 nm)	±4% ±50 pW (1000 to 1650 nm)
Linearity 18° to 28° C, const. temp. 0° to 55° C, const. temp.	±0.015 dB ±0.3 pW ±0.05 dB ±0.5 pW	±0.015 dB ±30 pW ±0.05 dB ±50 pW	±0.015 dB ±1 pW ±0.05 dB ±1.5 pW	±0.015 dB ±0.3 pW ±0.05 dB ± 0.5 pW	±0.04 dB ±0.5 pW ±0.15 dB ±0.5 pW (+10 to −80 dBm)	±0.04 dB ±50 pW ±0.15 dB ±50 pW (+3 to −60 dBm)

The display may vary by ±1 count, in −50 dBm range ±3 counts.

Source Module Specifications

	81551MM	81552SM	81553SM	81554SM	81541MM	81542MM	81542MM Opt 001
Diode type	Laser	Laser	Laser	Laser	LED	LED	LED
Central wavelength (nm)	850 ± 10	1310 ± 20	1550 ± 20	1310/1550 ± 20	850 ± 30	1300 ± 40	1300 ± 40
Fiber type	50/125 μm	9/125 μm	9/125 μm	9/125 μm	50/125 μm	50/125 μm	62.5/125 μm
Spectr. bandwidth	<1.5 nm	<2.5 nm	<4 nm	<2.5/4 nm	<90 nm	<90 nm	<90 nm
Output power	> −2 dBm	>0 dBm	>0 dBm	> −1 dBm	> −17 dBm	> −20 dBm	> −20 dBm
CW stability (15 min, T-const.)	±0.01 dB	±0.003 dB	±0.003 dB	±0.005 dB	±0.003 dB	±0.002 dB	±0.002 dB

- Single-mode operation at each wavelength
- Accurate and fast tuning
- Independent control of power and wavelength

NEW

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Ordering Information

	Price
HP 8153A Lightwave Multimeter Mainframe	$2,950
Power Sensor Modules[1]	
HP 81530A Si, +3 to −110 dBm, 450 to 1020 nm	$3,050
HP 81531A InGaAs, +3 to −90 dBm, 800 to 1700 nm	$3,350
HP 81532A InGaAs, +3 to −110 dBm, 800 to 1700 nm	$5,050
HP 81536A InGaAs, +3 to −70 dBm, 800 to 1700 nm	$2,650
Optical Heads[2]	
HP 81533A Optical Head Interface Module[3]	$1,250
HP 81520A Optical Head, Si, +10 to −100 dBm, 450 to 1020 nm	$2,500
HP 81521B Optical Head, Ge, +3 to −80 dBm, 900 to 1700 nm	$2,750
Laser-Source Modules[1]	
HP 81551MM 850 nm, Multimode	$6,150
HP 81552SM 1310 nm, Single-Mode	$6,300
HP 81553SM 1550 nm, Single-Mode	$9,450
HP 81554SM 1310/1550 nm, Single-Mode	$12,600
LED-Source Modules[1]	
HP 81541MM 850 nm, 50 μm Multimode Fiber Output	$3,350
HP 81542MM 1300 nm, 50 μm Multimode Fiber Output	$4,600
HP 81542MM Opt 001 62.5 μm fiber instead of 50 μm fiber output	$320
Return Loss Module[4] **and Accessories**	
HP 81534A Return Loss Module	$5,650
HP 81102AC Patchcord HP/HRL, HP/HRL	$720
HP 81102BC Patchcord HP/HRL, Bare Fiber	$440
HP 81102DC Patchcord HP/HRL, Radiall VFO/DF	$720
HP 81102PC Patchcord HP/HRL, FC/APC	$720
HP 81102SC Patchcord HP/HRL, Diamond HRL-10	$720
HP 81109AC Patchcord HP/HRL, Diamond HMS-10/HP	$720
HP 81000UM Universal Through Adapter	$95
HP 81000BR Reference Reflector	$230

[1]One connector interface (HP 81000xI) required per module.
[2]For required lenses and adapters, see lightwave catalog.
[3]Required to connect the optical head to the mainframe.
[4]Two connector interfaces (HP 81000xI) required per module.

HP 8167A and 8168A Tunable Laser Sources

The HP 8167A and 8168A tunable laser sources are basic tools for characterizing and testing optical amplifiers and components. The HP 8167A addresses the 1300 nm transmission window; the HP 8168A operates in the 1550 nm window. A built-in side mode filter ensures that a true single-mode laser line is generated for every wavelength point, eliminating any possible multimoding. A 0.001 nm resolution also makes these tunable lasers valuable tools for heterodyne measurements and coherent applications. Both tunable lasers provide independent control of output power and wavelength on a what-you-set-is-what-you-get basis. Therefore, the user does not need to monitor values with additional instruments. Wavelength scans, which require an output power that is stable over time and flat across all wavelengths, can be performed reliably, accurately, and quickly. In manufacturing applications, the instruments can be integrated into a fully automated production-test environment for precise, repeatable high-speed testing. The front-end connector is an angled, noncontact high-return-loss (HRL) connector. This HP/HRL typically ensures more than 60-dB return loss over its entire lifetime, since it is abrasion-free.

For more information, refer to the *Lightwave Test and Measurement Catalog* and the data sheet.

Key Specifications

	HP 8167A	HP 8168A
Wavelength range (output power > −4 dBm)	1280 nm to 1330 nm	1500 nm to 1565 nm
Wavelength resolution	0.001 nm	0.001 nm
Tuning repeatability	±0.05 nm (typ. ±0.02 nm)	
Tuning Speed (typ.) **for a 1-nm step** **for a 10-nm step** **for a 100-nm step**	<150 ms <300 ms <2 s	
Side mode suppression ratio	>40 dB	
Linewidth (typ.)	<100 kHz	

Ordering Information

	Price
HP 8167A Tunable Laser Source	$63,000
HP 8168A Tunable Laser Source	$63,000
HP 81000UI Interface Adapter	$860
HP 81102AC Patchcord HP/HRL, HP/HRL	$720
HP 81102BC Patchcord HP/HRL, Bare Fiber	$440
HP 81102DC Patchcord HP/HRL, Radiall VFO/DF	$720
HP 81102PC Patchcord HP/HRL, FC/APC	$720
HP 81102SC Patchcord HP/HRL, Diamond HRL-10	$720

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

LIGHTWAVE TEST EQUIPMENT

Optical Attenuators

HP 8157A, 8158B

- High resolution (0.01 dB)
- Short settling time (typical 20 ms)
- For multimode and single-mode fibers (8158B)
- > 45 dB return loss (8157A)

HP 8157A/8158B Attenuator

The HP 8158B is a programmable optical attenuator for single-mode and multimode optical fibers with a numerical aperture up to 0.3. Options are available for the short- and the long-wavelength range.

The HP 8157A is a high-performance single-mode attenuator for the 1200 to 1650 nm wavelength window. Its excellent linearity, very high return loss, and polarization-insensitivity make it the ideal attenuator for bit error rate measurements on optical systems for high data rates.

Specifications

	HP 8158B Opt 001	HP 8158B Opt 002	HP 8157A
Wavelength range	600 to 1200 nm	1200 to 1650 nm	1200 to 1650 nm
Fiber type	all with NA <0.3	all with NA <0.3	single-mode
Attenuation range	60 dB	60 dB	60 dB
Insertion loss (typical)*	1 dB	2 dB	2 dB
Linearity (typical)	±0.05 dB	±0.05 dB	±0.05 dB
Return loss*	14 dB	14 dB	45 dB

* depending on connector type

Size: 212 mm W × 89 mm H × 345 mm D (8.36 in × 3.5 in × 13.6 in)
Weight: Net, 5.3 kg (11.7 lb); shipping, 9.6 kg (21.2 lb)

Ordering Information

	Price
HP 8158B Optical Attenuator Mainframe	$2,650
Opt 001 600 to 1200 nm	$4,300
Opt 002 1200 to 1650 nm	$4,300
Opt 011 HMS-10/HP Connector	$710
Opt 012 FC/PC Connector (multimode only)	$1,020
Opt 013 DIN 47256 Connector	$1,020
Opt 014 ST Connector (multimode only)	$1,020
HP 8157A Optical Attenuator	$9,550
HP 81000AI/FI/GI/KI/SI/VI/WI Connector Interface (each)	$170

Accessories

Optical Isolators

Optical isolators from HP offer very high peak-isolation (>60 dB) as well as very high return loss (>60 dB). Polarization dependence is less than 0.2 dB, and insertion loss less than 3 dB. They are available either with pigtails (standard version) or with connectors (see Options).

Optical Power Splitters for HP 81521B

The optical power splitters are mode- and polarization-insensitive, and offer a split ratio of approximately 10:1. The HP 81000BS accept single-mode and multi-mode fibers with a maximum numerical aperture of NA = 0.3 and have factory-installed connector options. The HP 81010BS accepts single-mode fibers only and offers high return loss for physical-contact connectors. Depending on connector type, the return loss is up to 45 dB.

High-Performance Bare-Fiber Adapter for HP 81520A/81521B Optical Heads

The HP 81000BA for fibers with 125-um cladding diameter and the HP 81000CA for fibers with 140 μm cladding diameter are capable of interfacing fiber pigtails to the 81520A/81521B with 0.02 dB repeatability. The sophisticated design makes it very easy to use and ensures not only high accuracy but also high throughput in serial testing.

Attenuating Lens Adapter for Direct Chip Measurements

With the HP 81230FL mounted on an HP 81521B optical head, the output power of LED or laser chips up to 200 mW can be measured precisely, before the pigtail is attached. Anti-reflection coating on all optical surfaces guarantees minimum back-reflections. The maximum acceptable numerical aperture is NA=0.5 in the wavelength range from 1200 nm to 1650 nm.

Connector Interfaces for Both Easy Cleaning and Easy Adaptation

User-exchangeable connector interfaces permit easy cleaning of the instrument's front end connector, and also allow the use of different connector types with the same instrument. They are available for Diamond HMS-10, FC/PC, D4, SMA, SC, ST, DIN, and Biconic.

A Variety of Other Accessories Help Solve Your Measurement Problems

Patch cords and adapters enable users to interface virtually every connector type to the instruments. Filters and filter holders extend the measurement range to higher power levels. For more detailed information about accessories, please see the lightwave catalog.

Ordering Information*

	Price
Optical Isolators	
HP 81210LI 1310 nm ±20 nm Wavelength Range	$4,500
HP 81310LI 1550 nm ±20 nm Wavelength Range	$4,500
Opt 001 Input: Bare Fiber, Output: Diamond HMS-10/HP	$440
Opt 010 Input: Diamond HMS-10/HP, Output: Bare Fiber	$440
Opt 011 Input and Output: Diamond HMS-10/HP	$890
Opt 002 Input: Bare Fiber; Output: PC	$440
Opt 022 Input and Output: PC	$890
Connector Interfaces	
HP 81000AI Diamond HMS-10/HP	$170
HP 81000FI FC/PC	$170
HP 81000GI D4	$170
HP 81000JI SMA (lensed interface only)	$170
HP 81000UI SC	$170
HP 81000SI DIN 47256	$170
HP 81000VI ST	$170
HP 81000WI Biconic	$170

*For more information, please see the *Lightwave Test and Measurement Catalog.*

LIGHTWAVE TEST EQUIPMENT

Optical Time Domain Reflectometer – Optical Loss Test Set/Power Meter

HP 8146A, 8140A

- High-resolution and long-range capability in one module
- Automatic link characterization in less than 7 seconds
- Optional built-in printer, floppy disk drive, and memory card reader
- Modular design
- Sources and sensors for all common wavelength ranges
- Standalone LED source, power meter and loss test set

HP 8140A with 81401A sensor module and 81412A LED source module

HP 8146A Optical Time Domain Reflectometer

The HP 8146A is a high-performance optical time domain reflectometer for installation, field maintenance, and bench applications. Plug-in modules are available for all common wavelengths and single- and multimode fibers.

Each module can be used as a high-resolution or long-range module (switch-selectable). With 30 dB dynamic range and 3 m event deadzone in one module (HP 81462SM), the complete link can be tested. In less than 7 seconds the HP 8146A will automatically characterize the link with up to 100 reflective and non-reflective events. The minimum detectable splice loss is 0.05 dB.

For documentation purposes, the HP 8146A features an optional built-in printer, 3½-in floppy disk drive or a memory card reader.

Specifications

Module	HP 81462SH	HP 81463SH	HP 81465SH
Wavelength	1310 ±20 nm	1550 ±20 nm	1310/1550 ±20 nm
Dynamic range	30 dB	27 dB	30/27 dB
Event deadzone	3 m	3 m	3 m
Attenuation deadzone	30 m	40 m	30/40 m
Module	**HP 81461MH**	**HP 81462MH**	**HP 81464MH**
Wavelength	850 ±10 nm	1300 ±10 nm	850/1300 ±10 nm
Dynamic range	25 dB	28 dB	25/28 dB
Event deadzone	3 m	3 m	3 m
Attenuation deadzone	20 m	25 m	20/25 m

Span: 1 to 200 km
Distance Accuracy: ±0.5 m ± sample spacing ± meas. distance × 10^{-4} (±1.5 m for 850 nm)
Compare Mode: Two waveforms can be compared on screen
Size: 340 mm W × 190 mm H × 465 mm D (13.4 in × 7.5 in × 18.3 in)
Weight: Net, 15 kg (33 lb), including one module

Ordering Information

	Price
HP 8146A Optical Time Domain Reflectometer	$12,100
Opt 001 Additional dc Input	$770
Opt 003 3½-in Floppy Disk Drive	$250
Opt 002 Thermal Printer	$1,100
Opt 004 Memory Card Reader	$630
HP 81462SH 1310 nm, Single-Mode Module	$14,250
HP 81463SH 1550 nm, Single-Mode Module	$17,500
HP 81465SH 1310/1550 nm, Single-Mode Module	$23,750
HP 81461MH 850 nm, Multimode Module	$10,200
HP 81462MH 1300 nm, Multimode Module	$13,500
HP 81464MH 850/1300 nm, Multimode Module	$22,000
HP 81460SA MS-DOS PC-Based OTDR Emulation SW	$1,050
HP 81000AI/FI/GI/KI/SI/VI/WI Interface (each)*	$170

(see page 564)

HP 8140A Optical Loss Test Set/Power Meter

The HP 8140A is a compact, lightweight instrument for hand-held operation in the installation and maintenance of optical links and component characterization. It may be configured as a power meter, a stand-alone source, or a loss test set.

As a power meter, it is an ideal tool for the measurement of the output power of transmitter modules and of power levels at the fiber end, and for the check for "dark" fibers.

The HP 8140A, in a standalone source or loss test set configuration, covers all wavelengths commonly used in datacom LANs and telecommunications networks. Its main applications include the insertion loss of optical passive components and the total link loss to check for power budgets.

Specifications

Power Meter/Sensor	HP 81400A	HP 81401A
Wavelength range	400 to 1100 nm	750 to 1700 nm
Fiber type	up to 100/140 µm	up to 100/140 µm
Measurement range	+10 to −70 dBm 1 pW to 10 mW	+3 to −70 dBm 1 pW to 2 mW
Noise floor	<3 pW pp	<3 pW pp
Measurement uncertainty	±5%	±5%***
Calibrated wavelength	660/780/820/850 nm	820/850/1300/1550 nm
Sensor element	Si	InGaAs

Loss Test Set/Source	HP 81411A	HP 81412A	HP 81413A
Wavelength	850 ±10 nm	1300 ±20 nm	1550 ±20 nm
Spectral bandwidth (FWHM)	<50 nm	<140 nm	<200 nm
Output power (into 50/125 µm)*	> −17 dBm	> −20 dBm	> −25 dBm
Dynamic range (into 50/125 µm)*	>53 dB	>50 dB	>45 dB
Stability (15 min, cons. temp, 0° to 40° C)**	±0.03 dB	±0.03 dB	±0.03 dB

* Typically 20 dB less into single-mode fiber
** After 5-min. warmup
*** Add 2% for 820 nm and 850 nm

Size: 81 mm W × 185 mm H × 41 mm D (3.2 in × 7.2 in × 1.6 in)
Weight: Net, 600 g (incl. source, sensor, 4 batteries, and 2 connector interfaces)

Ordering Information

	Price
HP 8140A Optical Loss Test Set (mainframe)	$790
HP 81400A Optical Sensor 400 to 1100 nm	$440
HP 81401A Optical Sensor 750 to 1700 nm	$890
HP 81411A LED Module 850 nm	$790
HP 81412A LED Module 1300 nm	$1,350
HP 81413A LED Module 1550 nm	$1,900
HP 81000AI/FI/GI/JI/KI/SI/VI/WI Interface	$170
HP 8140CC Carrying Case (each)	$120

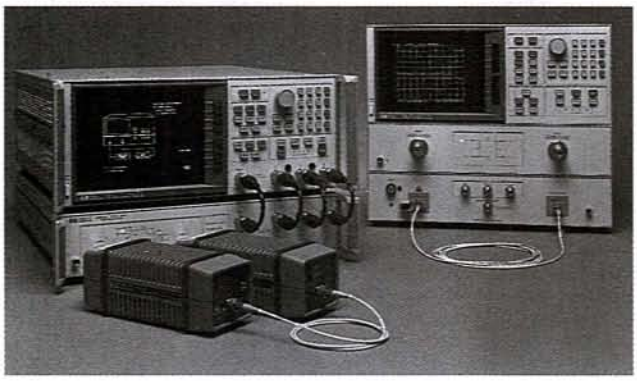
For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

LIGHTWAVE TEST EQUIPMENT

Lightwave Component Analyzers

HP 8702B, 8703A

- 300 kHz to 20 GHz modulation frequency
- Calibrated measurements of high-speed optical, electro-optical, and electrical components
- 850, 1300, or 1550 nm operation
- Reflection measurements with <1 mm resolution up to 50 dB optical dynamic range



HP 8702B and 8703A

DESIGNED FOR HP-IB SYSTEMS

Lightwave Component Analyzers

As the transmission rate or bandwidth of fiber optic systems is pushed upward, high frequency design considerations become key. Both the HP 8702B and 8703A measure each of the elements that transmit these wide bandwidths. They make calibrated measurements of lasers or LED transmitters, photodiode receivers, optical fibers, and the electrical components they work with. The lightwave component analyzers operate with a swept modulation frequency precisely to characterize how these components operate on the high-speed, information-bearing signal. Information on how each component responds, independent of the others, provides insight into how systems can be predicted and improved.

Both the HP 8702B and 8703A operate at a fixed wavelength and sweep the frequency of the intensity modulation signal over the bandwidth you select. The HP 8702B has transducers (lightwave source and receivers), which allow it to operate at 850, 1300, and 1550 nm. The HP 8703A can operate at 1300 and 1550 nm. These sources and receivers come with calibration data to allow calibrated measurements of the electro-optical components.

Measure Optical Components

Measurements can be made of such components as connectors, splitters, couplers, and lenses, as well as fiber itself. This yields modulation bandwidth, insertion loss, length, and optical return loss. In the distance-time domain, reflections can be located without the dead zone typical of OTDR type measurements. Transmission measurements can also be displayed in the distance-time domain to view the impulse or step response of the component. Delay and dispersion are easily viewed in this manner.

Measure Electro-Optical Components

Often the limiting elements in a fiber optic system are the electro-optical components (for example, lasers, APD's, PIN photodiodes, and modulators), which convert the electrical information to optical or vice versa. The conversion efficiency or responsivity of these devices is a function of many variables. The characterized lightwave source and receiver in the lightwave component analyzer allows each of these devices to be tested uniquely. Data can be displayed in the frequency domain as the modulation frequency response or in the time domain as the step response.

Measure Electrical Components

When used to measure linear electrical components, such as amplifiers, filters, and transmission lines, the lightwave component analyzers have the full measurement capability of a microwave network analyzer. Typical measurements are bandwidth, insertion loss/gain, phase, impedance, match, and group delay.

Measure Both Transmission and Reflection Characteristics

Complete characterization of component behavior depends on knowing how the signal is transmitted through it and how it is reflected back. For optical reflections, the lightwave component analyzers use a lightwave directional coupler to make the reflection measurements. Data can be presented in the modulation frequency domain or in the distance-time domain to locate and measure the source of the reflection. Because of the wide measurement bandwidth, single reflections can be located with <1 mm of resolution and up to 50 dB optical dynamic range and 100 dB electrical dynamic range. For electrical reflection measurements, the analyzer uses a test set to perform the measurement. Results, such as impedance, can then be displayed.

HP 8702B

DESIGNED FOR HP-IB SYSTEMS

HP 8702B Lightwave Component Analyzer

Standard configuration requires an HP 8702B, an RF interface kit, a lightwave source, lightwave receiver, and fiber cable. All HP 8340xB sources have built-in optical isolators for reflection sensitivity and improved optical source match compared to the A models. A lightwave directional coupler is required for reflection measurements.

HP 8702B Accessories

Lightwave Source Modules

All with directly modulated Fabry-Perot lasers.

HP 83400A/B, 300 kHz to 3 GHz, 1300 nm, 9/125 μm fiber
HP 83401A, 300 kHz to 3 GHz, 1300 nm, 50/125 μm fiber
HP 83402A/B, 300 kHz to 6 GHz, 1300 nm, 9/125 μm fiber
HP 83403A/B, 300 kHz to 3 GHz, 1550 nm, 9/125 μm fiber
HP 83404A/B[1], 300 kHz to 3 GHz, 850 nm, 50/125 μm fiber

Lightwave Receiver Modules

All with PIN photodiodes.

HP 83410C, 300 kHz to 3 GHz, 1300/ 1550 nm, 62.5/125 μm fiber
HP 83411C, 300 kHz to 6 GHz, 1300/ 1550 nm, 9/125 μm fiber
HP 83411D, 300 kHz to 6 GHz, 1300/ 1550 nm, 9/125 μm fiber
HP 83412B, 300 kHz to 3 GHz, 850 nm, 62.5/125 μm fiber

Lightwave Directional Couplers

A three-port, directional coupler for making reflection measurements and monitoring transmission signals. The couplers have a nominal 3 dB coupling factor.

HP 11890A 9/125 μm fiber
HP 11891A 50/125 μm fiber

RF Interface Kit

HP 11889A

This kit contains the RF accessories required to operate the HP 8702 when a test set is not used. Contains a power splitter, a 20 dB pad, SMA accessories and adapters for the analyzer.

Probe Power Supply

HP 11899A

This power supply provides regulated dc power to the HP 8340x and HP 8341x lightwave sources and receivers or HP 85024A RF Probe.

[1]The following sticker applies to the HP 83404A:

S-Parameter Test Set
HP 85046A 300 kHz to 3 GHz
HP 85047A 300 kHz to 6 GHz

These test sets provide the capability to measure impedance and transmission characteristics of two-port electrical devices in either forward or reverse direction with a single connection. The HP 85047A is required for 6 GHz operation.

Calibration Kit
HP 85033C 3.5 mm

Contains precision 3.5 mm standards used to calibrate the HP 8702 for electrical measurements of components with 3.5 mm or SMA connectors.

Workspace Cabinet
HP 11895A

This cabinet fits beneath an HP 8702 system making the system easier to use and reducing required bench space.

Ordering Information	Price
HP 8702B Lightwave Component Analyzer	$37,245
Opt 006 6 GHz Receiver Operation	+$3,000
Opt 011 Delete Time Domain	−$5,300
HP 83400A Lightwave Source	$13,000
HP 83400B Lightwave Source	$17,500
HP 83401A Lightwave Source	$13,000
HP 83402A Lightwave Source	$15,000
HP 83402B Lightwave Source	$19,500
HP 83403A Lightwave Source	$13,000
HP 83403B Lightwave Source	$17,500
HP 83404A Lightwave Source	$12,700
HP 83404B Lightwave Source	$17,500
HP 83410C Lightwave Receiver	$6,150
HP 83411C Lightwave Receiver	$4,600
HP 83411D Lightwave Receiver	$12,000
HP 83412B Lightwave Receiver	$6,000
HP 11890A Lightwave Coupler	$3,900
HP 11891A Lightwave Coupler	$3,900
HP 11889A RF Interface Kit	$1,500
HP 11895A Workspace Cabinet	$450
HP 11899 Probe Power Supply	$200
HP 85046A S-Parameter Test Set	$9,000
HP 85047A S-Parameter Test Set	$10,800

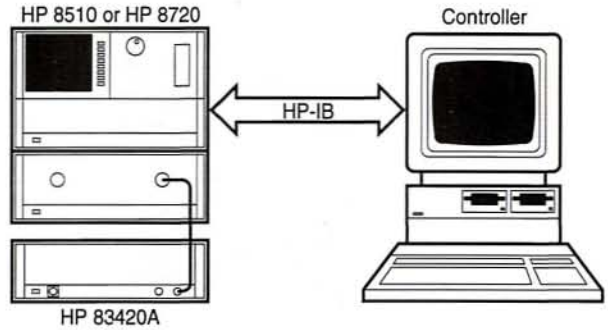
HP 8703A Lightwave Component Analyzer

- 130 MHz to 20 GHz Modulation Frequency
- 1300 and 1550 nm operation
- FP and DFB lasers

HP 8703A

Standard configuration includes an internal 1300 nm Fabry-Perot (FP) laser and one 1300/1550 nm receiver. Optional 1300 or 1550 nm DFB internal laser sources are also available. The external lightwave source input (Option 100) is used with the HP 83424A or 83425A[1] Lightwave CW Sources for additional 1550 or 1300 nm DFB wavelength flexibility.

20-GHz Lightwave Test Set, Source, Modulator, and Receiver



HP 83420A Lightwave Test Set

Includes a 1300 nm FP laser, modulator, receiver, and directional coupler. Basic lightwave component analyzer tests from 130 MHz to 20 GHz can be made when the HP 83420A is combined with an external controller and an HP 8510, HP 8720/H80, HP 8719/H80, or HP 8757 microwave analyzer system.

20 GHz Lightwave Sources and Receivers
HP 83421A Lightwave Source
HP 83422A Lightwave Modulator
HP 83423A Lightwave Receiver

For standalone applications, these instruments have modulation frequency ranges of 130 MHz to 20 GHz.

Ordering Information	Price
HP 8703A Lightwave Component Analyzer	$116,245
Opt 01X Select Optical Connector	$0
Opt 100 External Lightwave Source Input	+$2,800
Opt 210 1550 nm DFB Laser	+$15,000
Opt 220 1300 nm DFB Laser	+$10,500
Opt 300 Additional Lightwave Receiver	+$10,900
Opt 830 Add HP 3.5 mm Cal Kit & Cable	+$5,100
HP 83424A Lightwave CW Source—1550 nm	$27,500
Opt 100 External Lightwave Source Input	+$2,800
HP 83425A Lightwave CW Source—1300 nm	$24,100
Opt 100 External Lightwave Source Input	+$2,800
HP 83420A Lightwave Test Set	$49,500
Opt 01X Connector Option	$0
Opt 100 External Lightwave Source Input	+$2,800
Opt 210 1550 nm DFB laser	+$15,000
Opt 220 1300 nm DFB laser	+$10,500
HP 83421A Lightwave Source	$29,500
Opt 01X Connector Option	$0
Opt 100 External Lightwave Source Input	+$2,800
Opt 210 1550 nm DFB Laser	+$15,000
Opt 220 1300 nm DFB Laser	+$10,500
HP 83422A Lightwave Modulator	$20,000
Opt 01X Connector Option	$0
HP 83423A Lightwave Receiver	$13,500
Opt 01X Connector Option	$0
Opt 300 Additional Lightwave Receiver	+$10,900

[1]The following sticker applies to the HP 83425A:

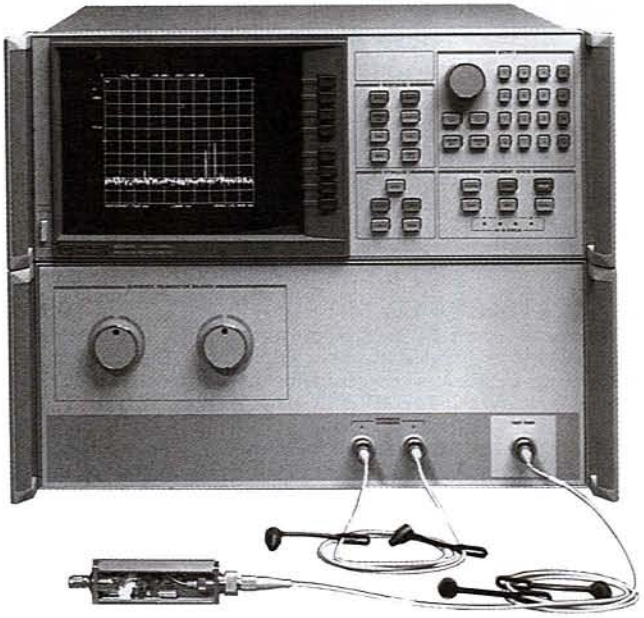
For the most current prices and product information, contact your local Hewlett-Packard sales office, see page 665.

LIGHTWAVE TEST EQUIPMENT

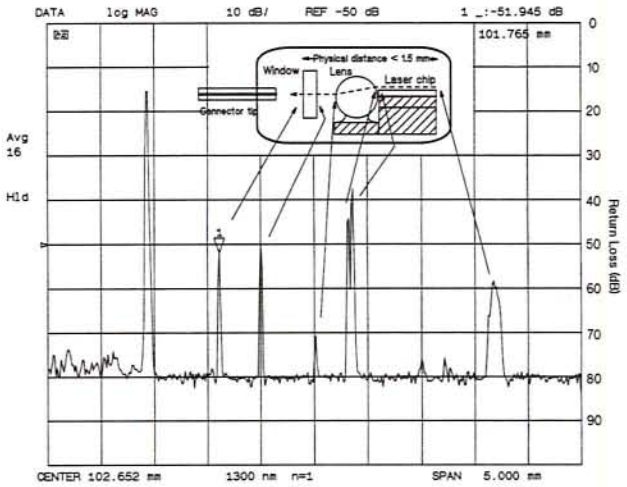
Precision Reflectometer

HP 8504A

- Return loss measurement range beyond 75 dB
- 25 μm two-event resolution (in air, 16 μm in glass)
- 1300 and 1550 nm wavelengths
- 1 mm to 400 mm scan widths



DESIGNED FOR HP-IB SYSTEMS



Characterizing multiple interface devices

HP 8504A Precision Reflectometer

The HP 8504A Precision Reflectometer provides state-of-the-art lightwave reflection measurements. Individual reflections are measured and displayed as a function of distance or position. Return loss measurements beyond 75 dB are achievable, even when larger reflections are present in the measurement path. Two reflections can be closer than 25 μm (equivalent distance in air) and still be individually identified. Engineers and scientists now have a tool to precisely locate, identify, and quantify individual reflections within lightwave components and assemblies. Designs are optimized easily in the development phase. In product manufacturing, problems are solved quickly as even very small faults and discontinuities are found easily. Calibrated measurements are performed in seconds using a simple user interface and a rapid scan rate.

The HP 8504A precision reflectometer measures connectorized components in single-mode fiber. (Performance is good, but not optimum in multimode fiber.) The measurement span can be varied from 1 mm to 40 cm. The location of the 40 cm measurement window can be offset by adding the appropriate length of extension cable. Measurements are made using internal 1300 nm and 1550 nm light sources.

Small optical devices often have several reflecting interfaces. The above plot is a measurement of the reflections inside a small laser assembly. Seven reflections are detected in a span of only 5 mm. It is important to note that because the HP 8504A displays reflections spatially, very small reflections (such as the 70 dB return loss at the front of the lens) can be detected even though there are very large reflections in the measurement path (such as the 15 dB reflection at the fiber end).

The HP 8504A can also be an important tool in preventing and solving component failure modes. Determining the precise location of a crack or break in a small optical assembly is easily achieved with the HP 8504A precision reflectometer.

In addition to measuring reflections, there are also a variety of other applications including source coherence functions, precision length measurements, and characterization of the effects of birefringence (including polarization mode dispersion and fiber beat length).

Ordering Information	Price
HP 8504A Precision Reflectometer	$55,000
Opt 011-015 Connector Options	$0
Opt 210 Delete 1300 nm source	−$5,500
Opt 220 Delete 1550 nm source	−$6,500

- Calibrated, real-time measurements of state and degree of polarization
- Fast, automatic measurements of polarization-dependent loss in optical components
- Simple method for determining polarization-mode dispersion (PMD)

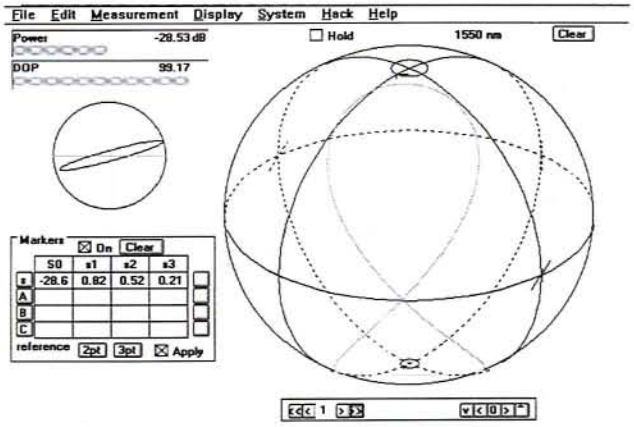
HP 8509B

DESIGNED FOR HP-IB SYSTEMS

HP 8509A/B Lightwave Polarization Analyzers

Designers and users of lightwave components and systems now have the tools necessary to fully measure the polarization characteristics of optical signals and devices. The HP 8509A/B lightwave polarization analyzers offer polarization data you need in formats you use.

The HP 8509A/B measure optical signals' degree and state of polarization. Measurements are displayed real time in the graphical formats of the Poincare sphere and polarization ellipse, or numerically as Stokes parameters. Wherever a reference polarizer can be inserted, a calibrated, absolute state of polarization can be measured.



HP 8509 Scope

Stimulus-Response Measurements with the HP 8509B

Only the HP 8509B has internal sources that enable stimulus-response measurements as a function of polarization. Measurements include automated polarization-dependent loss or the Jones matrix of a device. The ability to measure polarization accurately with the addition of a tunable source (HP 8167A, HP 8168A, HP 83424A, or HP 83425A) provides a simple, high-resolution method for determining polarization-mode dispersion.

Specification Summary

Measurement Range: 1200 to 1600 nm
Measurement Rate: 1000 samples/second
Internal Sources: 1300 and 1550 nm
Normalized Stokes Parameters Uncertainty: ±0.008
Input Power Range: +15 to −55 dBm
Polarization-Dependence Uncertainty
Delta transmission uncertainty: ±0.08 dB
Compatible Fiber: 9/125 μm

The HP 8509A/B operates through an HP Vectra 386 PC in the Windows 3.0 graphical environment. Special PC hardware interface and measurement software are included.

HP 11894A Polarization Controller

The HP 11894A polarization controller allows for easy and precise adjustment of lightwave polarization. Full polarization adjustment is available through three polarization paddles.

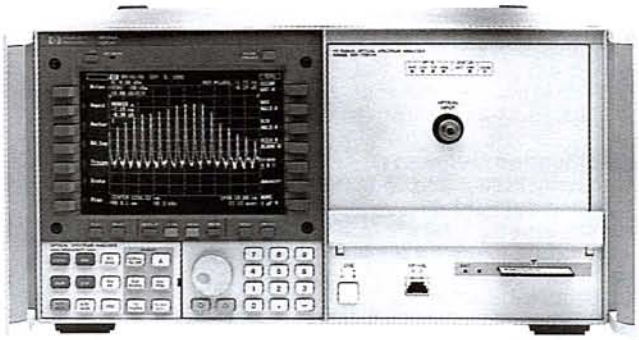
Ordering Information	Price
HP 8509A Polarization Analyzer	$36,000
HP 8509B Polarization Analyzer	$52,000
Opt 210 Delete 1300 nm source	−$2,000
Opt 220 Delete 1550 nm source	−$2,000
For both HP 8509A and HP 8509B:	
Opt 011-015 Connector Options	$0
Opt 1FF Delete Computer	−$3,000
HP 11894 Polarization Controller	$1,500
Opt 011-015 Add Connectors	$1,400

LIGHTWAVE TEST EQUIPMENT

Optical Spectrum Analyzers, 600 nm to 1700 nm

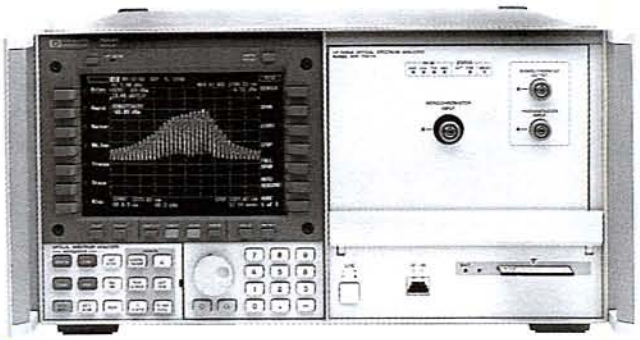
HP 71450A, 71451A

- Spectral measurements from 600 to 1700 nm
- Unique double-pass monochromator
- Real-time sweep rates
- −85 dBm sensitivity and 60 dB dynamic range
- Excellent amplitude accuracy, low polarization dependency
- Wavelength and amplitude calibration across full measurement range
- Optional current-source output
- Five modes of operation (HP 71451A)



HP 71450A

NEW



HP 71451A

DESIGNED FOR HP-IB SYSTEMS

HP 71450A and 71451A Optical Spectrum Analyzers

The new HP 71450A and 71451A are grating-based optical spectrum analyzers that display the amplitude of light versus wavelength over the 600 to 1700 nm wavelength range. These instruments make fast spectral measurements of LEDs, Fabry-Perot lasers, DFB lasers, and Erbium-doped fiber amplifiers. Capable of sweeping 40 nm in 50 ms and the full frequency range in 500 ms, they can save hours of measurement time in the laboratory or on the production floor.

A unique double-pass monochromator provides the optical spectrum analyzers with the high dynamic range of double-monochromator instruments (−55 dBm at 0.5 nm from the peak) and the sensitivity of single-monochromator instruments (better than −85 dBm). They also offer high amplitude and wavelength accuracy, as well as polarization insensitivity.

The optical spectrum analyzers are housed in a single, 9-in-high mainframe. They operate in temperatures from 0° to 55° C, and they meet rigorous environmental tests, including those for shock and vibration. The analyzers maintain full calibration for two years, even after normal transportation—across the room or across the country.

Measurement Versatility

The features of an electrical spectrum analyzer are found in the HP 71450A and 71451A. Modification of screen data allows immediate wavelength-position or span adjustments. Fully variable spans with full control over sweep speeds, sensitivity, and resolution, and the choice of automatic or manual settings, make the analyzers easy to use. In addition, automatic features include an auto-measure function that locates the signal, zooms in, and centers the display; and an auto-align feature that automatically centers the light on the photodiode for optimum amplitude accuracy.

Three advanced functions measure and characterize LEDs and DFB and Fabry-Perot lasers. The LED measurement identifies the spectral FWHM value, mean-wavelength position, and peak-power density of the LED. The Fabry-Perot function measures the spectral FWHM, center wavelength, mode spacing, and total power of the laser. One-button measurements of DFB lasers include center wavelength, automatic side-mode suppression ratios, peak power, and stop-band characterization.

An optional current source can source or sink up to 200 mA of current to bias your laser or LED. The current source allows either continuous current or variable duty-ratio current pulses to minimize chip heating effects. The source can be set from the front panel or over HP-IB. It provides transient suppression and voltage clamping to protect your diode under test.

The optical spectrum analyzers save data in several ways. Displayed information can be transferred directly to a printer or plotter, and trace and instrument setups can be saved internally in the standard 256 KB or optional 1 MB memory, stored on a memory card, or sent over HP-IB to an external disk drive.

Part of the Modular Measurement System (MMS), the HP 71450A and 71451A consist of a color mainframe/display and a new HP 70950A or 70951A optical spectrum analyzer module. Either optical module can be added to existing MMS systems.

Five Modes of Operation with the HP 71451A

The HP 71451A extends the standard optical spectrum analysis capability by adding four measurement ports: monochromator input, photodetector input, monochromator output, and transimpedance amplifier input. An internal transfer switch, automatic fiber alignment, and access to the photodetector and transimpedance amplifier allow the HP 71451A to be operated in five modes.

- OSA mode provides basic optical spectrum analysis with precise amplitude accuracy and less than ±0.5 dB polarization sensitivity.
- Preselector mode allows front-panel output of light that has passed through the monochromator. Wavelength-division multiplexed channels, individual modes of Fabry-Perot lasers, and selected widths of LEDs or white light sources can be output on 62.5 μm fiber.
- Stimulus-response mode allows you to take the output light from the monochromator, pass it through a device or filter, and then reinsert it into the analyzer for spectral analysis.
- Power-meter mode offers direct access to the photodetector. In this mode, a trace of average power versus time is displayed, allowing you to log amplitude changes over time. Long-term drift can be monitored, and a digital readout of power is provided.
- Photodetector mode allows access to the transimpedance amplifier input. With the monochromator also active, a white light source can quickly plot or display a photodetector's responsivity over the full spectral range of the optical spectrum analyzer.

Specifications

Wavelength

Range: 600 to 1700 nm
Span Range (contin. variable): 0.2 nm to full range
Absolute Accuracy[1]**:** ±1 nm
Absolute Accuracy[1] (after user cal): ±0.5 nm
Differential accuracy[1,2]**:** ±0.1 nm, for separations ≤20 nm
Reproducibility ≤1 minute: ±0.005 nm
Tuning Repeatability: ±0.005 nm
Settability (zero span): ±0.005 nm
Readout Resolution[2]**:** Span/trace length

Resolution[1]

FWHM: 0.08 and 0.1 to 10 nm in a 1,2,5 sequence
Resolution Accuracy (≥0.5 nm, 1250 to 1600 nm): ±20%

Amplitude (for resolutions ≥0.2 nm)

Calibration Accuracy[1] **at −30 dB, 1300 nm:** ±0.5 dB
Scale Fidelity, sensitivity in Auto: ±0.25 dB
sensitivity in Manual: ±0.5 dB
Display Resolution: 0.01 dB, log; 0.23% of measurement + 0.01% of reference level, linear

	600 to 1700 nm	750 to 1600 nm	1250 to 1600 nm
Flatness[1]**:**	±2 dB[3]	±2 dB	±1 dB
Polarization dependence[1]**:**	±2.5 dB[2]	±1.5 dB[2]	±0.5 dB[3]

Sensitivity[4]

600 to 750 nm: −65 dBm
750 to 1000 nm: −70 dBm
1000 to 1600 nm: −85 dBm
1600 to 1750 nm[3]**:** −80 dBm

Dynamic Range[1,3] (excluding multiple order grating responses)

600 to 1700 nm: −50 dB ≥ ±1 nm
1250 to 1600 nm: −55 dB ≥ ±0.5 nm; −60 dB ≥ ±1 nm

Input Power

1 dB Compression Level, within selected resolution: ≥ 10 dBm
Maximum Displayed Level: ≥ 15 dBm
Maximum Safe Input Level: +20 dBm per 5 nm, +30 dBm total

Input Return Loss[1]

With PC or HMS-10/HP Connector: > 14 dB + 2 times monochromator loss

Sweep Time (with functions auto-coupled)[2]

Maximum Sweep Rate	40 nm/50 ms	
Sweep Time Cycle	50 nm span, auto zero off	<180 ms
	50 nm span	<340 ms
	100 nm span	<400 ms
	full span	<1 s

Additional Specifications for the HP 71451A

Monochromator Insertion Loss

850 nm: <17 dB (1st order)
1300 nm: <7 dB
1550 nm: <10 dB
Maximum Input Power: +20 dBm per 5 nm, +30 dBm total

Monochromator Output (into 62.5 μm fiber)

Polarization Dependence[1]**, for Resolutions ≥0.2 nm**
1250 to 1600 nm: ±0.5 dB[3]
600 to 1700 nm: ±2.5 dB
Resolution Selections (FWHM): 0.08 nm and 0.1 to 10 nm in a 1,2,5 sequence
Resolution Accuracy for ≥0.5 nm, 1250 to 1600 nm: ±20%

Photodetector Input (in power meter mode)

Accuracy at −30 dBm[1] (ref to 1300 nm): ±0.25 dB
Maximum Safe Power Level: +20 dBm
1 dB Compression Level: ≥7 dBm
Scale Fidelity on Screen[5] **for ≤2 dBm Inputs:** ±0.25 dB with fixed reference level

Display Resolution:	0.01 dB	
	600 to 1700 nm	1250 to 1600 nm
Power Range:	+15 to −80 dBm	+15 to −90 dBm
Flatness[1] (for ≤ 3 dBm inputs):	±2.0 dB[3]	±0.4 dB

Transimpedance Input

Current Range: 0 to −10 mA
Maximum Current: ±10 mA
Maximum Voltage: ±10 V

Specifications: Optional Current Source

Current Output

Range: 0 to ±200 mA (source or sink)
Resolution: 50 μA steps

Pulse Mode

Pulse Range: 1 μs to 6.5 ms
Pulse Resolution: 100 ns
Duty Cycle Range: pulse width/1 s to 100%

General Specifications

Inputs/Outputs

Optical Output (HP 71451A): 62.5 μm fiber
Optical Input: 62.5 μm fiber, standard; 9 μm fiber, Opt 009
Optical Connectors: FC/PC standard; other interface adapters available
Rear Panel Connectors: SMB (electrical)

Size

222 mm H × 425.4 mm W × 526 mm D (8.74 in H × 16.75 in W × 20.7 in D)

Weight

HP 71450A, 71451A: 28 kg (61.6 lb)
HP 70950A, 70951A: 8 kg (17.6 lb)

Environmental

Temperature: 0° to +55° C (operational), −30° to +71° C (storage)
Shock and Vibration: Tested to MIL-T-28800D class 5, par. 3.7.4, 3.7.5.2&3
EMI: Conducted and radiated interference complies with CISPR Pub 11, FTZ 526/527/79, MIL-STD 461B part 7 CE03 (AF) and RE02

Power Requirements

Voltage: 100, 120, 220, 240 VAC (+5, −10%)
Maximum Power: 260 W max (350 VA max)
Frequency: 47 to 66 and 356 to 444 Hz

Ordering Information

	Price
HP 71450A Optical Spectrum Analyzer	$36,700
Opt 001 Built-in Programmable Current Source	+$1,200
Opt 002 Built-in White Light Source	$3,500
Opt 009 9 μm Input Connector	+$200
Opt 010 Delete FC/PC Connector Interface	−$130
Opt 512 1 MB Memory	+$515
HP 71451A Optical Spectrum Analyzer	$45,700
Opt 001 Built-in Programmable Current Source	+$1,200
Opt 002 Built-in White Light Source	$3,500
Opt 003 Swept PDL Kit	$7,100
Opt 009 9 μm Input Connector	+$200
Opt 010 Delete FC/PC Connector Interface	−$390
Opt 512 1 MB Memory	+$515
HP 70950A Optical Spectrum Analyzer Module	$26,000
Opt 001 Built-in Programmable Current Source	+$1,200
Opt 002 Built-in White Light Source	$3,500
Opt 009 9 μm Input Connector	+$200
Opt 010 Delete FC/PC Connector Interface	−$130
Opt 512 1 MB Memory	+$515
HP 70951A Optical Spectrum Analyzer Module	$35,000
Opt 001 Built-in Programmable Current Source	+$1,200
Opt 002 Built-in White Light Source	$3,500
Opt 003 Swept PDL Kit	$7,100
Opt 009 9 μm Input Connector	+$200
Opt 010 Delete FC/PC Connector Interface	−$390
Opt 512 1 MB Memory	+$515

Additional Interface Connectors

HP 81000AI Diamond HMS-10
HP 81000FI FC/PC
HP 81000JI D4
HP 81000KI SC
HP 81000SI DIN 47256
HP 81000VI ST
HP 81000WI Biconic

[1]With applied input fiber 9/125 μm
[2]Characteristic
[3]Temperature range 20° to 30° C
[4]Signal value ≥6 times the RMS noise value
[5]To within 15 dB of the sensitivity noise limit

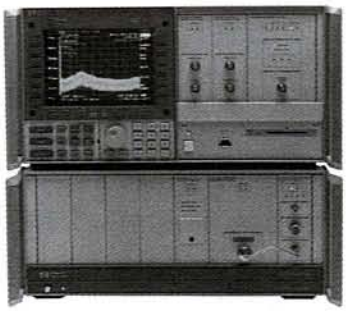
For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

LIGHTWAVE TEST EQUIPMENT

Lightwave Signal Analyzers and Accessories

HP 71400C, 71401C, 70810B, 83810B, 11980A

- Calibrated measurement of intensity modulation
- 22 GHz bandwidths
- RIN measurements to −165 dB/Hz
- Interferometer for laser linewidth and chirp measurements



HP 71400C with HP 70810B

HP 83810B

HP 11980A

DESIGNED FOR HP-IB SYSTEMS

DESIGNED FOR HP-IB SYSTEMS

HP 71400C and 71401C Lightwave Signal Analyzers

Calibrated Measurement of Intensity Modulation to 22 GHz

The HP 71400C combines a high-performance microwave spectrum analyzer with a wideband, sensitive optical receiver. This system measures modulated light on single-mode optical fibers from 100 kHz to 22 GHz. Optical modulation, noise, and average power are presented on a fully calibrated display. With the HP 11980A fiber-optic interferometer, the system measures linewidth. Together the lightwave signal analyzer, interferometer, and a gated source measure chirp and FM characteristics of distributed-feedback (DFB) and other single-line lasers.

This system is also a fully functional microwave spectrum analyzer with all the capability of the HP 71210C. Because the lightwave signal analyzer is part of the HP 70000 modular measurement system, its measurement capabilities can be expanded easily. For example, you can add a tracking generator module for modulation response measurements to 18 GHz. (See pages 88 to 96.)

The HP 71400C measures intensity modulation up to 22 GHz and operates over the wavelengths from 1200 to 1600 nm or, with Option 850, from 750 to 870 nm. It can achieve an optical sensitivity of better than −60 dBm. The analyzer also offers average-power measurement, displayed both as a real-time vertical power bar and as a digital readout. Full calibration of both average power and modulation power makes this system a reference receiver for measuring and characterizing optical detectors and receivers.

A program for relative intensity noise (RIN) measurement is included. This program subtracts thermal noise and shot noise components of a measurement and calculates the RIN of only the laser to −165 dB/Hz.

The HP 71401C has an upper frequency limit of 2.9 GHz and the same features as the HP 71400C. Both models provide lightwave optical or electrical units in watts or decibels, and microwave units for electrical spectrum analysis.

HP 70810B Lightwave Receiver Module

The HP 70810B lightwave section is a one-slot lightwave receiver module for the HP 70000 modular measurement system. The module has a built-in average power meter and attenuator, a wavelength range of 1200 to 1600 nm (750 to 870 with Option 850), a detected modulation bandwidth of 100 kHz to 22 GHz, and a built-in, 32-dB RF amplifier that gives an optical sensitivity of −60 dBm in a 10-Hz bandwidth. The HP 70810B also features both optical- and electrical-input capability. It can be used in standalone applications as a lightwave receiver housed in an HP 70000 mainframe. In this configuration, the electrical output is the detected intensity modulation in its amplified and uncorrected state.

If a lightwave module is ordered for an existing HP 70000 system that has an HP 70908 or 70904 RF (input) section, Option 20 offers extended system calibration and adjustment. In this case, the two modules are mated, tested, and calibrated together at the factory for optimum optical and electrical specification and amplitude flatness.

HP 83810B Portable Lightwave Signal Analyzer

This low-cost system has a wavelength range of 1200 to 1600 nm and bandwidths of 9 kHz to 22 GHz. It displays optical modulation power as a function of frequency and also measures and displays intensity modulation, distortion, and laser intensity noise. Maximum optical sensitivity is −54 dBm at 100 MHz and −39 dBm at 22 GHz. Frequency response is ±2.2 dB at 100 MHz and ±3.2 dB at 22 GHz. An optical marker function allows measurements to be expressed in optical or electrical units, logarithmic or linear. Frequency-response corrections and optical power are calculated automatically.

The HP 83810B consists of a fully functional HP 8593E portable microwave spectrum analyzer, the HP 11982A amplified lightwave converter, the HP 11982A Option 001 lightwave frequency-response corrections and menus, an interface cable, and a type-N-to-SMA adapter.

The lightwave converter improves system sensitivity with conversion gain of 300 V/W. The frequency response corrections allow you to observe and measure changes in noise floor and distortion products when a laser is modulated, thus enabling you to predict the effects of laser noise. Adding the HP 11980A fiber-optic interferometer allows you to make linewidth, chirp, and frequency modulation measurements of single-line lasers.

HP 11980A Fiber-Optic Interferometer

This accessory for use with any HP lightwave signal analyzer is a Mach Zehnder interferometer of fixed delay for measuring and characterizing single-linewidth lasers. Using a technique developed by Hewlett-Packard, the HP 11980A and an HP 71400 Series or HP 83810B lightwave signal analyzer measure chirp and FM components on DFB lasers. They also make traditional measurements of laser linewidth. Together, the interferometer, lightwave signal analyzer, and a gateable RF source permit the display of a true power spectrum of single-frequency lasers, including intensity modulation linewidth and components of chirp caused by the intensity modulation. Option 005 replaces the standard 0.76 km of delay with 5.2 km to measure laser linewidth down to 30 kHz.

Specifications

HP 71400C

(For general analyzer and electrical-mode specifications, refer to data sheets for the HP 71210C.)
Wavelength Range: 1200 to 1600 nm
Input return Loss: >35 dB total, >40 dB internal
Frequency
Frequency range: 100 kHz to 22 GHz
Span: 1 Hz to 22 GHz plus 0 Hz
Amplitude (at 25° C)
Maximum input average power: +30 dBm (optical)
Modulated power: +15 dBm (optical)
Average power accuracy (at 1300 or 1550 nm): ±0.65 dB (optical), ±0.5 nW, ± connector losses
Modulated power accuracy at 100 MHz (relative to average power): ±1.0 dB (optical)
Frequency response (relative to 100 MHz): 100 kHz to 22 GHz, ±1.0 dB (optical)
Displayed average optical noise level, optical dB (10 Hz Res BW, 0 dB input attenuation): −51 dBm, 100 kHz to 1 MHz; −57 dBm, 1 to 10 MHz; −62 dBm, 10 to 100 MHz; −66 dBm, 100 MHz to 8 GHz; −64 dBm, 8 to 16 GHz; −60 dBm, 16 to 22 GHz
Inputs
Optical: Choice of single-mode fiber optic input connectors (see Ordering Guide)
Electrical: SMA for optical bypass, 100 Hz to 22 GHz (see HP 71210C data sheet for other system inputs)

HP 71401C

Specifications for the HP 71401C are identical to those of the HP 71400C with the following exception:
Frequency Range: 100 kHz to 2.9 GHz

HP 71400C/71401C Option 850

Specifications for these systems are identical to those of the standard systems with the following exceptions:
Wavelength Range: 750 to 850 nm
Noise Equivalent Power: Exactly 4 dB greater than standard system

HP 83810B

Optical
Wavelength range: 1200 to 1600 nm
Input return loss (characteristic): >27 dB
Frequency Range: 9 kHz to 22 GHz
Amplitude
Optical frequency response, absolute, 10 dB attenuation, 20 to 30° C

9 kHz to 12.8 GHz	+2.2 dB
12.4 to 19.4 GHz	+3.0 dB
19.1 to 22.0 GHz	+3.2 dB

Displayed average optical noise level, characteristic, 1 kHz RBW, 30 Hz VBW, 0 dB attenuation

400 kHz to 6.4 GHz	−54 dBm
6.0 to 12.8 GHz	−48 dBm
12.4 to 19.4 GHz	−44 dBm
19.1 to 22 GHz	−39 dBm

Harmonic Distortion: >70 dB below fundamental with modulated power < −30 dBm
Maximum Safe Optical Input Power, Average: 10 mW
Maximum Operating Optical Input Power, Peak: 1.5 mW
Optical Input Connectors: Single-mode fiber connectors such as Diamond HMS-10/HP, FC/PC, ST, Biconic, DIN

HP 70810B

Optical
Wavelength range: 1200 to 1600 nm
Responsivity: Determined for each instrument to ±20%; typical value: 1200 V/W
Input return loss: >35 dB total, >40 dB internal
Frequency
Frequency range: 100 kHz to 22 GHz
Amplitude
Maximum input average power: +30 dBm (optical)
Modulated power: +15 dBm (optical)
Frequency response, corrected, relative to 100 MHz: 100 kHz to 2.9 GHz, ±2.0 dB; 2.9 to 22 GHz, ±5.0 dB
Uncorrected: Typically < 25 dB roll-off 100 kHz to 22 GHz
Noise equivalent power (optical dBm/$\sqrt{\text{Hz}}$): −55, 100 kHz to 10 MHz; −66, 10 to 100 MHz; −70, 100 MHz to 8 GHz; −68, 8 to 16 GHz; −64, 16 to 22 GHz
Inputs
Optical: Choice of single-mode fiber optic input connectors (see Ordering Guide)
Electrical: SMA for optical bypass

HP 70810B Option 850

Specifications for this module are identical to those of the standard HP 70810B with the following exceptions:
Wavelength Range: 750 to 870 nm
Responsivity, Characteristic: 500 V/W nominal value at 100 MHz
Amplitude
Noise equivalent power (optical dBm/$\sqrt{\text{Hz}}$): −51, 100 kHz to 10 MHz; −62, 10 to 100 MHz; −66, 100 MHz to 8 GHz; −64, 8 to 16 GHz; −60, 16 to 22 GHz

HP 11980A

This accessory is a Mach Zehnder interferometer for use with the HP 71400C, 71401C, and 83810B.
Wavelength Range: 1250 to 1600 nm
Optical Insertion Loss: <8 dB (optical) at 1300 and 1550 nm
Delay Time: Typically 3.5 μsec; Opt 005, 25 μsec
Inputs
Optical: Choice of Diamond*, PC/FC, ST, Biconic, or DIN single-mode fiber connectors (see Ordering Information)

Ordering Information

	Price
HP 71400C Lightwave Signal Analyzer, 100 kHz to 22 GHz	$104,950
Order must also include one of the connector options, 011 to 015, listed below.	
Opt 850 750 to 870 μm Wavelength	$0
HP 71401C Lightwave Signal Analyzer, 100 kHz to 2.9 GHz	$75,900
Opt 850 750 to 870 μm Wavelength	$0
HP 83810B Lightwave Signal Analyzer, 9 kHz to 22 GHz*	$40,000
Opt 010 Built-In Tracking Generator, 300 kHz to 2.9 GHz	+$6,500
Opt 023 Substitute RS-232 for HP-IB	+$500
Opt 094 Replace HP 8593E with HP 8594E	−$12,300
Opt 095 Replace HP 8593E with HP 8595E	−$6,270
Opt 110 Delete FC/PC Connector	−$130
Opt 130 Narrow Resolution Bandwidths (30 Hz to 300 Hz)	+$995
Opt 301 TV Sync Trigger, Fast Time Domain Sweeps, AM/FM Demodulator	+$1,500
HP 70810B Lightwave Section, 100 kHz to 22 GHz	$20,300
Order must also include one of the connector options, 011 to 015, listed below.	
Opt 850 750 to 870 Wavelength	$0
Opt 020 System Adjustment and Calibration (use HP 71400A specifications)	+$2,060
Opt 098 or 099 System LO Firmware Upgrade	$0
HP 70810AB Upgrade Kit	$1,030
HP 11980A Fiber-Optic Interferometer	$6,920
Order must also include one of the connector options, 011 to 015, listed below.	
Opt 005 25 μsec Delay	$3,110

Connector Options for the HP 71400C, 71401C, 70810B, and 11980A

Opt 011 Diamond HMS-10/HP Connector Interface	$0
Opt 012 FC/PC Connector Interface	$0
Opt 013 DIN 47256 Connector Interface	$0
Opt 014 ST Connector Interface	$0
Opt 015 Biconic Connector Interface	$0

*HP 8593E spectrum analyzer, Opt 021 HP-IB interface; HP 11982A amplified lightwave converter, Opt 001 frequency response correction/menus, Opt 012 FC/PC connector; interface connector; cable.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

LIGHTWAVE TEST EQUIPMENT

dc-Coupled Lightwave Converters

HP 11982A, 83440B/C/D

- dc-coupled optical-to-electrical converters
- Bandwidths from dc to 32 GHz
- Fast pulse response
- Low pulse aberrations
- High sensitivity
- Time- and frequency-domain measurements

HP 83440 Series

HP 11982A

dc-Coupled Optical Converters

Optical communication systems that incorporate time-domain instruments often require optical-to-electrical (O/E) converters in order to make optical pulse and wavelength measurements. Whether to use an unamplified or an amplified O/E converter depends on the measurement application. If signal power levels are high enough, a simple photodiode-only converter such as the HP 83440 offers well-behaved pulse response performance. To measure low power signals, an RF-amplified O/E converter such as the HP 11982A may be required.

In frequency-domain applications, O/E converters allow frequency-domain instruments such as network and spectrum analyzers to accept optical signals for basic lightwave measurements. Users can measure, quantify, and model modulation characteristics such as spectral purity, harmonic content, and noise spectral density.

HP 83440 Series Unamplified Lightwave Converters

The HP 83440 Series offers a variety of bandwidth options for converting incoming modulated optical power or optical pulses into electrical current. Ideal for optical pulse parameter measurements, these fully integrated hermetic InGaAs photodetectors feature very low noise and pulse aberrations; fast, accurate O/E conversion; and a standard user interface compatible with most electrical instruments. The converters mount directly on test-instrument front panels. Simple internal structure ensures low signal distortion for improved output-signal fidelity, a novel optical launch ensures low optical reflection, and integral dc-bias regulation ensures stable frequency response performance.

The HP 83440 Series can be used with high-speed digitizing oscilloscopes to accurately measure rise and fall time, overshoot, undershoot, ringing, peak power (pulse amplitude), pulse width, amplitude noise, and extinction ratio. The HP 83440 Series also makes excellent mask measurements when sufficient optical power is available.

HP 11982A Amplified Lightwave Converter

A wide-bandwidth, sensitive O/E converter for characterizing lightwave systems and components, the HP 11982A combines a PIN photodetector with a low-noise dc-coupled preamplifier to create a general-purpose front end. It covers wavelengths from 1200 to 1600 nm and bandwidths from dc to 15 GHz. With 300 V/W conversion gain and 0.05 percent input optical reflections, it significantly improves the sensitivity of the measurement system. The converter comes with a calibration chart of instrument-specific data for making corrected frequency response measurements.

The HP 11982A can be used with an electrical spectrum analyzer to display optical modulation power as a function of frequency. Intensity modulation, distortion, and laser intensity noise are also measured. The Option 001 memory card programs an HP 8590 E Series spectrum analyzer with frequency response corrections and menus for easy, accurate lightwave measurements to 22 GHz. Using this converter with the HP 11980A interferometer, you can measure linewidth (with a gateable modulation source), chirp, and frequency modulation of single-line lasers.

Combine the HP 11982A with an HP 54120 Series digitizing oscilloscope to make optical eye-pattern and impulse-response measurements. Use the results to verify optical and optoelectronic components and optical system level performance.

Specifications

	HP 83440B	HP 83440C	HP 83440D	HP 11982A
Wavelength	1000 to 1600 nm			1200 to 1600 nm
Bandwidth (optical)	6 GHz	20 GHz	32 GHz	dc to 15 GHz
FWHM* pulse width	74 ps	22 ps	14 ps	29.4 ps
Conversion gain	35 V/W	35 V/W	15 V/W	300 V/W, nominal
Noise equivalent power	$<18\ pW/\sqrt{Hz}$			$<30\ pW/\sqrt{Hz}$
Maximum operating optical power	2 mW peak			1.5 mW peak
Maximum safe Optical input power	10 mW peak			10 mW average
Input optical reflection	<0.05% (>33 dB)			0.05%

*Full Width Half Maximum, the pulse width at one-half the maximum deflection

Ordering Information	Price
HP 11982A Amplified Lightwave Converter	$13,410
Opt 001 Frequency Response Correction/Menus	+$875
HP 83440B Unamplified Lightwave Converter	$4,500
HP 83440C Unamplified Lightwave Converter	$7,500
HP 83440D Unamplified Lightwave Converter	$12,000
Connector Options (for all models)	
Opt 011 Diamond HMS-10/HP	$0
Opt 012 FC/PC	$0
Opt 013 DIN 47256	$0
Opt 014 ST	$0
Opt 015 Biconic	$0

- Conversion efficiency and offset voltage optimized for use with oscilloscopes
- Low distortion for accurate pulse and eye diagram measurements
- dc coupled, stable output for accurate extinction ratio measurements
- Bessel-Thompson filters for conformance testing of SONET OC-3 and OC-12 (SDH STM-1, STM-4) data rates
- Small, convenient package

NEW

HP 83441A, 83441B, and 83442A Lightwave Receivers

Optical pulse and eye diagram measurements become easy with the new Hewlett-Packard 83441A, 83441B, and 83442A lightwave receivers. Designed especially for use with high-speed single shot and sampling oscilloscopes, these receivers provide the sensitivity and bandwidth necessary for pulse parameter measurements on SONET/SDH optical waveforms at data rates up to 622 Mb/s (OC-12, STM-4).

The HP 83441A and 83441B are reference receivers designed especially for SONET/SDH production test applications. The HP 83441A includes an internal 155 Mb/s fourth order Bessel-Thompson filter. The HP 83441B includes a 622 Mb/s filter. Both filters are designed with 0.75 bit rate cutoff frequencies per CCITT G.957 specifications.

To ease the problem of conformance testing, optional mask measurement software for use with HP 54120 series oscilloscopes can be specified (see description below).

The HP 83442A is designed for applications where internal filters are inappropriate. Because of its wide dc to 1 GHz bandwidth, one HP 83442A is a versatile component for use in pulse parameter measurement systems. For conformance testing, attach the appropriate filter from the HP 87441 family of fourth order Bessel-Thompson filters. Changing from 155 Mb/s to 622 Mb/s and back is as easy as removing and replacing a single filter.

SONET/SDH Mask Measurement Software

Conformance testing of SONET and SDH transmitters in both manufacturing and development environments is easy with the optional mask measurement software. Designed for use with HP 54120 series oscilloscopes and run from an external controller, this software can be used with many optical-to-electrical converters including the HP 83440 family and the 11982A, as well as the HP 83441/2 family. It automatically scales and positions SONET/SDH masks, counts mask hits, measures extinction ratio, and makes pass/fail determinations. For convenience, all controls are accessed directly from the oscilloscope front panel once the program is running.

Bessel-Thompson Filters

For conformance testing SONET and SDH signals, standards such as CCITT G.957 specify a reference receiver with a fourth order Bessel-Thompson frequency response whose 3-dB bandwidth is 0.75 times the bit rate. Such a filter provides a standard frequency response that reduces the impact of higher order distortion and noise.

These filters, included internally in the HP 83441A/B, are also available separately for use with the HP 83442A and other reference receivers. The HP 87441D filter is especially useful in conjunction with the HP 11982A lightwave receiver for conformance testing of 2.488 Mb/s signals. Other filters in this family include the HP 87441A for 155 Mb/s signals, and HP 87441B for 622 Mb/s signals.

Product Specifications	HP Model		
	83441A	83441B	83442A
Frequency response (−3 dBe, MHz)	116	466	1000
Wavelength range (nM)	1200–1600	1200–1600	1200–1600
Typical conversion gain (V/W) 1300 nM 1550 nM	 750 750	 750 750	 750 750
Saturated optical input power (dBm)	−5	−5	−5
Equivalent optical input noise (μW)	0.15	0.5	0.8
Typical offset voltage drift (mV/° C)	0.05	0.05	0.05
Overshoot/undershoot (%) Settling time (ps)	2	2	10 200

Ordering Information

	Price
HP 83441A SONET/SDH Reference Receiver (155 Mb/s)	$3,500
HP 83441B SONET/SDH Reference Receiver (622 Mb/s)	$3,500
HP 83442A dc-1 GHz Lightwave Receiver	$3,000
Note: All HP 83441 orders must specify an optical connector option.	
Opt 011 Diamond HMS-10/HP	$0
Opt 012 FC/PC Connector	$0
Opt 013 DIN 47256 Connector	$0
Opt 014 ST Connector	$0
Opt 100 Mask Measurement Software for HP 54120 Series Oscilloscopes	$750

Related Accessories:

HP 87441A 155 Mb/s SDH Filter	$500
HP 87441B 622 Mb/s SDH Filter	$500
HP 87441D 2488 Mb/s SDH Filter	$500

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

RF COMMUNICATIONS TEST EQUIPMENT
Leading the Way in Digital Testing

RF Communications Test

Hewlett-Packard offers a wide selection of products for the RF communications industry. From analog to digital, these products cover R&D, manufacturing, and support needs. The following tables show products for the new digital technologies.

RF Digital Communications Measurements

	HP 8922A GSM RF Test Set	HP 8922B GSM RF Test Set	HP 8922G GSM RF Test Set	HP 83212A GSM Test Software	HP 8953DT Automated Test System	HP 8657J π/4 DQPSK Signal Generator	HP 8657B Option 022 0.3 GMSK Mod Signal Generator	HP 8657D π/4 DQPSK Signal Generator	HP 87804 Vector Signal Generator w/HP 11846B π/4 DQPSK IQ Generator	HP 11835A Option 001/002 Data Buffer	HP 11836A 0.3 GMSK Mod Meas Software	HP 70912A/B Downconverter Module	HP 11847A/B/C π/4 DQPSK Mod Meas Software	HP 71150C/71250C GSM TX Tester	HP 8590 Series Portable Spectrum Analyzer	HP 8560 Spectrum Analyzer	HP 53310 Option 031 Modulation Domain Analyzer	HP 11759C RF Channel Simulator	HP 8990A Peak Power Analyzer	HP 37900D Signaling Test Set	HP 3070 Board Test System
TXRX Frequency Bands	X	X	X	X	X									X	X	X					
TXRX Channels and Numbering	X	X	X	X	X									X	X						
TXRX Frequency Hopping	X	X	X	X													X				
Timebase Tuning Range	X	X	X	X													X				
TX In-Channel																					
TX Peak Trans. Power	X	X	X	X	X									X	X				X		
TX Amplitude Envelope	X	X	X	X						X	X	X	X	X	X				X		
TX Phase and Frequency Error	X	X	X	X	X					X	X	X	X			X					
Spectrum Measurements																					
TXRX Spurious Emissions	2	2	2										X	X	X						
TX RF Spectrum due to Switching	X	X	X	X									X	X	X						
TX RF Spectrum due to Modulation	X	X	X	X									X	X	X						
RX In-Channel																					
RX Sensitivity	3	3	X	X	X	3	3	3	5												
RX Usable Input Level Range	3	3	X	X	X	3	3	3	5												
RF Out-of-Channel																					
RX Co-channel Rejection	3	3	4		X	3	3	3	5	X											
RX Adjacent Channel Rejection					X	3		3	5												
Same Frequency/Different Timeslot	3	3	4																		
Different Frequency/Same Timeslot	3	3	4		X		3	3		X											
RX Intermodulation Rejection			4		4	3	3	3	5	X											
RX Blocking and Spurious Responses			4																		
Fading Simulation																		X			
Signaling																					
Monitor/Analyze/Emulator																				X	
Analog ICT[1]																					X
Digital ICT[1]																					X
Cluster Functional Test																					X

[1] In-circuit test [2] Limited spurious measurement capability [3] RF source only [4] Need additional RF source
[5] Requires HP 11846A/B premodulating filter for GSM, NADC, JDC & PHP systems (RF source only)

RF Digital Communications Systems

	HP 8922A GSM RF Test Set	HP 8922B GSM RF Test Set	HP 8922G GSM RF Test Set	HP 83212A GSM Test Software	HP 8953DT Automated Test System	HP 8657A H42 CT2 Signal Generator	HP 8657J π/4 DQPSK Signal Generator	HP 8657B Option 022 0.3 GMSK Mod Signal Generator	HP 8657D π/4 DQPSK Signal Generator	HP8664A Opt H10 DECT Mod. Signal Generator	HP 87804 Vector Signal Generator w/HP 11846B π/4 DQPSK IQ Generator	HP 11835A Option 001/002 Data Buffer	HP 11836A 0.3 GMSK Mod Meas Software	HP 70912A/B Downconverter Module	HP 11847A/B/C π/4 DQPSK Mod Meas Software	HP 71150C/71250C GSM TX Tester	HP 8590 Series Portable Spectrum Analyzer	HP 53310 Option 031 Modulation Domain Analyzer	HP 11759C RF Channel Simulator	HP 8990A Peak Power Analyzer	HP 37900D Signaling Test Set	HP 3070 Board Test System
GSM	X	X	X	X				X			X	X	X	X		X	X	X	X	X	X	X
NADC					X				X		X	X		X	A		X	X	X	X	X	X
JDC									X		X	X		X	B		X	X	X	X	X	X
DECT										X								X	X	X		X
CDMA																			X	X		X
DCS1800	X[1]	X[1]	X[1]	X[1]				X				X	X	X		X		X	X	X	X	X
PHP (JDCT)							X				X	X		X	C			X	X	X		X
CT2-CIA						X				X							X	X	X	X		X
CT3																		X	X	X		X

[1] with HP 83320A Translator

HP 8920A RF Communications Test Set

The HP 8920A is a full-feature, one-box test set designed to meet the communication test needs of both service and manufacturing environments. Combining 22 complete instruments, the HP 8920A offers the full functionality needed in testing land mobile radios, cellular phones, and communications systems.

Test and Troubleshoot Faster

The HP 8920A decreases standard test and troubleshooting time by simplifying standard measurement tasks and providing more needed capability in one box. Transmitters and receivers are simply characterized with single-key RX, TX, and duplex tests. All measured results are displayed on a single screen as either digital measurements or analog bar graphs. All settings and measurements are easily accessed and changed using the front-panel knob, and all settings can be saved in nonvolatile save/recall register for future access.

Minimize Production Test Costs

The HP 8920A's built-in I-BASIC Computer combined with the HP 11807A Radio Test Software provides a complete solution for automated radio test in the production environment. Production costs are lowered by increasing throughput with decreased test times and automating measurements without the added expense of an external controller. Test equipment costs are also reduced as the HP 8920A allows you to replace several individual instruments with one.

Standard Features Summary

- Synthesized AM/FM signal generator to 1 GHz
- AM/FM modulation analyzer
- Duplex offset generator
- SSB demodulator
- RF power meter
- RF frequency counter/frequency error meter
- Audio frequency counter
- AF power meter
- ac/dc voltmeter
- SINAD meter
- Distortion meter
- Two variable audio sources
- Digital oscilloscope
- Built-in I-BASIC controller
- 2 μV sensitivity (typically <1 μV)

Optional Features Summary

- Spectrum analyzer and tracking generator
- Signaling source and analyzer
- Cellular-phone test capability
- Function generator
- dc current meter
- HP-IB/RS-232 interface buses for remote programming
- Radio test software
- Radio interface card
- Clearchannel LTR[®1] and EDACS[®2] trunked radio test software
- AMPS cellular base station test software

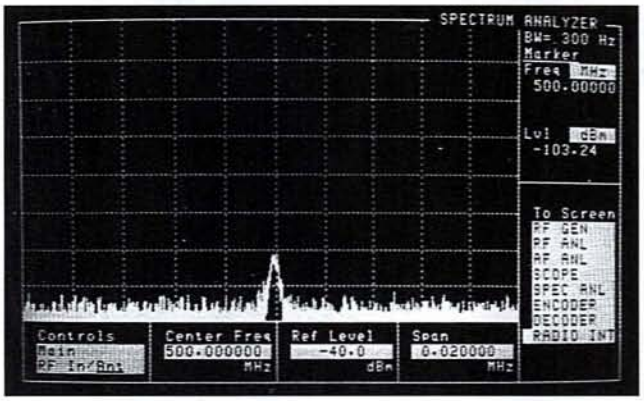
RF COMMUNICATIONS TEST EQUIPMENT

RF Communications Test Set (cont'd)

HP 8920A

Spectrum Analyzer with Tracking Generator

The HP 8920A's optional synthesized spectrum analyzer measures signals from 400 kHz to 1 GHz with variable spans from 5 kHz to 1 GHz (full span). Display resolution is selectable from 1, 2, or 10 dB per division. The tuneable marker provides automatic readout of frequency and amplitude, or of relative frequency or amplitude from a reference. The tracking generator included with the spectrum analyzer allows for swept characterization of devices with fully settable amplitude and sweep spans (to 1 GHz).



Sensitive Receiver: 2 μV sensitivity (typically <1 μV), available through the ANT IN port, allows for off-the-air monitoring of low-level signals. For measuring high-power signals, the HP 8920A can accept 100 W intermittently (for 10 seconds) or 60 W continuous.

Signaling Encoder and Decoder

The optional signaling encoder and decoder support all common signaling formats, including tone sequential, digital paging, DTMF, trunking, and cellular signaling. Common standards are list-selectable and easily modified for different user formats. The decoder displays the tone or digital sequence transmitted, and the duration of the tone or tone pair. For digital paging transmitters, the decoder will display the address/code, the message, and the transmission rate.

HP 11807A Radio Test Software

The HP 11807A is an easy-to-use software solution for automatic testing of radio receivers and transmitters. Running on the HP 8920A's built-in I-BASIC computer, the HP 11807A offers a complete selection of tests for land mobile radios, cellular phones, and communication systems. Its flexibility and modularity allows the user to select and change test sequences, test parameters, and pass/fail limits without programming expertise. All test results are displayed on the screen and can be documented with hard-copy printouts when an external printer is added.

The HP 11807A system support tests (Option 100) give technicians automated test capability for commonly performed tasks on communications systems. System support tests include cable-fault location, intermodulation-products calculation, frequency scanning, and field-strength measurement.

Cellular-Phone Testing

The HP 8920A tests the most common cellular phones when the signaling option (Option 004) is combined with the HP 11807A software for cellular tests. Three levels of phone testing are available: manual phone troubleshooting, quick functional checkout, and full parametric testing to system specifications. Cellular formats supported include AMPS, NAMPS, TACS, NTACS, NMT 450, NMT 900, and JTACS. In addition to phone testing, the features and performance of the HP 8920A make it an ideal solution for base station test. Channels are easily characterized using the duplex test function, and duplexers and combiners are easily tuned using the spectrum analyzer with the tracking generator.

Trunked Radio Testing

Three HP 11807A software options are available for testing trunked mobile radios. The options support LTR*[1], EDACS[2], and MPT 1327 trunked radio equipment with a variety of automated tests available to the user.

Through software control, the HP 8920A will test the ability of a radio to establish a link on a trunked system and can retrieve trunking parameters programmed into a mobile radio. The user can choose from manual operations or automated test sequences for full characterization. Detailed printouts of the radio's performance, with failures highlighted, are output when a printer is used with the HP 8920A. (HP 8920A Option 003 is required for printouts.)

HP 8920A Options 004 and 005 are required for trunked system tests with HP 11807A software.

Specifications Summary

Signal Generator

RF Frequency
- **Range:** 250 kHz to 1 GHz
- **Accuracy and stability:** Same as reference oscillator ±0.015 Hz

Output
- **Range:** −137 to −19 dBm into 50 Ω (RF in/out)
  −127 to +7 dBm into 50 Ω (duplex out)
- **Level accuracy:** ±1.8 dB (RF in/out)
  ±1.5 dB (duplex out)
  Typically ±1.0 dB for all levels

Modulation

FM (ac/dc-coupled)
- **FM deviation:** (Rates >25 Hz) 100 kHz; 0.25 to 250 MHz
  50 kHz; 250 to 500 MHz
  100 kHz; 500 to 1000 MHz
- **FM rate:** dc to 75 kHz (3 dB BW)
- **FM accuracy:** ≤10 kHz dev: ±7.5% of setting ±50 Hz
  >10 kHz dev: ±7.5% of setting ±500 Hz

AM
- **AM depth:** 0% to 90%
- **AM rate:** 20 Hz to 25 kHz (3 dB BW)
- **AM accuracy:** ≤10% AM: ±5% of setting ±1.0% AM
  >10% AM: ±5% of setting ±1.5% AM

Audio Generator

Frequency Range: dc to 25 kHz
Output Level Range: 0.1 mV to 4 V rms
Output Impedance: <1 Ω

RF Analyzer

RF Frequency Measurement
- **Measurement range:** 400 kHz to 1 GHz
- **Accuracy:** ±1 Hz plus timebase accuracy

RF Power Measurement
- **Measurement range:** 1 mW to 60 W continuous
  100 W for 10 s/min
  40 μW to 2.4 W continuous, 4 W for 10 s/min (Opt 007)
- **Accuracy:** ±10% of reading ±1 mW (for inputs ≥200 mW)

FM Measurement
- **Frequency range:** 5 to 1000 MHz
- **Deviation:** 20 Hz to 75 kHz
- **Sensitivity:** 2 μV (typically <1 μV)
- **Accuracy:** ±4% of reading plus residual FM and noise contribution
- **Residual FM and noise:** <20 Hz (0.3 to 3 kHz rms)

AM Measurement
- **Frequency range:** 10 to 1000 MHz
- **Depth:** 0% to 95%
- **Accuracy:** ±5% of reading ±1.5% AM

SSB Measurement
- **Frequency range:** 400 kHz to 1 GHz
- **Bandwidth (3 dB):** 20 Hz to 70 kHz

AF Analyzer

Frequency Measurement
- **Measurement range:** 20 Hz to 400 kHz

Accuracy: ±0.02% plus resolution plus reference oscillator accuracy

ac/dc Voltage Measurement
ac range: 0 to 30 Vrms
ac accuracy: ±3% of reading ±150 μV rms
dc range: 100 mV to 42V
dc accuracy: ±1.0% of reading ±45 mV
Input impedance: Switchable between 600 Ω and 1 MΩ
SINAD/Distortion Measurement
Fundamental frequency: 1 kHz ±5 Hz
Distortion range: 0.1% to 100%
Accuracy: ±1 dB (0.5 to 100% distortion)
SINAD range: 0 to 60 dB
Accuracy: ±1 dB (0 to 46 dB SINAD)
Audio Filters
Standard: 50 Hz HPF, 300 Hz HPF, 300 Hz LPF, 3 kHz LPF, 15 kHz LPF, 750 μs de-emphasis, 1 kHz notch
Optional: C-Message, CCITT, 400 Hz HPF, 4 kHz BPF, 6 kHz BPF

Oscilloscope Specifications

Bandwidth: (3 dB): 2 Hz to 50 kHz
Scale/Division: 10 mV to 10V
Time/Division: 10 μs to 100 ms

Spectrum Analyzer Specifications (Option 002)

Frequency Range: 400 kHz to 1 GHz
Frequency Span/Resolution Bandwidth (coupled):

Span	Bandwidth
≤50 kHz	300 Hz
≤300 kHz	1 kHz
≤5 MHz	3 kHz
≤50 MHz	30 kHz
>50 MHz	300 kHz

Plus full span capability
Display Range: 80 dB

Tracking Generator (Included with Option 002)

Frequency Range: 400 kHz to 1 GHz
Frequency Offset: Frequency span endpoints ± frequency offset cannot be <400 kHz or >1 GHz
Output Level Range: Same as signal generator
Sweep Modes: Normal and inverted

Signaling Encode/Decode (Option 004)

CDCSS, DTMF, 1 TONE, 2 TONE, 5/6 TONE SEQUENTIAL (EIA, CCITT, CCIR, ZVEI, EEA, Euro, NATEL), RPC1 (Pocsag), GOLAY, AMPS, NAMPS, TACS, NTACS, NMT-450, NMT-900

dc Current Meter (Option 003)

Measurement Range: 0 to 10 A (usable to 15 A)
Accuracy: The greater of: ±10% of reading or ±30 mA

Reference Oscillator Specifications

TCXO (Standard)
Temperature: 1 ppm (0 to +55° C)
Aging: <2 ppm/year
OCXO (Opt 001)
Temperature: 0.05 ppm (0 to +55° C)
Aging: <0.5 ppm/year (<1 ppm in 1st year)

Remote Programming (Option 003)

HP-IB: Hewlett-Packard's implementation of IEEE Standard 488.2
RS-232: Three-wire RJ-11 connector used for serial data in and out
Baud Rates: 300, 1200, 2400, 4800, 9600, and 19200 selectable

General Specifications

Size: 330 mm W × 188 mm H × 456 mm D
Weight: 15.9 kg (35 lbs)
CRT Size: 7 × 10 cm
Operating Temperature: 0 to + 55° C
ac: 100/120/220/240 V, 48 to 440 Hz, approx. 80 watts
dc: 11 to 28 V, approx 120 watts
Leakage: *At Signal Generator output frequency and level <40 dBm typical leakage is <0.5 μV induced in a resonant dipole antenna 1 inch from any surface except the rear panel. Spurious leakage levels are typically <1 μV in a resonant dipole antenna.*

Ordering Information

	Price
HP 8920A RF Communications Test Set	$13,800
Opt 001 High-Stability Timebase	$600
Opt 002 Spectrum Analyzer with Tracking Generator	$1,750
Opt 003 HP-IB/RS-232/dc Current Measurement	$600
Opt 004 Tone/Digital Signaling	$600
Opt 005 256 k RAM Memory	$500
Opt 007 Low Level RF Power Measurement	$0
Opt 010 400 Hz High-Pass Filter	$300
Opt 011 CCITT Weighting Filter	$300
Opt 012 4 kHz Bandpass Filter	$300
Opt 013 C-Message Weighting Filter	$300
Opt 014 6 kHz Bandpass Filter	$600
Opt 020 Radio Interface Card	$2,000
Opt 908 Rack Flange Kit (5061-9677)	$400
Opt 910 Extra Operating/Quick Reference Assembly Level Repair Manuals (08920-90010, 08920-90012, 08920-90036)	$600 ☎
Opt 915 Assembly Level Repair Manual (08920-90036)	$250
Opt W30 Three-Year Warranty	$335
HP 11807A Radio Test Software (requires Opt 005 on HP 8920A)	
Opt 001 North American FM Tests	$500
Opt 002 European PM Tests	$500
Opt 003 AM Tests	$500
Opt 004 AMPS/EAMPS/NAMPS Cellular Tests	$1,500
Opt 005 TACS/ETACS/NTACS Cellular Tests	$1,500
Opt 006 NMT Cellular Tests	$1,500
Opt 007 JTACS Cellular Tests	$1,500
Opt 010 LTR[1] Trunked Radio Tests	$1,000
Opt 011 EDACS[2] Trunked Radio Tests	Contact HP
Opt 012 MPT 1327 Trunked Radio Tests	Contact HP
Opt 100 System Support Tests	$75
Optional Accessories	
08920-61060 Antenna	$30
08920-61059 Microphone	$50
08920-80027 DC Battery Pack (24 V)	$150
08920-80028 Battery Charger	$250
08920-90034 IBASIC Reference/HP 8920A Programming Manual	$113 ☎
08920-90036 Service Kit	$250 ☎
08920-61061 Connector Kit	$50
HP 85700A 32 Kbyte SRAM Memory Card	$100
HP 85702A 128 Kbyte SRAM Memory Card	$175
HP 85704A 256 Kbyte SRAM Memory Card	$350
HP 85705A 512 Kbyte SRAM Memory Card	$525

☎ For off-the-shelf shipment, call 800-452-4844.

Available Literature	Ref #
HP 8920A Technical Data Sheet	5091-4428
Service Applications/Brochure	5952-2797
Manufacturing Application/Brochure	5952-2796
Cellular Applications/Brochure	5091-0902
HP 11807A Technical Data Sheet	5091-5330

[1]LTR is a registered trademark of E.F. Johnson Company
[2]EDACS is a trademark of Ericsson GE Mobile Communications, Inc.

RF COMMUNICATIONS TEST EQUIPMENT

GSM Test Sets

HP 8922A, 8922B, 8922G, 83212A

- Complete, one-box GSM mobile-station tester
- Designed to minimize production costs
- Full-featured "tool kit" of instruments
- GSM base-station tester
- Fast, one-key GSM measurements
- Built-in I-BASIC controller

HP 8922B

HP 8922A/B/G GSM Test Sets

The HP 8922A, 8922B, and 8922G are integrated test solutions for the production of GSM radios. These test sets are based on a common, expandable platform. Hewlett-Packard is working on new test sets based on this platform to meet your expanding digital radio measurement needs. The HP 8922A is a toolbox with the necessary hardware to test the RF characteristics of GSM radios. For base-station testing, the HP 8922B builds on this platform by adding a large memory and reference section to provide baseband data patterns for bit-error-rate (BER) testing. The HP 8922G is a stand-alone GSM mobile station tester. It adds bit-error-rate testing and signaling capability to the performance of the HP 8922A to fully test GSM mobile radios without additional equipment.

Minimize Production Testing Costs

Fast, accurate testing is crucial to producing competitive GSM radios. Because testing is a critical success item, the cost associated with testing a high-quality radio is a substantial component of the final production cost. The HP 8922 is carefully tuned to provide optimal measurement speed without sacrificing performance. Key measurements, such as phase and frequency error, utilize dedicated digital signal-processing hardware for high throughput. To facilitate measurements, the coherent data demodulation mode recovers and outputs the transmitted data from a timeslot every frame (1 timeslot/frame). In addition, the HP 8922G adds bit-error-rate capability. All measurements in the HP 8922 have been crafted in a similar manner to address the speed requirements of the GSM radio production market.

GSM Radio Test Solutions

The HP 8922A contains a complete set of instrumentation for testing the RF sections of GSM radios. In addition to the frequency-agile 0.3 GMSK RF generator, the RF analyzer has an agile local oscillator, coherent data demodulator, pulse demodulator, FM demodulator, global method analyzer for phase and frequency error, synthesized spectrum analyzer, and pulsed power meter. The HP 8922B adds a large programmable RAM and phase-lock-loop timing generator for generating long GSM data patterns. The HP 8922G adds a bit-error-rate tester (BERT) for performing GSM receiver measurements, channel CODEC for speech encoding and decoding, and call control protocol to set up a phone call and maintain the link while performing measurements. Echo mode is facilitated by the voice CODEC for functional testing of a mobile, and the electrical man-machine interface (EMMI) is implemented for controlling the mobile and supporting the digital audio interface (DAI).

Complete Tool Set

Besides this complement of GSM-specific instruments, the HP 8922 contains general-purpose tools useful for module test, troubleshooting, and debugging activities. These tools include a digital oscilloscope, a CW RF frequency counter, a CW RF power meter, an ac voltmeter, a dc voltmeter, a 1 kHz distortion/SINAD meter, an audio frequency counter, and a synthesized audio source. The combination of these capabilities makes the HP 8922 an extraordinarily powerful tool for the manufacture and installation of GSM radio equipment.

NEW

HP 83212A GSM Mobile Station Test Software

The HP 83212A is an easy-to-use software solution for automatic testing of GSM mobile stations. Running on the HP 8922G's built-in I-BASIC controller, the HP 83212A offers a comprehensive set of tests ideal for manufacturing and servicing GSM mobile stations. Its flexibility and modularity allows you to select and change test sequences, test parameters, and pass/fail limits without programming expertise. All test results are displayed on the screen and can be documented with hard-copy printouts when an external printer is added. Three levels of MS testing are available with the HP 83212A: manual mobile station troubleshooting, quick functional checkout, and full parametric testing. Automating your measurements provides repeatable results while allowing the user to test more mobile stations in less time. This increase in throughput lowers your testing costs.

HP 8922A/B/G Specifications

RF Generator
Frequency Range: 10 to 1000 MHz
Frequency Resolution: 1 Hz
Switching Speed: 577 μs
0.3 GMSK Modulation: External clock and data
Pulse Modulation: External
30 dB Pulse Modulation: External
Reverse Power: 30 W continuous, 100 W for 10 s/min (RF input)

RF Analyzer
Frequency Range: 10 to 1000 MHz
Frequency Resolution: 1 Hz (100 kHz in hop mode)
Switching Speed: 577 μs
Coherent Data Demodulation: 0.3 GMSK at 270.833 Kbits/s, 1 time-slot/frame
FM Analog Demodulation: 0.3 GMSK
Global Method: RMS and peak phase error, frequency error
Amplitude Envelope: Rise, fall, and burst flatness over useful bits
Peak Transmitter Power: +10 to +45 dBm
Output RF Spectrum Measurements: Due to modulation and switching transients
CW Frequency Counter: 10 to 1000 MHz

Spectrum Analyzer
Frequency Range: 10 to 1000 MHz
Frequency Accuracy and Stability: Same as timebase
Display Range: 80 dB
Other Features: External trigger, marker

Digital Oscilloscope
Frequency Range: 2 Hz to 50 kHz
Sweep Times: 10 μs to 100 ms in 1, 2, 5, 10 steps

Audio Analyzer
Frequency Range: 20 Hz to 400 kHz
ac Voltage Range: 0 to 30 V_{rms}
dc Voltage Range: 100 mV to 42 V
THD + Noise: 1 kHz ±5 Hz
SINAD: 1 kHz ±5 Hz

Audio Source
Frequency Range: dc to 25 kHz
Output Level Range: 0.1 mV_{rms} to 4 V_{rms}

Reference Oscillator
External Reference Input Frequency: 13, 10, 5, 2, or 1 MHz
External Reference Output: 10 and 13 MHz

Remote Programming
HP-IB: IEEE 488.2
RS-232: 300, 1200, 2400, 4800, 9600, and 19200 baud

Internal Programming
Programming Language: Hewlett-Packard Instrument BASIC
Program Storage: 32 Kbyte to 256 Kbyte external memory cards

General Specifications
Size: 177 mm H × 426 mm W × 574 mm D (7 in × 16.75 in × 23 in)
Weight: 32 kg (70 lb)
Operating Temperature: 0° to +55° C
Storage Temperature: −40° to +75° C
Power: 100, 120, 220, 240 Vac, 48 to 440 Hz, ±10% of line voltage

HP 8922B Additional Specifications

Data Buffer
Frame Control RAM: Memory for 102 unique GSM frames
Data RAM: 64 Kbyte FIFO for active timeslot (load via GPIO)
Hop RAM: 32 Kbytes for controlling HP 8922B frequency hopping

GSM Reference
External Reference Input Frequencies: 13, 10, 5, 2, 1 MHz, bit clock, or frame clock

HP 8922G Additional Specifications

Broadcast Channel Capability: BCCH + CCCH or BCCH + CCCH + SDCCH/4
Control Channels: BCCH + CCCH, BCCH + CCCH + SDCCH/4, SDCCH/8 (non-hopped), SACCH/FACCH
Traffic Channels: TCH/FS
Call Control Capabilities: BS originated call (FS), MS originated call (FS), MS camp on, BS call disconnect, MS call disconnect
Encryption (with Opt. 005): On, off, user-supplied key
Timing: Auto, manual, uplink-downlink offset measurement
Hopping: Cyclic only, 2 independent MA tables with offsets
Digital Audio Interface (DAI): Normal operation and test of acoustic devices and A/D & D/A
Electrical Man-Machine Interface: Control via HP-IB
Speech Encoding/Decoding: Full rate speech (FS)
Echo Mode: User-selectable delay, 0 to 5 seconds
Bit/Frame-Error-Rate Measurements: Class Ia, Ib, and II bits
MS Power Output Level Control: 0 to 15 with RF analyzer auto adjust
Measurement Coordination: Flexible control of burst and ARFCN
SACCH MEAS Results: RXLEV, RXQUAL, timing advance

Ordering Information	Price
HP 8922A GSM RF Test Set	$61,350
Opt 001 High-Stability Timebase (08922-61062)	+$1,775
Opt 002 Transit Protection (front panel cover, accessory pouch, and extended rear feet) (08922-61070)	+$675
Opt 910 Total of Two Sets of Operation Manuals (08922-90009) and Service Manuals (08922-90006)	+$500 ☎
Opt 913 Rack Mount Flange Kit (5062-4072)	+$32 ☎
Opt 915 Add Service Manual (08922-90006)	+$250 ☎
Opt W30 Extended Repair Service (see page 636)	+$1,180
HP 8922B GSM BS Test Set	$65,000
Opt 001 High-stability Timebase (08922-61062)	+$1,775
Opt 002 Transit Protection (front-panel cover, accessory pouch, and extended rear feet) (08922-61070)	+$675
Opt 910 Total of Two Sets of Operation Manuals (08922-90010) and Service Manuals (08922-90006)	+$500 ☎
Opt 913 Rack Mount Flange Kit (5062-4072)	+$32 ☎
Opt 915 Add Service Manual (08922-90006)	+$250 ☎
Opt W30 Extended Repair Service (see page 636)	+$1,380
HP 8922G GSM MS Test Set	$75,000
Opt 001 High-stability Timebase (08922-61062)	+$1,775
Opt 002 Transit Protection (front-panel cover, and extended rear feet) (08922-61070)	+$675
Opt 003 Protocol Logging (with HP 37900D)	+$X
Opt 005 Ciphering/Encryption Capability	N/C
Opt 012 GSM MS Test Software (HP 83212A)	+$2,000
Opt 910 Total of Two Sets of Operation Manuals (08922-90011) and Service Manuals (08922-90006)	+$600 ☎
Opt 913 Rack Mount Flange Kit (5062-4072)	+$32 ☎
Opt 915 Add Service Manual (08922-90006)	+$250 ☎
Opt W30 Extended Repair Service (see page 636)	+$1,957

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

RF COMMUNICATIONS TEST EQUIPMENT

Automated Test Systems

HP 8953XT/CT/DT/ST, 11805B, 83211A, 11809A/B

- High-performance radio testing
- Test AM, FM, ØM, cellular, NADC, SSB radios
- Automated measurements

DESIGNED FOR HP-IB SYSTEMS

- Fast, repeatable results
- Flexible configurations for changing needs
- Expandable for future needs

Transceiver Test Systems

Hewlett-Packard offers a full line of transceiver test systems. The HP 8953 Series of transceiver test systems are designed to offer maximum performance, flexibility, and expandability for the mobile communications market. All systems are based on 3 "designed-for-systems" instruments: the HP 8656B/8657A synthesized signal generator, the HP 8903B audio analyzer, and the HP 8901A/B modulation analyzer. These 3 basic building blocks, together with software and a programmable interface for system integration, create an automated solution flexible enough to meet your needs today and tomorrow.

These systems and their options are designed to perform the majority of in-channel and out-of-channel tests on AM, FM, ØM analog and digital cellular, and SSB radios. The performance inherent in these systems gives you the margin you need to measure your radio without being limited by your test equipment.

HP 11805B Transceiver Test Software

- Repeatable test routines based on industry standards
- Menu-driven to tailor software to the radio under test
- User graphics for system-interconnection verification
- Calibration routines for measuring/correcting path losses
- Electronic data storage

Transceiver Test Made Easy

The Hewlett-Packard 11805B transceiver test software is an easy-to-use, comprehensive solution for automatically testing land mobile, analog cellular, and single-sideband transceivers. It supports all instruments in the HP 8953S configuration guide (publication number 5952-1988). The HP 11805B software package provides quick and easy testing with full menu-driven operation, concise graphics, and easy-to-read test results.

The HP 11805B transceiver test software consists of a main executive interface program combined with at least one of three options. Option 001 includes test procedures for AM, FM, and ØM radios derived from EIA/TIA standards for AM and FM transceivers and CEPT/ETSI standards for ØM transceivers. Option 002 performs test over-the-air and via the AMPS test bus on both AMPS and TACS radios. Tests are derived from EIA/TIA standards for AMPS radios and Mobile Station Compatibility standards for TACS/ETACS radios. Option 003 tests single-sideband suppressed carrier radios with procedures derived from IEC standards.

Operating Environment

The HP 11805B is compatible with the HP 9000 Series 300 computers with 2 Mbytes user RAM, BASIC 6.2 operating system, printer, and disk drive. The display compatibility interface card should be used with series 300 controllers to eliminate display flicker. System software is shipped on 3½-inch, double-sided diskettes.

Ordering Information[1] (data sheet p/n 5952-1987)	Price
HP 11805B Transceiver Test Software	$3,675
Opt 001 AM, FM, and ØM Radio Tests	+$525
Opt 002 Cellular Radio Tests	+$525
Opt 003 Single-Sideband Radio Tests	+$525

[1] For additional ordering information, contact your local Hewlett-Packard sales representative.

HP 8953XT

HP 8953XT AM, FM and ØM Radio Test

The HP 8953XT is a high-performance system for testing land mobile radios. It has the capability to test two-way AM, FM, and ØM transceivers, both single-channel and multi-channel, with or without continuous tone-controlled squelch systems (CTCSS) signaling formats. Radios with digital coded squelch (DCS) signaling can also be tested with additional equipment. The HP 11805B software, included with the HP 8953XT system, provides test routines derived from EIA/TIA standards for AM and FM transceivers and CEPT/ETSI standards for ØM transceivers.

Ordering Information[1] (data sheet p/n 5952-1987)	Price
HP 8953XT Transceiver Test System	$41,465
HP 8953XT Components:	
HP 8656B Opt 002 Synthesized Signal Generator	
HP 8903B Opts 001, 010, 051 Audio Analyzer	
HP 8901A Opts 001, 002 Modulation Analyzer	
HP 8954A Transceiver Interface	
HP 437B Opt 003 Power Meter	
HP 8482A Power Sensor	
HP 11805B Opt 001 Transceiver Test Software	
All Necessary Cables and Adapters	
Opt 100 Extended Tranceiver Test System (adds equipment for out-of-channel testing)	+$74,230

HP 8953ST Single-Sideband Radio Test System

The HP 8953ST single-sideband test system is specially configured to test single-sideband suppressed-carrier transceivers (A3J). This system uses 2 signal generators for receiver tests and a high-performance spectrum analyzer for transmitter characterization. All test procedures are derived from IEC standards for A3J radios.

Ordering Information[1] (data sheet p/n 5952-1987)	Price
HP 8953ST Single Sideband Test System	$100,995
HP 8953ST Components:	
HP 8656B Opts, 001, 002 Synthesized Signal Generator	
HP 8644A Opts, 003, 007 Synthesized Signal Generator	
HP 8903B Opts, 001, 010, 051 Audio Analyzer	
HP 8568B Spectrum Analyzer	
HP 8956A System Interface	
HP 6652A System DC Power Supply	
HP 11805B Opt 003 Transceiver Test Software	
All necessary Cables and Adapters	

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 8953CT

HP 8953CT Analog Cellular Radio Test

The HP 8953CT cellular radio test system is configured for testing AMPS, TACS, and ETACs cellular radios. Flexible instrument connections and signal paths, coupled with digital signaling, give the HP 8953CT system the ability to automate complex cellular radio measurements. The HP 8953CT can be expanded to perform digital tests on North American dual-mode cellular radios.

Testing can be performed over-the-air on both AMPS and TACS radios. The HP 11805B software performs cellular radio tests derived from EIA/TIA standards for AMPS radios and Mobile Station Compatibility standards for TACS/ETACS radios.

Ordering Information[1] (data sheet p/n 5952-1987)	Price
HP 8953CT Cellular Test System	$50,865
HP 8953CT Components:	
HP 8656B Opt 002 Synthesized Signal Generator	
HP 8903B Opts 001, 013, 051 Audio Analyzer	
HP 8901B Opts 001, 002 Modulation Analyzer	
HP 8958A Cellular Radio Interface	
HP 8482A Power Sensor	
HP 11805B Opt 002 Transceiver Test Software	
All Necessary Cables and Adapters	
Opt 100 Extended Cellular Radio Test System (adds equipment for out-of-channel testing)	+$61,100
HP 11809A/B Calibration Kits to calibrate system path losses	
HP 11809A Kit for 8953XT, CT, ST	$630
HP 11809B Kit for 8953DT System	$1,925

NEW

HP 8953DT Dual-Mode Cellular Radio Test System

The HP 8953DT North American dual-mode cellular (NADC) radio test system provides a high-performance solution for testing NADC radios. It adds digital signaling and measurement capability to the HP 8953CT to test both the digital and the analog modes of NADC radios. All test routines are derived from EIA/TIA IS-54 and IS-55 and are performed automatically under the control of the HP 83211A NADC digital signal-processing controller, which is included.

The HP 8953DT NADC radio test system is based on the HP 8953CT instruments that test the radio for AMPS compatibility. For digital receiver measurements, the HP 11835A data buffer and HP 8657D signal generator provides $\pi/4$ DQPSK modulated signals while the HP 83211A generates data streams and performs BER/WER, (bit error-rate and word error-rate) measurements. Digital transmitter measurements such as frequency accuracy, and error vector magnitude are performed by the HP 83211A digital signal processor.

Ordering Infomation[1] (data sheet p/n 5091-1701)	Price
HP 8953DT NADC Radio Test System	$142,550
HP 8953DT Components:	
HP 8657A Opt 002 Synthesized Signal Generator	
HP 8903B Opts 001, 010,053 Audio Analyzer	
HP 8901B Opts 001, 002, 030, 033, 035 Modulation Analyzer	
HP 8958A Opt 003 Cellular Radio Interface	
HP 8657D $\pi/4$ DQPSK Synthesized Signal Generator	
HP 11835A Opt 002 Data Buffer	
HP 83211A Opt 002 NADC Digital Signal Processing Controller	
Opt 001 Adds Second Digital Source (8657D and 11835A Opt 002)	+$34,200
Opt 003 Emulate HP Series 300 Computer	+$3,300

HP 83211A NADC Digital Signal Processing Controller

The HP 83211A NADC digital signal processing controller is a digital analyzer and system controller for the HP 8953DT NADC radio test system. It automates NADC radio testing, and also codes and generates digital data streams and performs digital analysis. Menu-driven software included in the HP 83211A runs in the MS-DOS® environment and allows complex NADC radio measurments to be performed quickly and easily. In addition to the HP Vectra RS-25 personal computer, the HP 83211A consists of a high-performance, floating-point digital signal processor; a 10 MHz, 12-bit digitizer; an HP-IB board, a GPIO board, and software for digital tests, radio test menus, and instrument control. The HP 83211A includes two days of factory consultive training.

Ordering Information[1] (data sheet p/n 5091-1701)	Price
HP 83211A NADC Digital Signal Processing Controller	$53,550
Opt 001 Adds Second GPIO Card for Second Digital Source	+$1,510
Opt 002 Accessory Kit (HP 8482A power sensor, cables, attenuators, and terminations for HP 8953DT)	+$2,825
Opt 003 Emulate HP Series 300 Computer	+$3,300

[1] For additional ordering information, contact your local Hewlett-Packard sales representative.

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RF COMMUNICATIONS TEST EQUIPMENT

RF Interfaces

HP 8954A, 8956A, 8958A

HP 8954A

HP 8956A

HP 8958A

HP 8954A Transceiver Interface

The HP 8954A is Hewlett-Packard's lowest priced transceiver test interface. It is fully programmable and uses microwave switches and hardware in all RF paths. Designed for dc to 18 GHz measurements, the HP 8954A Transceiver Interface provides the flexibility needed for most AM, FM, and SSB receiver and transmitter testing.

HP 8956A System Interface

The HP 8956A System Interface, with its multiple paths and connections, provides added flexibility in the designing of systems in the frequency range from dc to 1000 MHz. It has two RF test ports for duplex testing, stimulus/response testing, and reduced connect/disconnect times. A built-in, switchable 120 watt 30 dB attenuator can be inserted for transmitter testing and removed for receiver testing, increasing receiver measurement range.

Additional functions of the HP 8956A include current drain and timing measurements.

HP 8958A Cellular Radio Interface

The HP 8958A Cellular Radio Interface gives your system the capability to fully test a cellular radio. With this flexible channel simulator, you can simulate cell-site operation, verify signaling protocol, or perform highly complex and sophisticated tests using an external controller to generate and analyze data content.

Ordering Information	Price
HP 8954A Transceiver Interface	$4,815
Opt 907 Front Handle Kit (5061-9688)	+$52
Opt 908 Rack Flange Kit (5061-9674)	+$32
Opt 909 Front Handle w/Rack Flange Kit (5061-9675)	+$75
Opt 910 Extra Manual (08954-90010)	+$15
HP 8956A System Interface	$15,975
Opt 001 Rear Panel Connectors	+$115
Opt 907 Front Handle Kit (5061-9689)	+$57
Opt 908 Rack Flange Kit (5061-9677)	+$33
Opt 909 Front Handle & Rack Flange Kit (5061-9683)	+$82
Opt 910 Extra Manual (08956-90020)	+$21
HP 8958A Cellular Radio Interface	$13,365
Opt 002 Diversity Switch	+$900
Opt 003 Frequency/Dynamic Range Extension	+$1,735
Opt 907 Front Panel Handles (5061-9689)	+$57
Opt 908 Rack Mount Flanges (5061-9677)	+$33
Opt 909 Front Handles & Rack Mount Kit (5061-9683)	+$82
Opt 910 Extra Manual (08958-90002)	+$52

System Interface Comparison

	HP 8954A	HP 8956A	HP 8958A
Frequency range	DC to 18 GHz	DC to 1000 MHz	10 to 1500 MHz
Number of RF ports	4	6	6
Number of audio ports	2	4	2
Number of UUT ports	1	2	1
Duplex capabilities	NO	YES	YES
Typical applications	AM, FM, ØM, SSB	AM, FM, ØM, SSB	AMPS, TACS, NADC, TDMA

RF COMMUNICATIONS TEST EQUIPMENT

0.3 GMSK and π/4 DQPSK Modulation Measurement Software

HP 11836A, 11847A/B/C

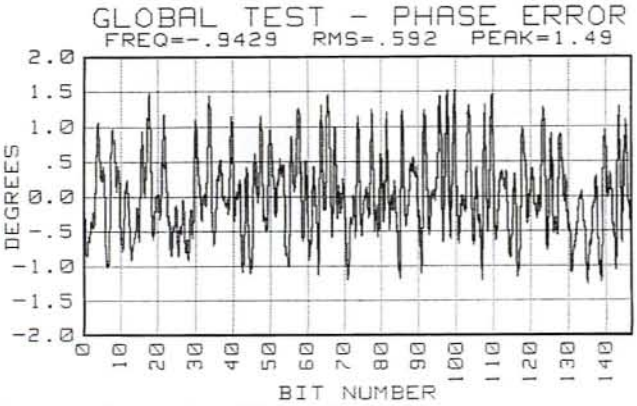
- Global measurement of GSM and PCN digital cellular radio transmitters
- Characterization of North American dual-mode cellular and Japanese digital cellular (JDC) and cordless (PHP) transmitters
- Measurements on I-Q baseband drive signals

HP 11847A display of I-Q Constellation

HP 11836A 0.3 GMSK Modulation Measurement Software

The HP 11836A software package is an easy-to-use, accurate solution for testing transmitters designed for PCN and the Global System for Mobile Communications (GSM), Pan-European Digital Cellular Radio System. By downconverting the transmitter to an IF of 700kHz and digitizing 1 time slot, the HP 11836A recovers the transmitted data and measures the spectrum of the signal. The software performs mathematical calculations to measure the transmitter carrier, frequency accuracy, amplitude envelope, and modulation phase error (peak and rms). This technique is known as the global method.

The software digitally reconstructs the actual transmitted data, from which is computed the ideal phase trajectory of a theoretically perfect 0.3 Gaussian minimum shift keying modulator. It also uses the recovered data to very precisely regenerate the data clock, which is used to synchronize the data stream. By subtracting the actual phase trajectory from the calculated ideal trajectory, the phase error is obtained. The frequency error, rms phase error, and peak phase error are then determined from the phase-error data.



Sample software output (HP 11836A)

Modulation Measurement Software for π/4 DQPSK Systems: HP 11847A for NADC, HP 11847B for JDC Systems, and HP 11847C for PHP Systems

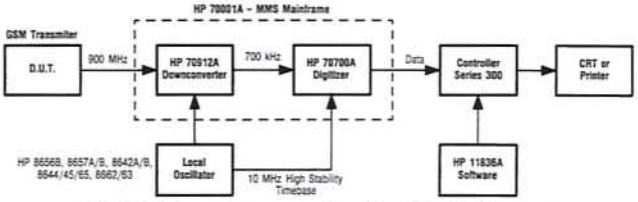
The HP 11847A/B/C π/4 DQPSK modulation measurement software builds on the successful algorithms used in the HP 11836A 0.3 GMSK software. The design was adapted for the Japanese and North American systems that use the π/4 DQPSK format.

The HP 11847A software is designed to make measurements specified in the TIA/EIA standards IS-54 and IS-55 for North American dual-mode systems. These include transmitter frequency error, burst amplitude droop, modulation phase, magnitude error, and error vector magnitude. The software has a filter factor of 0.35 and is designed for symbol rates of 24.3 kHz and bit rates of 48.6 kHz.

The HP 11847B software is designed to make measurements on JDC system transmitters that use the π/4 DQPSK modulation. These differ from the NADC system transmitters because the channel spacings in Japan are 25 kHz. The resulting symbol rate is 21 kHz and the Nyquist filter factor is 0.5.

The HP 11847C software is designed to measure transmitters in the Japanese digital cordless telephone system also called Personal Handy Phone (PHP). This system operates from 1.8 to 2.0 GHz, with data rates of 384 kbps and a Nyquist filter of 0.5. Channel spacing is 300 KHz.

In all versions, the menu-driven software offers a selection of many graphs and displays of the demodulated signal. These graphs include I and Q channel eye diagrams, the I-Q constellation diagram, phase and magnitude vs. time, and error vector magnitude vs. time for one complete burst. The test option menu allows the user to choose to test mobile or base-station bursts, using internal or external triggers, and allows synchronizing to appropriate synch words. The software runs on an HP 9000 Series 300 computer using BASIC 6.0 or higher, and requires 4 Mbytes of memory.



Modulation measurement system block diagram

Ordering Information

	Price
HP 11836A 0.3 GMSK Modulation Measurement Software	$11,085
HP 11847A/B/C π/4 DQPSK Modulation Measurement Software	$10,715

Associated Equipment Required:

HP 70001A System Mainframe	$7,250
HP 70700A Digitizer Module	$8,600
HP 70912A Downconverter Module	$3,885
HP 70912B Downconverter (required for PHP)	$4,885
Local Oscillator (one of the following):	Contact HP
HP 8642A/B, HP 8644A, HP 8645A, HP 8656B, HP 8657A/B, HP 8662A, HP 8663A, or HP 8665A	

Controller: The software requires BASIC 6.0 on an HP 9000 Series 300 instrument controller. However, due to the extensive computations by the software, the HP 9000 models with coprocessor are recommended, such as Models 362 or 382.

Memory: 4 MB RAM (HP 11847A/B/C)
3 MB RAM (HP 11836A)

Optional Equipment:

Printers: HP-IB Printers such as HP QuietJet Plus	
Modular Measurement System Graphics Displays:	
HP 70205A Graphics Display	$6,160
HP 70206A System Graphics Display	$9,950

For the most current prices and product information, contact your local Hewlett-Packard sales office – see page 665.

RF COMMUNICATIONS TEST EQUIPMENT

Data Buffer, GSM, NADC, JDC

HP 11835A

The HP 11835A Data Buffer with HP 8657A Option 022

HP 11835A Data Buffer

The HP 11835A Data Buffer is a configurable data output device. Its primary function is to buffer data from a computer and output the data as a serial stream. It can output the serial data at rates from dc to 4 MHz with a user-supplied clock. Optionally, an internal reference board will provide the bit clock used in the GSM system (Option 001) or the bit and symbol clock used in the North American and Japanese digital cellular systems (Option 002).

The HP 11835A contains a large memory which can be configured as a programmable state machine. This is useful in generating the data streams to test the new digital mobile communications systems. The memory is divided into four locations. There are two first-in, first-out (FIFO) RAMS each with a capacity of 1024 Mbits. One FIFO can be loaded via the GPIO interface while the active data is clocked out the other. This allows continuous data streams to simulate digital radio transmissions. In addition to FIFO memory, a frame control RAM (128 K × 16 bits) controls the operation of the HP 11835A. It determines when to output data and sends internal clock signals as well as external trigger signals for timing control. The fourth RAM is a hop control RAM, used to drive a fast-hopping source such as the HP 8662A-H25 to simulate frequency hopping in GSM radios, for example.

Option 001 GSM Reference

The Option 001 GSM reference board provides synchronization of the HP 11835A with clock frequencies used by the Pan-European Digital Cellular Radio System. This option permits the use of the 1, 2, 5, or 10 MHz instrumentation references and the 216.67 Hz frame clock, the 270.833 kHz bit clock, or 13 MHz GSM clock as reference inputs. From these inputs, 10 MHz, 13 MHz, 270.833 kHz (bit clock), and 216.67 Hz (frame clock) signals are output.

Option 002 NADC and JDC Reference

The Option 002 reference board provides similar capabilities as Option 001 but for the North American (NADC) and Japanese digital cellular (JDC) systems. When configured for the NADC system, the HP 11835A Option 002 can input 1, 2, 5, or 10 MHz instrumentation references, as well as the 48.6 kHz bit clock and the 24.3 kHz symbol clock. From these inputs the Option 002 outputs the bit clock (48.6 kHz), the symbol clock (24.3 kHz), and the frame clock (25 Hz). For the JDC system, Option 002 provides the same inputs and outputs, but uses the Japanese system frequencies. These include the 42 kHz bit clock, the 21 kHz symbol clock, and the 50 Hz frame clock.

HP 11835A Specifications

Inputs (TTL Levels)
- **Bit clock input:** BNC, rear panel
- **GPIO input:** 50-pin, front panel
- **Trigger input:** BNC, rear panel

Outputs (TTL Levels)
- **Data output:** BNC, front panel
- **Clock output:** BNC, front panel
- **Program outputs:** 25-pin, front panel
- **Parallel bus outputs:** 25-pin, rear panel
- **Hop control bus:** 50-pin, rear panel
- **Programmable outputs:** 3 BNCs, rear panel

Option 001 Specifications (for use with the GSM System)
- **Reference modes:** Reference Lock, Bit Clock Lock, Frame Clock Lock, or Free Run
- **Inputs:** (rear panel BNCs)
  - **Reference:** 1, 2, 5, 10, 13 MHz, >0 dBm (50 Ω nominal)
  - **Frame clock:** 216.67 Hz, TTL levels
  - **Bit clock:** 270.833 kHz, TTL levels
- **Outputs:** (rear panel BNCs)

10 MHz, 13 MHz, 270.833 kHz (bit), 216.67 Hz (frame)

Option 002 Specifications (for use with NADC or JDC systems)
- **Reference modes:** Reference Lock, Bit Clock Lock, Frame Clock Lock, or Free Run
- **Inputs:** (rear panel BNCs)
  - **Reference:** 1, 2, 5, 10 MHz, >0 dBm (50 Ω nominal)
  - **Frame clock:** 21 kHz (JDC), 24.3 kHz (NADC) TTL levels
  - **Bit clock:** 42 kHz (JDC), 48.6 kHz (NADC) TTL levels
- **Outputs:** (rear panel BNCs)
  - **Reference:** 10 MHz (50 Ω nominal)
  - **Symbol clock:** 21 kHz (JDC), 24.3 kHz (NADC) TTL levels
  - **Bit clock:** 42 kHz (JDC), 48.6 kHz (NADC) TTL levels
  - **Frame clock:** 25 Hz or 50 Hz, TTL levels

Note: For bit and symbol clocks, rates can be varied ±10ppm.

General Information
- **Power:** 90 to 264 volts from 48 to 66 Hz; 75 VA maximum
- **Size:** 425 mm W × 88.1 mm H × 346 mm D (16.75 in × 3.5 in × 13.6 in)
- **Weight:** Net, 6 kg (14 lb); shipping, 11 kg (24 lb)

Cables Included: The HP 11835A includes a GPIO cable to connect to the host computer and a ribbon cable to connect to a HP 8662-H25 Fast Hop Signal Generator.

Recommended Computer and Operating System:

HP Model 9000 Series 300 with 4 Mbyte of RAM. Requires a GPIO card, HP 98622A.

HP Vectra PC with the HP 82300C or HP 82324A Measurement Coprocessor and 4 Mbytes of RAM. Requires GPIO card, HP 82306C.

Operating System is HP BASIC 5.0 or later version.

Ordering Information

	Price
(Only one option can be ordered)	
HP 11835A Data Buffer	$9,360
Opt 001 GSM Reference	$1,040
Opt 002 NADC and JDC Reference	$1,250
Opt 907 Front Handle Kit (5062-3988)	$50
Opt 908 Rack Mount Flange Kit (5062-3974)	$31
Opt 909 Handles w/Rack Mount Flange Kit (5062-3975)	$73

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

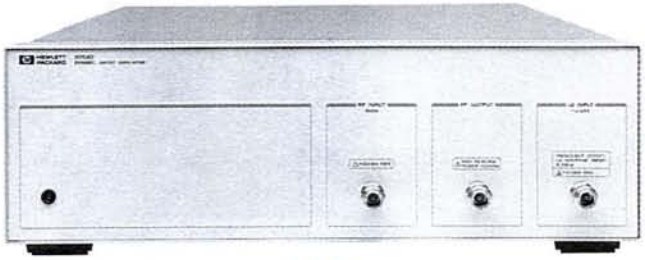
- Simulates realistic signal propagation for NADC, GSM, JDC, DCS1800, . . . systems
- Rayleigh, Rice or Log-normal fading
- RF Bandwidth >6.0 MHz
- Doppler to 340 Hz

HP 11759C

NEW

DESIGNED FOR HP-IB SYSTEMS

- Simulates realistic propagation models for analog and digital television
- Static and time varying ghosts
- 12-bit processing for minimum distortion
- RF input/output for full IF/VHF/UHF coverage



HP 11759D

NEW

DESIGNED FOR HP-IB SYSTEMS

HP 11759C RF Channel Simulator

The HP 11759C RF Channel Simulator has all the features and performance characteristics that make it ideally suited for testing digital cellular radios under RF multipath conditions. Whether the radio is designed for operation with the GSM, NADC, DCS1800, or JDC cellular systems, it is easy to simulate the fast and slow fading, time dispersion, and Dopplers experienced in the mobile radio environment. The HP 11759C is also suitable for testing many other analog and digital wireless communications systems with RF bandwidths to 6.0 MHz under multipath fading conditions.

The HP 11759C consists of the applications software and the RF processing hardware. To complete the RF multipath simulation system, two user-supplied components are necessary—a personal computer (PC) acting as a user-interface and a synthesized LO used to determine the RF operating frequency and to supply a 10 MHz clock signal.

Two Multipath Channels Provide Test Flexibility

The HP 11759C contains two independent 40 MHz to 2500 MHz RF channels of three paths each. Each path can be Doppler shifted or, Rayleigh or Log-normal faded, delayed, and attenuated relative to the others. In addition, under Rayleigh fading conditions, the correlation factor for path pairs in the two channels is adjustable from 0 to 1.

For test applications requiring more paths per channel (e.g. GSM or DCS1800), the HP 11759C Opt 001 configures the HP 11759C as one channel of 6 paths. By pairing two HP 11759C Opt 001 units and controlling them from a single PC, the full 12-ray testing requirements of the GSM and DCS1800 systems can easily be accomplished. And, to make it even easier, the 12- and 6-ray propagation models are pre-stored in memory for easy recall and set-up.

With an external power divider and/or power combiner, and two separate channels available, it is easy to configure the HP 11759C(s) for single-channel 6- (or 12-) path tests, co-channel interferer tests, adjacent and alternate channel tests, and space and/or frequency diversity tests. This flexibility is particularly important during the radio R&D phase and also important for manufacturing test and type acceptance testing.

Easy to Use Manually or Remotely

Simple-to-use on-screen menus guide the user through the task of creating complex RF multipath signals for testing a mobile or base station radio. These same menus are accessed remotely by installing an HP-IB interface card in the PC.

HP 11759C Partial Specifications

(See technical data sheet for complete specifications)

Independent RF Channels: 2 of 3 paths each (1 of 6 paths with Opt 001)
RF Input/Output Frequency Range: 40 to 2500 MHz
RF Bandwidth (1 dB): >6.0 MHz typically
LO Input Frequency Range: RF input frequency less 6 MHz
Simulation Specifications
Independent Rayleigh (Classical) fading, Delay, Doppler and level available on each path
Path Attenuation Range: 0 to 45 dB, in 0.1 dB steps
Path Delay Interval Range: 0 to 170 μs, in 10 ns steps
Simulated Vehicle Speed Range (at 900 MHz): 0 to ±400 km/h
Simulated Doppler Range: 0 to ±340 Hz
Rayleigh (Classical) Amplitude Distribution: Available on all paths for vehicle speeds from 1 to 400 km/h (at 900 MHz)
Repetition interval: >30 seconds
Deviation from Rayleigh CDF (typical):
<±1.0 dB from +10 to −20 dB relative to the mean power
<±3.0 dB from −20 to −30 dB relative to the mean power

HP 11759D Dynamic Ghost Simulator

The HP 11759D Dynamic Ghost Simulator easily simulates the ghosting and airplane flutter that commonly degrade terrestrial TV broadcasts. With the HP 11759D, ghost canceller designs can be tested under the real-world conditions of multiple reflections, long delays and motion. The simulation of motion is required to account for the dynamic effects of tower sway, airplane flutter and the movement of people, vehicles, and trees. The HP 11759D is ideally suited to simulate these phenomena.

Like the HP 11759C, the HP 11759D consists of the applications software and the RF processing hardware and requires two user-supplied components to complete the Dynamic Ghost Simulation system—a PC and a Local Oscillator with a 10 MHz timebase output.

HP 11759D Partial Specifications

(See technical data sheet for complete specifications)

The HP 11759D retains most of the features and specifications of the HP 11759C plus the following unique characteristics.

RF Channels: 1 of 6 paths
RF Input/Output Frequency Range: 40 to 1,000 MHz
Path Delay Interval Range: 0 to ±170 μs, maximum delay spread between paths of 170 μs
Relative Phase Between Paths: Adjustable 0 to ±540°, 1° steps
Simulated Doppler Range: 0 to 340 Hz, in 0.01 Hz steps

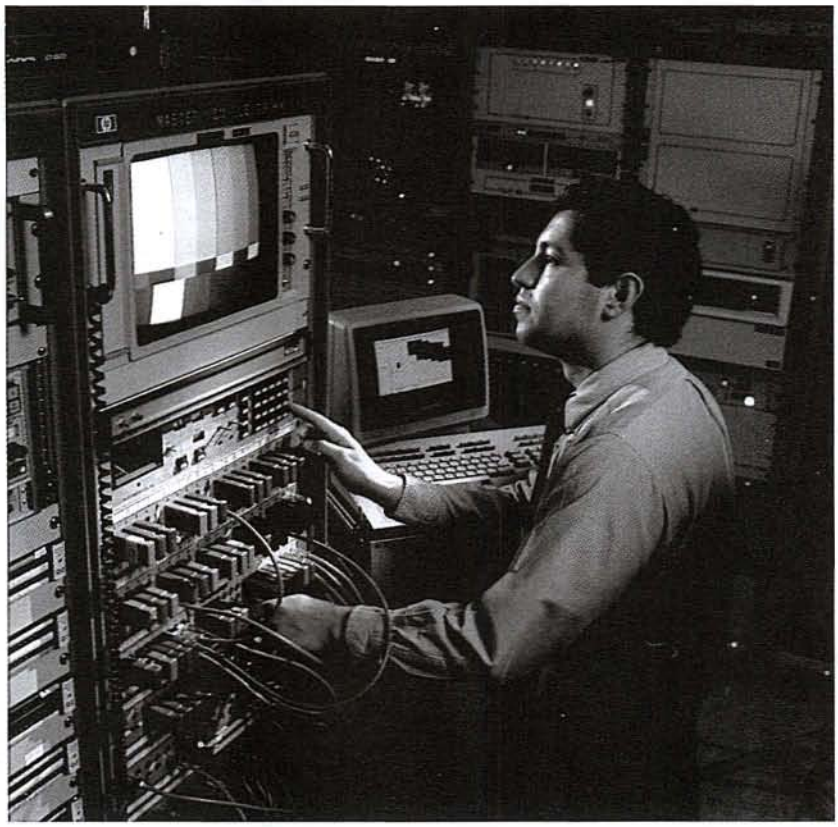
Ordering Information*

HP 11759C RF Channel Simulator
Opt 001 One channel of 6 paths
Opt 002 Rear panel only RF connectors
Opt 003 One channel of 6 paths with rear panel only RF connectors
HP 11759D Dynamic Ghost Simulator
Opt 002 Rear panel only RF connectors

*Price not available at publication date.

For the most current prices and product information, contact your local Hewlett-Packard sales office, see page 665.

VIDEO TEST PRODUCTS
Tools for Video Test and Measurement



Introducing Hewlett-Packard Test and Measurement Tools for the Video Professional

No other company matches HP's breadth of test and measurement equipment for R&D, production, and maintenance. From lightwave to RF to digital, we're ready to help you make the leap into the digital video revolution. So, when you think of your future in video, think HP.

Whether you design, test, or repair video equipment, there's a good chance you're already using HP test and measurement gear to help you solve tough problems.

Now, with a major commitment to digital video and HDTV, HP is ready to help you bridge the gap from analog to digital testing. Though the transition won't happen overnight, recent advances in digital compression are accelerating cost reductions in video processing equipment and digital transmission systems.

Around the world, broadcasters and studios are gearing up for the most significant revolution in the video industry since color TV. From the satellite link right down to the fiber interface, HP test equipment is poised to help you succeed in a dynamic market.

As the world's leading supplier of test and measurement equipment, HP's breadth of choice goes unchallenged. Whether it's an elusive bit error in your satellite uplink or a video compression problem in your CATV headend, count on HP to listen to your needs and solve them. Our years of experience in digital transmission stimulus and analysis are unmatched in the industry.

With HP's reputation for high quality and uncompromising technical performance, you'll be pleased to discover a growing family of tools priced within reach of even the smallest studios and repair shops. From digital oscilloscopes that have the friendly look and feel of analog, to dynamic multipath simulators for development of ghosting cancelers, HP tools for video test and measurement will help you move into the next generation of high-performance video—the *digital* generation.

Tools for Video Test and Measurement: Product Matrix

Signal/pattern generators	Research and development	Equipment manufacturing	Component testing/benchtop repair	Satellite link/ direct broadcast/ studio links	Broadcasting/ production studio/ control room	CATV	See page
Baseband/IF video-signal synthesizers	HP 8770A arbitrary waveform synthesizer (dc to 50 MHz) HP 8791 Model 7 baseband FASS (dc to 50 MHz)						419 422
Digital/vector modulation generators	HP 8782B vector signal generator (1 to 250 MHz) HP 8780A vector signal generator (10 MHz to 3 GHz) HP 8780A/8770A vector arbitrary waveform synthesizer (VAWS) HP 8791 family of frequency agile signal simulators (to 18 GHz)						403 402 418 422
Function/pulse generators	HP 8904A multifunction synthesizer HP 8111A pulse/function generator						447 441
RF/microwave synthesizers	HP 8643A RF synthesizer (0.252 to 1030 MHz) HP 8370 Series microwave sources/local oscillators						406 414
Video channel/ ghosting simulators	HP 11759D RF dynamic ghost simulator						587
Software	HP 11755A RF simulator WorkSystem driver (for modeling/testing video/digital transmission systems) HP 11736B I/Q Tutor (digital modulation/transmission training software for engineers and technicians)						418 560

Tools for Video Test and Measurement: Product Matrix (continued)

Signal analyzers	Research and development	Equipment manufacturing	Component testing/benchtop repair	Satellite link/ direct broadcast/ studio links	Broadcasting/ production studio/ control room	CATV	See page
Audio analyzers	HP 8903B audio analyzer						262
CATV analyzers						HP 85716A or HP 85711A CATV system monitoring/ measuring pers.	236
Distortion analyzers	HP 8903E distortion analyzer HP 339A distortion measuring set See also dynamic signal analyzers						262 258 214
Dynamic/ acoustic signal analyzers (1/3 octave)	HP 3561A single-channel dynamic signal analyzer HP 35665A dual-channel dynamic signal analyzer				HP 3560A portable 40-kHz analyzers		214 215
Digital video-transmission analyzers	HP 8981B vector-modulation analyzer HP 3708A C/N test set HP 3709B constellation analyzer HP 3764A Opt 7 BERT HP 71600 MMS BERT (50 to 1000 Mb/s)						261 559 559 550 556
Fiber-optic/ lightwave analyzers	HP 8153A lightwave multimeter HP 8702B/03A lightwave component analyzer HP 71000 Series lightwave signal analyzers HP 8504A/HP 8509A/B reflectometers HP 83810A portable lightwave signal analyzer					HP 8153A lightwave multimeter HP 8146A optical TDR	563 566 249 569 573
Logic analyzers	HP 16500 Series logic analyzers						319
Network analyzers	HP 3577B audio/video/IF network analyzer HP 8711A RF network analyzer						284 293
Radio test sets				HP 11758V digital radio test system			558
Spectrum analyzers	HP 3588A or HP 3589A spectrum/network analyzer HP 8566B or HP 8568B spectrum analyzers HP 70000 Series MMS spectrum analyzers HP 8560 high-performance portable spectrum analyzers HP 8590E Series TV signal room monitor			HP 8590 portable spectrum analyzers			232, 235 246 89 241 237
Vector-modulation analyzers	HP 8981B vector modualtion analyzer HP 89440A vector signal analyzer						261 229

General-purpose tools	Research and development	Equipment manufacturing	Component testing/benchtop repair	Satellite link/ direct broadcast/ studio links	Broadcasting/ production studio/ control room	CATV	See page
Digital multimeters	HP 34401A low-cost 6½-digit multimeter HP E2373A, E2377A, E2378A low-cost handheld multimeters HP 3478A high-performance digital multimeters HP 3458A system multimeter			HP 3468A/B battery-operated digital multimeters			158 169 164 161
Electronic counters	HP 5347A 20-GHz counter/power meter HP 5384A, 5385A, 5386A (225 MHz to 3 GHz) counters HP 53310A modulation domain analyzer			HP 5347A 20-GHz counter/power meter	HP 5314A, 5315A low-cost counters	HP 5384A (225-MHz counter, battery operable)	199, 202 199 186, 187
Noise figure meters	HP 8970B/71B noise figure meters			HP 8970B Opt 020 (10 to 2047 MHz)			366
Oscillo-scopes	HP 54600, HP 54601A low-cost digitizing oscilloscopes HP 54500 Series digitizing/single-shot oscilloscopes						142 138
Power meters	HP 437B CW power meter HP 8990A peak power analyzer	HP E1416A VXI HP 70100A MMS CW power meters	HP 8990A peak power analyzer				172 171
Power supplies	HP E3610A, HP E3612A, HP 6234A HP 6205C, HP 6235A, HP 6236B, HP 6237B						479 478

DATA ACQUISITION SYSTEMS
General Information

- Reduce manufacturing costs
- Reduce product development time
- On-going payback
- Improve product quality
- Higher process throughput
- More process up-time

Every data acquisition system requires a combination of computers, instruments, transducers, and software. The extent to which these pieces are packaged together depends on your individual needs. Whether it is a completely integrated turnkey system, system components, plug-in board products, or a customized in-house system, Hewlett-Packard can help. Turnkey solutions can be provided by HP's own Customer Support Group or through a growing network of independent systems integrators and software suppliers. Contact your local HP sales office for more information about these programs.

Data acquisition software products are described on page 592. Information on instruments and computers for custom-built systems can be found under the headings for those products. The remainder of this section contains detailed information on data acquisition component systems. These systems provide solutions for a broad range of applications. Contact your local Hewlett-Packard sales office for more information on how these systems can work for you.

Data Acquisition Family Matrix

System Description	Typical Application Areas	Max. Channels/ System Differential	Max. Channels/ System Single-ended	Interfaces	Typical Computers	Programming Method	Supporting Software Packages
HP System 10+ HP 75000 Series B cardcage with measurement cards programmed by Labtech products using a PC	• chemical experimentation • pharmaceutical testing • material evaluation • energy research	112	336	IEEE-488	HP Vectra PC (or IBM AT compatible)	Iconic & menu driven	Labtech® NOTEBOOK[1] Labtech® CONTROL[1]
HP System 20 HP 75000 Series B cardcage with measurement cards programmed by built-in IBASIC controller or external computer	• process characterization • facility monitoring • process troubleshooting • remote station control	112	336	IEEE-488 RS232/422 (option)	HP Vectra PC, (or IBM AT compatible), HP BASIC workstations or internal IBASIC controller	Front panel, external terminal, or external computer	HP DACQ/PC HP DACQ/300 HPITG
HP 3852A HP 3852 cardcage with measurement cards programmed over IEEE-488 using an external computer	• product characterization • process characterization • electromagnetic test • manufacturing test	1848	4620	IEEE-488 RS232/422 (option)	HP Vectra PC (or IBM AT compatible), HP BASIC or HPUX workstations, HP 1000 computer	Front panel or external computer	HPITG HP DACQ/PC HP DACQ/UX HP DACQ/300
HP 3421A HP 3421 cardcage with built-in A/D, plug-in relay multiplexer, and digital I/O, programmed by external computer	• small process monitoring • environmental monitoring • material evaluation	30	56	HPIL IEEE-488 (option)	HP Vectra PC (or IBM AT compatible), HP BASIC workstations	External computer	HP DACQ/PC HP DACQ/300
HP 3497A HP 3497 cardcage with measurement cards programmed by external computer	• process/product characterization • process monitor & control • process troubleshooting	1000	8070	IEEE-488 RS232/422 (option)	HP Vectra PC (or IBM AT compatible), HP BASIC workstations	Front panel or external computer	HP DACQ/PC HP DACQ/300

[1]Labtech products available from Laboratory Technologies Corporation, Wilmington, MA (508) 657-5400
[2]ISI Autonet available from Imagination Systems Incorporated, or The Netherlands (31) 1670 64500 Virginia Beach, VA (804) 497-8200

HP 75000 Series B

HP 75000 Series B: Time-Saving Solutions

Whether your application is in product test/evaluation, process design/test, process monitoring/characterization, or process automation/control, you'll benefit from instrumentation that fits together quickly and has all the flexibility to adapt to your unique application.

When you purchase an HP 75000 system, you get:

- Menu-driven software
- A wide selection of measurement and control cards
- Built-in transducer linearizations (thermocouples, RTDs, thermistors, strain gages)
- Flexible configuration for up to 112 3-wire channels (336 single-ended) per cardcage
- Accurate, repeatable measurements each time
- Reliable hardware (20+ years MTBF)
- Worldwide consulting and support services

HP 75000 System 10+: The Nonprogrammer's Solution

The HP 75000 System 10+ saves you time because you don't have to be a programmer to capture data. It is a PC-based data-gathering system for nonprogrammers. Iconic software supplied with examples will allow you to capture data almost immediately.

Software Suited to Your Needs

You can monitor or control your application with one of System 10+'s two easy-to-learn software packages: Labtech® Notebook or Labtech Control.

Labtech Notebook is designed for experiments and tests in which you want to gather data and analyze the results. Labtech Control is made for applications in which you want to continuously monitor and/or control a process. You can make changes to setpoints and limits as your process unfolds.

Nonprogramming Software

- No programming required (use only icons and menus)
- Software runs on any MS-DOS PC-AT compatible computer
- Example setups provided
- Software growth path (two compatible programs)

Versatile Hardware

- Complete line of data acquisition cards
- Modular design lets you add just the cards you need
- Designed to get accurate measurements, even in the presence of noise

HP 75000 System 20

HP 75000 System 20: The Intelligent System

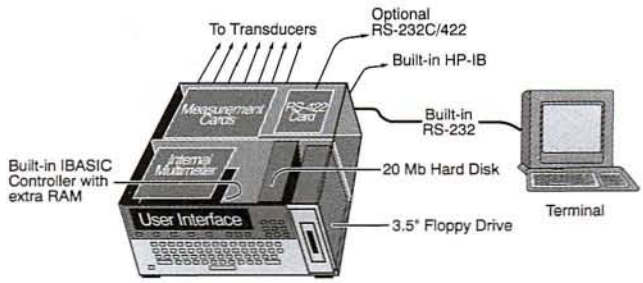
The HP 75000 System 20 is a completely self-contained data acquisition system that is ideally suited for remote assignments. Whether your application is down the hall or across the city, System 20's built-in microprocessor lets you collect data, control your application, and send the results back to your computer.

Instrument BASIC (IBASIC)

At the heart of System 20 is the IBASIC language, with all the functionality of an HP 9000 Series 300 BASIC workstation. Attach a terminal on the RS-232 port and you can develop programs using the built-in, full-screen IBASIC editor. You'll have the power of a stand-alone workstation right in the cardcage. You'll also have complete control of all plug-in cards as well as any external RS-232 or HP-IB equipment.

System 20 Allows You to:

- Collect data, make decisions, and store results without a computer
- Place the instrumentation close to the transducers to reduce wiring costs and improve accuracy
- Make decisions locally for better response and to avoid tying up your computer
- Continue operating even during a power failure, using a battery backup as a UPS (uninterruptible power supply)
- Control other HP-IB or RS-232 equipment in addition to making measurements



System 20 Functional Diagram

System 20's Power and Intelligence Is Built On:

- Built-in Motorola MC 68000 microprocessor running at 8 MHz
- Up to 2 MB of RAM (all of which can be configured as nonvolatile)
- Optional built-in 3½-in floppy drive and/or 20-MB hard disk (floppy drive reads both LIF and DOS formats)
- Autostart from hard, floppy, or nonvolatile RAM disk files
- Battery-power operation (switches automatically when ac power fails)
- Control of either RS-232 or HP-IB instruments, disks, printers, or devices

DATA ACQUISITION SYSTEMS

Instruments for Measurement and Control (cont'd)

HP 75000 Series B

Custom Systems: Build-Your-Own Versatility

HP 75000 Custom Systems save you time because you don't have to build your own system from scratch. We can supply you with everything you need in one system.

The Series B cardcage is a modular architecture designed to configure in minutes. Instrumentation and switch cards can be easily inserted into slots in the rear of the instrument. When the cardcage is turned on, it automatically identifies the cards and sets the menu accordingly. To save even more time, order the Installation Option and HP will install the cards for you.

Industry Standards: Path to the Future

The Series B is a member of the HP 75000 family of industry-standard VXI products. It is programmed with easy-to-understand Standard Commands for Programmable Instruments (SCPI) over HP-IB (an IEEE-488.2 standard).

Flexible Architecture

The HP 75000 Custom Systems are built on a flexible architecture that allows you great versatility in the way you configure your system:

- Seven external B-size VXI slots, plus two internal slots for optional multimeter
- Three external A-size VXI slots
- 112 3-wire channels (336 single-ended)
- Five high-performance instrument cards
- 18 high-quality switch cards
- Compatible with VME cards (P1 connector only)

Optional Features

- IBASIC controller (puts the power of a workstation in the instrument)
- ½, 1-, or 2-MB nonvolatile memory for program/data storage
- Power for portable or UPS capability—automatically switches to dc power operation when ac power fails
- 3½-inch floppy disk drive (LIF and/or DOS format)
- 20-MB hard disk drive (LIF and/or DOS format)

Series B Cards—The Right Connections

Series B cards come with removable screw terminal connectors designed for fast and easy wiring to your system. No-solder connections and built-in strain reliefs ensure that wires won't come loose.

Customize Your System

An HP E1399A breadboard card makes it easy for you to develop custom instrumentation and switches. We supply you with access to the cardcage power supplies, backplane interface circuitry, and logic circuits, and we provide a comprehensive manual.

Plug-In Cards

Multimeter (two-slot card mounted internally or in rear slots)

- Programmable speed/resolution trade-off
- Balanced differential input for noise rejection
- Variety of measurements (dc volts, ac volts, ohms)
- Floats up to 120 V above ground (450 V pk terminal to chassis)
- Integration technique for noise rejection (84 dB @ 22 bits)
- 150 dB common mode noise rejection

Relay Multiplexers

- Break-before-make operation
- Detachable terminal block provided
- Space available for series and shunt-signal conditioning

FET Multiplexers

- Break-before-make operation
- Detachable terminal block provided
- Space available for series and shunt-signal conditioning

D/A Converter

- Output voltage or current on each channel
- Software calibration
- Four isolated channels

Counters

- Totalize
- Frequency
- Period
- Pulse width
- Time interval
- Gated totalize
- Up/Down count
- Ratio (range)

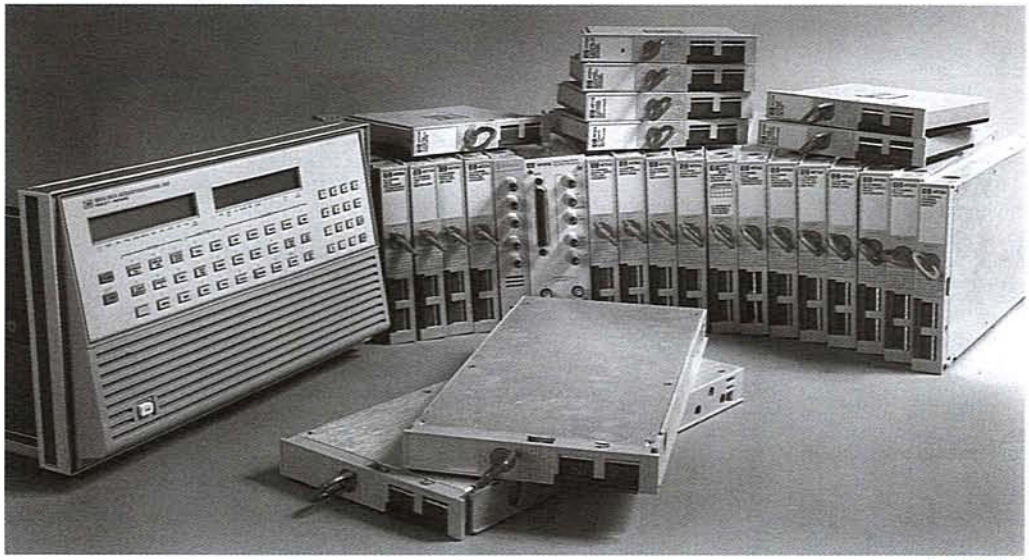
Digital I/O

- Four 8-bit bidirectional data ports
- Three handshake lines (GPIO protocols)
- TTL logic levels
- Plug-compatible with industry standard opto-isolators

Form C General Purpose Switch

Ordering Information	Price
Cardcage Required (choose one)	
E1300A Blank Front Panel	$2,320
E1301A Front Panel	$2,900
Software Required	
E1395C Labtech Notebook	$1,100
Optional	
E1395C Opt 001 General-purpose HP-IB programming	$300
Plug-In Cards Required	
Opt 009 Internal Multimeter (E1326B)	$1,340
Recommended	
E1326-80005 Banana Plug Adapter for Multimeter	
Opt 500 Installation of Cards	
Optional (choose maximum of seven)	
E1345A 16-Chl Relay Multiplexer	$660
E1347A 16-Chl Thermocouple Relay Multiplexer	$760
E1346A 48-Chl Single-Ended Relay Multiplexer	$810
E1355A 8-Chl 120 Ω Strain Relay Multiplexer	$925
E1356A 8-Chl 350 Ω Strain Relay Multiplexer	$925
E1351A 16-Chl FET Multiplexer	$875
E1353A 16-Chl Thermocouple FET Multiplexer	$975
E1352A 32-Chl Single-Ended FET Multiplexer	$1,000
E1357A 8-Chl 120 Ω Strain FET Multiplexer	$1,125
E1358A 8-Chl 350 Ω Strain FET Multiplexer	$1,125
E1330B Quad 8-bit Digital I/O	$625
E1364A 16-Chl Form C Switch	$660
E1328A 4-Chl D/A Converter	$1,110
E1332A 4-Chl Counter/Totalizer	$910
E1333A 3-Chl Universal Counter	$910
Computer Recommended	
HP Vectra (or IBM-AT compatible) with mouse	
MS-DOS 3.0 or later	
Memory: 640 KB Labtech Notebook 2 MB Labtech Control	
Disks: 20-MB hard disk or 3½-in floppy drive	
Interface: HP 82335A (or PCIIA compatible)	
Printer: HP QuietJet or HP LaserJet	
Note: To work with the System 10+ software, your cardage must have serial prefix (first four digits of the serial number) 3034 and above for E1300A, and 3035 and above for E1301A.	
Cardcage Required (choose one)	
E1300A Blank Front Panel	$2,320
E1301A Front Panel	$2,900
Software Required (choose one)	
Opt 020 IBASIC with 512 K RAM	$1,000
Opt 021 IBASIC with 1 MB RAM	$1,600
Opt 022 IBASIC with 2 MB RAM	$2,400
Disk Drives Recommended (choose one)	
Opt 005 3½-in Floppy Drive	$850
Opt 006 20-MB Hard Disk	$1,900
Opt 007 Floppy and Hard Disk	$2,100
Other	
Opt 008 dc Power	$700
E1324A RS-232C/422 Data Comm Card	$650
Plug-In Cards Recommended	
Opt 009 Internal Multimeter (E1326B)	$1,340
E1326-80005 Banana Plug Adapter for multimeter	
Opt 500 Installation of cards	
Optional (choose maximum of seven)	
E1345A 16-Chl Relay Multiplexer	$660
E1347A 16-Chl Thermocouple Relay Multiplexer	$760
E1346A 48-Chl Single-Ended Relay Multiplexer	$810
E1355A 8-Chl 120 Ω Strain Relay Multiplexer	$925
E1356A 8-Chl 350 Ω Strain Relay Multiplexer	$925
E1351A 16-Chl FET Multiplexer	$875
E1353A 16-Chl Thermocouple FET Multiplexer	$975
E1352A 32-Chl Single-Ended FET Multiplexer	$1,000
E1357A 8-Chl 120 Ω Strain FET Multiplexer	$1,125
E1358A 8-Chl 350 Ω Strain FET Multiplexer	$1,125
E1330B Quad 8-bit Digital I/O	$625
E1364A 16-Chl Form C Switch	$660
E1328A 4-Chl D/A Converter	$1,110
E1332A 4-Chl Counter/Totalizer	$910
E1333A 3-Chl Universal Counter	$910
E1361A 4 × 4 Relay Matrix	$660
E1366A 50 Ω RF Multiplexer	$860
E1367A 75 Ω RF Multiplexer	$860
E1368A 18-GHz Microwave Switch	$2,120
E1369A Microwave Switch Driver	$510
E1370A Microwave Switch/Attenuator Driver	$500
E1399A Breadboard	$400

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.



HP 3852A

DESIGNED FOR HP-IB SYSTEMS

Hewlett-Packard Instrument Drivers

HP 3852A Data Acquisition and Control System

You can easily configure an HP 3852A Data Acquisition and Control System to meet your needs for measuring physical parameters through transducers, and for providing control outputs. The HP 3852A Data Acquisition/Control Unit (mainframe) has 8 slots for plug-in function modules. If more slots are needed, up to seven extenders can be added, each with 10 additional slots. You can choose any combination of capabilities that include precision and high-speed plug-in voltmeters and a variety of analog and digital input/output functions.

A system clock and programmable pacer are built-in to drive your system. The clock—non-volatile for four years, 1 msec—resolution allows data to be time-stamped and events to be timed. The pacer—0.25 μsec resolution—provides powerful capabilities to initiate and pace measurements, scans, or events.

Include High-Speed and Accurate Analog Measurements in One System

Choose from three digital voltmeters to meet your measurement needs. For applications that require sensitive, accurate measurements in the presence of noise (for example, thermocouples), use the 5½-Digit Integrating Voltmeter and Relay Multiplexers. If you need speed, the 13-Bit High-Speed Voltmeter and High-Speed FET Multiplexers are the answer, providing single-channel bursts, channel-to-channel, random channel, full auto-ranging, and direct DMA transfers to a hard disk at an honest 100,000 readings/sec. High speed, high accuracy readings can be achieved with the 16-bit, 100 kHz high speed voltmeter. The system voltmeters can be used in the mainframe or any extender, and multiple voltmeters are allowed per cardcage.

Add Versatility and Expandability to Your System

With the HP 3852A Data Acquisition and Control System, you'll have available a complete set of input and output plug-in modules for interfacing to measurements and for controlling and sequencing your tests. Modules are available to handle physical measurements of temperature, flow, pressure, level, and strain. The HP-IB controller module gives you the capability to autoboot subroutines stored on a disk and to store data to the disk without computer assistance.

Take Advantage of Extensive Front-End Intelligence

The HP 3852A mainframe has considerable built-in intelligence to increase the speed of collecting measurement and control data. Control decisions can be handled faster using subroutines running within the mainframe. This intelligence can be used to *return only significant data* to the computer, thus increasing its efficiency.

Up to 5,500 readings can be stored in the standard HP 3852A mainframe. Expand this memory (used for storage of user routines as well as readings) to 256 KB, 1 MB, 2 MB, or 4 MB with an Extended Memory board. Extended memory fits inside the mainframe controller module without using an I/O slot.

The power of this front-end intelligence in combination with an HP 9000 Series 300 computer and the optional data acquisition software adapts easily to testing your complex product or characterizing your process. Of course, the mainframe can be also used with HP 1000 computers, HP Vectra PCs, other IEEE-488 controllers and instruments, and a variety of computer peripherals.

Reduce Your Test Development Investment

Optional data acquisition software for an HP 9000 Series 300/200 computer or HP Vectra PC gets your application running quickly and easily by providing off-the-shelf solutions for:

- Data base management—store large amounts of data in files that are easy to identify and access later.
- Graphics presentations—display or plot color graphs; display a real-time strip chart; plot data with linear, log, semilog, or automatic axis scaling.
- Data analysis—this software provides high-level subroutines as tools used in a test system program running with HP BASIC.

Ease-of-use is exemplified by:

- Automatic creation of a database for storing data using only one subroutine
- Fast access to a single data item or a block of data items using only one subroutine
- Manipulation and formatting of gathered data any way you wish

Program development time is leveraged using this software, while allowing a powerful, highly customized system to be developed. Furthermore, the software can be used with any HP-IB instrument.

DATA ACQUISITION SYSTEMS

Instruments for Measurement and Control (cont'd)

HP 3852A

Data Acquisition and Control Unit — HP 3852A

Mainframe Supports

- 8 Function Module Slots
- Data Acquisition Operating System
- System Timer
- Measurement Pacer
- Full Alphanumeric Keyboard, Command and Result Displays

Benefits

- Make real-time decisions and reduce data without burdening your computer:
  - — Multitasking operating system prioritizes and timeslices tasks.
  - — Powerful HP 3852A command statements simplify complex measurements.
  - — Execution speed of command sequences are enhanced by executing subroutines stored in the HP 3852A memory.
  - — Built-in, easy-to-use transducer conversions are supported for thermocouples, thermistors, RTDs, and strain gages.
  - — Post-processing and data reduction before transferring results to a computer are achievable by first storing data to the HP 3852A internal memory.
  - — Limit checking of analog measurements is performed in real time or after the measurements have been stored in mainframe memory.
- Optimize measurement timing and throughput to meet your needs:
  - — Real-time interrupts allow higher priority tasks and external inputs to be serviced at any time.
  - — Asynchronous communication with a computer is achieved through input and output buffering.
  - — Control can be timed using built-in clock and alarm capabilities (can cause an interrupt).
  - — A built-in pacer simplifies measurement timing and triggering.
  - — Multiple voltmeters can be used. The high-speed voltmeter can control scanning, timing, and triggering of its own high-speed FET multiplexer subsystem via ribbon cable. Several of these subsystems can run simultaneously.

Extender Chassis — HP 3853A

Extender supports: 10 Function Module Slots

Expand your system with no loss of functional capability:

- — Up to seven extenders may be used with each HP 3852A mainframe.
- — Any slot can be used for any function module and multiple voltmeters can be used with parallel triggering.
- — All mainframe functions, including interrupts and triggering, are available through the extender control cable.

5½- to 3½-Digit Integrating Voltmeter

HP 44701A

Directly measures: • dc voltage • ac voltage • Resistance

The HP 44701A lets you:

- Accurately measure small signal changes in noisy environments
- Choose the resolution, accuracy, and noise rejection needed while maximizing measurement speed
- Optimize resistance measurements to the accuracy you need

Best dc voltage accuracy: ±(0.008% + 8μV) for 3 V range

13-Bit High-Speed A/D

HP 44702A/B

Directly measures: • dc voltage • dc resistance

The HP 44702A/B will allow you to:

- Collect data quickly (100,000 readings/sec)
- Maximize your measurement throughput

Best dc voltage accuracy: ±(0.05% + 1.88 mV) for 2.56 V range

16-Bit High-Speed A/D

HP 44704A

Directly measures:

• dc voltage • Resistance • 100,000 readings/sec @ 16 bits

The HP 44704A will let you:

- Enjoy high accuracy at high speed
- Maximize your measurement throughput

Best dc voltage accuracy: ±(0.015% + 340 μV) for 2.56 V range

Relay Multiplexers

HP 44705A/44705H/44706A/44708A/ 44708H/44717A/44718A

Directly multiplexes:

• Voltage • Resistance • Thermocouples • Strain gages

Relay Multiplexers for the HP 3852A do the following:

- Reduce the effects of real-world measurement errors in a multichannel system
- Optimize thermocouple measurement accuracy
- Measure strain accurately

Solid State Relay Multiplexers

HP 44705F/44708F

Directly multiplexes:

- Voltage
- 4-wire Ω resistance (44705F only)
- Thermocouples (44708F only)

Solid State Relay Multiplexers give you the following benefits:

- Solid state switching, free from wearout associated with electromechanical relays
- Precision measurements of real-world electrical systems
- Optimized thermocouple measurement accuracy (44708F)

FET Multiplexers

HP 44709A/44710A/44711A/44711B/44712A/ 44713A/44713B/44719A/44720A

Directly multiplexes:

• Voltage • Resistance • Thermocouples • Strain gages

HP's FET Multiplexers allow you to:

- Maximize your measurement throughput
- Increase your system reliability

20-Channel Low Resistance FET Multiplexers

HP 44709A Opt H01/HP 44710A Opt H01

Directly multiplexes:

• Voltage • Resistance • Thermocouple • Strain gages

The low resistance of the FETs reduces the effects of injected current from scanning with high-speed guarded voltmeters (e.g. HP 3458A).

Anti-Noise Filter Option

HP 44713A/B Opt 003

Directly provides:

- Attentuation of 60 or 50 Hz noise
- Fast scanning; no need to average to get rid of unwanted noise
- One filter for each of the 24 channels

The anti-noise filter option allows you to:

- Scan lists quickly and accurately
- Reduce noise in a single measurement

12-Channel Isolated FET Multiplexer with Gain of 100

HP 44713A Opt H01

Directly multiplexes: • Voltage • Thermocouple

Amplify low level signals with built-in gain of 100 to reduce offset and noise effects.

Measure voltage and temperature with common mode voltages of up to 100 V.

12-Channel Isolated FET Multiplexer with Gain of 0.1

HP 44713A Opt H02

Measure voltages up to ±50 V with the gain of 0.1

Measuring inputs with common mode voltages of up to 100 V.

4-Channel Track/Hold with Signal Conditioning

HP 44730A

4-Channel Dynamic Strain Gage Multiplexers

HP 44732A/44733A

Directly multiplexes:

• Transient dc voltages • Dynamic strain gages

HP's 4-Channel Track/Hold and Strain Gage Multiplexers let you:

- Enhance dynamic signal measurement accuracy
- Set gains of 1, 10, or 100 on each channel
- Use the analog peak detect/hold feature

Serial Interface
HP 44789A
Directly provides:
- Serial programming port for the HP 3852A
- Control port for RS-232 or RS-422 devices

The HP 44789A Serial Interface allows you to:
- Interface your computer to the HP 3852A using RS-232 or RS-422 devices
- Locate the HP 3852A long distances from your host computer
- Control RS-232 or RS-422 devices directly from the HP 3852A
- Program the HP 3852A from a remote terminal

Specifications
Baud Rates: 300, 600, 1200, 2400, 4800, 9600, and 19200
Interrupts: Special character, buffer conditions, carrier detect, ring indicator, and receiver error conditions
Handshake: None, XON/XOFF, or hardware
Buffer Size: User-defined up to 8 KB on both transmitter and receiver

Arbitrary Waveform Digital-to-Analog Converter
HP 44726A
Directly outputs:
- Arbitrary waveforms
- dc voltages (2-channel, non-isolated)

The HP 44726A Arbitrary Waveform D/A Converter:
- Provides a stimulus voltage signal with a step rate of up to 800 kHz
- Gives you random-access memory (RAM) for each channel on this accessory

Digital-to-Analog Converter
HP 44727A/44727B/44727C
Directly outputs:
- dc voltage • dc current

Simplify your test setup by providing test or control of devices with one data acquisition control system.
Specifications
dc Voltage:
Ranges: 0 to +10.235 V or −10.235 to +10.235 V
Resolution: 2.5 mV (12 bits plus a sign for bipolar range)
dc Current:
Ranges: 0 to +20.16 mA or +4 to +20.16 mA
Resolution: 2.5 μA (13 bits)

3-Channel Stepper Motor Controller
HP 44714A
Directly provides:
- Stepper motor control signals
- Limit inputs
- Built-in quadrature counters
- Pulse output

The HP 44714A 3-Channel Stepper Motor Controller lets you:
- Completely control three stepper motors with one module
- Use the module as a pulse generator

8-Channel LVDT Signal Conditioner/Multiplexer
HP 44736A Opt H05
Directly provides:
- Conditioning/multiplexing for up to 8 LVDTs
- Independent excitation source for each transducer
- Independent demodulation circuits for each transducer
- Fast FET multiplexer scanning of demodulator outputs
- Analog output for each demodulator at terminal block

The HP 44736A will help you:
- Simplify your data acquisition system configuration
- Reduce your cost per channel

5-Channel Counter/Totalizer
HP 44715A
Directly provides:
- Count measurements
- Frequency measurements
- Period measurements
- Interrupts

Reduce your costs by taking advantage of this frequency counting versatility.

Digital Inputs with Totalize and Interrupt
HP 44721A/44722A
Directly provides:
- Logic readings
- Totalize count measurements
- Interrupts

Conveniently read a variety of digital values in your system.

32-Channel High-Speed Digital Sense/Control
HP 44723A
Directly provides:
- High-speed digital input and output
- Triggered input and output
- Interrupts
- Output handshaking

The HP 44723A allows you to:
- Input 16 channels or output 16 channels over 150,000 times per second
- Capture and load 16-bit patterns with external triggers
- Interrupt on any input channel on any transition or on a user-specified 16-bit pattern

16-Channel Digital Output
HP 44724A
Directly Provides Open Drain Digital Outputs
The HP 44724A gives you convenient control of dc devices or logic levels.
Open drain outputs are used to control dc devices of up to 55 V, or drive TTL logic levels. An external power supply and external pull-up resistors are required.

Switching
HP 44725A/44728A/44729A
Directly switches:
- Voltage • Current • Power

Reliably switch the voltage, current, or power you need.

Binary Mode Software
HP 44790A
HP 44790A Binary Mode Software is a collection of subprograms used to access high-speed opcodes within the HP 3852A. It helps system programmers increase the run-time speed of data acquisition functions up to *five times* over standard high-level commands. The software is written for the professional programmer familiar with opcode programming. HP systems engineers can provide consulting services for those unfamiliar with this type of programming.
System Requirements
Binary Mode Software requires HP 3852A firmware Rev. 3.5 or later. It is supplied on a 3½-in single-sided disk. The subprograms are written in HP BASIC in modular form, so they can be ported to other languages.

HP-IB Controller
HP 44788A
Directly controls:
- HP-IB disk drives (CS80/SS80)
- HP-IB printers
- HP-IB instruments

The HP-IB Controller lets you:
- Conduct remote operations without a computer
- Load subroutines at power-up into an HP 3852A from an HP-IB disk drive and start executing the subroutines
- Send data to an HP-IB disk drive without using a computer
- Print out data stored in the HP 3852A without using a computer
- Control other HP-IB instruments directly through the HP 3852A

32-Channel Isolated Digital Input/Interrupt
HP Z2204A
Directly provides:
- Logic readings
- Positive and negative interrupts
- Change of state interrupts

2 sets of three handshake lines usable for banks of 16 or 32 channels (Strobe In, Ready for Data, and Interrupt Out)

DATA ACQUISITION SYSTEMS
Ordering Information

Ordering Information

To order, specify an HP 3852A system with the appropriate software, controller, mainframe, extenders, function modules, racks, and extra terminal modules. The HP 3852A itself has no cost—each component of the system is priced individually. ROM revision is in Brackets [ ]. Please contact your local sales office for ROM upgardes, pricing, and information.

Data Acquisition Manager	Price
HP 44458A Data Acquisition and Control Software for Series 300/200 Computers on 3½-in and 5¼-in diskettes (BASIC 4.X, 5.X, and 6.X)	$2,480
HP 44458R License to Reproduce HP 44458A or 44458B. Includes one set of software manuals.	$1,500
HP 44459A Data Acquisition and Control software for HP Vectra Computers on 3½-in and 5¼-in diskettes (BASIC 5.3X)	$1,840
HP 44459R License to reproduce HP 44459A/44459B. Includes one set of software manuals.	$1,140
HP 44460A HP DACQ/UX Manual and Software, ¼-in tape	$2,210

Mainframe

HP 3852A Data Acquisition and Control Unit	$4,500
HP 44703A Mainframe Extended Memory Card—256 KB*	$860
HP 44703B Mainframe Extended Memory Card— 1 MB*	$1,890

Order extended memory cards for 2 MB and 4 MB from Infotek Systems, 1045 S. East Street, Anaheim, CA 92805-8508, as AM220B and AM244B, respectively. These products have been *functionally tested, but are not warranted or supported by HP* (no RFI or environmental tests were conducted). Two-year warranty and support of individual cards are provided by Infotek.

Extender Chassis

HP 3853A Extender Chassis with 10 additional slots for function modules. A 1-m extender control cable, and two 1-m (3 wires each) analog signal extender cables are included. A total of seven extenders may be added to a mainframe. Extender control cables are always needed. Analog signal extender cables are needed if analog voltages must be switched to the mainframe or another extender.	$3,000

Voltmeters

HP 44701A 5½- to 3½-Digit Integrating Voltmeter	$1,900
HP 44702A 13-Bit High-Speed Voltmeter (100,000 readings/sec; buffer for over 8,000 readings)	$3,230
HP 44702B 13-Bit High-Speed Voltmeter (100,000 readings/sec; buffer for over 64,000 readings)	$3,900
HP 44703C High Speed Extended Memory Card for expanding HP 44702A Buffer to over 64,000 readings	$750
HP 44704A 16-Bit High-Speed Voltmeter (100,000 readings/sec; buffer for over 64,000 readings) [4.2]	$4,060

Relay Multiplexers

HP 44705A 20-Channel Relay Multiplexer	$1,000
HP 44705H 20-Channel High-Voltage Relay Multiplexer	$1,250
HP 44706A 60-Channel Single-Ended Relay Multiplexer	$1,250
HP 44708A 20-Channel Relay Multiplexer with Thermocouple Compensation	$1,160
HP 44708H 20-Channel High-Voltage Relay Multiplexer with Thermocouple Compensation	$1,450
HP 44717A 10-Bridge 120 Ω Static Strain Gage Relay Multiplexer [2.0]	$1,330
HP 44718A 10-Bridge 350 Ω Static Strain Gage Relay Multiplexer [2.0]	$1,330

FET Multiplexers

HP 44709A 20-Channel FET Multiplexer	$1,140
HP 44710A 20-Channel FET Multiplexer with Thermocouple Compensation	$1,260
HP 44711A 24-Channel High-Speed FET Multiplexer	$1,210
HP 44711B 24-Channel High-Speed FET Multiplexer (use with HP 44704A)	$1,140

*Only one extended memory option may be added per mainframe.

HP 44712A 48-Channel High-Speed Single-Ended FET Multiplexer	$1,390
HP 44713A 24-Channel High-Speed FET Multiplexer with Thermocouple Compensation	$1,330
HP 44713B 24-Channel FET Multiplexer with Thermocouple Compensation	$1,330
HP 4471BA/B Opt 003 Anti-Noise Filter Option	$360
HP 44719A 10-Bridge 120 Ω Static Strain Gage FET Multiplexer	$1,450
HP 44720A 10-Bridge 350 Ω Static Strain Gage FET Multiplexer	$1,450
HP 44730A 4-Channel Track/Hold Multiplexer with Signal Conditioning [3.5]	$1,890
HP 44732A 4-Channel 120 Ω Dynamic Strain Gage Multiplexer [3.5]	$2,120
HP 44733A 4-Channel 350 Ω Dynamic Strain Gage Multiplexer [3.5]	$2,120
HP 44736A Opt H05 LVDT Sig Conditioner/MUX [4.2]	$1,820

Solid State Relay Multiplexer

HP44705F 20-Channel Solid State Multiplexer	$1,590
HP44708F 20-Channel Solid State Multiplexer T/C	$1,660

Analog Outputs

HP 44726A 2-Channel Arbitrary Waveform DAC [3.5]	$2,340
HP 44727A 4-Channel Voltage DAC	$1,600
HP 44727B 4-Channel Current DAC	$1,600
HP 44727C 2-Channel Voltage; 2-Channel Current DAC	$1,600

Stepper Motor Controller

HP 44714A 3-Channel Stepper Motor Controller/Pulse Output [3.0]	$2,340

Counter

HP 44715A 5-Channel Counter/Totalizer (200 kHz)	$1,270

Digital Inputs/Outputs—Switching

HP 44721A 16-Channel Digital Input with Totalize and Interrupt	$900
HP 44722A 8-Channel AC Digital Input with Totalize and Interrupt	$940
HP 44723A 32-Channel High-Speed Digital Sense/Control [3.0]	$1,230
HP 44724A 16-Channel Digital Output	$890
HP 44725A 16-Channel General Purpose Switch	$1,000
HP 44728A 8-Channel Relay Actuator	$850
HP 44729A 8-Channel Power Controller	$1,410

Interfaces

HP 44788A HP-IB Controller [3.5]	$780
HP 44789A Serial Interface [4.2]	$1,080

Breadboard

HP 44736A Breadboard	$500

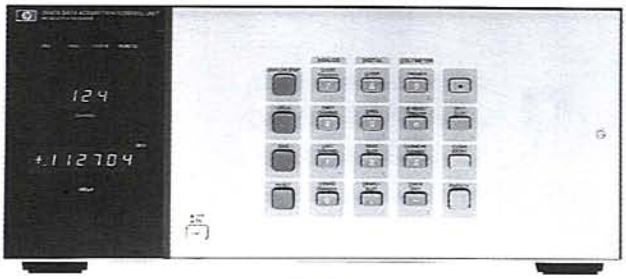
High-Speed Accessories

HP 98620B 2-Channel DMA Controller for HP Series 300/200 Computers	$530
HP 98622A GPIO Interface for HP Series 300/200 Computers	$390
HP 98625B High-Speed HP-IB Disc Interface for HP Series 300/200 Controllers	$1,000
HP 44744A 2-m GPIO Cable with Mating for HP 44702A/B and HP 98622A	$370
HP 44744B 4-m GPIO Cable with Mating for HP 44702A/B and HP 98622A	$420
HP 44745A 4-m GPIO Cable with Mating for HP 44702A/B and HP 12006A (GPIO interface for HP 1000 Computers)	$420
HP44790A Binary Mode Software [4.2]	$1,110

Service and Support Products

HP 44743F Service Kit consists of specially designed hardware and software for operationally verifying and calibrating the HP 3852A. Fixtures for testing individual plug-in modules should be ordered separately.	$2,000

- Relay multiplexer
- DVM
- FET multiplexer
- Real-time clock
- Bridge completion
- Digital inputs/outputs
- Counter
- Programmable D/As
- Optional RS-232C interface



HP 3497A

DESIGNED FOR HP-IB SYSTEMS

HP 3497A Data Acquisition/Control Unit

The HP 3497A Data Acquisition/Control Unit combines the capabilities of several instruments and is a basic building block of an automatic data acquisition and control system. The HP 3497A is used in an HP-IB automated system and can be viewed as a precision measurement and control computer peripheral.

The HP 3497A has been designed to be a very versatile and very powerful instrument. A basic HP 3497A consists of a mainframe that includes a front panel keyboard and display, a nonvolatile real-time clock, and an HP-IB interface. Available as an option is a 5½-digit integrating digital voltmeter and current source that occupies a dedicated slot in the HP 3497A chassis. Capability is added to the HP 3497A by using any combination of plug-in assemblies. Available plug-in assemblies are:

—Relay Multiplexers with or without thermocouple compensation
—FET Multiplexer
—Digital Input/Interrupt
—Counters
—Strain gage/bridge completion
—Actuators
—Programmable voltage and current D/As
—Breadboard Assembly

Up to 5 assemblies can be added to an HP 3497A and the HP 3498A Extender chassis can hold up to 10 more plug-in assemblies.

High Performance

The HP 3497A DVM can resolve 1-μV signals and is ideal for the precise measurement of the outputs of thermocouples, strain gages, and other transducers. Included on the DVM is a programmable current source that allows four-terminal resistance measurements. The multiplexer assemblies switch 3 wires (Hi, Lo, and Guard) and add less than 2 μV of thermal offset to the measured signal.

Flexible Hardware Configuration

The HP 3497A card cage can hold 5 of any combination of the plug-in assemblies. This allows the multiplexing of up to 100 3-wire inputs to the DVM in a single HP 3497A, or a single HP 3497A might contain 60 multiplexer channels, 16 digital inputs, 16 actuator outputs, and a DVM. By using HP 3498A Extenders, up to 1,000 analog channels or 1,360 digital channels can be controlled, all at a single bus address.

Ease of Use

The HP 3497A keyboard and display make the HP 3497A very easy to use and make debugging of an HP 3497A–based system easy. The calibration adjustments for the HP 3497A DVM are located behind a hinged front panel; this allows complete calibration of the DVM without removing it from the test rack. Connections to all of the HP 3497A assemblies are made with screw terminals, eliminating the need for soldering.

Real-Time Clock

The HP 3497A mainframe includes a quartz-referenced, nonvolatile, real-time clock. In addition to providing timing data, the clock can measure elapsed time, interrupt at a preset time, and output a programmable pulse train.

Software

HP Data Acquisition Manager is general purpose data acquisition software for computers running the HP BASIC programming language. The software reduces development time by providing a library of software "tools" (subroutines) that you can use in your programs (see page 598 for more information).

Each HP 3497A can hold one DVM assembly (Option 001) and up to 5 plug-in assemblies. Each HP 3498A (Option 298) can hold 10 additional plug-ins. To order plug-ins without a mainframe, order as 444xxx Field Installation Kits as shown below.

Clock format and power line frequency and voltage will be set at the factory based on the country from which the order was placed.

Ordering Information	Price
HP 3497A Data Acquisition/Control Unit	$4,900
Opt 001 or 44420A 5½-Digit DVM and Current Source	$2,530
Opt 010 or 44421A 20-Channel Relay Multiplexer Assembly	$1,040
Opt x20 or 44422x Relay Multiplexer Assembly. Substitute A in place of x for software compensation. For hardware compensation, substitute the thermocouple type B, E, J, K, R, S, or T for x.	$950
Opt 030 or 44423A 20-Channel FET Multiplexer Assembly	$1,200
Opt 050 or 44425A 16-Channel Isolated Digital Input/Interrupt Assembly	$890
Opt 060 or 44426A 100 kHz Reciprocal Counter	$1,010
Opt 070 or 44427A 120 Ω Strain Gage/Bridge Completion Assembly	$1,450
Opt 071 or 44427B 350 Ω Strain Gage/Bridge Completion Assembly	$1,450
Opt 110 or 44428A 16-Channel Actuator/Digital Output Assembly	$1,200
Opt 115 or 44431A 8-Channel High-Voltage Actuator Assembly	$1,010
Opt 120 or 44429A Dual Output Voltage DAC Assembly	$1,630
Opt 130 or 44430A Dual Output Current DAC Assembly	$1,630
Opt 140 or 44432A Breadboard Card	$260
Opt 232 Delete HP-IB Interface, add RS-232C Interface	$510
HP 3498A Extender and Connecting Cables	$3,610

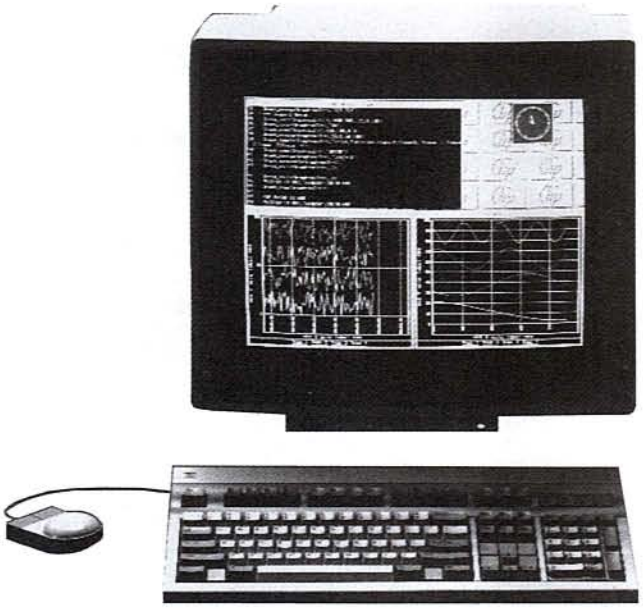
For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

DATA ACQUISITION SYSTEMS

Software Solutions

Data Acquisition Manager - DACQ/300, DACQ/PC, DACQ/UX (HP 44458A, 44459A, 44460A)

- Reduce your software development time
- Customize your data management needs
- Optimize your software performance
- Use with the controller of your choice: either HP 9000 Series 200/300, HP Vectra PC, or HP-UX Workstation
- Use with any HP-IB instrument



DESIGNED FOR HP-IB SYSTEMS

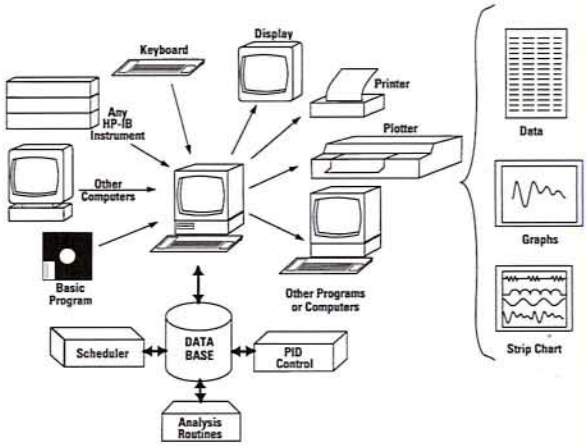
HP Data Acquisition Manager

HP Data Acquisition Manager is a general-purpose subroutine library for the HP 9000 Series 200/300 controllers (HP DACQ/300), the HP-UX Workstation (DACQ/UX), or the HP Vectra Personal Computer equipped with the HP BASIC language processor (HP DACQ/PC). The software reduces your development time by providing you with software tools (subroutines written in HP BASIC and compiled Pascal) that you can add to your HP BASIC program to handle up to 90 percent of your data management functions. Customize your data management programs by adding these subroutines to match your final application needs. Optimize your software performance through HP Data Acquisition Manager's compiled subroutines and use of memory volumes (electronic disk). Eliminate the need to have several software packages because HP Data Acquisition Manager provides you with subroutines that cover a wide range of data acquisition and control tasks and works with any HP-IB instrument. Use HP Data Acquisition Manager with the controller of your choice—either the HP 9000 Series 200/300 controller, the HP Vectra Personal Computer, or the HP-UX Workstation.

Data Management

Use HP Data Acquisition Manager to:

- Set up a database organized into archives, books, and pages
- Specify the format of books and pages
- Collect data over HP-IB, over GPIO, from the program, or from the keyboard
- Time-stamp and store the data into the database
- Document the data
- Retrieve the data from the database to display, analyze, or transmit it elsewhere



Data Analysis

Entire arrays of data captured over HP-IB or retrieved from the database can be analyzed quickly using the data analysis subroutines. Analysis functions available are:

- Scaling (mx+b)
- Limit checking
- Statistics (high, low, mean, standard deviation)
- Math (+, −, *, /)
- FFT and inverse FFT
- Temperature conversions (thermocouples, thermistors, RTDs)
- Strain gage conversions
- User-defined look-up tables
- Unpacking packed HP 3852 high-speed voltmeter readings

Supported Computers

HP BASIC and HP-UX Workstations:

Series 300 Model 370
Series 300 Model 360
Series 300 Model 350
Series 300 Model 340
Series 300 Model 332
Series 300 Model 330
Series 300 Model 320
Series 300 Model 319
Series 300 Model 310
Series 200 Model 236 (monochrome only)
Series 200 Model 220
Series 200 Model 217
Series 200 Model 216

Operating System for HP DACQ/300 and HP DACQ/UX

HP BASIC 5.0 or greater for the HP BASIC workstations
HP BASIC/UX 5.52 with HP-UX 7.0 for the HP-UX workstations
Basic Language Processor for HP DACQ/PC-BASIC emulators

Memory

1.5 MB or greater

Ordering Information

	Price
HP 44458A HP DACQ/300 software and manual, 3½-in and 5¼-in disks	$2,480
HP 44458R HP DACQ/300 manual and license to copy HP DACQ/300 software (HP 44458A or HP 44458B) for use on one other computer	$1,500
HP 44459A HP DACQ/PC software and manual, 3½-in and 5¼-in disks, requires HP 82300C Basic Language Processor	$1,840
HP 44459R HP DACQ/PC manual and license to copy HP DACQ/PC software (HP 44459A or 44459B) for use on one other computer	$1,140
HP 44460A HP DACQ/UX software and manual, ¼-in tape	$2,210
HP 44460R HP DACQ/UX manual and license to copy HP DACQ/UX software (HP 44460A) for use on one other computer	$1,350

- Up to 30 differential channels, 56 single-ended channels
- Electronic calibration for repeatable answers
- Built-in 5½-digit A/D converter with 1-μV sensitivity
- HP-IL (standard) and HP-IB (optional) with rear panel switch
- Optional 12-V remote charging adapter
- "Sleep mode" for extended battery life in remote locations
- Front terminals for convenient DCV, ACV, 2- and 4-wire Ω, frequency, and temperature
- Display shows channels closed, digital states, and self-test conditions

HP 3421A

HP 3421A Data Acquisition/Control Unit

If your measurement needs exceed the capabilities of plug-in cards but don't quite call for a top-of-the-line data acquisition unit, the HP 3421A is just what you are looking for. The HP 3421A is the instrument that beats the high cost of data logging. Use it for small data acquisition projects with the assurance that it will quickly pay its own way. The HP 3421A can be configured with several different computers into a variety of systems designed for low- to medium-size applications.

The Instrument

The HP 3421A scans up to 30 channels, measuring DCV, ACV, 2- and 4-wire Ω, frequency, and temperature. It also reads and writes digital information and stores up to 30 analog readings. The standard HP 3421A comes with an HP-IL interface for battery-powered flexibility or, optionally, an HP-IB for more computational power.

The HP 3421A is battery-powered with latching relays that will not change state when the ac line power is removed.

Up to three of the following assemblies may be added to the HP 3421A mainframe:

- 10-channel analog multiplexer/actuator assembly with thermocouple compensation
- 8-bit input/8-bit output digital assembly
- Breadboard assembly for custom circuitry

Measurement Integrity

With its 5½-, 4½-, 3½-digit A/D converter, the HP 3421A can resolve 1 μV out of 300 mV to monitor thermocouples and other low-level transducers. Or it can read higher-level signals by auto-ranging up to 300 V dc.

HP 3421A Mainframe Specifications

The HP 3421A mainframe comes with:

- A 5½-, 4½-, and 3½-digit integrating A/D converter
- Built-in counter
- Thermocouple compensation
- Type T thermocouple linearization built in
- HP-IL
- 30-reading storage buffer
- LCD 30 channel display with power and error indicators
- Electronic calibration
- Rechargeable battery
- High-level command set

All specifications apply for relative humidity less than 85 percent at 30° C

dc Voltage

Ranges: 300 mV, 3 V, 30 V, 300 V, Autorange
Basic accuracy: ±(.009% reading + 3 counts); 5½ digits
Reading rates: 2 to 35 readings/second

Ordering Information	Price
HP 3421A Data Acquisition/Control Unit	$3,060
Input and I/O Assembly Options	
Opt 020 8-Channel Multiplexer/2-Channel Actuator Assembly	+$680
Opt 021 9-Channel Multiplexer/1-Channel Actuator Assembly	+$680
Opt 022 10-Channel Multiplexer Assembly	+$680
Opt 040 Breadboard Assembly with connector block	+$160
Opt 050 8-Bit In, 8-Bit Out Digital I/O Assembly with Connector Block	+$680
Opt 201 Add HP-IB Interface. Allows use of either HP-IB or HP-IL controller.	+$550
Opt 214 Add 12 V Remote Charging Adapter. Cannot be added if Opt 201 is specified.	+$720
Field Installation Kits*	
HP 44461A: Add HP-IB Interface. Allows use of either HP-IB or HP-IL controller (same as Opt 201).	$550
HP 44462A: 8-Channel Multiplexer/2-Channel Actuator Assembly with thermocouple compensation, connector block. (Same as Opt 020. Can be reconfigured to same as Opt 021 or Opt 022.)	$680
HP 44463A: Extra Connector Block for HP 44462A	$80
HP 44464A: Breadboard Assembly with Connector Block (same as Opt 040)	$160
HP 44465A: 8-bit in, 8-bit out Digital I/O Assembly with Connector Block (same as Opt 050)	$680
HP 44466A: Extra Connector Block for Digital or Breadboard Assembly	$40
HP 44469A: Seven 10:1 dividers for measuring 300 Vac	$40
Accessories	
HP 11340A: 20-m HP-IL Cable	$170
HP 11340B: 50-m HP-IL Cable	$310
HP 11340C: 100-m HP-IL Cable	$610

* Field installation is recommended to be performed only by service trained personnel.

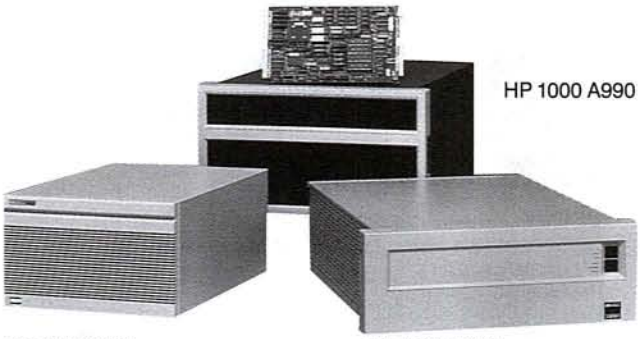
For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

TECHNICAL COMPUTER SYSTEMS

HP 1000 Computers for Real-Time Applications

- Computer-aided manufacturing
- Computer-aided testing
- Real-time monitoring and control
- Real-time data acquisition

HP 1000 A400
Single-Board Computer



HP 1000 Real-Time Computers

HP 1000 open-architecture computers are modular machines designed for real-time multiprogramming and multi-user applications in manufacturing, communications, research, and other fields that require real-time response. A choice of processors and a wide variety of interfaces and software equip HP 1000 computers to solve many different applications, taking advantage of HP 1000 real-time performance features to meet the most demanding needs of OEMs, system designers, and end users.

Fast, Efficient Handling of I/O

External sensors, measurement instruments, and other I/O devices connect to HP 1000 systems via I/O interfaces that implement multilevel, vectored hardware interrupts that expedite I/O. Each I/O channel has its own interrupt priority level from which interrupts directly initiate service programs. Direct memory access, controlled under a distributed-intelligence I/O design, speeds data transfers to and from memory with minimal involvement of the CPU.

Fast Processing of Data

HP 1000 systems can process data at base instruction rates up to 7 MIPS and floating-point processing speeds up to 1300 KWIPS-B1D. This minimizes the time needed to process input data, evaluate results, and initiate real-time action.

Clocked Operations Timing

Clocked operations timing is provided by timebase generator interrupts that maintain a real-time clock.

Large Main Memory Capacity

Up to 32 MB of main memory can be provided to keep most critical programs resident and ready to execute quickly, avoiding the delays inherent in moving programs to and from disk.

Powerful Real-Time Operating System

The RTE-A system supports memory-based or disk-based real-time multiprogramming operation with easy, efficient interprocess communication and priority-based scheduling of programs in response to event-interrupt, time-of-day, program, or user requests. RTE-A manages sharable memory-resident data arrays up to 2 MB and virtual data arrays up to 128 MB in main memory and on disk. With its VC+ extension, RTE-A supports execution of programs as large as 7.75 MB.

A Choice of Processors for Diverse Applications

Performance level	HP 1000 processor	Base speed (MIPS)	Floating-point speed (KWIPS-BID)	I/O B/W using DMA MB/s CP
1	A400	1	120	4.4
2	A900	3	820	3.7
3	A990	7	1300	4.0

HP A400 Minicomputer

The HP A400 minicomputer packs a 1.0 MIPS CPU, double-precision floating-point firmware, 0.5 MB of memory, and a 4-port serial I/O multiplexer onto a single plug-in board computer (SBC). At a price close to what you'd expect to pay for a personal computer, the HP A400 SBC delivers full A Series functionality, including support under the RTE-A real-time executive operating system and complete compatibility with all other members of the A Series family.

HP A900 Computer

The HP A900 computer is a 5-board set that incorporates a pipeline implementation and a cache memory scheme providing three times the base performance of the HP A400 computer and over seven times the floating-point performance. The HP A900's floating-point processor and scientific and vector instruction sets are built in. ECC memory is standard for maximum system integrity.

HP A990: A New Single-Board Processor

The HP A990 has been developed for customers who require even more performance than that provided by the HP A900. In addition to approximately doubled base speed and floating-point speed, the HP A990 also provides increased I/O bandwidth and significantly improved memory cycle time. The HP A990 is also available in the same package configurations as the current HP A900.

For those applications in which speed is critical, the HP A990, with its standard on-board writable control store, is also user-microprogrammable.

Customers who already have A Series computers can field-upgrade to the new HP A990 processor by purchasing the 12990C upgrade package. Also, customers upgrading from an HP A400, the discontinued HP A600+ or HP A700 to either an HP A900 or the new HP A990, will receive significant trade-in credits.

Exceptional Applications Flexibility

Programs can be developed on any member of the A Series family and executed without change on any other member, from the HP A400 up through the HP A990. Processing power, capacity, and even cost can be closely matched to application requirements with the guaranteed ability to grow as and whenever necessary.

Flexible Packaging: From Board Computers to System Processor Units

HP 1000 A Series processors are available in a variety of packaging configurations to meet the requirements of many different applications. (See the summary below.)

Processor	A400	A900	A990
Board computer	12100A	Not avail.	12990C (Upgrades only)
Micro 14 6-slot box computer	2424A	Not avail.	Not avail.
Micro 24/29/99 14-slot box computer system proc. unit	2434A 2484B	2439B 2489B	2939A 2989A
20-slot box computer	2134A	2139B	2959A
Model 29/99 system proc. unit in 20-slot	Not avail.	2199E	2999A
Configuration intended for rackmounting in either a tall or short rack cabinet. HP 29431G or HP 29429A, respectively			

Board Computers

Board computers make the HP A400 processor available to OEMs or system designers in a space-conserving package for either embedded controller applications, or for other uses in which custom integration is required either to fit within defined physical constraints or to meet cost objectives.

Box Computers

Box computers incorporate the CPU card(s) and memory in a fully powered card cage that can be installed in a rack cabinet. Because a system console and system disk are not prerequisite to purchase, the box computer offers OEMs and system designers more configuration flexibility than the system processor unit.

System Processor Units

System processor units (SPUs) include a box computer, interface to the system disk, the RTE-A operating system and diagnostics, site prep consultation and installation/checkout services, and a 90-day on-site warranty. The higher level of SPU integration simplifies design, ordering, and implementation of systems that use a system console and a system disk. The SPU also complies with FCC and VDE EMI regulations.

High-Density Memory

HP 1000 memory uses 1 MB DRAMs for their 2-, 4-, and 8-MB parity memory boards for the HP A400 and discontinued HP A600+ computers, and an 8-MB ECC memory board for the HP A900 and HP A990 computers.

HP A400 and the discontinued HP A600+ computers typically incorporate the less-expensive parity memory as the preferred memory system. For large systems in critical applications, Error Correcting Code (ECC) memory, which detects and corrects all single-bit errors and detects all double-bit errors to provide the best possible system integrity, is preferred. All HP A900s and HP A990s use ECC memory.

HP 1000 Software

HP 1000 software products for program development, database management, graphics, distributed systems networking, quality decision management, programmable controller communications, and process monitoring and control are supported on all HP 1000 A Series computers. This universality of HP 1000 software helps you to tailor comprehensive, coherent solutions to your specific application needs. Further help is available from a growing array of HP 1000 software products offered by third-party suppliers under the HP PLUS software program.

Program Development

With a hard disk and optional software, HP 1000 systems can be used to develop programs in BASIC, FORTRAN 77, Pascal, C, and Macro/1000 assembly language. Symbolic Debug/1000, program profiling, and user microprogrammability (in the HP A900 and HP A990 processors) provide extra capability that can be used to gain extra performance.

Computer Networking

HP's AdvanceNet software makes it easy to connect HP 1000 systems across a city or a continent, sharing vital information throughout the network. LAN link is now available for fast local-area communications with other HP systems or with DEC VAX systems.

Compatibility with HP 9000 Series 800 Systems

Applications migration consulting services are available from Hewlett-Packard to promote compatibility of the HP 1000 systems with HP 9000 Series 800 systems. Multiple HP 1000 systems used as factory floor cell controllers can thus benefit from supervision and support by HP 9000 Series 800 systems used as area managers at Level 2 in the CIM hierarchy, or in similar supporting host roles.

Plant Automation

The HP 1000 can help improve productivity and reduce costs. Hewlett-Packard's wide range of hardware and software supports automation of instruments and machines as well as monitoring and control of real-time processes. For low point-count data acquisition, A-Series measurement and control cards provide many analog interfacing functions within the computer, without need for add-on peripheral devices.

Automated Test Systems

HP automated test systems can be configured from HP 1000 A-Series computers and a wide range of electronic instruments to perform virtually any electronic test application.

Ordering Information	Price
HP 12100A HP A400 Single-Board Computer with 0.5 MB Parity Memory, 4-Port Multiplexer	from $2,600
HP 2989 HP A990 Micro/1000 System with 3 MB ECC Memory, RTE-A/VC+ Operating System, 20 MB Integral Disk, System Console Connected Via 8-Port Multiplexer	to $45,000

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

HP 12016A SCSI

The HP 12016A SCSI (Small Computer Systems Interface) provides connection to the industry-standard SCSI I and SCSI II peripheral interfaces for fast, efficient handling of I/O. Up to seven devices, including flexible and hard magnetic disk drives, optical disk drives, and magnetic tapes, can be connected to the HP 12016A.

In addition, the HP 12016A also provides:

- An interface that is compatible with all HP 1000 A Series computers and systems
- An interface to HP and non-HP low-cost SCSI peripherals
- Built-in DMA capability for optimum I/O efficiency
- DMA transfer rates up to 2.4 MB/s to both HP and non-HP SCSI peripherals
- Concurrent operation of multiple SCSI interfaces under control of the RTE-A operating system
- Factory-supported design environment for custom device drivers
- Supported cable lengths of 6 m for single-ended operation and 25 m for differential operation
- A calculated MTBF of greater than 50,000 hours
- A diagnostic kit for the HP 12016A, provided with the HP 12016A SCSI

Ordering Information	Price
HP 12016A SCSI	$1,495

GFoX: HP Graphics and Forms Terminal Emulator for X11

GFoX is a Graphics/1000-II (AGP/DGL) and Forms/1000 I/O device that runs in an HP-UX X11 environment. GFoX interprets many of the HP 2397A color graphics terminal escape sequences and includes many of its features such as dithering, line styles, and independent toggling of alphanumeric and graphics planes. Besides the HP 2397A features, GFoX supports many X11 features such as dynamically resizable window and inputs from various sources including a keyboard, stylus pen, or mouse. GFoX can be run over multiple Telnet or RS-232C connections, and has provided increased performance when using Telnet over other HP 1000 graphics I/O solutions. GFoX is user-configurable either interactively or through the use of a .Xdefaults file.

GFoX allows customers to leverage existing real-time applications into an HP-UX (UNIX) environment since it runs on the HP 9000 Series 300 (345 and above), Series 400 and 700, and Series 800 (825 and above). It also runs on HP 700/RX X-Terminals.

Graphics applications using GFoX requires RTE-A revision 5.2 or later. (ARPA/1000 or NS-ARPA/1000 require 5.24 or later.)

SoftBench Link/1000 Encapsulation

SoftBench Link/1000 encapsulation is an HP 1000 product based on the industry-standard X Window system that transparently integrates the HP 1000 into the SoftBench environment for HP-UX. It is designed for RTE-A application developers who must provide ongoing maintenance of existing RTE-A application software projects, in addition to those undertaking new RTE-A application development.

SoftBench is an extensible software development environment featuring a tool integration platform that supports the integration of many tools into a common development environment.

SoftBench Link/1000 Encapsulation in conjunction with SoftBench provides a core set of tools for RTE-A application construction, test, and maintenance. It supports program development for the HP 1000 in FORTRAN 77, Macro/1000, and C/1000, and integrates the Debug/1000 debugger into the SoftBench environment for HP-UX.

In addition to reduced code development time, improved quality control of software analysis, design and documentation, and the access to additional development tools, SoftBench Link/1000 Encapsulation provides customers the productivity advantage of rapid interactive program development.

HP C Compiler

The new HP C Compiler, the HP C/1000, is the latest programming development tool available for the HP A Series computer. HP C/1000 increases investment savings in software by leveraging the C programming experience and through the portability of programs from other platforms.

HANDHELD COMPUTATION PRODUCTS

Calculators & Personal Information Management Products

HP 95LX

HP 95LX Palmtop PC

From your desktop PC, transfer documents, letters, Lotus® 1-2-3® worksheets, and other files into the HP 95LX palmtop. Choose either the 512-KB RAM or 1-MB RAM version. Both feature 1 MB of ROM, a serial interface, an easy-to-read 16-row by 40-column display, and a QWERTY-style keyboard with separate numeric keypad. Power is supplied by two AA batteries and one 3-V coin cell backup battery. A plug-in slot allows you to add other software applications or up to 2 MBs of RAM for file storage. Sized at 16 × 8.64 × 2.54 cm (6.3 × 3.4 × 1 in) (closed) and weighing 312 g (11 oz), both versions of the HP 95LX are truly portable PCs that are convenient enough to take with you anytime, anywhere.

Additional Specifications

Includes MS-DOS® 3.22 in ROM. Plug-in slot conforms to PCMCIA 1.0 and JEIDA 4.0 standards. IBM PC-XT architecture. Seven one-key access application keys. Built-in 3-wire serial interface for connection to RS-232 devices. Built-in infrared transmitter/receiver. Built-in data communications software including VT-100 terminal emulation, ANSI terminal emulation, TTY terminal emulation, Kermit protocol, and XMODEM protocol. Built-in print driver sets support HP LaserJet, Epson FX-80, and IBM Proprinter.

Built-in Software

Lotus® 1-2-3® Release 2.2

Use, edit, or create large worksheets and graphs. Use database commands. Create and execute macros. Link files. Note: Allways™, PrintGraph, and Translate are not included.

Appointment Book

Keep daily schedules; repeat appointments weekly, monthly, or yearly. Set alarms. Check and carry over to-do lists. Check local time in over 250 cities worldwide. Use as a timer or stopwatch.

Phone Book

Access alphabetical lists of names and phone numbers. For each name, keep a card of information: Address, job title, birthday, or whatever you want. Use this database capability to create additional useful lists.

Memo Editor

Create a memo, note, or letter. Edit ASCII-format transferred from your PC. Line width up to 240 characters. Contains standard word-processing features: Word wrap, cut and paste, insert/overwrite, tabs, and page break.

HP Financial Calculator

Do arithmetic and general math functions. Perform TVM calculations and currency or other unit conversions. Use HP Solve to create customized equations. Technical math functions include trig, exponentials, and logarithms. Choose RPN or algebraic data entry.

Data Communications

Access your company's e-mail system. Built-in configuration files include connections to CompuServe™, Dow Jones News/Retrieval, or MCI Mail. Automate logon using a script file. Optional products offer wireless messaging via national, regional, or local paging services.

Filer

Create, rename, and move among directories. View, copy and move, delete, or sort files. Transfer files to and from another HP 95LX or an IBM-compatible PC. Use split-screen feature to simplify file management tasks.

Setup Utility

Adjust display contrast, memory allocation, and beeper volume. View battery level. Set date and time formats and specify punctuation, language, keyboard, and currency settings. Create customized user keys.

Ordering Information

	Price
HP F1000A HP 95LX 512-KB version	$550
HP F1010A HP 95LX 1-MB version	$800
Opt ABA designates U.S. version	
HP F1001A Connectivity Pack, HP 95LX to IBM and IBM-Compatible PCs	$100
HP 82222A Serial Interface Cable, HP Handheld to IBM and IBM-Compatible PCs	$35
HP 82224A Serial Cable Adapter Kit, HP Handheld to Modems and Printers	$15
HP F1002A 128-KB RAM Card	$150
HP F1003A 512-KB RAM Card	$300
HP F1004A 1-MB RAM Card	$600
HP F1005A Dictionary/Thesaurus Card	$150
HP F1006A Mobile Data Link for the HP 95LX to NewsStream* Receiver	$120
HP F1009B Skystream Receiver and Mobile Data Link	$525
HP 82241A ac Adapter (U.S./Canada, 110 V, 50 to 60 Hz)	$15
Opt ABA	
F1000-90003 Owner's Manual and Quick Start Guide, English	$25

In the U.S., to locate the retailer nearest you, call 800-443-1254.

*NewsStream Advanced Information Receiver, a product of Motorola, Inc., is sold separately.

HP 48 Scientific Calculator Family

No other calculator comes close to matching the features of the HP 48S and HP 48SX, which are designed especially for engineering professionals, students, and educators. The HP Equation Writer application enables you to enter equations just as they appear on paper. Graphics and calculus are combined like never before to enable you to find roots, intersections, local extremes, slopes, areas, and derivatives while you view a graph of the equation. Easy unit management lets you enter constants and variables in the units you are given and get the answer in the units you want. With the HP MatrixWriter application, it's easy to enter and view large matrices. Symbolic math functions enable you to solve for variables in your equation before entering their numeric values. And with HP Solve you can enter your own equations and solve for any variable to explore "what-if" scenarios. An RS-232C serial port provides you with a link to your desktop computer for file exchange or program development. The HP infrared I/O offers wireless communication to another HP 48 or optional HP Infrared Printer. Both products have a large 8-line, 22-character dot-matrix display, RPN entry system, over 2100 built-in functions, and 32 KB of built-in RAM. In fact, the only difference between the HP 48S and the HP 48SX is the plug-in expansion option offered on the HP 48SX. With this option on the HP 48SX, you can increase RAM up to 288 KB or customize with up to 256 KB of plug-in application cards.

Ordering Information	Price
HP 48S Scientific Calculator (RPN)	$199
HP 48SX Expandable Scientific Calculator (RPN)	$350
Opt ABA designates U.S. version	
HP 82240B Infrared Printer	$135
HP 82208A Serial Interface Kit, IBM and IBM-Compatible PCs (cable and disk)	$60
HP 82208B Program Development Kit, IBM and IBM-Compatible PCs (cable and disk)	$120
HP 82209A Serial Interface Kit, Apple Macintosh Computers (cable and disk)	$60
HP 82222A Serial Interface Cable, HP Handheld to IBM and IBM-Compatible PCs (cable only)	$35
HP 82223A Serial Interface Cable, HP Handheld to Apple Macintosh Computers (cable only)	$35
HP 82224A Serial Cable Adapter Kit, HP Handheld to Modems and Printers	$15
HP 82210A HP 41CV Emulator Card (HP 48SX only)	$100
HP 82211A HP Solve Equation Library Application Card (HP 485X only)	$100
HP 82214A 32-KB Battery-Backed RAM Card (HP 48SX only)	$60
HP 82215A 128-KB Battery-Backed RAM Card (HP 48SX only)	$150
HP 82220A HP 48S/SX Overlay Kit	$15
HP 82221A Soft Case for HP 48S/SX	$15
HP 00048-90003 HP 48S/SX Owner's Manual, English (2 volumes)	$20
HP 00048-90054 HP 48 Programmer's Reference Manual	$20
HP 82211-90001 HP Solve Equation Library Application Card Owner's Manual, English (HP 48SX only)	$10
Additional Technical Calculators	
HP 20S Scientific Calculator (algebraic) (a program library to solve challenging problems)	$40
HP 32SII Scientific Calculator (RPN) (the RPN advantage at the lowest price)	$70
HP 42S Scientific Calculator (RPN) (the engineer's best tool for matrix math)	$120
HP 82240B Infrared Printer (works with HP 42S)	$135
Opt ABA designates U.S. version	
Business Calculators	
HP 10B Business Calculator (algebraic) (the economical choice for business)	$40
HP 12C Business Calculator (RPN) (the time-tested performer)	$95
HP 17BII Business Calculator (algebraic and RPN) (the practical, easy-to-use tool for RE/Finance)	$110
HP 19BII Business Calculator (algebraic and RPN) (the premier tool for commercial RE, banking and finance)	$175
HP 82240B Infrared Printer (works with HP 17BII and HP 19BII)	$135
Opt ABA designates U.S. version	

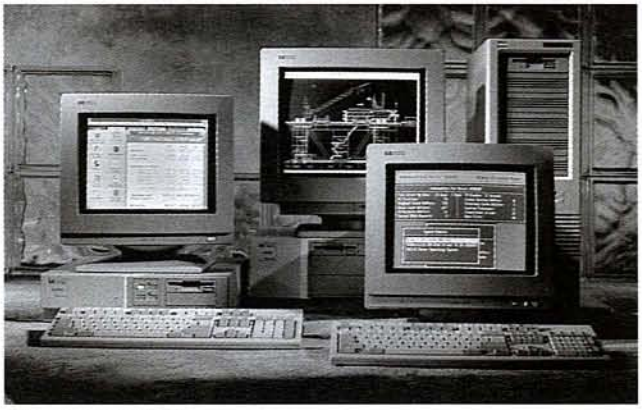
In the U.S., to locate the retailer nearest you, call 503-752-7736.

Additional accessories for the above calculators and for some obsolete calculators are available. These include owner's manuals, solutions books, application manuals, cases, battery packs, and re-chargers. Consult your local retailer for additional information on what's available.

For the most current prices and product information, contact your local Hewlett-Packard sales office, see page 665.

PCs & PC NETWORKING PRODUCTS

HP Vectra PC Overview



HP Vectra PC family

Network Server PC

Based on the 486 CPU, this deskside PC works as a powerful network and multiuser system server or as a sophisticated standalone system for extremely demanding technical and business applications. This PC is fully expandable, so you can easily add more internal storage or accessories to increase your productivity.

HP Vectra 486/33T PC: The Full-Power PC for LAN Users

CPU: 33-MHz, 32-bit, Intel486 microprocessor
Coprocessor: Integrated 80387-compatible coprocessor
Memory: HP's custom burst-mode memory controller, expandable from 4 to 64 MB on a single memory board
Memory Cache: 8 KB internal cache, 128-KB external cache memory
Expansion Slots and Mass Storage: Eight EISA accessory slots, six half-height mass storage shelves, 84 to 2000 MB IDE or SCSI-2 drives
LAN Capabilities: Certified with Novell and Banyan network operating systems
Video: Flexible video solution
Operating Environments: Certified with Novell and Banyan network operating systems; tested with Microsoft LAN Manager 2.1

Advanced PCs

These desktop systems bring advanced functionality and superior price/performance to office and technical users. Whether used as standalone or networked PCs, they offer plenty of expandability for internal accessories, superb security and ergonomics, and leading system and graphics performance for a full range of office productivity and technical applications.

HP Vectra 386/25 PC: HP's Most Powerful 386 PC

CPU: 25-MHz, 32-bit, Intel386 microprocessor
Memory: 2 MB of base memory expandable to 32 MB on system board; 42 to 336 MB of Internal hard disk capacity, with 16 ms average seek time
Memory Cache: 32 KB of high-speed cache memory
Operating Environments: Compatible with MS-DOS®, OS/2®, SCO™ UNIX® System V/386, SCO Xenix
Video: Super VGA video adapter with 800 × 600 resolution
Expansion Slots and Mass Storage: Five accessory slots, three mass storage shelves

HP Vectra 486s/20 PC: The PC for Advanced Power Computing

CPU: 20-MHz, Intel486 SX microprocessor
Memory: 4 MB of base memory, expandable to 64 MB on system board; 52 to 860 MB of internal hard disk capacity, with 14 ms average seek time
Memory Cache: 8-KB internal cache memory
Video: Ultra VGA video controller with 1024 × 768 and 800 × 600 resolutions
Expansion Slots and Mass Storage: Five accessory slots, four mass storage shelves, 52 to 860 MB of internal hard disk capacity with 14 ms average seek time
Ergonomics: Flicker-free video modes, temperature-controlled fans
Serviceability: Hinged chassis for easy access; BIOS stored in flash EPROM
Upgradability: Upgradable to HP Vectra 486U PC Series
Security: Control over conf, screen display, data I/O and network

HP Vectra 386s/20 PC: A Flexible 386 SX PC for Office and Technical Users

CPU: 20-MHz, Intel386 SX microprocessor
Memory: 2 MB of RAM, expandable to 16 MB on system board; 128 K of ROM for system and video BIOS shadowed with RAM
Memory Cache: Memory cache controller with 16 KB of static RAM
Video: Integrated Super VGA with 800 × 600 in up to 16 colors and 640 × 480 in up to 256 colors at 60 Hz or 72 Hz; 1024 × 768 noninterlaced in up to 16 colors at 60 Hz or 70 Hz
Expansion Slots and Mass Storage: Five 16-bit ISA accessory slots, four mass storage shelves, 52 to 480 MB of internal hard disk capacity with 17 ms average seek time
Security: Easy-to-use disk and port access control, pushbutton keyboard lock and screen blanking, separate user and administrator passwords
Ergonomics: Functions as both desktop and deskside systems, low-noise fan
Serviceability: Hinged chassis design for easy access
Upgradability: Upgradable to HP Vectra 486U PC Series

HP Vectra 486U PC Series (486/25U, 486/33U, 486/50U, 486/66U): The Ultimate Desktop PCs for Windows and CAD

CPU: 25-MHz Intel486 SX, 33-MHz Intel486 DX, 50-MHz Intel486 DX2, and 66-MHz Intel486 DX2 microprocessors
Memory: 4-MB base memory, expandable to 64 MB on system board
Memory Cache: 128-KB write-thru cache, 8-KB integrated cache
Video Subsystem: Local bus Ultra VGA + supports 1024 × 768, 800 × 600, noninterlaced, and 640 × 480 resolutions in 16 or 256 colors
Expansion Slots and Mass Storage: Four mass storage shelves, five EISA slots, 85 to 860 MB of internal hard disk capacity with 14 ms average seek time
Serviceability: Hinged chassis for easy access; BIOS stored in flash EPROM
Upgradability: HP Universal Processor Upgrade Socket accepting Intel487 SX, Intel486 DX, DX2, and Overdrive Chips
Security: Control over configuration, screen display, data I/O, and network

Network-Ready PCs

HP's network-ready PCs have integrated network and security features that make them ideal clients. They've already been tested in a variety of networked environments and support all of the major networking standards. Thus, you can connect them today, or have the assurance that they'll be ready to plug and use in the future. Their special ergonomic features help ensure high productivity in demanding office environments.

HP Vectra 386/16N, 386/20N, and 386/25N PCs: PCs That Are Ready to Network When You Are

CPU: 16-, 20-, and 25-MHz 32-bit Intel386 SX microprocessors
Memory: 2 to 4 MB base memory, expandable to 16 MB on system board; 52 to 240 MB of internal hard disk capacity, with 16 ms average seek time
Memory Cache: 16 KB of high-speed cache memory (20N/25N only)
LAN Capabilities: Certified with Novell, Microsoft® LAN Manager, Banyan VINES, DEC PathWorks, SCO UNIX, and Artsoft LANtastic network operating systems, plus leading Ethernet, Arcnet, and Token Ring network adapter cards
Security: Easy-to-use disk and port access control, pushbutton keyboard lock and screen blanking, separate user and administrator passwords
Ergonomics: Front-accessible control panel, flicker-free video, low-noise fan
Upgradability: Upgradable to future HP Vectra 486 PCs via system board swap
Video: Integrated Super VGA Video supporting 800 × 600 resolution in 16 colors at 60 Hz or 72 Hz
Expansion Slots and Mass Storage: Three 16-bit ISA accessory slots, two mass storage shelves, 52 to 240 MB of internal hard disk capacity with 17 ms average seek time
Serviceability: Snap-on chassis design for easy access

HP Vectra PC Matrix

HP Vectra PC	Model number[1]	Product number	Processor	Standard memory	Package type[2]	Flexible disk size (MB)	Hard disk (MB)	Video adapter
386/16N	0	D2470A	80386SX	2 MB	D	None	None	Super VGA[3]
	1	D2474A	(16 MHz)	2 MB	D	3.5 in (1.44 MB)	None	Super VGA[3]
	50	D2472A		2 MB	D	3.5 in (1.44 MB)	52	Super VGA[3]
	50L[4]	D2473B		2 MB	D	3.5 in (1.44 MB)	52	Super VGA[3]
386/20N	0	D2480A	80386SX	2 MB	D	None	None	Super VGA[3]
	1	D2486A	(20 MHz)	2 MB	D	3.5 in (1.44 MB)	None	Super VGA[3]
	50	D2482A		2 MB	D	3.5 in (1.44 MB)	52	Super VGA[3]
	50L[4]	D2483B		2 MB	D	3.5 in (1.44 MB)	52	Super VGA[3]
	120	D2484A		2 MB	D	3.5 in (1.44 MB)	120	Super VGA[3]
386/25N	0	D2490A	80386SX	4 MB	D	None	None	Super VGA[3]
	1	D2496A	(25 MHz)	4 MB	D	3.5 in (1.44 MB)	None	Super VGA[3]
	80[6]	D2492A		4 MB	D	3.5 in (1.44 MB)	85 MB	Super VGA[3]
	80L[5,6]	D2493A		4 MB	D	3.5 in (1.44 MB)	85 MB	Super VGA[3]
	170	D2494A		4 MB	D	3.5 in (1.44 MB)	170 MB	Super VGA[3]
386s/20	1–3	D2514A	80386SX	2 MB	D	3.5 in (1.44 MB)	None	Super VGA[3]
	1–5	D2515A	(20 MHz)	2 MB	D	5.25 in (1.2 MB)	None	Super VGA[3]
	50	D2512A		2 MB	D	3.5 in (1.44 MB)	52 MB	Super VGA[3]
	120	D2513A		2 MB	D	3.5 in (1.44 MB)	120 MB	Super VGA[3]
386/25	1	D2360A	80386	2 MB	D	5.25 in (1.2 MB)	None	None
	1	D2371A	(25 MHz)	2 MB	D	3.5 in (1.44 MB)	None	None
	80	D2363A		2 MB	D	5.25 in (1.2 MB)	84	Super VGA
	80	D2361A		2 MB	D	3.5 in (1.44 MB)	84	Super VGA
	170	D2364A		2 MB	D	5.25 in (1.2 MB)	168	Super VGA
	170	D2362A		2 MB	D	3.5 in (1.44 MB)	168	Super VGA
486s/20	1	D2260A	80486SX	4 MB	D	3.5 in (1.44 MB)	None	Ultra VGA
	1	D2261A	(20 MHz)	4 MB	D	5.25 in (1.2 MB)	None	Ultra VGA
	120	D2262A		4 MB	D	3.5 in (1.44 MB)	120	Ultra VGA
	430	D2264A		4 MB	D	3.5 in (1.44 MB)	430	Ultra VGA
	120 turbo	D2265A	80487SX	4 MB	D	3.5 in (1.44 MB)	120	Ultra VGA
486/25U	1	D2266A	80486SX	4 MB	D	3.5 in (1.44 MB)	None	Ultra VGA+
	120	D2268A	(25 MHz)	4 MB	D	3.5 in (1.44 MB)	120 MB IDE	Ultra VGA+
	240	D2269A		4 MB	D	3.5 in (1.44 MB)	240 MB IDE	Ultra VGA+
4886/33U	1	D2272A	80486DX	4 MB	D	3.5 in (1.44 MB)	None	Ultra VGA+
	120	D2274A	(33 MHz)	4 MB	D	3.5 in (1.44 MB)	120 MB IDE	Ultra VGA+
	240	D2275A		4 MB	D	3.5 in (1.44 MB)	240 MB IDE	Ultra VGA+
486/50U	1	D2278A	80486DX2	4 MB	D	3.5 in (1.44 MB)	None	Ultra VGA+
	240	D2280A	(50 MHz)	4 MB	D	3.5 in (1.44 MB)	240 MB IDE	Ultra VGA+
	430	D2281A		4 MB	D	3.5 in (1.44 MB)	430 MB SCSI	Ultra VGA+
486/66U PC	1	D2284A	80486DX2	4 MB	6-D	3.5 in (1.44 MB)	None	Ultra VGA+
	240	D2286A	(66 MHz)	4 MB	6-D	3.5 in (1.44 MB)	240 MB	Ultra VGA+
	430	D2287A		4 MB	6-D	3.5 in (1.44 MB)	430 MB	Ultra VGA+
486/33T	1	D2236A	80486	4 MB	F	3.5 in (1.44 MB)	None	None
	1	D2237A	(33 MHz)	4 MB	F	5.25 in (1.2 MB)	None	None
	170	D2238A		4 MB	F	3.5 in (1.44 MB)	168	None
	440	D2239A		4 MB	F	3.5 in (1.44 MB)	440	None
	1000	D2240A		4 MB	F	3.5 in (1.44 MB)	1.0 GB	None

[1] Note: A language option must be specified when ordering an HP Vectra PC (for example, Option ABA for U.S. English).
[2] D = desktop, F = floor-standing
[3] Super VGA integrated on motherboard
[4] Includes 8-bit HP EtherTwist network adapter card
[5] Includes 16-bit HP EtherTwist network adapter card
[6] Includes Microsoft DOS 5.0 and Windows 3.1 plus HP mouse

PCs & PC NETWORKING PRODUCTS

HP Vectra PC Matrix (cont'd)

HP Vectra PC Accessories

Option	Product Number	HP Vectra 486/33T	HP Vectra 486/66U 50U, 33U, &25U	HP Vectra 486s/20	HP Vectra 386/25 PC	HP Vectra 386s/20	HP Vectra 386/25N	HP Vectra 386/20N	HP Vectra 386/16N
Memory									
2-MB Memory Expansion Kit	D2406A					X	X	X	X
8-MB Memory Expansion Kit	D2404A					X	X	X	X
1-MB Memory Module	D2150A	X		X					
2-MB Memory Module	D2381A	X	X	X	X				
4-MB Memory Module	D2156A	X		X					
8-MB Memory Module	D2152A	X	X	X	X				
1-MB Memory Expansion Kit	D1640A								
4-MB Memory Expansion Kit	D1642A								
Mass Storage									
5¼-in, 1.2-MB Flexible Disk Drive	45812A	X			X				
3½-in, 1.44-MB Flexible Disk Drive	D1667A	X			X				
42-MB IDE Disk Drive	D1665A	X			X				
84-MB IDE Disk Drive	D1666A	X			X				
120-MB IDE Disk Drive†	D1679A	X			X				
168-MB IDE Disk Drive†	D1680A	X			X				
330-MB ESDI Disk Drive	D1660A	X							
670-MB ESDI Disk Drive	D1661A	X							
440-MB SCSI-2 Disk Drive	D1685A	X							
670-MB SCSI-2 Disk Drive	D1686A	X							
1-GB SCSI-2 Disk Drive	D1687A	X							
ESDI Controller	D1664A	X							
Flexible Disk Expander	D1678A								
5¼-in, 1.2-MB Flexible Disk Drive	D2036A		X	X		X			
3½-in, 1.44-MB Flexible Disk Drive	D2035A		X	X		X	X	X	X
52-MB, 3½-in IDE Disk Drive	D1694A			X		X	X	X	X
85-MB, 3½-in IDE Disk Drive	D2329A						X		
120-MB, 3½-in IDE Disk Drive	D1696A		X	X		X	X	X	X
170-MB, 3½-in IDE Disk Drive	D2330A						X		
240-MB, 3½-in IDE Disk Drive	D1697A		X	X		X	X	X	X
430-MB, 3½-in SCSI-2 Disk Drive	D1699A		X	X		X			
EISA SCSI Host Bus Adapter	D1681A	X	X	X					
ISA SCSI Host Bus Adapter	D1682A	X	X	X	X	X			
120-MB Tape Drive, (5-pack)	D2045A	X	X	X	X	X			
525-MB SCSI Tape Drive, (5-pack)	D2034A	X	X	X	X	X			
3½-in Drive Trays, (5-pack)	D2037A		X	X		X	X	X	X
5¼-in Drive Trays, (5-pack)	D2038A		X	X		X			
Coprocessors									
387SX/16 MHz	D1453A								X
387SX/20 MHz	D2403A					X		X	
387SX/25 MHz	D2408A						X		
387/25 MHz	D2070A				X				
487SX/20 MHz	D2162A			X					

HP Vectra PC Upgrades

		486/50U	486/33U	486/25U	486s/20	386s/20
Processor Upgrades						
Intel486DX/33	D2169A			X		
Intel OverDrive/25 (Upgrade to 50 MHz)	D2171A		X	X		
Intel OverDrive/33 (Upgrade to 66 MHz)	D2172A	X	X	X		
System Board Upgrades						
HP Vectra 486/25U	D2173A				X	X
HP-Vectra 486/33U	D2174A				X	X
HP Vectra 486/50U	D2175A				X	X
HP Vectra 486/66U	D2176A				X	X

HP Vectra PC Product Line Accessories

	Product Number
HP Monochrome VGA Display (page white)	D1192A
HP Super VGA Display (integrated tilt/swivel)	D1194A
HP Ergonomic Super VGA Display (integrated tilt/swivel)	D1195A
HP Ultra VGA 17-in Display (1024 × 768)	D1193A
VGA Video Extension Cable (2 m) (for D1192A, D1193A, D1194A, and D1195A)	D1184A
20-in High Resolution Monitor (up to 1280 × 1024)	D1187A
Tilt/Swivel Base for 20-in Color Display	D1189A
Video Cable, 15-pin to 5 Line BNC (required to connect high resolution monitors with Super VGA or Ultra VGA Controller)	D1191A
256 KB DRAM Upgrade Kit for HP Super VGA (for D2382A and HP Vectra 386s/20)	D2383B
Ultra VGA Board: 0.5 MB VRAM	D2325A
0.5 MB VRAM Upgrade Kit for Ultra VGA Controller	D2326A
MS-DOS® 5.0 (3½-in and 5¼ in disks)	D1152A
HP NewWave 3.0	D1704B/ABA
HP Mouse with Mini-DIN Interface	C1413A

HP EtherTwist Network Hardware Products

HP Network Server PCs

The HP Vectra 486/33T PC combines minicomputer features, HP's legendary quality, and a 1-year, on-site limited warranty* into a high-performance server designed for your mission-critical environments. The extended industry standard architecture (EISA) I/O bus is 32 bits wide, helping the I/O subsystem keep pace with the 33-MHz Intel486 processor. A full 64 MB of RAM are available to handle memory-hungry network applications. The solid internal connections of the expansion slots can handle the frequent reconfigurations that are all part of a server's job, while the heavy-duty 360-W (peak) power supply manages the demanding loads placed on the server.

HP Advanced PCs

The HP Vectra 486s/20 PC is built with a 32-bit, 20-MHz Intel486SX microprocessor to satisfy the most demanding needs for power and speed at an affordable price. Designed to function as either a desktop client or deskside server, the HP Vectra 486s/20 PC offers easy-to-use security features, ergonomic design, full compatibility with a wide variety of operating systems, and a 1-year, on-site limited warranty. Its high-performance video controller—optimized for graphics-intensive applications—and fast IDE drives make it ideal as a cost-effective power client. With its EISA architecture, SCSI-2 hard disks, and memory expansion of up to 64 MB, the HP Vectra 486s/20 PC is an excellent choice for a midrange PC network server.

HP Client PCs

The HP Vectra 386/16N, 386/20N, and 386/25N PCs put the dynamic power of the Intel386SX in a new, slimline design for today's most critical business applications. With convenient built-in network and security features, these computers are ideal client PCs on a network. They include, for example, simple plug-and-play setup for both HP-only and multivendor network environments. They have been tested and certified with a variety of network operating systems, cards, and media to meet the most stringent network compatibility standards. There are also multiple levels of security to ensure confidentiality for the individual and for the entire network. Their enhanced ergonomic design makes them easier to set up and use, with integrated HP Super VGA, reduced noise emission, and even built-in software utilities.

HP Storage System, HP DAT PC Backup Solution, and HP Digital Audio Tape (DAT) Drives

The HP storage system brings the full functionality and diagnostics of the minicomputer environment to network and multiuser PCs. The system includes a wide selection of large-capacity external SCSI-2 devices, all of which are remarkably reliable and easy to use. Designed to extremely exacting standards, the mean-time-between-failure (MTBF) rate on HP hard disk drives—ranging from 234 MB to 1.3 GB—is an industry-leading 150,000 hours.

The HP DAT PC Backup Solution provides a quick and easy way to back up all the data on your PC network. It brings you unattended, fully automated and scheduled backup and is compatible across a wide range of systems. The complete solution uses a 2-GB drive, so you can back up 300 MB in 30 minutes and access any file in an average of 30 seconds.

HP's DDS-format digital audio tape (DAT) drives provide fast, unattended operation and encourage frequent backups. The new HP DDS-DC tape drive provides data compression and the ability to back up 8.0 GB of data in three hours—four times the performance of HP's standard DAT. Both drives employ three levels of error correction, plus read-after-write recording technology to ensure data integrity.

HP EtherTwist Hubs, Bridges, Routers, and Network Management

The HP EtherTwist Hub/8, 12-port Hub Plus, Hub Plus/48, ThinLAN Hub Plus, and FiberOptic Hub Plus are the central components of HP's family of 10Base-T and Ethernet networking products. Because these matched components don't require a card cage, you can build your network without a large upfront investment and then expand simply and easily at fixed-cost increments. The HP EtherTwist Hub Plus products and the HP Fiber-Optic Hub Plus all work with HP OpenView Hub Manager to give you full network management capability. For expanding your network, the HP 10:10 LAN Bridge, 10:10 LAN Bridge LB, Remote Bridge, Router ER, and Router TR all enable you to connect local and remote networks into a single, integrated communication system. These products are managed by HP OpenView Interconnect Manager software, which—with HP OpenView Hub Manager—provides convenient, centralized control of all hubs, bridges, and routers in your network, whether from HP or other suppliers. The result is an interface for managing multivendor connections from the workgroup to the wide-area network.

HP EtherTwist LAN Adapter Cards

The HP EtherTwist LAN Adapter cards provide a direct connection for turning PCs with AT and Micro Channel backplanes into clients on a 10-Mb-per-second twisted-pair Ethernet network. The HP EISA LAN Adapter/32TP increases throughput and reduces the CPU utilization of EISA-based servers.

The HP PC LAN Adapter/16TP Plus and Adapter/8TP optimize network performance in small- to medium-sized workgroups. HP EtherTwist LAN adapter cards support many of the popular software environments, such as Novell NetWare,* Microsoft LAN Manager, and SCO™ UNIX.*

HP EtherTwist Transceivers

HP EtherTwist transceivers provide easy and quick connections to twisted-pair, fiber-optic, or thin coaxial LAN cable networks. The transceivers easily extend your network by allowing Ethernet-compatible devices with an AUI port, such as PCs, workstations, hubs, and bridges, to be connected quickly and cost effectively. These compact transceivers fit where larger, bulkier transceivers wouldn't even be a consideration.

HP LaserJet Network Printers

The HP LaserJet IIISi printer—designed to meet the needs of network users—combines high performance, high volume, and flexible paper handling into a 17-page-per-minute "business speed" printer. Engineered for printing volumes of up to 50,000 pages per month, its RISC-based formatter ensures that most documents are processed at top engine speed. In addition, resolution enhancement technology and new microfine toner deliver sharp 300 dpi print quality that challenges 600 dpi. For increased flexibility, the HP LaserJet IIISi printer offers users in shared environments the ability to switch between PCL 5 and optional PostScript® via software, from any workstation.

HP JetDirect Cards

The HP JetDirect cards allow HP LaserJet printers and other HP network-ready peripherals to be connected anywhere on the PC network. In addition to convenience and security, the HP JetDirect cards boost network printing performance and network performance by offloading the file server. The HP JetDirect cards support many popular environments including Novell NetWare, LAN Manager, LAN Server, 3Com 3+Open, SunOS, SCO UNIX, and HP-UX.

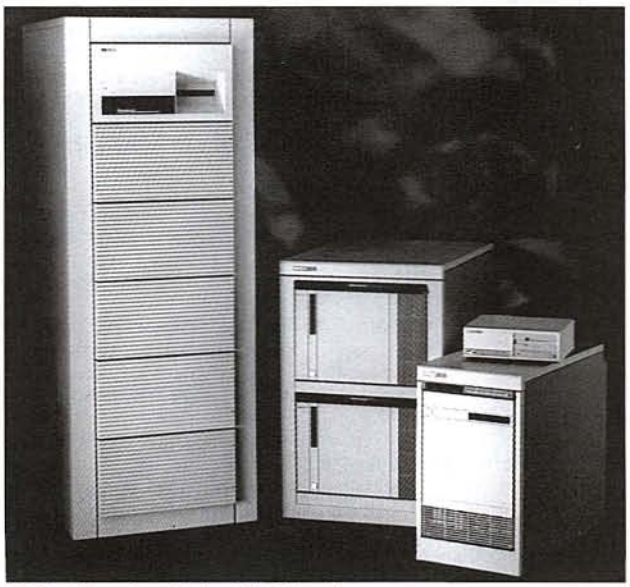
HP NewWave Software

The premier desktop manager for Windows, NewWave 4.0 tracks all the DOS/Windows files and programs on your system and lets you organize information in folders by subject, project or any way you want . . . like in a real office.

NewWave makes it easy for you to share and access information across a network, as well as to automate repetitive network administration tasks, such as performing backups or generating reports about network status. NewWave works with Microsoft Windows and is fully compatible with virtually all industry-standard PC hardware and software.

* Limited warranty available on the HP Vectra 486/33T, 486/25T, 486s/20 PCs, and the HP Vectra 486U PC Series.

MASS STORAGE DEVICES
Secondary Storage



HP Multifunction Optical Disk Family

Optical Disk Libraries and Drives

Direct-Access Secondary Storage

Hewlett-Packard's family of optical products spans the 5¼-in multifunction, optical storage spectrum—from the single-disk 650 MB drive to the 144-disk, 93.6 GB library. Optical libraries offer immediate access to files that would customarily consume hard disk space or reside offline in a tape vault. Multifunction capability allows both rewritable and write-once operations in a single library.

Durable, Industry-Standard Media

The 5¼-in magneto-optical disks used in the optical product family are compact and removable, simplifying storage and transport. Data is not susceptible to head crashes, most magnetic interference, or damage from common office mishandling. HP optical products conform to ANSI and ISO Continuous Composite format standards, and use a SCSI interface.

Ordering Information	Price
HP C1701M Model 650 Desktop Optical Disk Drive, 650 MB	$4,995
HP C1708C Model 10LC High-Performance Entry-Level Library, 16-disk, 10.4 GB (not shown above)	$9,495
HP C1703A Model 10 Optical Library, 16-Disk Capacity, 10.4 GB	$14,600
HP C1700A/M/C Model 20 Optical Library, 32-Disk Capacity, 20.8 GB	$31,800
HP C1704A/M/C Model 60 Optical Library, 88-Disk Capacity, 57.2 GB	$73,100
HP C1705A/M/C Model 100 Optical Library, 144-Disk Capacity, 93.6 GB	$99,900

Contact your HP representative for details on available options.

HP Series 6400 Models 2000 and 2000DC

HP DAT System Backup Solutions

The HP Series 6400 Models 2000 and 2000DC digital data storage (DDS) format tape drives are based on digital audio tape (DAT) technology. The Model 2000 is a low-cost, unattended backup solution for all levels of workstation, workstation servers, and entry-level multiuser systems. It provides 2 GB of data storage on a single 90-m DDS cassette and has a transfer rate of 11 MB per minute. The Model 2000 is a direct replacement for the 1.3 GB SCSI DAT drive (HP C1512A).

The Model 2000DC offers significant performance benefits over the Model 2000 through the use of data compression (DC). Using 90-m DDS media and data compression, up to 8 GB of data can be stored on each DDS cassette at transfer rates of up to 44 MB per minute.

Ordering Information	Price
HP C1520B Series 6400 Model 2000 2 GB DAT tape drive (SCSI)	$3,150
HP C1521B Series 6400 Model 2000DC DC-DAT tape drive (SCSI)	$4,150

See product data sheet #5091-2935E and sales guide #5091-3639E for further information.

Part number	Description	Height	Width	Depth	Quantity	Price
HP 92214A	*Design Plus* Mobile terminal support and transport system table. Designed to safely move terminals and small systems.	720 mm (28.4 in)	750 mm (29.5 in)	711 mm (28.0 in)	(1 to 2 tables) (3+)	$475 each $445 each
HP 92214B	Medium *Design Plus* System table. Comes with cable management, locking casters, and is same height as 92211R mobile rack system cabinet.	720 mm (28.4 in)	1125 mm (44.3 in)	711 mm (28.0 in)	(1 to 2 tables) (3+)	$525 each $495 each
HP 92214C	Large *Design Plus* System table. Comes with cable management, adjustable leveling glides, and is same height as 92211R mobile rack system cabinet.	720 mm (28.4 in)	1500 mm (59.0 in)	711 mm (28.0 in)	(1 to 2 tables) (3+)	$585 each $545 each
HP 92213B	*Design Plus* CAD Mini-workstation. For use with the HP 9000 Series 300/500 computers. Comes with 362-mm (4.25-in) wide raised monitor platform.	720 mm (28.4 in)	1125 mm (44.3 in)	711 mm (28.0)	(1 to 2 tables) (3+)	$849 each $799 each
HP 92213F	*Design Plus* CAD workstation is designed for use with HP CAD systems. It comes with a pull-out work surface, keyboard drawer, raised monitor platform.	720 mm (28.4 in)	1500 mm (59.0 in)	711 mm (28.0 in)	(1 to 2 tables) (3+)	$899 each $849 each
HP 92213Q	*Design Plus* ergonomic task lamp. Specifically designed for computer workstations. Lamp stem fits *Design Plus* tables.	N/A	N/A	N/A	(1 to 2 units)	$290 each
HP 92213D	"C" and "D" sized drawing holder. Mounts to workstation and system tables. Two-section arm for height and tilt position extension.	508 mm (20.0 in)	762 mm (30.0 in)	6 mm (2.6 in)	(1 to 2 units) (3+)	$219 each $199 each
HP 92214J	90-degree *Design Plus* Corner turn. Used for joining two system tables together for a larger work area. **NOTE:** Not intended to support CAD monitors.	Each side	711 mm (28.0 in)		(1 to 2 units)	$375 each
HP 92214K	*Design Plus* CAD corner workstation. Perfectly fitted for use with HP CAD systems. Workstation comes with keyboard drawer and cable management.	720 mm (28.4 in)	1125 mm (44.3 in)	1125 mm (44.3 in)	(1 to 2 tables) (3+)	$899 each $849 each
HP 92211U	*Design Plus* joining bracket. For use on all *Design Plus* furniture pieces to anchor one to another. Comes with needed screws and instructions for use.	N/A	N/A	N/A	(1 to 2 units) (3+)	$40 each $37 each
HP 92211W	*Design Plus* Mobile sound enclosure cabinet. For use with all 293X serial 720 mm impact dot matrix printers.	720 mm (28.4 in)	750 mm (29.5 in)	500 mm (19.7 in)	(1 unit)	$775 each
HP 92211N	*Design Plus* drawer unit. Rolls easily and sits next to all *Design Plus* system tables (also same height as tables). Comes with three drawers.	720 mm (28.4 in)	375 mm (14.8 in)	711 mm (28.0 in)	(1 to 2 units) (3 to 9)	$745 each $705 each
HP 92211R	*Design Plus* Mobile mini-rack system cabinet for HP modular peripherals and systems. Comes fully assembled with casters. Back opens for easy access.	720 mm (28.4 in)	375 mm (14.8 in)	711 mm (28.0 in)	(1 to 2 racks) (3 to 9)	$685 each $650 each
HP 92211S	Rail kit for 92211R Mobile mini-rack cabinet. Comes with four set of rails and module locks. Used to mount up to four HP computer and peripheral modules.		Rail length-638 mm (25.1 in)		(1 to 2 kits) 3 to 9	$50 each $45 each
HP 92211T	Filler panel for 92211R mobile mini-rack cabinet. Kit contains 20 snap-in panels used to fill empty space not occupied by computer equipment modules.	23 mm (0.9 in)	325 mm (12.8 in)	23 mm (0.9 in)	(1 to 2 kits) (3 to 9)	$40 each $35 each
HP 92214P	*Design Plus* Universal support stand. For use with HP LaserJet, HP 2932/33/34, HP 2563A printers, and small HP plotters. Comes with printout catcher shelf.	720 mm (28.4 in)	600 mm (23.6 in)	450 mm (17.7 in)	(1 to 2 units)	$420 each
HP 92211D	*Design Plus* Mobile LaserJet Printer cabinet. Comes fully assembled with a storage shelf for paper trays and space for toner cartridges and other supplies	720 mm (28.4 in)	508 mm (20.0 in)	711 mm (28.0 in)	(1 to 2 units)	$490 each
HP 46298A	*Design Plus* 19-in (483 mm) wide EIA rack cabinet. Available in 28.4 in (720 mm), 40 in (1000 mm) and 63 in (1600 mm) heights.	720 mm (28.4 in)	600 mm (23.6 in)	800 mm (31.5 in)		$850

HP Ergonomic executive chair with arm support:

Part number	Color	Seat		Chair back		Quantity	Price
HP 92208M HP 92208N HP 92208P	Gray Blue Beige	Height Depth Width	413 to 483 mm (16.25 to 19 in) 457 mm (18 in) 483 mm (19 in)	Height Width	457 to 514 mm (18 to 20.25 in) 445 mm (17.5 in)	(1 to 2) (3+)	$475 each $440 each

HP Ergonomic workstation/managerial chair:

Part number	Color	Seat		Chair back		Quantity	Price
HP 92208E HP 92208F HP 92208G	Gray Blue Beige	Height Depth Width	413 to 527 mm (16.25 to 20.75 in) 457 mm (18 in) 470 mm (18.50 in)	Height Width	267 to 394 mm (10.50 to 15.50 in) 406 mm (16 in)	(1 to 2) (3+)	$245 each $225 each
HP 92208K	Dark brown	Arm set				(1 to 2) (3+)	$79 each $69 each

HP Ergonomic workbench chair

Part number	Color	Seat		Chair back		Quantity	Price
HP 92208S	Blue	Height Depth Width	483 to 648 mm (19 to 25.50 in) 457 mm (18 in) 470 mm (18.50 in)	Height Width	267 to 394 mm (10.50 to 15.50 in) 406 mm (16 in)	(1 to 2) (3+)	$365 each $340 each

For off-the-shelf shipment, call 800-452-4844.

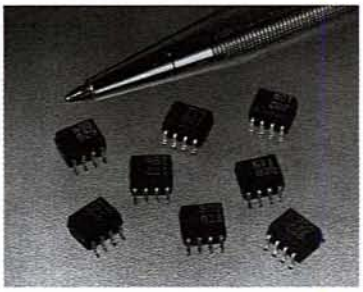
Replacement parts may be ordered from your local HP sales and service office or contact HP Support and Materials Organization at 1 (800) 227-8164.
For more information and a template to design your optimum work area, order the **Design Plus Furniture** brochure #5954-9798.

SOLID STATE DEVICES
Components

Solid-State Lamps

Solid-State Displays

Motion-Control Components



Optocouplers and Solid-State Relays

LED Solid-State Lamps, Light Bars, and Arrays

Hewlett-Packard is a world leader in LED semiconductor technology and offers a broad range of discrete LED indicator products. Products are available in SiC blue; high-performance green, yellow, and orange; AlGaAs red; high-efficiency red and standard red colors; as well as a broad variety of industry-standard packages. The transparent substrate AlGaAs LED is the brightest commercially available red LED in the world (15 cd at 20 mA) as well as being the key component in LED-based automotive exterior lighting. Recent advances in fundamental semiconductor materials have produced new AlInGaP materials, which are the basis for the additions to the product line that offer high-brightness yellow (8.4 cd at 20 mA). The AlInGaP materials are expected to be the basis for numerous future LED products across a broad spectrum of colors.

Solid-State Displays

HP offers a complete lineup of seven-segment displays in AlGaAs red (low current or very high brightness), red, high-efficiency red and yellow, and high-performance green. These displays are available in a wide variety of package sizes. HP also offers several types of specials, such as luminous intensity/color selection, marking/painting change, customer-specific packaging, mechanical changes, and more.

LED alphanumeric displays are useful for 1- to 32- digit applications that need to show numeric, upper- and lowercase, and symbolic information. The integration of rugged packaging, on-board intelligence, dimming, and other functions make these easy-to-use products a good choice for a wide range of applications, from consumer to military.

The aesthetic appearance and reliable performance of LED displays make them appropriate for use in business machines, point-of-sale terminals, medical instruments, appliances, moving message panels, telephones, and other applications that require information that is displayed in a highly visible fashion.

Motion-Control Components

Hewlett-Packard's developments in III–IV materials, integrated circuits, lenses, and packaging allow for a natural expansion of these efforts into development of optical incremental shaft encoders. The first HP shaft encoder was introduced in 1981. Since then, the product line has expanded to include a broad range of motion-sensing and control components.

HP's motion-sensing products include 2- and 3-channel kit encoders for commercial and industrial applications, as well as 2- and 3-channel encoder modules for high-volume computer peripheral applications and digital potentiometers. The encoder modules replace analog potentiometers for manual data entry in medical and measurement instrumentation.

HP's motion-control products include a quadrature decoder/counter integrated circuit. This allows an encoder, a microprocessor, and a general-purpose motion-control IC (which acts as a slave processor in closed-loop servo systems) to interface easily.

Optocouplers

Hewlett-Packard's family of logic-compatible, high-performance optocouplers provides solutions to problems caused by ground loops and induced common-mode noise for both analog and digital applications in commercial, industrial, and military products.

Types of optocouplers available include high-speed and high-gain devices, ac/dc to logic interface optocouplers, high-speed CMOS logic-to-logic products, and 20-mA current-loop devices.

The optocouplers are offered in a variety of package styles: 8-pin DIP, surface-mountable gull wing, SOIC-8, and VDE0834-approved.

Solid-State Relays

As an extension of the high-performance logic-compatible optocoupler family, HP offers miniature dual–in-line package solid-state relays for small-signal and low-power load-switching applications. HP's solid-state relays are replacements for low-current electro-mechanical relays in both commercial and military equipment.

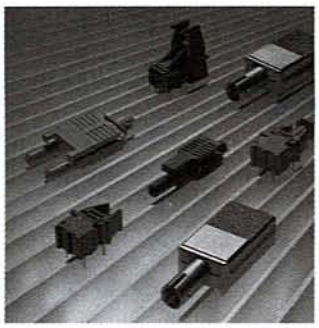
Fiber-Optic Components

HP offers three families of LED-based fiber-optic components that are designed to meet a wide range of communications needs.

The first product, an 1300-nm LED and PIN photodiode-based transceiver, complies fully to the ISO Fiber Distributed Data Interface (FDDI) Physical Layer Medium Dependent (PMD) networking standard. The product is specified for use in both 62.5/125 μm and 50/125 μm optical fibers. Per the standard, it operates at 125 MBd over 2 k. The FDDI transceiver features multiple sources of supply for the two rows of 11 pin-outs and a user-installable key.

The Low Cost Miniature Link family offers a wide range of price and performance choices for local area network, computer, industrial control, and Tempest applications. The 820-nm LED and PIN photodiode-based transmitter and receiver components are specified for use with a variety of fiber sizes and are offered in a variety of package styles. The products interface with ST, SMA, and FC industry-standard fiber-optic connectors. Various combinations of performance are available. Some configurations can achieve data rates up to 150 MBd and distances as great as 4 k.

The lowest-cost fiber-optic solution from HP is the Versatile Link 665-nm based transmitter and receiver components. Designed for use with inexpensive 1-mm plastic optical fiber, these transmitters and receivers are ideal for use in high-EMI/RFI environments and for providing voltage isolation and secure data transmission. With speeds ranging from 40 kBd to 50 MBd, the components provide a cost-effective alternative to communicating over wire.



Fiber-Optic Components

Communications Components

Bar-Code Components

Hybrid Cascadable Amplifiers

Communications Components

In November of 1991, Hewlett-Packard acquired Avantek, Inc., a company well-known for its microwave products. As a result of the combination of organizations, HP can now offer its customers complete component solutions to worldwide communications problems and provide these solutions to the defense and instrumentation industries—along with the strength of HP's worldwide sales, service, and support.

Discretes

Hewlett-Packard manufactures a broad line of diodes, usable from RF to MW (100 GHz) frequencies. Utilizing silicon and GaAs technologies, Schottky, PIN, and SRD diodes are offered in chip, beam-lead, and packaged forms (including industry-standard SOT 23 and SOT 143 packages). Silicon bipolar transistors and cascadable amplifier building blocks, along with GaAs FETs and PHEMTs, complement HP's diode solutions to provide customers with a total solution for their block diagrams.

Wireless IC Products

Hewlett-Packard silicon and GaAs microwave semiconductor processes are used to produce multitransistor high-speed ICs and assemblies for communications markets such as cellular telephone, PCN/PCS, commercial GSM-band applications, GPS, VSAT, and satellite TV. Typical products include receiver and transmitter components, such as active mixers, vector modulators, variable-gain amplifiers, specialty amplifiers, switches, and power devices. There is a strong focus on high performance, low cost, surface-mountable packaged products.

High-Speed Data Communications

To address the growing need for data communications, HP has introduced two breakthrough products. The 266-MBd Fiber Channel Optical Link Card provides a complete and affordable solution for the FC-0 level of the ANSI fiber channel interface standard. The second product, the 1.5-Gb/s Link Chipset, provides a versatile and complete high-performance parallel bus extender that complies with the IEEE P1596 SCI-FI standard and the Serial HIPPI standard. These two new products complement HP's growing family of SONET ICs.

Telecom Microwave Assemblies

HP also manufactures microwave assemblies for telecom applications, including products designed for cellular base stations; PCN/PCS; and GSM applications, such as cellular analog base station amplifiers, linear power amplifiers, and cell enhancers (standalone repeaters for poor-reception areas). Other products for telecom applications include L-band transceivers, which operate via the INMARSAT satellite network; transmitters, up-and-down-converters spanning C and Ku band for VSAT applications, and a family of standard rackmounted C-band power amplifiers. HP also offers a family of standard 3-, 5-, and 10-W solid-state power amplifiers, which directly replace klystrons and traveling wave tubes.

The Avantek Subsidiary

The Avantek subsidiary is a supplier of microwave components and assemblies for space, government and defense, instrumentation, and related industrial uses. Its product line is based on thin-film hybrid construction and a combination of proprietary GaAs and HP silicon semiconductor technology. Products include microwave and millimeter-wave amplifiers; YIG-tuned, varactor-tuned, and dielectric-resonator oscillators; extremely high efficiency, solid-state power amplifier modules; surface-mountable and other hermetic IF, RF and microwave modules (including mixers, voltage-controlled oscillators, PIN-diode switches and amplifiers); and miltifunction assemblies (such as down-converters and digitally tuned signal sources).

Bar-Code Products

Hewlett-Packard offers a broad line of quality bar-code components. Designed to meet OEM's bar-code needs, HP offers an extensive array of products that ranges from optical reflective sensors and tips and decoder ICs to slot readers, digital bar-code wands, and intelligent scanners. In essence, HP's family of bar-code products is designed for ease of use, flexibility, integrity of design, and ruggedness.

The intelligent wand family of products represents the integration of HP's varied product offerings. HP's newest product, the KeyWand bar-code reader (HBCK-1XXX), lets you scan data directly into a personal computer via the keyboard interface, without hardware or software modification. The need for an external decoder box or wedge is eliminated. All electronics are self-contained within a rugged compact polycarbonate wand for clutter-free operation. The SmartWand (HBCR-8XXXX) is an intelligent peripheral designed to easily add bar-code–scanning capability to any host system that can support a +5-V asynchronous interface.

Whether you need a high-performance, low-current digital wand with an extremly low power consumption; an industrial slot reader; optical reflective sensor; precision sapphire tip; or ICs for decoding, HP can meet your bar-coding needs.

High Reliability

Many Hewlett-Packard components meet U.S. military specifications. The reliability of these devices is established by one of the finest high-reliability testing facilities in the component industry. Hewlett-Packard's High-Reliability Test Groups maintain military-approved parts in stock and can recommend HP-standard screening programs, patterned after MIL-S-19500, MIL-M-38534, or MIL-D-87157—for any HP component.

Call for More Information

Specifications of Hewlett-Packard's component products are available in individual data sheets or complete catalogs for designers. Catalogs are available free of charge from your local HP sales office or authorized distributor. Call 1 (800) 752-0900.

ANALYTICAL INSTRUMENTS FOR CHEMICAL ANALYSIS

HP 1090 Series II Liquid Chromatograph

Liquid Chromatography

HP 1090M Series II liquid chromatograph automates sample preparation by allowing data archival from a single keyboard. This allows researchers to work interactively while acquiring data from ongoing analyses. New optimization software and a quaternary solvent-delivery system provide greater speed and flexibility. The HP 1090L Series II analyzes high volumes of routine samples reliably and facilitates methods development while providing convenient control of all modules from a simplified, built-in keyboard. And, with the HP PC-based 1090 Win system, you can acquire and integrate data at multiple wavelengths, run purity checks, and search spectral libraries automatically.

HPLC Pumps and Autosamplers

With HP 1050 modular LC pumps, you can add capabilities one module at a time. Modules include the HP 1050 isocratic pump, whose variable-stroke design provides superior flow stability; the HP 1050 quaternary pump, which will deliver up to four solvents separately; and the HP 1050 autosampler, which is compatible with any modular HPLC system.

HP 1050 Series HPLC Modules

LC Detectors

HP's standards for quality and reliability extend to our line of HPLC detectors, which include the HP 1049A electrochemical detector, the HP 1050 multiple-wavelength detector, the HP 1050 variable-wavelength detector, the HP 1040 Series II diode array detector, the HP 1047A refractive index detector, and the HP 1046A fluorescence detector.

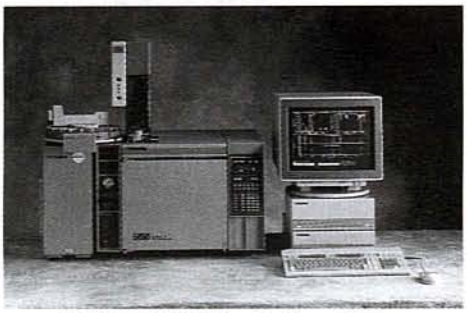
Bioanalytical Solutions

HP offers a number of turnkey bioanalytical solutions. The HP AminoQuant Series II combines automated OPA and FMOC precolumn derivatization chemistries for primary and secondary amino acid analysis in a single run. These devices can perform analyses without interference from unreacted reagents; manual extraction or evaporation steps are eliminated. The HP AminoQuant Series II yields picomole sensitivity with UV and femtomole sensitivity with fluorescence detection. It determines amino acids accurately at the 10-pmol level, with as little as 20 to 40 pmol of hydrolyzed protein. Quantitative reproducibility at low levels is guaranteed. In addition, the HP 1050 Series LC modules are offered in titanium to provide corrosion resistance in separations requiring aggressive mobile phases. Titanium replaces stainless steel for high corrosion resistance. The HP 1050 Ti Series easily interfaces to a choice of fraction collectors for automatic collection by time or volume increments.

HP 3365 MS-DOS ChemStation

UV-Visible Spectroscopy

HP diode-array spectrophotometers provide more information by acquiring data at all wavelengths simultaneously. The HP 8452A UV-Visible spectrophotometer with MS-DOS controller provides exceptional reliability and virtually instant spectra from 190 to 820 nm. The HP 8452A UV-Visible spectrophotometer with HP 89550A dissolution testing software combines advanced analytical features with simple, secure operation. In addition, modules are available for multicell kinetics, single- and multicomponent quantification, and general scanning optimized for spectral mathematics and standard automation tasks.



HP 5965B GC/IRD with ChemStation

Data Handling: The HP Unified Laboratory

HP offers data-handling solutions from integrators to laboratory information management systems (LIMS), plus networking capabilities that encompass the full range of HP analytical instruments. These solutions include:

- Integrators—the lowest priced, most cost-effective on the market today
- ChemStations, which offer single- or multi-instrument control, data evaluation, and reporting
- Laboratory automation systems, which are flexible multiuser systems for high-volume routine analysis
- ChemLMS laboratory information management system to improve information and sample flow; coordinate results from multiple techniques; and link manufacturing, QA, and other corporate systems to your lab
- ChemLAN, which connects multiple techniques on diverse computer platforms by using standards-based networking for your laboratory

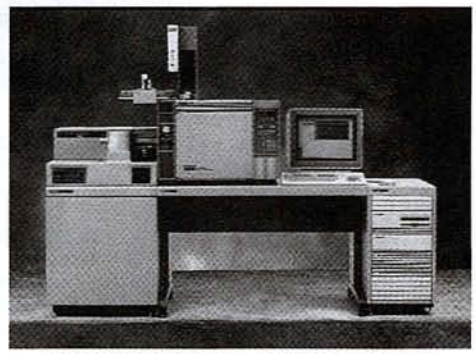
Gas Chromatography

The industry-standard HP 5890 Series II gas chromatograph handles even the most demanding applications with ease. The result of the evolution of the HP 5890A industry-standard GC, the highly versatile HP 5890A Series II continues the tradition of high performance with high reliability. Complementing a full line of inlets and detectors, electronic pressure control (EPC) and programming is available for complete control of your chromatography.

HP 5971A GC/MS with MS-DOS ChemStation

GC Sample Introduction and Management Systems

Hewlett-Packard offers several proven solutions for automated sample handling. The HP 7673 automatic injector and sampler offers discrimination-free injection to meet your needs for precision and high throughput. You can run up to 100 different samples automatically. With dual simultaneous injection, you can double throughput. Add the HP 18587A bar-code identification system for precise sample tracking. Advanced fast injection, automated on-column injection, and modular design with sophisticated robotics make it the right choice for your laboratory. The HP 19395A headspace sampler helps eliminate many sample workup and extraction steps that normally add complexity and uncertainty to the procedure. Use this sampler with any packed or capillary technique. Move it freely from one GC to another.



HP 5989 GC/MS with UNIX ChemStation

GC Detectors

HP is a single-source supplier of reliable high-performance detection systems that provide the selectivity and sensitivity choices necessary for routine or complex chromatographic analysis. These include:

- An atomic emission detector—detects any element (except helium).
- A flame ionization detector—designed for easy operation.
- A thermal conductivity detector—single filament, single-column design.
- An electron capture detector—high sensitivity for electrophilic compounds.
- A nitrogen-phosphorus detector—optimizes selectivity and sensitivity.
- A flame photometric detector—selective detection of sulphur and phosphorus.
- An infrared detector—first FTIR specifically for use with capillary GC.
- A mass selective detector—provides electron impact (EI) spectra of GC effluents.

Mass Spectrometry

We offer GC/MS systems for general qualitative analysis, for research and method development, and for target compound analysis. The PC-controlled HP 5971A GC/MSD system (not shown) provides ultra-sensitivity and superior quantitation in the analysis of most organic compounds. With HP Enviroquant PC software, this system also meets the target compound analysis needs of small environmental labs. In addition, the HP 5971A/5890 is available, under HP-UX control, in our HP MS ChemSystem for networking workgroups doing high-volume target compound analysis. The HP MS Engine shown here is our versatile, high-performance GC/LC/MS/IR/DS system for research, method development, and service laboratories.

HP 7680T Supercritical Fluid Extractor

Sample Preparation

The easy-to-use HP 7680T Supercritical Fluid Extractor cuts sample preparation to just minutes, thus maximizing throughput. Fully computer-controlled, it's now enhanced with an automatic sampler for greater productivity. A breakthrough in robotic technology, the HP Optimized Robot for Chemical Analysis (ORCA) system simplifies the automation of sample preparation and analysis. Designed specifically for system integrators, it speeds development time and improves the reliability of automated sample preparation systems.

Columns, Supplies, and Software

HP is one of the few analytical instrument makers to offer a comprehensive line of competitively priced, high-quality supplies, accessories, LC and GC columns, and consumables. In addition, HP offers dedicated software to provide turnkey solutions. All are available through HP Analytical Direct, our easy-access ordering system. Along with off-the-shelf delivery and on-line technical assistance, HP Analytical Direct brings you one-stop shopping for most of your chromatographic needs.

Customer Support

To help maximize your return on investment, we offer a wide range of support and training programs that can be tailored to your needs—from economical phone-in consulting to management of multiple facilities. No matter what program you choose, you're assured of competent, responsive support. Around the world. Around the clock.

If You Would Like to Know More

Just call your local HP sales office or distributor and ask for the analytical products representative.

HP Columns, Software, and Supplies

MEDICAL INSTRUMENTATION
Diagnostic Cardiology and Echocardiography

Cardiography Instrumentation

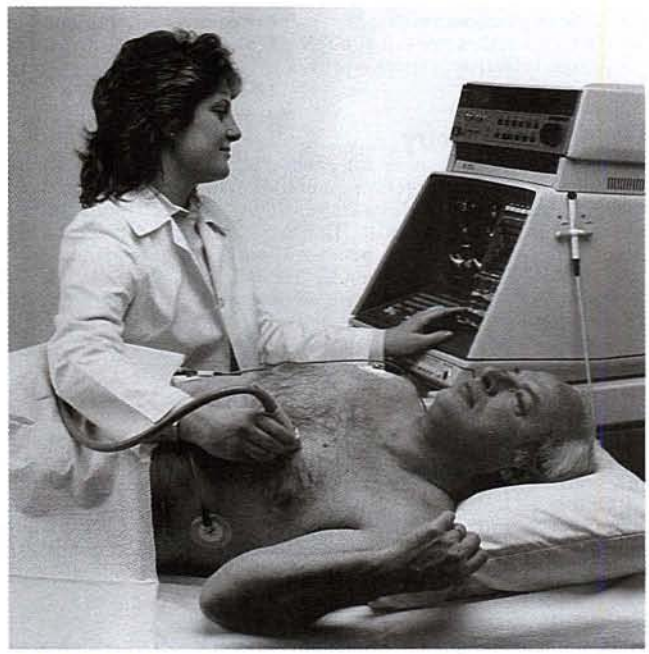
- HP PageWriter XLi advanced cardiograph with interpretive capability and preview display
- HP PageWriter XLs standard, real-time cardiograph
- HP PageWriter XLe basic cardiograph
- Signal-averaged ECG system for the HP PageWriter XLi measures and displays ECG "late potentials"
- Two-way, direct-digital ECG fax capability transmits ECGs directly from the HP PageWriter XLi cardiograph
- ECG Management Systems for computer-aided management of electrocardiograms
- ECG Workstations for PC-based ECG department management

Holter Monitoring

- HP 43420B NewWave Holter system includes HP Vectra PC, custom software, and an HP LaserJet III printer
- Optional HP 43405A Memory Module for full disclosure
- Real-time Holter analysis with advanced editing features
- Easy-to-use graphical computing environment

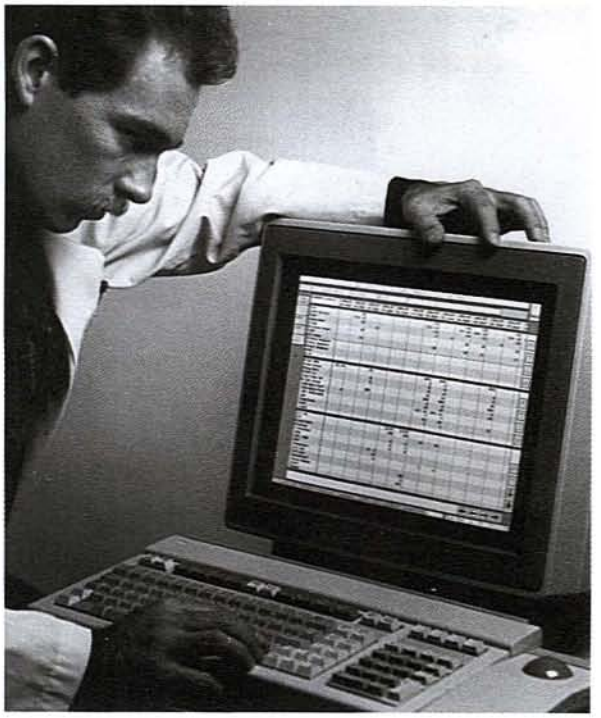
Cardiovascular Instrumentation

- Computerized catheterization data analysis system automates on-line data collection analysis
- Comprehensive data base for generating both clinical and administrative reports



HP SONOS Cardiovascular Imaging Systems

- The most advanced ultrasound imaging systems
- Wide range of transducers to meet your application needs:
  - Dual- and single-frequency sector transducers
  - Peripheral vascular imaging
  - Transesophageal imaging for pediatric and adult patients
- Superior color flow imaging
- Steerable PW/CW Doppler
- Sophisticated image review and analysis capabilities
- Acoustic Quantification for automatic quantification of cardiac function in real-time



HP CareVue 9000 Clinical Information System

- Bedside-oriented system for critical care
- Replaces paper-based charting process
- Easily adapted to each unit's specific needs
- Advanced human interface
- Collects information directly from bedside monitors and other bedside devices
- Uses local area network to incorporate information directly from ancillary departments
- Applications include flowsheet, nursing/physician notes, nursing care plans, patient acuity, severity of illness and more

HP Series 50 Fetal Monitoring Family

- Antepartum—single and twin heart-rate models
- Intrapartum—models for routine and high-risk applications
- Fetal movement profile tracks fetal movement patterns
- Twin offset feature provides twin fetal heart rate recordings

Other Obstetrical Products Include:

- Obstetrical Information Systems
- Fetal Ultrasound Telemetry

HP Component Monitoring System

- Patient monitoring system for the OR, CCU, and ICU
- Monitors up to 16 parameters simultaneously
- Choose 4, 6, or 8 waveforms, color or monochrome
- Intuitive, 2 levels of operation
- Comprehensive data management
- Interface to HP Critical Care Network

Resuscitation: HP CodeMaster Defibrillators

- Charges from 0 to 360 joules in less than five seconds
- Integral, noninvasive pacing available
- Easy-to-use, three-step operation
- Event Summary documents pre- and post-shock data
- Optional hands-free defibrillation available
- Optional high-visibility yellow case

For additional information on HP Medical instrumentation, write to Inquiries Manager, Hewlett-Packard, 3000 Minuteman Road, Andover, MA 01810, and indicate category of interest.

- Patient Monitoring Systems
- OR Monitoring
- Arrhythmia Central Stations
- Clinical Information Systems
- Ultrasound Imaging
- Cardiography Instrumentation/Ambulatory ECG
- Obstetrical and Neonatal Instrumentation
- Resuscitation
- Healthcare Information Systems
- Supplies, Consumables, Pressure Transducers

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X-RAY EQUIPMENT

Cabinet X-Ray Systems

Models 43855A, 43855B

Faxitron Model 43855A
with Option A02

Faxitron Model 43855B

Faxitron® Cabinet Systems

Radiography, the art and science of making pictures with X-rays, has an important place in modern technology. It is one of the major nondestructive test methods available to industry, provides an indispensable tool in scientific investigations, and is a valuable aid to law enforcement agencies.

Hewlett-Packard makes a major contribution to these activities with X-ray equipment that offers a "better way" through advanced technology and design. This equipment makes radiographs easier and safer to take.

Scientific Applications

Oceanography, geology, marine biology, paleontology, pathology, botany, forestry, and agricultural research are a few examples of scientific disciplines that use X-rays. Applications range from the study of the interior anatomy of fossils to determining the viability of seeds.

These are among the many applications served by HP Faxitron Cabinet X-Ray Systems. They offer a unique combination of high quality radiographic capability, simplicity of operation, and convenience of use that is expanding the capabilities of scientific and industrial concerns throughout the world.

Industrial Inspection

Industrial quality control and inspection procedures, especially in the field of electronics, benefit from nondestructive testing by radiography. The advantages of a testing method that does not harm the test objects are obvious. Radiography, therefore, offers benefits in design engineering, incoming inspection, production quality control, product reliability, and failure analysis. X-rays are used to detect misregistration or plate-thru problems in multilayer PC boards; porosity, poor substrate bonding, and wiring or lead location in transistors and integrated circuits; voids and other encapsulation problems in potted components; and solder balls or other defects in sealed relays.

Die casting is another industry that benefits from the nondestructive aspects and ability to "see inside" provided by radiography. Porosity, gas void, trapped metal inclusion, and other common defects can be detected easily and the cause determined. Expensive machining time can be avoided for castings found to be defective through X-ray inspection. The integrity of welds, alignment of connectors, inspection for proper assembly, and mechanical defects are further examples of tests that radiography performs for industry. The benefits of X-ray testing are reduced production costs, better quality assurance, and product safety. The results are increased profits.

Medical Applications

HP Faxitron Cabinet X-Ray Systems are used by the medical profession for specimen radiography in support of diagnostic surgical procedures and in biological research. Specimen radiographs of biopsy samples are correlated with preoperative mammograms, for example, and in the evaluation of mastectomy specimens. Typical research applications include microradiography of thin bone specimens and microangiographic studies of vasculature.

Model 43731A
150kV

Model 43733A
300kV

Model 43734A
450kV

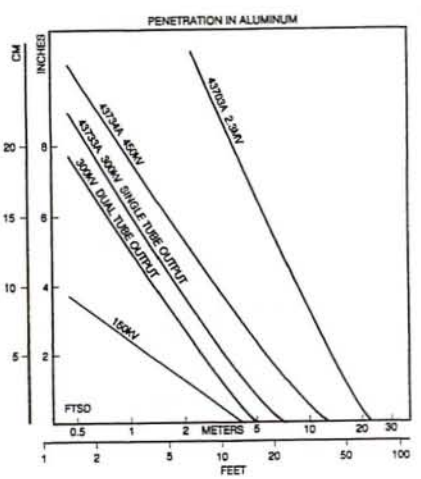
Option 035—Dual Remote Tubehead

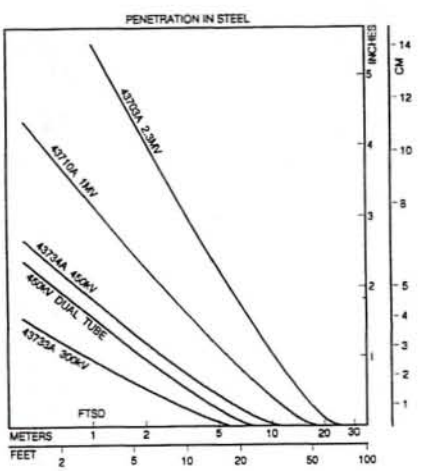
High-speed (flash) radiography is used to record and study dynamic events where interposed material, smoke, flame, debris, or pressure variations exclude the use of high-speed cameras. Typical events include ballistics, shaped charges, explosives, behind-armor studies, shock waves in solids, aerospace phenomena, and crash-injury studies.

The basic performance requirement of a flash X-ray system used for the study of transient mechanisms is to provide high-resolution radiographs with exposure times short enough to eliminate motion blur. HP series 43700 Flash X-Ray Systems produce X-ray pulses of submicrosecond duration and are designed specifically for "stop motion" radiographic applications. All HP 43700 series systems utilize the same basic components, and the same electrical theory and are modular in concept. Standard systems include 150 kV, 300 kV, 450 kV, 1 mV, and 2.3 mV models.

An HP basic single "channel" flash X-ray system, composed of a pulse generator, high-voltage power supply, cold-cathode field emission X-ray tube, and associated controls, provides a single radiograph per event. Additional pulser/X-ray tube sets (add-on channels) may be combined with the initial single-channel system to provide multiple-channel "systems." Multiple channel systems may be of identical output voltage or may use varied output voltage pulser/tube combinations.

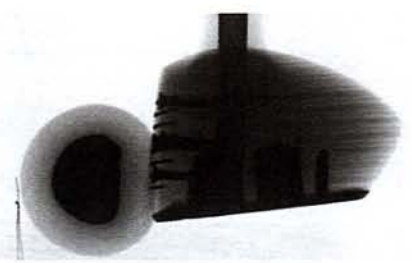
For specific information and consultation regarding HP X-ray systems, contact Hewlett-Packard, 1700 S. Baker Street, McMinnville, Oregon 97128; telephone (503) 472-5101.





ROCKVILLE (Sales)
No. 2 Choke Cherry Road
Rockville, Maryland 20850
Telephone (301) 258-2000

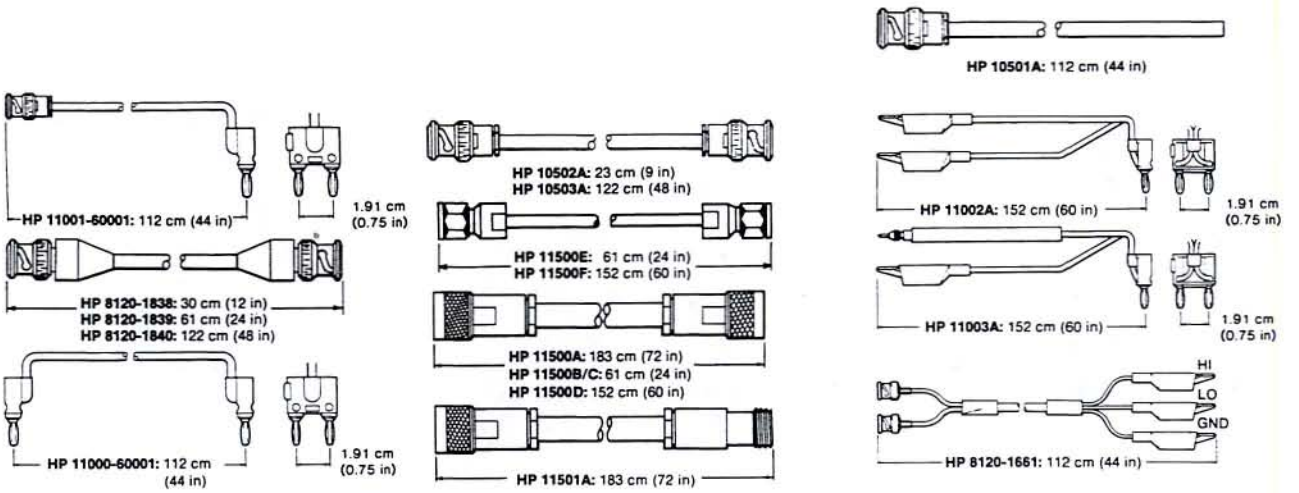
ALBUQUERQUE
7801 Jefferson Street, N.E.
Albuquerque, New Mexico 87109
Telephone (505) 823-6100

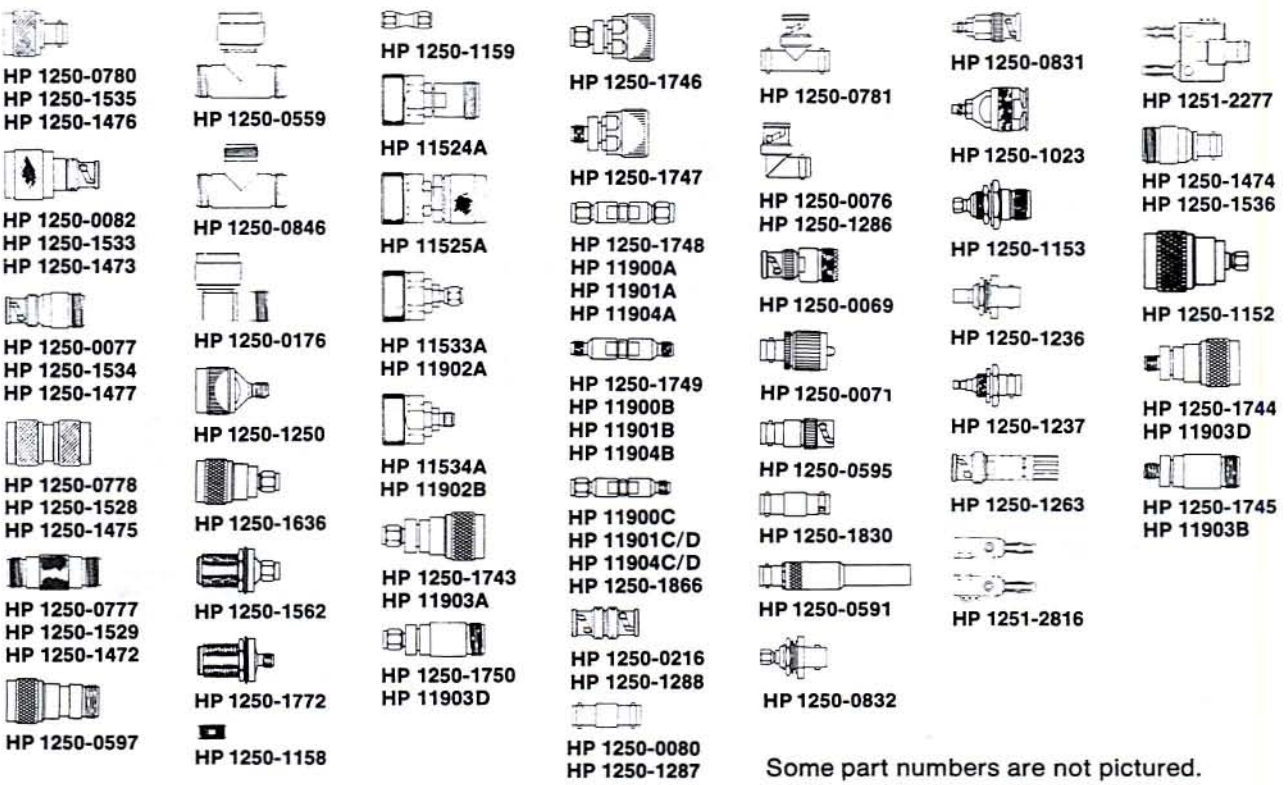


Compression of golf ball when hit with club

CABLES & ADAPTERS

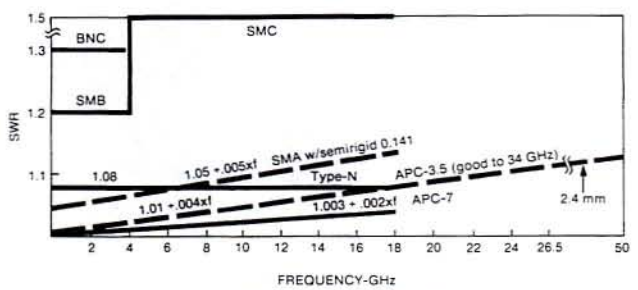
Cables, Adapters, and Typical SWR Performance





Some part numbers are not pictured.

Coaxial Connector and Adapter Performance



Typical SWR for connector pairs

The performance curves in the graph will help you in choosing and applying HP cables, connectors, and adapters. SWR curves show design specifications for mated pairs of connectors of the type indicated. You can expect typical performance in that range.

For cross-series adapters, use the curve with the highest SWR in each case. For applications of Tee-adapters such as HP 1250-0559, 1250-0846, and 1250-0781, be sure to consider the extra shunt capacitance of the Tee.

Of course, when HP mounts various connectors onto RF and microwave products, the product specification predominates and SWR is often far superior to that shown in these utility curves. For example, the HP "precision" Type-N adapters shown on these pages are for high accuracy use dc to 1.3 GHz where SWR <1.03.

For more information on history and performance of various coax connectors, see HP's *Microwave Test Accessories Catalog* (Lit. #5952-2843(D)).

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

Ordering Information — Cable Assemblies

	Price
HP 10501A 112 cm 50 Ω Coax with One UG-88C/U BNC (m) Connector	$37.50
HP 10502A 23 cm 50 Ω Coax with UG-88C/U BNC (m) Connector	$32.50
HP 10503A Like HP 10502A, but 122 cm	$35.00
HP 8120-1838 30 cm 50 Ω Coax with Two BNC (m) Connectors	$19.50
HP 8120-1839 Like HP 8120-1838, but 61 cm	$20.00
HP 8120-1840 Like HP 8120-1838, but 122 cm	$23.50
HP 11000-60001 112 cm 50 Ω Coax with Dual Banana Plugs	$30.00
HP 11001-60001 112 cm 50 Ω Coax, UG-88C/U BNC (m) to Dual Banana Plug	$30.00
HP 11002A Test Leads: 152 cm, Alligator Clips to Dual Banana Plug	$21.00
HP 11003A Test Leads: 152 cm, Probe and Alligator Clip to Dual Banana Plug	$21.00
HP 8120-1661 112 cm, Dual BNC (m) to Alligator Clips	$90.00

HP model no.	Frequency range (GHz)	Length cm (in)	Connectors	SWR	Ins. loss (dB)	Price
11500A	dc to 12.4	183 (72)	N(m) (2)	—	—	$110
11500B	dc to 12.4	61 (24)	N(m) (2)	—	—	110
11501A	dc to 18	183 (72)	N(m)-N(f)	—	—	110
11500C	dc to 18	61 (24)	Precision N(m) (2)	1.4	1.5	625
11500D	dc to 18	152 (60)	Precision N(m) (2)	1.4	3.0	700
11500E	dc to 26.5	61 (24)	APC-3.5 (m) (2)	1.4	2.0	650
11500F	dc to 26.5	152 (60)	APC-3.5 (m) (2)	1.4	4.0	750

Adapters, 2.4 mm

(See page 618 for technical description and performance)

HP 11900A 2.4 mm (m) to 2.4 (m)	$450
HP 11900B 2.4 mm (f) to 2.4 (f)	$450
HP 11900C 2.4 mm (m) to 2.4 (f)	$450
HP 11901A 2.4 mm (m) to APC-3.5 (m)	$375
HP 11901B 2.4 mm (f) to APC-3.5 (f)	$375
HP 11901C 2.4 mm (m) to APC-3.5 (f)	$375
HP 11901D 2.4 mm (f) to APC-3.5 (m)	$375
HP 11902A 2.4 mm (m) to APC-7	$425
HP 11902B 2.4 mm (f) to APC-7	$425
HP 11903A 2.4 mm (m) to Type N (m)	$450
HP 11903B 2.4 mm (f) to Type N (f)	$450
HP 11903C 2.4 mm (m) to Type N (f)	$450
HP 11903D 2.4 mm (f) to Type N (m)	$450
HP 11904A 2.4 mm (m) to K (m)[5]	$500
HP 11904B 2.4 mm (f) to K (f)[5]	$500
HP 11904C 2.4 mm (m) to K (f)	$500
HP 11904D 2.4 mm (f) to K (m)	$500

Adapters Type N, Standard 50 Ω

HP 1250-0077 N (f) to BNC (m)	$13
HP 1250-0082 N (m) to BNC (m)	$15
HP 1250-0176 N (m) to N (f) Right Angle (use < 12 GHz)	$21
HP 1250-0559 N tee, (m)(f)(f)	$38
HP 1250-0777 N (f) to N (f)	$13
HP 1250-0778 N (m) to N (m)	$12
HP 1250-0780 N (m) to BNC (f)	$14
HP 1250-0846 N tee (f)(f)(f)	$20
HP 1250-1250 N (m) to SMA (f)	$35
HP 1250-1562 N (f) to SMA (m)	$68
HP 1250-1636 N (m) to SMA (m)	$130
HP 1250-1772 N (f) to SMA (f)	$73

Adapters Type N, Precision 50 Ω[1]

HP 1250-1472 N (f) to N (f)	$45
HP 1250-1473 N (m) to BNC (m)	$45
HP 1250-1474 N (f) to BNC (f)	$30
HP 1250-1475 N (m) to N (m)	$60
HP 1250-1476 N (m) to BNC (f)	$41
HP 1250-1477 N (f) to BNC (m)	$35

Adapters Type N, Standard 75 Ω[2]

HP 1250-0597 N (m) (50 Ω) to N (f)(75 Ω)	$30
HP 1250-1528 N (m) to N (m)	$60
HP 1250-1529 N (f) to N (f)	$40
HP 1250-1533 N (m) to BNC (m)	$41
HP 1250-1534 N (f) to BNC (m)	$40
HP 1250-1535 N (m) to BNC (f)	$42
HP 1250-1536 N (f) to BNC (f)	$38

Ordering Information — Adapters APC-3.5

	Price
HP 1250-1743 APC-3.5 (m) to N (m)	$135
HP 1250-1744 APC-3.5 (f) to N (m)	$165
HP 1250-1745 APC-3.5 (f) to N (f)	$115
HP 1250-1746 APC-3.5 (m) to APC-7	$150
HP 1250-1747 APC-3.5 (f) to APC-7	$160
HP 1250-1748 APC-3.5 (m) to APC-3.5 (m)	$170
HP 1250-1749 APC-3.5 (f) to APC-3.5 (f)	$185
HP 1250-1750 APC-3.5 (m) to N (f)	$135
HP 1250-1866 APC-3.5 (mm) to APC-3.5 (f)	$320

Adapters Subminiature, SMA

HP 1250-1158 SMA (f) to SMA (f)	$18
HP 1250-1159 SMA (m) to SMA (m)	$19
HP 1250-1249 SMA Right Angle (m) (f)	$32
HP 1250-1397 SMA Right Angle (m) (m)	$40
HP 1250-1462 SMA (m) to SMA (f)	$25
HP 1250-1698 SMA tee (m) (f) (f)	$50
HP 1250-1787 SMA (m) to BNC (m)	$35
HP 1250-2015 SMA (f) to BNC (m)	$36

Adapters APC-7®

HP 11524A APC-7 to N (f)	$175
HP 11525A APC-7 to N (m)	$170
HP 11533A APC-7 to SMA (m)	$235
HP 11534A APC-7 to SMA (f)	$235

Adapter Banana Plug

HP 1251-2816 Dual Banana Plug	$6

Adapters BNC, Standard 50 Ω

HP 1250-0069 BNC (m) to UHF (f)	$30
HP 1250-0071 BNC (f) to UHF (m)	$15
HP 1250-0076 Right Angle BNC(UG-306/D)	$10
HP 1250-0080 BNC (f) to BNC (f) (UG-914/U)	$7
HP 1250-0216 BNC (m) to BNC (m)	$10
HP 1250-0591 BNC (f) to WECO Video (m)	$24
HP 1250-0595 BNC (f) to BNC Triaxial (m)	$20
HP 1250-0781 BNC tee (m) (f) (f)	$12
HP 1250-1263 BNC (m) to Single Banana Plug	$55
HP 10110B BNC (m) to Dual Banana Plug	$27
HP 1250-1830 BNC (f) to BNC Triaxial (f)	$60
HP 1251-2277 BNC (f) to Dual Banana Plug	$16

Adapters BNC, Standard 75 Ω[3]

HP 1250-1286 Right Angle BNC	$20
HP 1250-1287 BNC (f) to BNC (f)	$10
HP 1250-1288 BNC (m) to BNC (m)	$13

Adapters Subminiature, SMB, SMC[4]

HP 1250-0670 SMC tee (m) (m) (m)	$30
HP 1250-0671 SMB (m) to N (m)	$58
HP 1250-0672 SMB (f) to SMB (f)	$15
HP 1250-0674 SMB (m) to SMA (f)	$37
HP 1250-0675 SMC (m) to SMA (f)	$33
HP 1250-0813 SMB (m) to SMB (m)	$63
HP 1250-0827 SMC (m) to SMC (m)	$8
HP 1250-0831 SMC (m) to BNC (m)	$26
HP 1250-0832 SMC (f) to BNC (f)	$30
HP 1250-0837 SMC tee (m) (m) (m)	$27
HP 1250-0838 SMC tee (f) (m) (m)	$23
HP 1250-1023 SMC (m) to N (m)	$37
HP 1250-1113 SMC (f) to SMC (f)	$13
HP 1250-1152 SMC (f) to N (m)	$55
HP 1250-1153 SMC (f) to N (f)	$65
HP 1250-1236 SMB (f) to BNC (f)	$32
HP 1250-1237 SMB (m) to BNC (f)	$37
HP 1250-1391 SMB tee (f) (m) (m)	$31
HP 1250-1857 SMB (f) to BNC (m)	$58

[1]"Precision": typically ≥36 dB return loss to 1.3 GHz
[2]Type N outer conductor; center pin sized for 75 Ω characteristic
[3]BNC outer conductor; center pin sized for 75 Ω characteristic
[4]SMB & SMC are used often inside HP instruments for intermodule RF connections
SMB is snap-on configuration; SMC is screw-on configuration
[5]The K-connector is developed and manufactured by the Wiltron Co., Morgan Hill, California.

*APC=7 is a registered trademark of the Bunker Ramo Corporation.

For off-the-shelf shipment, call 800-452-4844.

OPERATING CASES
Rugged Protection for Instruments

Typical Series 5000 Operating Cases with instruments and options in place.

Operating Cases

Hewlett-Packard operating cases protect instruments and equipment from the hazards of transportation and the rigors of the environment. They offer sturdy protection when instruments are transported and used onsite. Operating cases are compression molded from a glass fiber reinforced composite material (FRP) that is lighter than aluminum and provides excellent strength and durability. Tests of this molded material show tensile and compressive strength exceeding 33,000 PSI and flexural strength exceeding 46,000 PSI.

Both standard and optional heavy-duty hardware afford excellent protection from damage and the elements. Conveniently placed, surface-mounted, spring-loaded handles fold flat when not in use, or they can be designed to reside in recesses. Front and back covers seal with O-ring gaskets and clamping latches. All cases are rainproof under MIL-STD-108. On request, operating cases can be fabricated to meet the requirements of USA and NATO military specifications.

Interior Configuration

Operating cases come equipped with shock-mounted aluminum frames that accept any standard 19-inch rackmounting instrument (EIA-RETMA standard) up to the height of the frames. Most full-size instruments and modular combinations of instruments can be rackmounted in any one of our operating cases. The frame arrangement and the ability to remove the front and back covers allows for convenience of operation without removing the instrument. Consequently, the instrument can be set up for operation with a minimum of delay. Both HP System I and System II cabinet styles can be mounted in operating cases (including System I and System II module combining cases).

Rackmounting offers a number of conveniences. Total systems configured of individual instruments and accessories can be combined in one or more operating cases. Patch cable, HP-IB, and HP-IL connections can be left in place within the case so that instruments are ready for use with little or no delay.

Exploded view of Series 5000 Operating Case with instrument and drawer ready for mounting

Operating Case Series 3000

(Standard Case with Surface Mount Hardware)

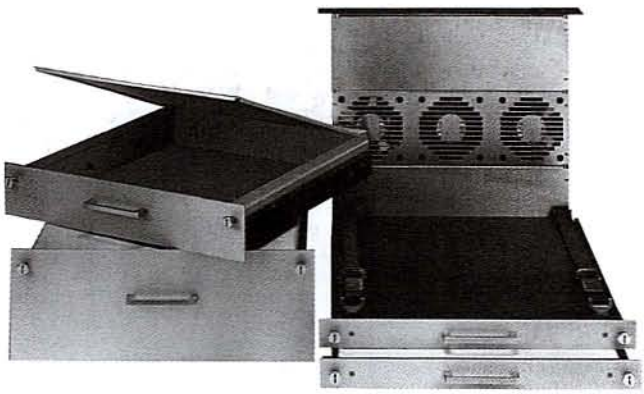
HP Operating Cases are available in six standard families with rack heights from two units up.

Nominal Rack Height ISO	in	Instrument Weight maximum kg	lbs	minimum kg	lbs	Case Height mm	in	HP Part Number	*Price 1 to 4	5 to 9	10 to 24
3U	5.25	34	75	9.1	20	280.2	11.03	9211-1302	$1,850	$1,600	$1,400
4U	7.00	34	75	9.1	20	348.7	13.73	9211-6472	$2,000	$1,750	$1,550
5U	8.75	59	130	13.6	30	393.2	15.48	9211-1303	$2,000	$1,800	$1,550
6U	10.50	59	130	13.6	30	438.9	17.28	9211-2635	$2,050	$1,800	$1,600
7U	12.25	59	130	13.6	30	486.4	19.15	9211-1163	$2,100	$1,850	$1,650
8U	14.00	59	130	13.6	30	527.8	20.78	9211-1241	$2,500	$2,250	$2,000
9U	15.75	59	130	13.6	30	572.3	22.53	9211-1242	$2,500	$2,250	$2,000
10U	17.50	59	130	13.6	30	616.7	24.28	9211-1243	$2,500	$2,250	$2,050
11U	19.25	59	130	13.6	30	661.2	26.03	9211-1244	$2,600	$2,350	$2,100
12U	21.00	114	250	22.7	50	718.3	28.28	9211-1245	$2,350	$2,050	$1,850
13U	22.75	114	250	22.7	50	762.8	30.03	9211-2636	$2,900	$2,500	$2,300
14U	24.50	114	250	22.7	50	807.2	31.78	9211-1911	$2,900	$2,500	$2,300
15U	26.25	114	250	22.7	50	851.7	33.53	9211-2637	$2,900	$2,700	$2,300
16U	28.00	114	250	22.7	50	896.1	35.28	9211-2638	$2,900	$2,700	$2,300
17U	29.75	114	250	22.7	50	940.6	37.03	9211-2639	$2,900	$2,700	$2,300
18U	31.50	114	250	22.7	50	985.0	38.78	9211-2640	$2,900	$2,700	$2,300
19U	33.25	114	250	22.7	50	1029.5	40.53	9211-1713	$2,900	$2,700	$2,300
20U	35.00	145	320	31.8	70	1073.9	42.28	9211-6473	$3,100	$2,800	$2,500
21U	36.75	145	320	31.8	70	1109.0	43.66	9211-6474	$3,200	$2,900	$2,600
22U	38.50	145	320	31.8	70	1162.8	45.78	9211-6475	$3,400	$3,000	$2,600
23U	40.25	145	320	31.8	70	1207.3	47.53	9211-6476	$3,500	$3,100	$2,700
24U	42.00	145	320	31.8	70	1254.8	49.40	9211-6477	$3,500	$3,200	$2,800
25U	43.75	145	320	31.8	70	1296.2	51.03	9211-6478	$3,600	$3,300	$2,900
26U	45.50	145	320	31.8	70	1340.6	52.78	9211-6479	$3,900	$3,400	$3,000
27U	47.25	145	320	31.8	70	1371.6	54.00	9211-2641	$4,000	$3,500	$3,000

Standard case width = 609.6 mm/24.00 in. Standard case depth = 723.9 mm/28.50 in. Basic case dimensions exclusive of hardware. Weight range will determine selection of shock mounts.

*Prices shown are subject to change.

Glass Fiber Reinforced Composite (FRP) Operating Case with optional surface mount latches.



Special Features Available

A. Mating feet for stacking one case on top of another ($130)
B. Mating feet (same as above) with locking mechanism ($98)
C. 88.9 mm H (3½-inch) drawer with slides ($440)
D. 133.4 mm H (5¼-inch) drawer with slides ($460)
E. 177.8 mm H (7-inch) drawer with slides ($460)
F. Slide-mounted shelf ($500)
G. Pair of instrument slides ($135)
H. Modified inner frame depth. Standard rack depth 20 inches from front-panel mounting surface to rear surface of the rack. This option includes an appropriate change in the overall depth of the enclosure. Please specify desired inner frame depth. ($400)
I. Increased front and/or rear cover depth. Maximum 6 inches. Please specify. (Price listed is per modification.) ($340)
J. MIL-C 4150 certification with the exception of design and pre-production testing. Case will have increased wall thickness, hardware anodized to military specification, and will be hermetically tested using the hot water method. ($300)
K. Latches recessed into the surface of case ($340)
L. Handles recessed into the surface of case ($135)
M. Addition of four permanently mounted 3½-inch diameter swivel casters ($215)
N. Addition of four removable 3½-inch swivel casters. Also available in kit form. Ask your HP sales representative. ($340)
O. Addition of two aluminum hat-section skids to the case bottom ($175)
P. Addition of lift rings to either side of the case ($105)
Q. Pair of T-bar instrument support brackets ($53)
R. Pair of L-bar instrument support brackets ($63)
S. Automatic relief valve (manual valves standard) ($80)
T. AC power receptacle strip with four outlets. Mounted on bottom rear of rack frame. Power cord 1 meter (3 feet, 3 inches long), NEMA connectors. ($155)
U. 1 U (1.75 inch) modular cooling device with three-fan upward venting action, 110 V. ($750)

If you require additional modifications or options that are not listed, contact your HP sales representative. Cases can be customized to meet nearly any requirement.

How to Order

Operating Cases are ordered through your local HP sales office. See Customer Ordering Guidelines on page 623.

TRANSIT CASES
Rugged Protection for Instruments

Transit Cases

Hewlett-Packard transit cases are sturdy containers for use when instruments must be frequently transported or used away from laboratory or office conditions. HP cases protect your instruments from shock, vibration, moisture, impact, and contamination to provide a secure enclosure for shipping. Transit cases are a necessity whenever equipment is frequently transported from one operating location to another.

Product Detail

Our transit cases are compression molded from a glass fiber reinforced composite material (FRP) that is lighter than aluminum and provides excellent strength and durability. Tests of this molded material show tensile and compressive strength exceeding 33,000 PSI and flexural strength exceeding 46,000 PSI. All cases seal tightly with O-ring gaskets and clamping latches. They are rainproof under the standards of MIL-STD-108. Carrying handles are conveniently placed and are spring-loaded to fold flat when not in use.

HP cases are usually provided with foam cushions designed to cradle the instrument securely. The cushion inserts are typically molded polyurethane, or are fabricated from slabs of polyurethane or polyethylene flexible foams. Each case/cushion unit is designed as its own shock and vibration damping system, protecting against damage from handling, dropping, or crushing.

Our standard transit cases safeguard your equipment from all but the most abusive treatment. To ensure maximum protection for instruments, transit cases are also available to meet the specified requirements of MIL-STD-108, MIL-T-21200, MIL-T-28800, MIL-T-4734, and MIL-C-4150.

Removable swivel casters are available as an option on certain cases. These are identified with an asterisk (*) in the case tables on pages 624 and 625.

Instrument Cabinet System Styles

Hewlett-Packard produces two styles of cabinet systems: System I and System II. The most visible difference between the two styles is handle configuration. The handles on System I instruments are part of the instrument sideframe, projecting at 90 degrees from the instrument face. The handles on System II modules also project at 90 degrees from the instrument face but are not part of the instrument frame. These handles can be easily removed and are turned outward at the handle grip. Each cabinet style requires a different cushion insert configuration. This difference makes it important that you order your case from the proper selection table.

Special or Custom Transit Cases

Proper fit is critical in protecting your instrument, and the dimensional measurements play a key role. We recommend when ordering a custom case that you provide your HP sales office with the instrument's exact height, width, depth, the serial and model number, and any other pertinent information that may affect the design of the case or cushions (see Customer Ordering Guidelines). For example, you may wish to have additional space available for the protected storage of materials necessary for your instrument's on-site operation. Space can be provided for power/data cables, operating supplies, accessories, additional printed circuit boards, and documentation or manuals.

Transit Case Styles

Each transit case is coded to its style in the following tables: Transit (T), a completely removable cover with a handle at each end; Valise (V), hinged with the handle opposite the hinge; and Valise Transit (VT), a hinged transit case with a handle opposite the hinge and a handle at each end. Each case is designed and manufactured in the style that best suits the configuration of its instrument. If a style other than the standard is required for your application, a custom case can be ordered.

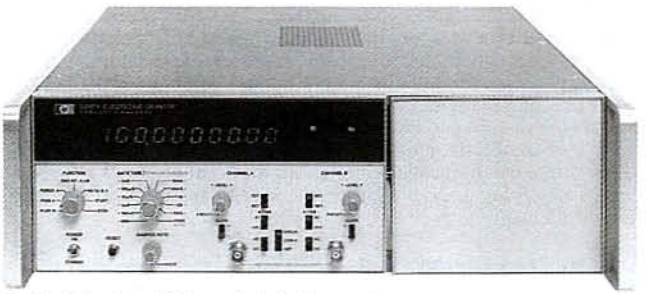
Typical System II Valise Transit (VT) Case

Customer Ordering Guidelines

Hewlett-Packard offers a Customer Questionnaire guide to help you identify specifications to meet your particular enclosure needs. To obtain information on how to order, contact your HP sales representative or call (916)785-8000, SMO Procurement.

Equipment Information	Enclosure Information
Part number: Identification of the equipment or equipment system to be enclosed by part number, drawing number, etc.	**Type:** Transit or operating case. Style and series.
Size: To assure proper fit, each instrument must be carefully measured in the following manner:	**Size:** The maximum size of the case or enclosure.
Width: The distance across the entire body of the instrument, not including rackmounting accessories. Instruments set up to be rackmounted require special cushion designs.	**Usage:** Operating/transportation/storage requirements. Environmental exposure to moisture, humidity, salt spray, temperature, altitude changes, corrosives, solar radiation, decontaminants, rough handling, etc.
Depth: The depth of the instrument from the front-panel face to the rearmost projection from the back of the instrument. On a System II instrument, add two inches if the instrument has handles.	**Options:** Special latches, casters, dust boots, ventilation, drawers, shelves, writing surfaces, hold-down straps, stacking feet, cushions, or internal power receptacles.
Height: The actual instrument height from the base of the cabinet to the top of the cabinet. Measure the height of feet separately.	**Miscellaneous:** Military specifications, inspection requirements, labels and markings, color, etc.
Weight: The weight of the equipment to be enclosed.	The case selection tables include American standard and metric measurements. The addition of any options, accessories, or standoff devices will affect the instrument's overall configuration and must be taken into consideration when ordering a transit or operating case.
Fragility: Specific fragility expressed in G forces, if that is known.	
Usage requirements: Specific information about how the equipment will be operated, stored, or shipped. Special requirements such as unusual heat dissipation, RFI/EMI/ESD shielding, orientation, operating environment, etc.	

TRANSIT CASES
Rugged Protection for Instruments (cont'd)



Typical System I full-module instrument

Typical System II full-module instrument

System I Cabinet Style Transit Cases

Full-Module Width Instruments
Instrument Width — 425.5 mm 16.75 in

Instrument Depth — 285.8 mm 11.25 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
88.9	3.50	VT*	9211-1288	$370	$330
133.4	5.25	VT*	9211-1289	$380	$340
177.8	7.00	VT*	9211-1290	$390	$360
222.3	8.75	T*	9211-1291	$289	$249

Instrument Depth — 412.8 mm 16.25 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
88.9	3.50	VT*	9211-1292	$400	$370
133.4	5.25	VT*	9211-0839	$420	$380
177.8	7.00	VT*	9211-1293	$430	$390
222.3	8.75	VT*	9211-1294	$430	$390
266.7	10.50	T*	9211-1295	$332	$287
311.2	12.25	T*	9211-1313	$450	$410

Instrument Depth — 489.0 mm 19.25 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
133.4	5.25	VT*	9211-1296	$440	$400
177.8	7.00	VT*	9211-1735	$450	$410

Instrument Depth — 565.2 mm 22.25 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
311.2	12.25	T	9211-1297	$480	$430

Two-Thirds Module Width Instruments
Instrument Width — 266.7 mm 10.50 in

Instrument Depth — 270.4 mm 11.00 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
165.1	6.5	V	9211-1895	$330	$300

Half-Module Width Instruments
Instrument Width — 196.9 mm 7.75 in

Instrument Depth — 203.2 mm 8.00 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
165.1	6.5	V	9211-1316	$300	$270

Instrument Depth — 279.4 mm 11.00 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
165.1	6.5	V	9211-1315	$310	$280

Instrument Depth — 406.4 mm 16.00 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
165.1	6.5	V	9211-1734	$330	$300

*Removable casters are an option.
**Prices shown are subject to change. For quote contact SMO Procurement.

One-Third Module Width Instruments
Instrument Width — 130.2 mm 5.125 in

Instrument Depth — 203.2 mm 8.00 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
165.1	6.5	V	9211-1317	$290	$260

Instrument Depth — 279.4 mm 11.00 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
165.1	6.5	V	9211-1318	$300	$270

System II Cabinet Style Transit Cases

Full-Module Width Instruments
Instrument Width — 425.5 mm 16.75 in

Instrument Depth — 387.4 mm 15.25 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
88.9	3.50	VT	9211-2642	$430	$390
133.4	5.25	VT	9211-2643	$430	$390
177.8	7.00	VT	9211-2644	$324	$280
222.3	8.75	VT	9211-2645	$323	$280
266.7	10.50	T*	9211-2646	$430	$390
311.2	12.25	T*	9211-2647	$430	$390

Instrument Depth — 463.6 mm 18.25 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
88.9	3.50	VT	9211-2648	$480	$430
133.4	5.25	VT	9211-2649	$480	$430
177.8	7.00	VT	9211-2650	$347	$300
222.3	8.75	T*	9211-2651	$480	$430
266.7	10.50	T*	9211-2652	$480	$430
311.2	12.25	T*	9211-2653	$480	$430

Instrument Depth — 546.1 mm 21.50 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
88.9	3.50	VT	9211-2654	$520	$470
133.4	5.25	VT	9211-2655	$520	$470
177.8	7.00	VT	9211-2656	$520	$470
222.3	8.75	T*	9211-2657	$520	$470
266.7	10.50	T*	9211-2658	$520	$470
311.2	12.25	T*	9211-2659	$520	$470

Instrument Depth — 622.3 mm 24.50 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
88.9	3.50	VT	9211-2660	$550	$500
133.4	5.25	VT	9211-2661	$550	$500
177.8	7.00	T*	9211-2662	$550	$500
222.3	8.75	T*	9211-2663	$550	$500
266.7	10.50	T*	9211-2664	$550	$500
311.2	12.25	T*	9211-2665	$550	$500

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

Typical System II half-module instrument

Typical System II quarter-module instrument

System II Cabinet Style Transit Cases *(continued)*

Half-Module Width Instruments
Instrument Width — 215.9 mm 8.50 in

Instrument Depth — 247.7 mm 9.75 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
88.9	3.50	V	9211-2666	$330	$300
133.4	5.25	V	9211-2667	$237	$203
177.8	7.00	V	9211-2668	$330	$300
222.3	8.75	V	9211-2669	$330	$300
266.7	10.50	V*	9211-2670	$330	$300

Instrument Depth — 323.9 mm 12.75 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
88.9	3.50	V	9211-2671	$390	$350
133.4	5.25	V	9211-2672	$390	$350
177.8	7.00	V	9211-2673	$390	$350
222.3	8.75	V	9211-2674	$390	$350
266.7	10.50	V	9211-2675	$390	$350

Instrument Depth — 400.1 mm 15.75 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
88.9	3.50	V	9211-2676	$400	$360
133.4	5.25	V	9211-2677	$400	$360
177.8	7.00	V	9211-2678	$400	$360
222.3	8.75	V	9211-2679	$400	$360
266.7	10.50	V	9211-2680	$400	$360

Instrument Depth — 476.3 mm 18.75 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
88.9	3.50	V	9211-2681	$400	$360
133.4	5.25	V	9211-2682	$400	$360
177.8	7.00	V	9211-2683	$400	$360
222.3	8.75	V	9211-2684	$400	$360
266.7	10.50	V	9211-2685	$400	$360

*Removable casters are an option.
**Prices shown are subject to change. For quote contact SMO Procurement.

Quarter-Module Width Instruments
Instrument Width — 104.8 mm 4.125 in

Instrument Depth — 247.7 mm 9.75 in

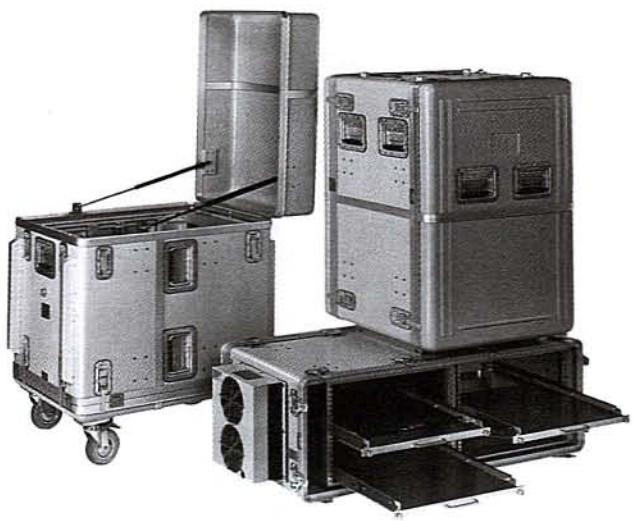
Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
88.9	3.50	V	9211-2686	$280	$250
133.4	5.25	V	9211-2687	$280	$250
177.8	7.00	V	9211-2688	$280	$250

Instrument Depth — 323.9 mm 12.75 in

Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
88.9	3.50	V	9211-2689	$290	$260
133.4	5.25	V	9211-2690	$290	$260
177.8	7.00	V	9211-2691	$290	$260

Instrument Depth — 400.1 mm 15.75 in

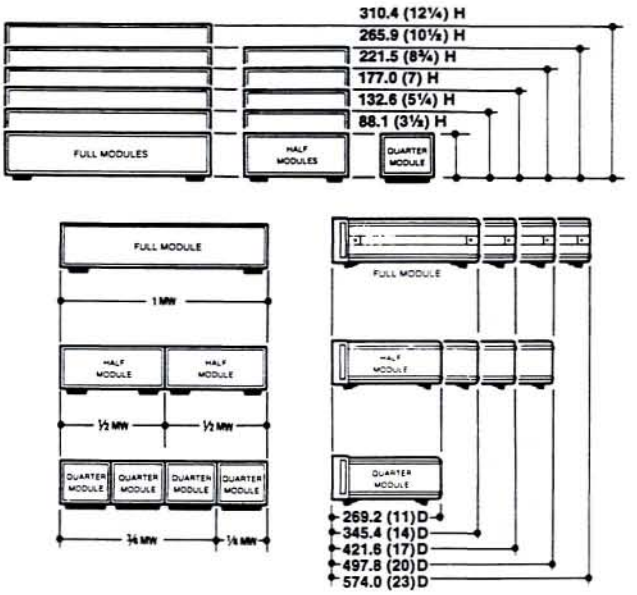
Inst. Height mm	Inst. Height in	Style	HP Part Number	Price** 1 to 4	Price** 5 to 49
88.9	3.50	V	9211-2692	$350	$310
133.4	5.25	V	9211-2693	$350	$310
177.8	7.00	V	9211-2694	$350	$310

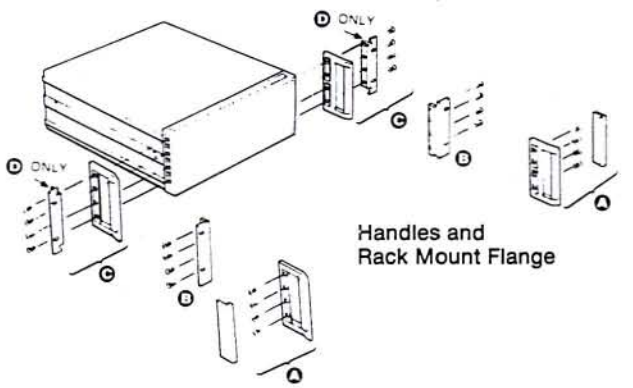


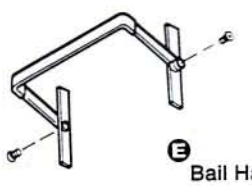
Variety of custom Operating Cases with options

CABINETS & CABINET ACCESSORIES

System II Plus—Handles and Rack Flanges, Bail Handle Kit







NOTE—The cabinet accessory kits shown on these pages include metric fasteners to make them compatible with metric fastener-cabinets. If your instrument requires inch fasteners order HP 5062-4078 with your handle & rack flange kits. It is most important for the user to be aware of these different fasteners to avoid thread damage when attaching the accessory kits. Metric-fastener-cabinets are identified with a yellow label on the rear, which reads "Caution—metric and inch hardware" and has a "metric" embossment in the front bezel casting under the plastic trim strip and on the middle of the rear bezel casting.

System II and System II Plus Cabinet Design

HP's modular cabinet system offers bench-stacking and rack mounting versatility. These cabinets are designed for compatibility with EIA and IEC standards, both in width and height.

System II Plus cabinets and accessories are identical in form, fit, and function to System II but are different colors for improved visual continuity. This catalog lists System II Plus part numbers only.

Handles and Rack Mount Flanges

Handles and rack flanges are available for all System II cabinets, although they find most use on full width modules or combinations of narrower modules locked together to form 1 MW (module width).

Certain instruments are supplied with front handles as part of the selling price. Handles and rack flanges can be supplied with most instruments by specifying the appropriate option from the following list, at the time of order. The extra cost of each option is usually specified on the instrument data sheet.

The table below describes kits available for use after receipt of equipment. Field installation is very straightforward. A plastic trim strip is easily removed and the handle or flange attached with screws supplied in the kit. Before rackmounting, bottom feet must be removed.

Opt 907 Front Handles
Opt 908 Rack Mount Flanges
Opt 909 Handles with Rack Flanges
Opt 913 Rack Mount Flanges (if handles already furnished)
(HP 5062-4069 version)

Bail Handle Kit

For ½ MW cabinets, you can attach this front bail handle for easy portability. Attaching hardware is furnished.

Ordering Information	Price
HP 5062-4001 Bail Handle Kit for 88.1 mm (3½ in) Module	$38
HP 5062-4002 Bail Handle Kit for 132.6 mm (5¼ in) Module	$35
HP 5062-4003 Bail Handle Kit for 177.0 mm (7 in) Module	$33

Handle and Rack Flanges

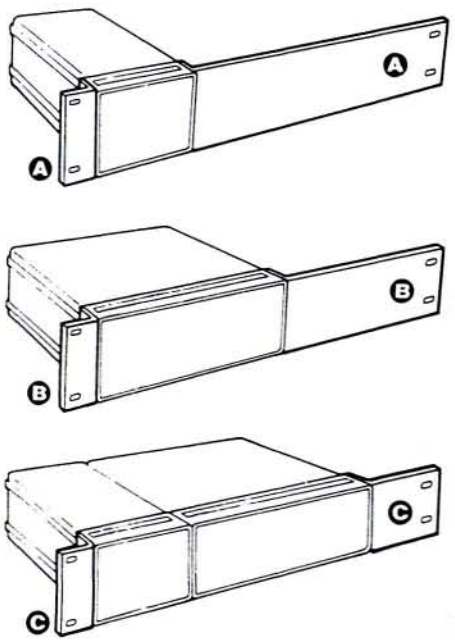
Instrument Module Height mm (in)	Ⓐ Front Handle Kit		Ⓑ Rack Mount Flange Kit[3]		Ⓒ Rack Mount Flange Kits with Handles		Ⓓ Rack Mount Flange Kit for Instruments with Previously Supplied Handles	
	Part no.	Price	Part no.	Price	Part no.	Price	Part no.	Price
88.1 (3½)	HP 5062-3988	$55	HP 5062-3974[1]	$35	HP 5062-3975[1]	$81	HP 5062-4069[1]	$35[4]
88.1 (3½)	—		HP 5062-3976[2]	$35	HP 5062-3982[2]	$81	HP 5062-4070[2]	$35[4]
132.6 (5¼)	HP 5062-3989	$60	HP 5062-3977	$41	HP 5062-3983	$91	HP 5062-4071	$40
177.0 (7)	HP 5962-3990	$70	HP 5062-3978	$40	HP 5062-3984	$100	HP 5062-4072	$40
221.5 (8¾)	HP 5962-3991	$80	HP 5062-3979	$45	HP 5062-3985	$115	HP 5062-4073	$45
265.9 (10½)	HP 5062-3992	$95	HP 5062-3980	$60	HP 5062-3986	$130	HP 5062-4074	$50
310.4 (12¼)	HP 5062-3993	$140	HP 5062-3981	$60	HP 5062-3987	$170	HP 5062-4075	$60
Kit includes	2 handles + 2 trim strips + metric fasteners		2 flanges + metric fasteners + mounting screws		2 handles + 2 flanges + metric fasteners + mounting screws		2 flanges + metric fasteners + mounting screws	

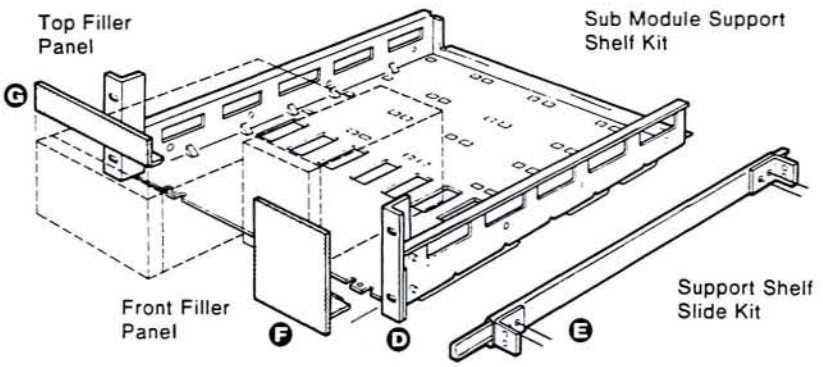
[1]HP 5062-3974/3975/4069 Kits use standard flanges with 1.75-in hole spacing.
[2]HP 5062-3976/3982/4070 Kits use special flange with 3-in hole spacing.
[3]Will not fit onto instruments with previously supplied handles.
[4]Option 913 ordered on instruments supplies HP 5062-4069. For 3-in spacing, order HP 5062-4070 instead of Opt 913.

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

NOTE—The cabinet accessory kits shown on these pages include metric fasteners to make them compatible with metric-fastener-cabinets. If your instrument requires inch fasteners order HP 5062-4078 with your rack mount adapter kits and filler panels. It is most important for the user to be aware of these different fasteners to avoid thread damage when attaching the accessory kits. Metric-fastener-cabinets are identified with a yellow label on the rear, which reads "Caution—metric and inch hardware" and has a "metric" embossment in the front bezel casting under the plastic trim strip and on the middle of the rear bezel casting.





Rack Mount Adapter Kits

Modules of less than 1 MW can be rack mounted using these kits. Individual ¼ MW or ½ MW modules use the kits shown below directly. Combinations of ¼ MW and ½ MW (of equal depth) are first joined side by side with the Lock Link Kit (HP 5061-9694) (following page 628), then have end flanges applied. Combinations adding to 1 MW use regular rack flange kit (previous page 626). Kits include attaching screws and front-panel rack mounting screws. Hole patterns conform to EIA and IEC standards.

Rack Mount Adapter Kits

Module Height mm (in)	Ⓐ Mounts ¼ MW Module		Ⓑ Mounts ½ MW or 2 each. ¼ MW[1] Modules		Ⓒ Mounts ¾ MW (3 ea. ¼ MW)[2] or ¼ & ½ MW side by side[1]	
	HP part no.	Price	HP part no.	Price	HP part no.	Price
88.1 (3½)	5062-3973	$65	5062-3972	$60	5062-3971	$60
132.6 (5¼)	–		5062-3957	$70	5062-3958	$70
177.0 (7)	–		5062-3960	$80	5062-3961	$80
265.9 (10½)	–		5062-3966	$86	5062-3967	$86
Kit includes	1 ea. rack flange 1 ea. ¾ MW extension adapter flange and screws		1 ea. rack flange 1 ea. ½ MW extension adapter flange and screws		1 ea. rack flange 1 ea. ¼ MW extension adapter flange and screws	

[1] Side-by-side modules of equal depth require Lock Link Kit (HP 5062-3994).
[2] ½ MW can be center mounted using two of these kits.

Support Shelf, Slide, and Filler Panels

Submodules of differing heights, widths, and depths (up to 20 D) may be rack-mounted using these support shelves. Any combination of ¼ MW and ½ MW will fit side by side up to 1 MW. Filler panels close up vacant spaces either on top of short modules or side by side. The slide kit provides ready access to internal shelf areas and is designed for HP racks with 24-in depth vertical support rails. Slide kit includes brackets and mounting screws.

Ordering Information		Price
HP 5062-3996	Ⓓ Support Shelf for 88.1 mm (3½ in) H Modules	$195
HP 5062-3997	Ⓓ Support Shelf for 132.6 mm (5¼ in) H Modules	$195
HP 5062-3998	Ⓓ Support Shelf for 177.0 mm (7 in) H Modules	$210
HP 1494-0015	Ⓔ Slide Kit (two each slides, brackets, hardware)	$120

Filler Panels

	Description	Size	HP part no.	Price
Ⓕ	For 88.1 mm (3½ in) H support shelf partially filled with instruments, and having the following front panel space to fill:	¼ MW to fill ½ MW to fill ¾ MW to fill	5062-4021 5062-4022 5062-4023	$75 $80 $95
Ⓕ	For 132.6 mm (5¼ in) H support shelf, and having the following front panel space to fill:	¼ MW to fill ½ MW to fill	5062-4024 5062-4025	$80 $90
Ⓕ	For 177.0 mm (7 in) H support shelf, and having the following front panel space to fill:	¼ MW to fill ½ MW to fill	5062-4066 4062-4027	$75 $110
Ⓖ	For ¼ MW and having the following vertical space to fill:	43.2 mm (1¾ in) H 87.6 mm (3½ in) H	5062-4035 5062-4036	$50 $50
Ⓖ	For ½ MW and having the following vertical space to fill:	43.2 mm (1¾ in) H 87.6 mm (3½ in) H	5062-4037 5062-4038	$50 $50

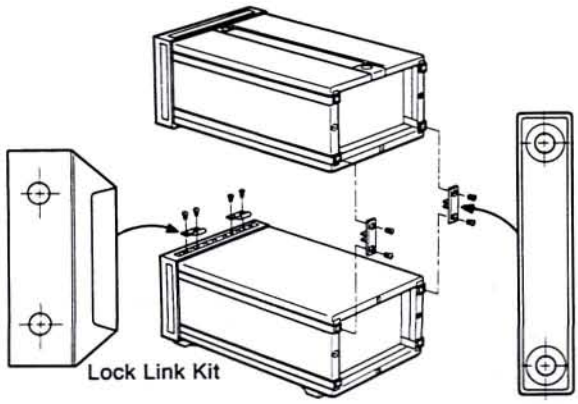
For off-the-shelf shipment, call 800-452-4844.

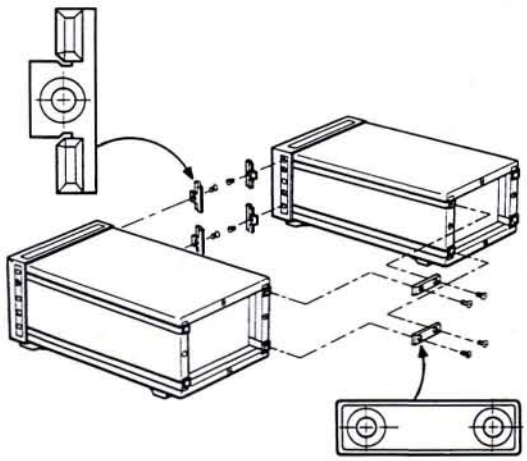
For the most current prices and product information, contact your local Hewlett-Packard sales office.

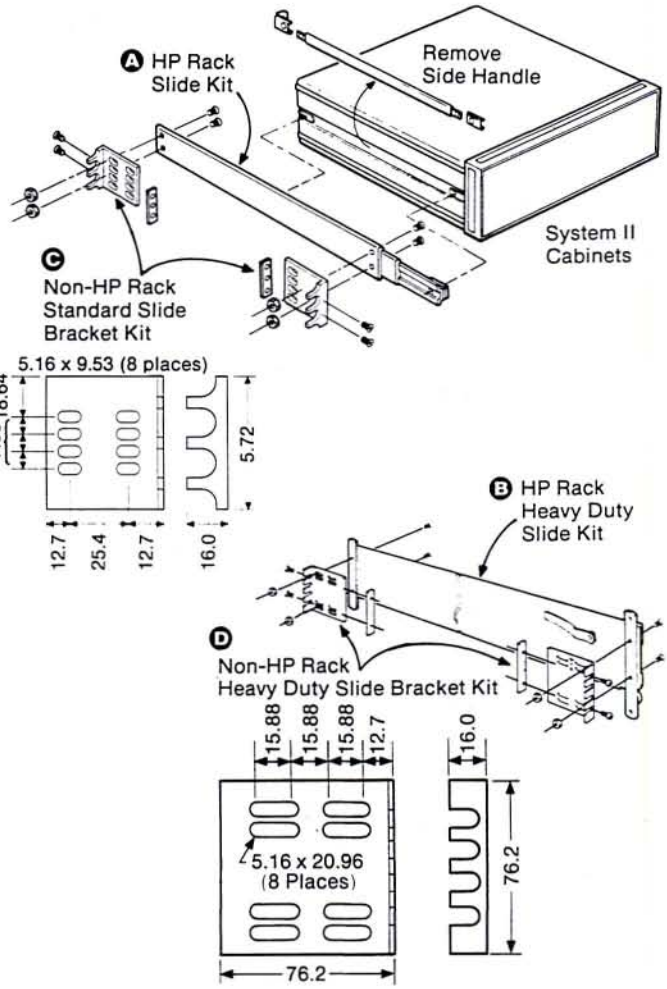
CABINETS & CABINET ACCESSORIES

System II Plus – Lock Link Kits, Rack Mount Slide Kits

NOTE—The cabinet accessory kits shown on these pages include metric fasteners to make them compatible with metric-fastener-cabinets. It is most important for the user to be aware of these different fasteners to avoid thread damage when attaching the accessory kits. Metric-fastener-cabinets are identified with a yellow label on the rear, which reads "Caution—metric and inch hardware" and has a "metric" embossment in the front bezel casting under the plastic trim strip and on the middle of the rear bezel casting. Due to design considerations, the slide-mount kits shown on this page are offered in both inch and metric-fastener versions.







HP 5061-9694 Lock Link Kits

All submodule cabinets of *equal depths* can be linked together over/under or side by side with hardware in the lock link kit. Cabinet frames are already prethreaded to allow quick assembly. For side-by-side connections, the kit contains 12 front hooks and 6 rear links, enough for 3 side-by-side joints. For vertical connections, the kit also contains 4 front hooks and 4 rear links enough for 2 over/under joints. Kit includes metric screws (order p/n 5062-4079: Inch Screw Kit for 5061-9694). Locking cabinets together horizontally in a configuration wider than 1 MW is not recommended.

If the over/under linked combination is to include rear standoff feet (HP 5062-4009), then the over/under locking feet kit HP 5062-3999 should be used for over/under connection.

The HP 5061-9694 Lock Link Kit is not recommended for full module over/under combinations. Use Kit HP 5061-9699 Locking Feet Kit to handle those larger weights.

Slide Kits and Rack Brackets

Rack slides are available for full-width System II cabinets to permit easy access to internal spaces. Each kit consists of two slides that mount directly to System II cabinet side-handle recess spaces (after removing side handles). The slides also mount directly to vertical support rails in HP racks. HP 1494-0060 mounts 345.4D and 421.6D depth System II cabinets; HP 1494-0059 mounts 497.8D and 574.0D.

Standard weight slides carry 38.6 kg (85 lb) maximum load. Tilting versions are available in standard duty only (HP 1494-0062 and 1494-0063).

For non-HP racks, end-bracket kits are available for both standard and heavy-duty slide kits. Slotted hole arrays in the brackets provide for front-to-back rack rail spacing of 24-, 26-, and 28-in nominal centers. They also allow choice of two vertical positions. Each kit of four brackets includes screws and four bar nuts. These general-purpose mounting brackets fit most common non-HP racks such as GE, Honeywell, etc.

Ordering Information

		Price
HP 5061-9694	Lock Link Kit	$45
HP 1499-0060	A Non-Tilting, Std. Slide Kit, Fits	
(HP 1494-0018)	345.4D and 421.6D Cabinets	$115
HP 1494-0059	A Non-Tilting, Std. Slide Kit, Fits	
(HP 1494-0017)	497.8D & 574.0D Cabinets	$115
HP 1494-0062	Tilting, Std. Slide Kit, Fits 345.4D and	
(HP 1494-0025)	421.6D Cabients	$200
HP 1494-0063	Tilting, Std. Slide Kit, Fits 497.8D and	
(HP 1494-0026)	574.0D Cabinets	$200
HP 1494-0058	B Non-Tilting, Heavy Duty Slide Kits	
(HP 1494-0016)	497.8D & 574.0D Cabinets Only	$300
HP 1494-0061	C (4) End Brackets for Non-HP Racks,	
(HP 1494-0023)	Std. Slides	$45
HP 1494-0064	D (4) End Brackets for Non-HP Racks,	
(HP 1494-0042)	Heavy Duty Slides	$70
(HP 5062-4079)	Inch Screw Kit for 5061-9694	

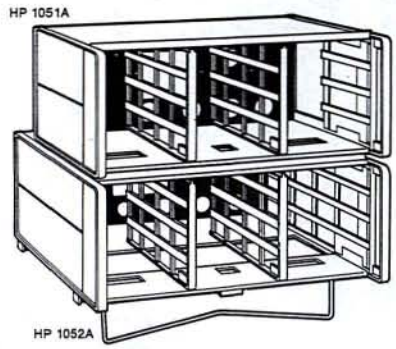
Note: These parts can be ordered as either metric or standard.

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

System I Cabinet Design

System I cabinets are still used on older Hewlett-Packard instruments. System I can be identified by its front handles being integral with the side casting frame. This page describes accessories for use with System I cabinets and small modular instruments.



Combining Cases

These cases conveniently rack or bench mount combinations of small modular HP System I instruments. Both cases accept ⅓ or ½ instrument modules, 130 mm or 198 mm wide (5⅛ or 7²⁵⁄₃₂ in). Each case is furnished with two dividers.

Ordering Information	Price
HP 5061A 482.6 mm (19 in) W × 178 mm (7 in) H × 337 mm (13¼ in) D	$1,600
HP 5062A 482.6 mm (19 in) W × 178 mm (7 in) H × 467 mm (18⅜ in) D	$1,600

Filler Panels

Filler panels can be used to close off any leftover space after instruments are mounted in combining cases or adapter frames. Panels are available in a variety of widths and heights.

Filler Panel Ordering Information

HP Part No.	Module Case Height × Width	Filler Panel Dimensions mm	Filler Panel Dimensions In	Price
5060-8540	¼ × ½	38 × 198	1½ × 7²⁵⁄₃₂	$75
5060-8757	¼ × ⅓	38 × 130	1½ × 5⅛	$75
5060-8758	½ × ⅓	77 × 130	3⁰⁄₃₂ × 5⅛	$75
5060-8759	full × ⅓	155 × 130	6⁰⁄₃₂ × 5⅛	$75
5060-8760	full × ½	155 × 198	6⁰⁄₃₂ × 7²⁵⁄₃₂	$75
5060-8761	full × ⅙	155 × 63	6⁰⁄₃₂ × 2³¹⁄₆₄	$75

Rackmounting Kits

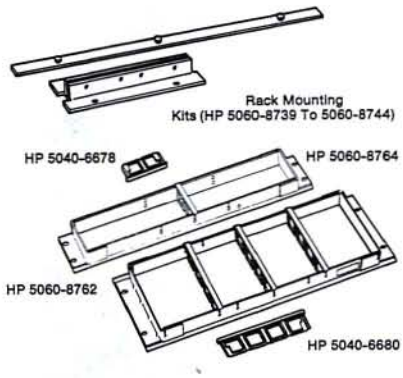
With these kits all HP products in full rack-width cabinets of the integral side frame-handle style (see HP 1051A, 1052A combining cases above) can be easily prepared for rackmounting. Each kit contains two flanges, a filler strip, and mounting screws.

Rackmounting Kit Ordering Information

HP Part No.	Nominal Cabinet Height mm	Nominal Cabinet Height In	Price
HP 5060-8739	88.1	3½	$50
HP 5060-8740	132.6	5¼	$55
HP 5060-8741*	177	7	$60
HP 5060-8742	221.5	8¾	$70
HP 5060-8743	265.9	10½	$70
HP 5060-8744	310.4	12¼	$80

*Also used to rackmount HP 1051A, 1052A combining kits shown above.

For off-the-shelf shipment, call 800-452-4844.



Rack Adapter Frames

These frames are used to hold combinations of small modular HP System I instruments for permanent rackmounting (use the HP 5061A or HP 5062A if easy removal of instruments is desired).

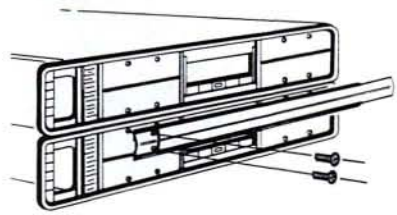
Ordering Information	Price
HP 5060-8762 Rack Adapter 178 mm (7 in) H	$180
HP 5060-8764 Rack Adapter 89 mm (3½ in) H	$180
HP 5040-6678 Extra Vertical Dividers for 5060-8764	$30
HP 5040-6680 Extra Vertical Dividers for 5060-8762	$15

Rack Mount Slide Kits and Cabinet Adapters

Slide kits can be attached for easy access to internal rack space. Both cabinet adapters and slide kits must be ordered.

Ordering Information	Price
HP 1490-0713 Slide Kit, extension length 482.9 mm (19 in)	$140
HP 1490-0714 Slide Kit, extension length 635.0 mm (25 in)	$160
HP 1490-0722 Adapter Plate for 88.9 mm H (3½ in)	$135
HP 1490-0721 Adapter Plate for 133 mm H (5¼ in)	$260

Cabinets



Joining Bracket Kits

These kits join HP System I instruments of the same width and length. Kit contains two brackets, mounting hardware, and trim.

Ordering Information	Price
HP 5060-8541 279 mm (11 in) EIA panel depth	$175
HP 5060-8543 406 mm (16 in) EIA panel depth	$175
HP 5060-8545 480 mm (19 in) EIA panel depth	$190

CABINETS & CABINET ACCESSORIES

EIA Racks

HP E3660A/E3905A/E3661A/E3662A Cabinets

HP E3660A, E3905A, E3661A, and E3662A Rack Cabinets

Rack Instruments Quickly and Easily

Everything Hewlett-Packard customers need to rack instrumentation is now available in 19-in Electronic Industries Association (EIA) rack cabinets in four heights: 1100 mm, 1300 mm, 1600 mm, and 2000 mm. A selection of options and accessories provides the flexibility to rackmount any system configuration, including non-HP products.

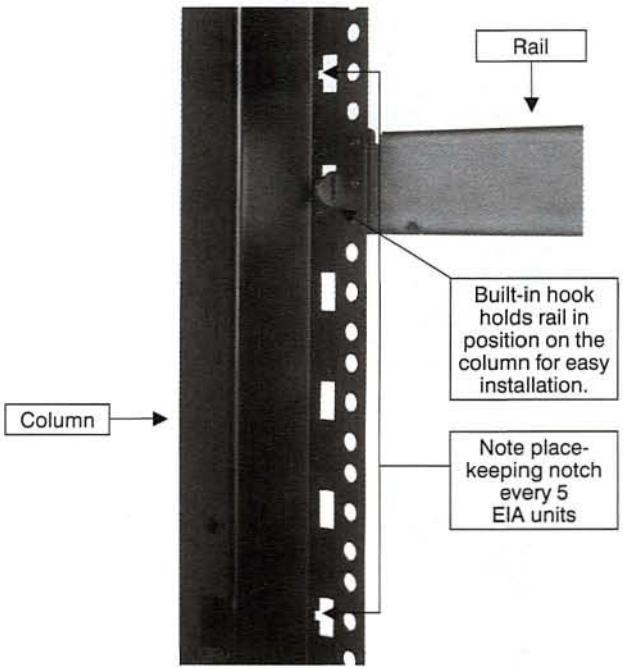
System Integration Easier Than Ever

Rackmounting is fast and easy with rack cabinets specifically designed for mounting instrumentation. Options allow a choice of size, power distribution units (PDUs), fans, front door, and tie-together kits. Most options are factory integrated, and rack mount kits and accessories further simplify system configuration.

Small, but critical, details such as a retractable anti-tip foot, a vented rear door, and heavy-duty casters are included for added safety and mobility.

Flexibility for Easy Configuration

HP rack cabinet accessories such as drawers, trays, and panels provide the flexibility to meet most rackmounting applications. A variety of rails, shelves, filler panels, and rack mount kits make system configuration easy. Through industry-standard 19-in design, space is used efficiently. A system of slots based on EIA units on the vertical mounting columns serve as reference points for quick and accurate instrument positioning. Rack cabinets are shipped fully assembled, with delivery based on customer requirements.



Vertical Mounting Columns

The vertical mounting columns have a slot feature to help position and secure the support rails. Assembly is easy since rails do not have to be held in position when bolting them to the vertical column, ensuring that the rails are located in proper EIA increments.

Configuration is simplified since it is now easy to count EIA units from the base of the rack. Straight-through mounting holes are provided on vertical columns for use in conjunction with sheet metal nuts. Either standard or metric mounting hardware can be used.

Side Panels

Lift up-and-off side panels allow fast and easy access to the interior of the rack from all angles without removing the top.

Top

The top of the HP 19-in rack incorporates a ventilation path through the roof on 1300-mm, 1600-mm, and 2000-mm models. This greatly enhances the ability to dissipate heat. Airflow can be passive (thermal convection) or enhanced with one of the fan options. The standard 1100-mm 19-in rack is provided with a solid top unless an extractor fan option is ordered.

Cable Access

The front-to-back depth of HP's racks is 905 mm. 105 mm of internal space in the rear of the rack houses the Power Distribution Unit (PDU) option and provides an excellent access path for bulky power and signal cables used in many current systems.

Standard Anti-tip Feet

A retractable anti-tip foot that easily pulls into place is standard on all racks. This provides temporary anti-tip capability for slide mounted products when they are in their extended position. The anti-tip ballast (HP C2790A) accessory can be used when permanent anti-tip capability is desired.

Rear Door

A vented rear door is standard. A lockable latch is provided to secure the system against disruption of tests or unauthorized removal of system components. The rear door is symmetrical, so the door can be mounted to open from the left or right. This is useful for multiple bay applications.

International Dimension Standards

These HP racks meet IEC 297-1, -2, -3 standards with regard to height, width, and depth.

Options

HP has included a series of optional features that provide flexibility for your configuration needs. Many of the options can be combined (for example: fan and PDU), but others are mutually exclusive. The most often requested options are shipped integrated into the basic rack.

Power Distribution Unit HP Option 1FB

Specifying 1FB in conjunction with a localization option provides you with a 16-amp, 10-outlet vertical PDU (6 outlets in a 1100-mm and 1300-mm rack). A front-panel master power switch is provided for rapid system shutdown in case of emergency and for added convenience. This switch operates low power signal lines that control a relay in the PDU(s) to minimize electrical noise from current-carrying conductors. Circuit breakers are provided on both hot (live) and neutral lines. A 1930-mm (6.3 ft) 20-A power cord is provided with each PDU. The U.S.A. ABA version is supplied with a 20-A plug. International ABB versions are supplied with an unterminated power cable, allowing the user to attach a plug compatible with local power requirements. The top receptacle of all versions is intended for use with the extractor fan option and is configured as IEC-320.

CABINETS & CABINET ACCESSORIES

EIA Racks (cont'd)

HP E3660A/E3905A/E3661A/E3662A Cabinets

Racks for use in the U.S. are provided with 5-15 NEMA style outlets for operation at 100/120 V (unless 200/240 V feature 0E3 is requested). International racks are provided with IEC-320 outlets for operation at 200/240 V.

Additional Power HP Option 2 × 1FB

Power capacity can be doubled to the maximum of 32 A by ordering two times Option 1FB, providing a second vertical PDU.

Localization Options ABA or ABB

These are required when ordering a Power Distribution Unit (PDU) to ensure that the HP rack meets your local power and regulatory needs. Specify ABA for a power system designed to match UL/CSA standards. Specify ABB for a power system designed to match International standards based on IEC-950 and VDE. Localization options are mutually exclusive.

200/240 V U.S. Power HP Option 0E3

Option 0E3 (in combination with ABA and 1FB) provides a 200/240 V PDU with IEC-320 outlets, which conforms to UL/CSA standards.

Extractor Fan (Top-Mounted) HP Option 1FA

Option 1FA provides a top-mounted extractor fan unit compatible with the PDU selection. This fan outputs 200 cubic feet per minute. Option 1FA also requires both a PDU and localization option when ordered. It should not be ordered in conjunction with Option 1FE blower fan.

Blower Fan (Base-Mounted) HP Option 1FE

Option 1FE provides a base-mounted blower fan unit compatible with the PDU selection. This fan inputs approximately 550 cubic feet per minute and has a replaceable/cleanable filter to reduce dust accumulation within the rack. A solid rear door is substituted for the standard vented door to create a system with air venting through the top of the rack. Option 1FE also requires that a PDU and localization option be specified. It should not be ordered in conjunction with Option 1FA extractor fan.

Tie-Together Kit HP Option 1FD

This option creates multiple bay solutions by bolting the vertical columns of adjacent racks together. The kit completes the cosmetic finish of the multibay solutions. When this option is ordered, no side panels are provided. At least one rack must be ordered without this option to provide left and right side panels for the completed multibay system. If a blower fan option is chosen for multibay systems, be sure to order a blower fan with each rack to ensure proper ventilation (blower fan racks have solid rear doors whereas standard racks have vented rear doors).

Front Door 1FC

This feature adds a transparent, smoke-colored Plexiglas front door that can be locked. It provides an ideal way to prevent systems from being tampered with during testing.

Uninterruptible Power Supplies (UPS)

The DELT series of rackmountable UPSs offer reliable protection against power problems that can interrupt critical test data and damage hardware.

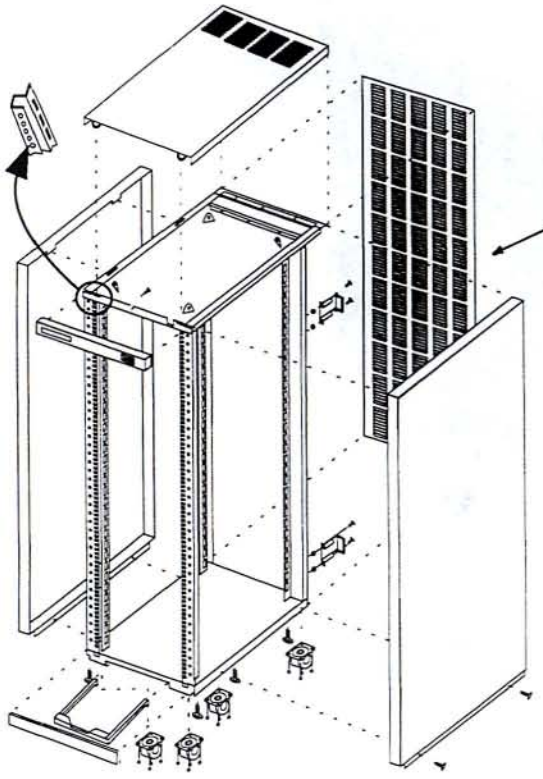
Ordering Information	Price
DELT-2026R2 2.4 kVA, 60 Hz, 208 V in, 115/208 V out	$4,275
DELT-2036R2 3.6 kVA, 60 Hz, 208 V in, 115/208 V out	$5,775
DELT-2025R1 2.4 kVA, 50 Hz, 220 V in, 220 V out	$4,275
DELT-2025R2 2.4 kVA, 50 Hz, 230 V in, 230 V out	$4,275
DELT-2025R3 2.4 kVA, 50 Hz, 240 V in, 240 V out	$4,275
DELT-2035R1 3.6 kVA, 50 Hz, 220 V in, 220 V out	$5,775
DELT-2035R2 3.6 kVA, 50 Hz, 230 V in, 230 V out	$5,775
DELT-2035R3 3.6 kVA, 50 Hz, 240 V in, 240 V out	$5,775

For more information, see data sheet 5091-0896E.

HP Rack System Design Guide

There is a complete Rack System Design Guide incorporated in the 19-in EIA Rack Cabinets, Options, and Accessories Data Sheet available from your local HP sales office. The design guide also includes rackmounting specifications for HP Instruments and controllers. To order, use literature part number 5091-0896E.

Ordering Information	Price
HP E3660A Rack 1100 mm	$750
HP E3905A Rack, 1300 mm	$790
HP E3661A Rack, 1600 mm	$830
HP E3662A Rack, 2000 mm	$870
Opt ABA U.S. localization	$0
Opt ABB European localization	$0
Opt 1FB 16 A PDU	$140
Opt 0E3 220/240 V U.S. Power	$0
Opt 1FA Extractor Fan	$100
Opt 1FE Blower Fan	$450
Opt 1FC Front Door	$290
Opt 1FD Tie Together Kit	$0
Accessories	
HP E3663A Support Rail (HP System II)	$35
HP E3664A Support Rail (third-party products)	$50
HP E3665A Support Rail (HP VXI)	$40
HP E3666A Plain Shelf	$60
HP E3900A Keyboard Rack Kit (fixed)	$75
HP 12131A Keyboard Rack Kit (retractable)	$360
HP 46298M Drawer Unit	$235
HP 46298N Work Surface	$270
HP 46298R Mounting Hardware	$70
HP 40101A 1-EIA Unit Filler Panel	$36
HP 40102A 2-EIA Unit Filler Panel	$37
HP 40103A 3-EIA Unit Filler Panel	$38
HP 40104A 4-EIA Unit Filler Panel	$40
HP 40105A 5-EIA Unit Filler Panel	$41
HP 40106A 6-EIA Unit Filler Panel	$42
HP 40107A 7-EIA Unit Filler Panel	$45
HP E3668A Feedthrough Panel (plain)	$45
HP E3669A Feedthrough Panel (BNC)	$100
HP C2790A Ballast (14 kg–30 lb)	$120
HP 35199A Vectra SPU Rack Mount Kit (HP 12679B Rail Kit required)	$79
HP E3904A HP Vectra SPU Rack Mount Kit (D2512A/17A, D2260A/65A)	$195
HP 35199B D1182A VGA Monitor Rack Kit (HP 12679C Rail Kit required)	$125
HP E3901A D1194/5A SVGA Monitor Kit	$175
HP E3902A A1497A 16-in Monitor Kit	$290
HP E3903A 98785A/98789A 16-in Monitor Kit	$290
HP 44496A Peripheral Drawer (8.75 in)	$632
HP 44496B Peripheral Drawer (15.75 in)	$632



Shown is the exploded diagram for the HP E3662A rack. See text for specifications.

HP E3660A, E3905A, E3661A, and E3662A Rack Specifications

General

Standard rack includes: frame, two side panels, rear door, top, lift hooks, four casters, four leveling screws, and a pair of System II support rails.

Material:
Frame/columns: 13-ga cold rolled steel
Side panels: 18-ga cold rolled steel

Finish:
Sides: HP parchment white
Top, trim strips: HP parchment white
Front door: HP parchment white
Frame: Umber black

Size

		Width	Height	Depth
E3660A	Exterior:	600 mm	1120 mm	905 mm
	Interior:	450.8 mm	933.45 mm	851 mm
E3905A	Exterior:	600 mm	1320 mm	905 mm
	Interior:	450.8 mm	1111.25 mm	851 mm
E3661A	Exterior:	600 mm	1620 mm	905 mm
	Interior:	450.8 mm	1422.5 mm	851 mm
E3662A	Exterior:	600 mm	2020 mm	905 mm
	Interior:	450.8 mm	1822.5 mm	851 mm

Front to rear column hole spacing: 610 mm (24 in)

Weight

Rack Rating:
HP E3660A 81 kg (179 lb) empty
HP E3905A 89 kg (196 lb) empty
HP E3661A 100 kg (221 lb) empty
HP E3662A 116 kg (255 lb) empty

Casters Rating: 318 kg (700 lb) each, 818 kg (1800 lb) total

Lift Hook Rating: 227 kg (500 lb) each
Total system and cabinet weight is a maximum 818 kg (1800 lb), static. Lift cabinet using all 4 hooks.

Cooling

HP E3360A	HP E3905A	HP E3661A	HP E3662A
Vented rear door, solid top	Vented rear door, vented top	Vented rear door, vented top	Vented rear door, vented top

Note: To calculate total BTUs of the cabinets, calculate the BTU of each product installed and add them. A rule of thumb for inside cabinet temperatures is 10 to 15 degrees above ambient. Ambient is typically measured 3 ft in all directions from the cabinet.

For more information on accessories, specifications, and configuration, order literature p/n 5091-0896E from your local sales office.

Rack Cabinet Option Details

Option	Description	Must order with option(s)	Detail[1]	Receptacles[2]	Plug
ABA	North American Localization	—	Meets UL/CSA standards	—	—
ABB	International Localization	—	Meets IEC standards	—	—
1FB	Power Distribution Unit (PDU) includes main power switch	ABA	—	NEMA 5-15[3]	NEMA 5-20P
1FB	PDU includes main power switch	ABB	—	IEC-320	Unterminated
0E3	PDU includes main power switch	ABA and 1FB	—	IEC-320	NEMA L6-20P
1FA	Extractor fan	ABA or ABB and 1FB	Substitutes vented top on 1100-mm rack	—	Uses one IEC-320 on PDU
1FE	Blower fan	ABA or ABB and 1FB	Substitutes solid rear door	—	Uses one IEC-320 on PDU
1FC	Front door	—	—	—	—
1FD	Tie-together kit	—	Deletes side panels	—	—

[1] All PDUs are 50 to 60 Hz, 16 A maximum.
[2] Quantity of receptacles varies based on height of rack ordered.
[3] PDUs have one IEC-320 to accommodate the extractor fan.

TESTMOBILE CARTS

Testmobile Carts for Transportable Testing

Shown left to right: the HP 1182A, HP 1181A, and HP 1180A testmobiles—the HP cart family.

Specifications for HP Testmobile Carts

	HP 1180A	HP 1182A	HP 1181A	
Testmobile description	Scope cart	Instrument cart	System cart	
Cart price	$290 ea	$490 ea	$950 ea	
Capabilities				
Tilt tray load	29.5 kg (65 lb)	68.2 kg (150 lb)	90.7 kg (200 lb)	
Total load	59.0 kg (130 lb)	159.1 kg (350 lb)	227.0 kg (500 lb)	
Cart net weight	14.9 kg (40 lb)	25.9 kg (57 lb)	39.0 kg (86 lb)	
Size				
Tilt tray				
Height	720 mm (28.4 in)	720 mm (28.4 in)	720 mm (28.4 in)	
Width	464 mm (18.25 in)	510 mm (20.1 in)	560 mm (22.1 in)	
Depth	460 mm (18.1 in)	607 mm (23.9 in)	658 mm (25.9 in)	
Vertical rack space	N/A	N/A	533 mm (21.0 in)	
	Note: Vertical rack space is reduced the more the tilt tray is angled.			
Cart selection criteria				
Max. instrument depth	432 mm (17 in)	508 mm (20 in)	635 mm (25 in)	
Host products (examples)				
HP 1630, HP 1650	YES	N/A	N/A	
HP 54200, HP 54500	YES	N/A	N/A	
HP 8560, HP 8590 Series	N/A	YES	N/A	
HP 8720, HP 8750 Series	N/A	YES	N/A	
HP 16500A, HP 16501A, HP 8566B	N/A	N/A	YES	
HP 8703A, HP 8703B, HP 35600	N/A	N/A	YES	
HP Workstations, VXI, etc.	N/A	N/A	YES	
Accessories				**Price**
HP 35181A printer/plotter stand	N/A	YES	YES	$100 ea
HP 35181B keyboard shelf	N/A	N/A	YES	$100 ea
HP 35181C 89 mm (3½-in)–high storage drawer	N/A	N/A	YES	$150 ea
HP 35181D work surface (550 × 305 mm)	N/A	YES	YES	$100 ea
HP 35181E antistatic mat for 35181D	N/A	YES	YES	$75 ea
HP 35181G 133-mm (5¼-in) storage drawer	N/A	N/A	YES	$175 ea
HP 35182A 89-mm (3½-in)–high storage drawer, supp. shelf	N/A	YES	N/A	$200 ea
HP 35182B 133-mm (5¼-in)–high storage drawer, supp. shelf	N/A	YES	N/A	$225 ea
HP 92199B power strip (U.S.)	YES	YES	YES	$36 ea
HP 92199E power strip (IEC 320)	YES	YES	YES	$45 ea
International use of 92199E requires one or more of the cable assemblies below:				
HP 8120-1575 cable, 762 mm (30 in)				$8 ea
HP 8120-1860 cable, 1.5 m (60 in)				$11 ea
HP 8120-2191 cable, 1.5 m (60 in) with right-angle plug				$15 ea
HP 5181-8707 IEC-320 male power cable adapter				$10 ea

For more information, contact your local sales office and ask for testmobile cart family data sheet, p/n 5091-2520E.

☎ For off-the-shelf shipment, call 800-452-4844.

For the most current prices and product information, contact your local Hewlett-Packard sales office—see page 665.

Supporting Your Success

You chose Hewlett-Packard equipment because it best meets your test, measurement, and computing needs. HP wants you to be successful and we're committed to helping you achieve the best results from your system for years to come. We don't stop serving you after the sale is completed. Our flexible support solutions—in hardware, software, customer education, and in consulting services—bring you many benefits. Our support services will:

- Shorten the period between purchase and effective use of an HP product.
- Customize your hardware and software for application-specific requirements.
- Make available unique worldwide resources for maintenance and troubleshooting.
- Ensure continued measurement accuracy.

You can measure the results in greater overall productivity and lower cost of ownership.

Maximizing the return from your equipment investment can be seen as a three-phase process of planning and design, implementation, and operation. Hewlett-Packard offers support services to ensure that you obtain maximum performance from your measurement system during each of these phases.

Performance by Design

A thorough design will ensure that your test and measurement system performs to your expectations and meets your needs. Whether you're planning a single instrument system or a complete factory, HP can offer you technical assistance through consulting services or design the system for you through project services.

Support Life Cycle

Planning and Design	Implementation	Operation
• Project services • Consulting	• Consulting • Installation services • Project services • Educational services	• Hardware support • Software support • Educational services

Smooth Implementation through Knowledge

A thorough understanding of your equipment's capabilities is essential to achieving maximum performance from your investment. That's why we back our products with education courses and materials to ensure that you learn the best way to apply our equipment to your environment.

We also offer site planning, site environmental surveys, and installation services to ensure that your system is installed correctly and quickly.

Peak Operation through Maintenance

To help maximize your equipment uptime and measurement accuracy, HP has a worldwide customer service organization staffed with trained engineers who are backed by factory designers. We focus the necessary resources to keep your equipment operating at peak performance.

Because computers are playing a key role in today's measurement systems, software support can be essential to optimizing your system's performance. HP keeps you up to date on the latest software improvements to ensure that your system continues performing to its maximum potential.

Support Life

To help you maximize your product's useful life, Hewlett-Packard will continue to offer standard support services for as long as feasible. To continue offering these services means managing our trained staff and repair parts inventories to match your needs.

In any event, HP offers support services on all of our products for at least five years beyond end of production.

In addition, we will make our best effort to repair or calibrate any Hewlett-Packard product, whatever its age, even if the product has passed through its support life. Charges will be made on a time and materials basis.

Support for Your Needs

The following pages provide more details on Hewlett-Packard's wide range of support services. Ask your local HP representative to help you select the services that best meet your needs in maximizing your measurement systems' performance.

Service Selection Guide

	Services	Major Benefits	Best Fit
Hardware Support (pg. 636)	• HP repair service • HP calibration service • 3 and 5 year on-site repair HP Support Options • 3 and 5 year customer return repair HP Support Options • 3 and 5 year customer return calibration HP Support Options	• Fast turnaround time • Cost savings • Dependable measurement accuracy • Defense standards compliance	• All instuments, especially those in critical applications or frequently used
Educational Services (pg. 641)	• Wide variety of courses covering latest HP products and technology • Variety of audiences and skill levels • Flexible delivery options	• Fast learning • Time and cost savings over learning independently	• Whenever new products or technology are introduced in your environment • New people
Consulting Services (pg. 640)	• Installation services • Project services • Productivity assistance	• Expert implementation assistance • Quick startup of instrument systems • Increased productivity	• Fast, efficient implementation of instrument system required
Software Support (pg. 639)	• HP Response Center services • Software and documentation update services	• Software usage and problem resolution assistance • New software releases • Up-to-date software information • Fast, accurate support	• Test systems • Instruments with software • Instrument controllers

HARDWARE SUPPORT

An Outstanding Array of Services to Protect Your Investment

Whatever your instrument support needs, HP aims to be as flexible as possible in meeting them. We offer repair and calibration to commercial or defense requirements on a contractual or per-incident basis. With HP's conscientious repair and precise calibration services, you can measure the difference in quality, reliability, and value. Services are available at HP Customer Service Centers worldwide and on your site.

HP Repair Services Maximize Product Uptime

Customer Return Repair

Factory-trained, expert technicians work quickly and accurately to reduce downtime so you get back to business fast. HP instruments covered by factory warranty, repair agreements, or the HP Support Options family are typically repaired within five working days of receipt. HP office products covered by repair agreements are typically repaired within three working days of receipt.

Each HP Customer Service Center manages its spare parts inventory so that over 85 percent of required parts are immediately available. Our global distribution network can usually deliver any other required part to us within 24 hours.

HP Customer Service Centers have the latest information about factory-designed engineering improvements or recommended modifications. These centers are equipped to install upgrades and enhance product performance and useful life.

Repair Agreement

HP's repair agreement covers all parts and all labor resulting from equipment failure. Similar to your product's warranty, it yields significant savings over per-incident repairs. Return freight is included.

Standard Repair

Standard repair (STREP) is our single-event, fixed-price, standard repair service. Instrument problems resulting from a single failure will be repaired to HP factory workmanship standards.

Mini-STREP ensures a lower price for a simple repair. If work on your equipment requires less than 1 hour of labor and falls below a set price in parts, your cost will be the published STREP price or the mini-STREP charge, whichever is lower.

HP SuccessLine

HP SuccessLine service provides high-quality on-site support that enables you to maximize instrument and measurement system uptime. The flexible response times and coverage periods allow you to tailor support to your service needs, while providing superior value for your money. Service includes an account-assigned customer engineer (CE), who becomes familiar with your environment and takes personal responsibility for managing your measurement systems' maintenance program.

Your CE also will perform preventive maintenance on a regular basis, scheduled in advance, to maintain your system at its optimal performance specifications.

Priority Plus Support

This service level provides on-site repair service 24 hours a day, seven days a week. It provides maximum coverage hours and days and HP's best possible response time. Customers within 100 miles of an HP Support Responsible Office receive an on-site visit within 4 hours.

Priority Support

This service level provides coverage for on-site repair service from 8:00 am to 9:00 pm Monday through Friday (excluding HP holidays). This coverage allows all scheduled maintenance to be performed after normal working hours. Customers within 100 miles of an HP Support Responsible Office receive an on-site visit within 4 hours.

Next Day Support

This repair service level provides next-day, on-site service coverage from 8:00 am to 5:00 pm Monday through Friday (excluding HP holidays) for customers within 100 miles of an HP Support Responsible Office.

Volume Discounts

HP offers volume discounts for both customer return and onsite services. Contact your HP representative for details.

HP SuccessLine Service Selection Guide*

	Priority Plus	Priority	Next Day
Coverage hours	24 hours a day, 7 days a week	8 am–9 pm Monday–Friday	8 am–5 pm Monday–Friday
Response time	Best response, not to exceed 4 hours	Best response, not to exceed 4 hours	Next working day
Usage environment	Highly critical; continuous user operations	Urgent; no substitute equipment	Less critical; substitute equipment available

* Available in most locations. Check with your local HP office for detailed coverage hours.

HP's Calibration Services Improve Measurement Accuracy

Hewlett-Packard offers a range of calibration services to ensure that your instruments continue to provide you with the consistently high levels of measurement accuracy for which they were designed. These services can be delivered at our highly automated HP Customer Service Centers or at your site.

All measurements made in HP's calibration processes are traceable to national and international standards. In the United States, measurements are traceable to the National Institute of Standards and Technology (NIST). HP product divisions' Primary Standards Laboratories, directly traceable to NIST, back up HP Customer Service Centers.

HP Calibration Service

HP engineers deliver thorough, high-quality calibrations that are among the most reliable in the industry, no matter where you are located. Your product's performance is compared to standards of known accuracy to ensure conformance with published specifications. Any adjustments necessary to bring the instrument within specification are made. HP Calibration service also includes the following features:

- A complete data report that states the measured product performance after adjustment for all manufacturer-specified parameters
- A calibration certificate stating environmental conditions at the time of calibration
- A calibration sticker indicating the next calibration due date

Standards Compliant Calibration Option

HP's calibration standards compliant option meets the requirements of national defense and international standards, including AQAP-6 and MIL-STD-45662. Most of our calibrations comply with version A of this standard. This option is also popular with customers who are moving toward International Standards Organization (ISO) compliance.

The standards compliant calibration option provides the same high-quality calibration as HP Calibration service plus the following features:

- An enhanced data report. If, during calibration, a parameter is found to be out of specification, we'll record data before any adjustment is made. Following adjustment, we'll record new data for the parameter affected by the adjustment. Both the "before" and "after" data appear in your data report.
- A calibration certificate stating compliance with the appropriate national or international standards and indicating environmental conditions at the time of calibration.
- A calibration sticker to your instrument indicating the next calibration due date.
- Out-of-tolerance notification. If one of HP's measurement standards is found to be out of tolerance such that your calibration may be compromised, we will notify you and recalibrate your instrument free of charge.

Calibration Agreements

Calibration agreements offer you substantial savings over one-time, fixed-price, per-incident services. Agreements also provide these significant added benefits:

- Free recalibration after any repair performed by Hewlett-Packard
- Free HP ExpressCal service for customer-return agreements
- Customized calibration intervals to fit your calibration management program
- Calibration-due notification

Customer Return Calibration

Using extensively automated processes to calibrate your instruments, HP Customer Service Centers enhance the quality, repeatability, and efficiency of calibration.

HP ExpressCal Service

You can reduce downtime with HP ExpressCal service. Simply call your HP Customer Service Center to schedule calibrations in advance. Most scheduled calibrations are completed within 24 hours. For per-incident calibrations, there is a service fee for HP ExpressCal service.

On-Site Calibration

Hewlett-Packard offers the measurement integrity of a traceable HP calibration with the convenience of on-site service. With an on-site calibration agreement, your account-assigned HP CE, who is familiar with your instrument support needs, calibrates individual instruments and measurement systems at your site. HP also offers on-site calibrations on a per-incident basis.

HP Volume On-Site Calibration

If you require maximum instrument uptime, many HP Customer Service Centers can provide you with HP Volume On-Site Calibration service. HP engineers will come to your site to calibrate groups of HP and non-HP instruments. This service provides traceable calibration, tailored to your needs, including:

- Calibration of all functions to specification
- Military standards-compliant calibration
- Custom calibration
- Operation verification

HP Volume On-Site Calibration Service can be delivered where you need it:

- In a centralized location on your site
- In your production and engineering work areas

HP's resources and technical expertise enable us to calibrate on site a broad range of sophisticated products—everything from dc to microwave—including a variety of test and measurement equipment from other vendors. Contact your HP Customer Service Center for local availability.

Save Time and Money

HP Support Options

The HP Support Options family of services allows you to lock in maintenance cost savings at the time you purchase your HP instrument. Each option provides additional support beyond original product warranty, delivering HP's quality repair or calibration service for an extended period of time. These easily ordered services demonstrate HP's commitment to quality services and low cost of ownership. You can also purchase any service in the HP Support Options family during the warranty period of your HP instrument. Ask your HP sales representative for more information.

Repair services provided under the HP Support Options family include all necessary parts, labor, and materials. Calibration services include:

- Calibration at HP's recommended intervals
- Calibration after HP repair
- Complete data reports for all measured product performance
- Calibration certificate and sticker
- Calibration-due notification

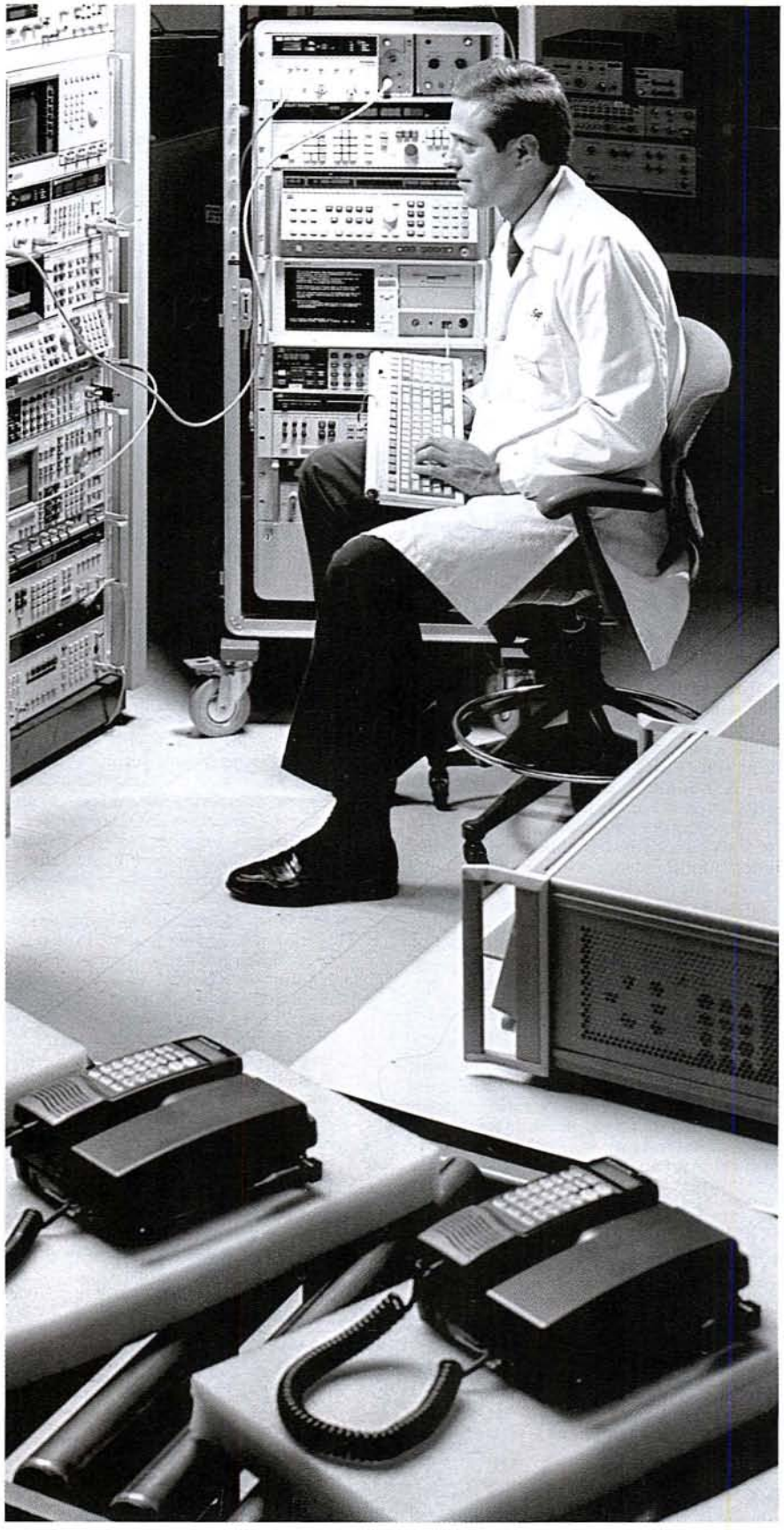
Customer return calibrations include free HP ExpressCal service. HP Support Option family customer return repairs and calibrations receive priority turnaround time at HP Customer Service Centers.

Standards compliant calibration options meet the requirements of national defense standards including MIL-STD-54662 and AQAP 6. They augment HP Calibration service with enhanced data reports that include "before" and "after" data. They also include out-of-tolerance notification and a certificate of calibration indicating standards compliance.

The HP Support Options family extends the benefits of factory warranties to provide a total of three or five years of service. Service is provided at HP Customer Service Centers or on your site, based on the location coverage of your factory warranty.

HP Support Options Table

Extended Service	Three Years	Five Years
Return-to-HP repair	W30	W50
On-site repair	W31	W51
Return-to-HP calibration	W32	W52
Return-to-HP standards compliant calibration	W34	W54



HP Software Support Services

Ongoing success with instrumentation products requires up-to-date information and software. HP offers two software support services for instrumentation products: Software Updates and Response Center services.

Software Update Subscriptions

HP continually updates test system software to incorporate improvements that enhance the productivity of your staff and repair known defects.

A specialized HP Test and Measurement Application Software Update Subscription service for each of your applications ensures that you receive the latest software and documentation as it becomes available. That way, you'll maximize productivity and the return on your investment. Materials and right-to-use licenses may be purchased separately, so you minimize costs by purchasing only the services you need.

HP Response Center Support

With test systems becoming larger and more complex, even the most experienced system users have questions. And the faster they receive answers, the more productive they become.

With HP Test and Measurement Response Center Support service, you place one telephone call; HP handles the rest. Specialists at the HP Response Center have access to sophisticated knowledge databases of known solutions to problems, product data, and system history. As a result, they can isolate the problem quickly and minimize downtime. Some of our systems even have remote diagnostic capabilities that enable our specialists to gain valuable information for identifying and resolving problems quickly.

HP Response Centers offer telephone assistance for normal software usage, clarification of documentation, and resolution of software problems.

Specific Support Services

Select the high-quality services that best meet your ongoing needs. HP provides software support services for our full range of HP test and measurement systems and products.

- Board test systems
- Semiconductor test systems
- Telecommunications test products
- Data communications test products
- High-frequency design systems
- Logic development systems
- HP VXI test systems
- Dynamic signal analyzers
- General-purpose test and measurement software

CONSULTING SERVICES

Test and Measurement Productivity Assistance Service

Productivity Assistance Services

As measurements and technology have become more complex, HP's equipment has become more sophisticated. Now that you've invested in the best instrument, let HP help you maximize your return. A wide range of productivity assistance services helps you fully take advantage of your equipment's capabilities. We help you quickly advance from installation to optimal system use. Whether you need a few hours of guidance from an experienced systems engineer or a custom plan, the Application Engineering Organization and HP Project Centers are ready to help through the following services.

Startup Productivity Assistance

When your measurement system arrives and your project is on a tight schedule, sometimes there is not enough time to study all of the manuals. Even though you or your people may be experts, you still might have questions about the best way to apply these new and powerful capabilities to your specific application.

HP's startup productivity assistance provides you with quick answers to your questions, letting you harness the power of your measurement system. One of HP's trained, experienced system engineers will come to your site, at your convenience, to work with you on your specific questions.

For example, startup productivity assistance service can be used to help you in the following areas:

- System setup, installation, and initialization
- Controller, instrument, and system interfacing
- Measurement techniques

Startup productivity assistance is available on a half-day and daily basis, which provides flexibilty to meet your needs.

General Problem Solving

A few hours with an expert can often help you overcome measurement system roadblocks, or help you fine-tune your system for optimal speed and accuracy. Our trained system engineers can show you the latest tips and techniques for maximizing your HP measurement system's performance, as well as assist you in customizing and integrating the system in your environment.

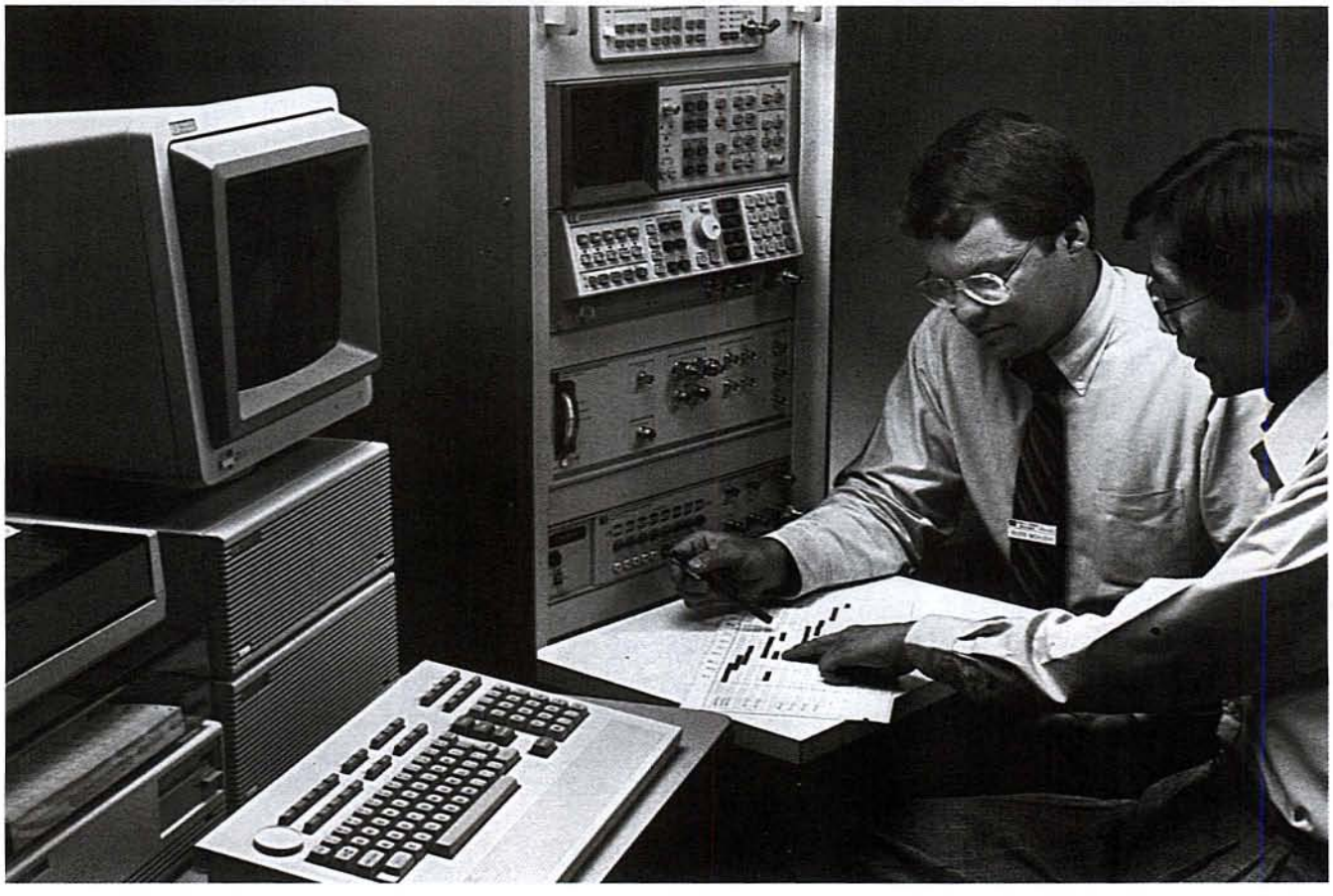
HP Project Center Services

For larger scale, complex requirements, HP Project Centers can provide you with custom solutions. Backed by the full resources of Hewlett-Packard, HP Project Center teams deliver on-time, on-budget solutions to meet your specifications. Look to our experts to save the time, expense, and worry of devising custom solutions yourself.

HP Project Center expertise in measurement automation results from extensive experience in test-system analysis and design. HP Project Center engineers are also adept in the design of other applications, including data acquisition and control, in-circuit and functional circuit testing, semiconductor testing, and microwave/RF testing.

How to Order

Your HP sales representative can help you select a combination of support services to help you gain maximum use from your HP system in the minimum time possible. Ask your local HP sales representative for more details.



HP Educational Services

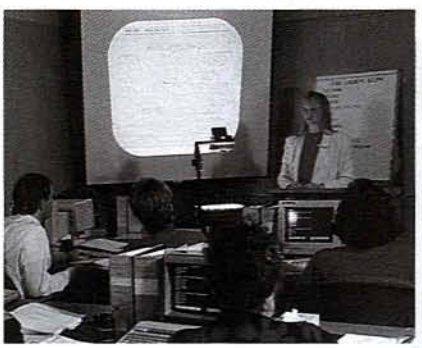
We are committed to offering training that will permit you to get the best possible use of Hewlett-Packard equipment. We recognize that both initial instruction and ongoing education contribute to your success: that is why we offer courses in operation, applications, and software and hardware maintenance for HP instrument and computer products.

Quality Training

Our instructors understand your industry

They speak the language. We make sure our instructors have a deep understanding of the subject and can effectively explain—in clear, concise terms—everything you need to know, from specialized test techniques to the physics behind the measurements.

Backing them up are HP class-development teams. Product specialists, industry experts, curriculum engineers, course writers, and instructors develop training materials and design courses with the goal of maximizing your learning experience.



Courses That Work for You

Our courses are consistently updated to keep pace with evolving technology and industry changes. HP designs instructional materials—including student manuals and lab and instructor materials—to serve as long-term references. A course cannot cover everything, but it can help guide your thinking on the subject matter. Our texts will help you keep in focus long after the class has ended.

Limited class sizes

Classes are limited to six to ten students. We believe small classes encourage closer interaction with the teacher and other students, thus permitting students to share learning experiences and applications expertise.

It's not all books

Hands-on training is important to your success. That is why we provide lab equipment in our classes. Each course has lab time as a key training benefit.

The payback

Our experience shows that you will learn faster with HP education courses. The benefits are twofold: the equipment can be used sooner and the time you would have spent on independent learning can be used for other opportunities.

Worldwide Training

HP has training centers throughout the world, with classes in continuous progress. Training schedules are published regularly.

On-site training

All HP courses can be scheduled and taught at your site. This option might prove more attractive to you, bringing the advantages of training in a familiar environment with your own equipment.

Off-schedule training

Additional HP classroom courses can be arranged beyond those published in the local training schedule. These classes can accommodate your emerging training needs.

EDUCATIONAL SERVICES
Customer Support (cont'd)

Customized classes

We can meet special training needs by developing custom training classes. These changes may include modification of class materials, development of modular training, development of special labs, integration of new sections in the course, and even the development of entirely new classes.

Specialized training materials

HP education is typically based on classroom training, led by professional instructors with solid engineering experience. Other HP training formats include computer-based training, videotape sessions, satellite-broadcast instructions, and self-paced training modules.

Test and Measurement Curriculum

General-Purpose Instrumentation/ Instrument Control/Data Acquisition

HP 34806G + 24D	3 days	Developing Test Plans Using FTM/300
HP 35629A	3 days	HP 3562A User Course
HP 3852S + 24D	4 days	HP 3852S User Training Course
HP 50011C	4 days	HP-IB Instrument Programming Using Series 200/300 BASIC
HP 50015A	3 days	Data Acquisition and Controls Fundamentals
HP 82302A	Book	Using HP BASIC for Instrument Control: A Self-Study Course (55 hours; computer/workbook)
HP B1796A	Video	General Measurements (self-paced video-enhanced course)
HP E1400 + 24D	3 days	VXIbus Technology Training
HP E2100A + 24D	3 days	Introduction to HP-VEE Engine
HP E2110A + 24D	5 days	Introduction to HP-VEE Test

Languages

HP 31112S	5 days	Introduction to Pascal
HP 31124S	5 days	Introduction to Ada/300 Development System
HP 35130B	5 days	ANSI C Programming
HP 50698S	5 days	Programming in FORTRAN 77
HP 98501B	5 days	Introduction to Workstation BASIC
HP 98510D	5 days	Series 200/300 BASIC Operating and Advanced Programming
HP 98511C	5 days	Series 200/300 Pascal Operating and Advanced Programming
HP 98880A	3 days	HP BASIC/UX Programming and Operating
HP H5094S	5 days	Advanced ANSI C Programming

Microwave

HP 11949A	2 days	Designing for EMC Seminar
HP 3048A + 24A	2 days	HP 3048A Phase Noise Measurement System
HP 50740A	4 days	Microwave Fundamentals Course (lecture/demo)
HP 50740B	4 days	Microwave Fundamentals Course (lecture/lab)
HP 50740C	3 days	Microwave Fundamentals Course (lecture only)
HP 70001A/M32	10 days	HP 7000MMS Spectrum Analyzer Service Training
HP 8510C + 24D	3 days	Basic Network Measurements Using the HP 8510C Network Analyzer
HP 8562A/M32	5 days	HP 8560 Series Spectrum Analyzer Service Training
HP 85668A	4 days	HP 8566/67/68 Spectrum Analyzer Operating and Programming Course
HP 8566B/M32	7 days	HP 8566/8567/8568 Spectrum Analyzer Service Training
HP 8590A/M32	4 days	HP 8590 Series Spectrum Analyzer Service Training
HP 8753B + 24A	1 day	HP 8753B RF Network Analyzer Course

HP-UX

HP 50710S	5 days	Programming with HP-UX System Calls
HP 50722S	3 days	HP-UX System Administration Basics
HP 51434S	5 days	Fundamentals of the UNIX System
HP 51436S	5 days	HP-UX Workstation Administration for the HP 9000 Series 300/400/700
HP 51489S	2 days	HP-UX Basics for Application Users
HP B1502B	Book	HP 9000 Visual Editor Training (6 hours)
HP H2550S	5 days	HP-UX Network Administration: LAN Link, ARPA/Berkeley, NFS, NIS, and Diskless
HP H2572S	3 days	UNIX System Basics II
HP B2793S	Book	HP-UX BLS User Tutorial (2 days)
HP B2794S	Book	HP-UX BLS Administrator Tutorial (3 days)
HP B2795S	Book	HP-UX BLS Application Programming Guide (3 days)

ATS 2000

HP 25608A	5 days	HP 25608A Test Expert User Training
HP 25609A	5 days	ATS 2000 HP-UX Analog Programmer Training
HP 25610A	2.5 days	HP 9417 Digital Test Unit User Training
HP 25611A	2.5 days	ATS Digital Instrument Functional Library Course
HP 25612A	5 days	ATS 2000 and Digital Test Unit HP 82000 User Training
HP 25613A	4 days	TDE User Training
HP 25614A	1 day	TDE System Administrator Training

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Datacom/Telecom

HP 18347A	1 day	HP 4951C Protocol Analyzer User Course
HP 37190A	8 days	HP 37100S Operator and Management Course
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HP 4957A + 24D	1 day	HP 4957A/PC User Certification Course
HP 4980A + 24D	2 days	Network Advisor User Certification Course
HP H5425A	Video	Network Advisor Video Training (NTSC)
HP H5426A	Video	Network Advisor User Training (PAL)
HP H5427A	Video	Network Advisor User Training (SECAM)
HP H5428A	Video	HP 4954A/4957PC User Training (NTSC)
HP H5429A	Video	HP 4957A/4957PC User Training (PAL)
HP H5430A	Video	HP 4957A/4957PC User Training (SECAM)
HP H5431A	Video	HP Media Scanner User Training (NTSC)
HP H5432A	Video	HP Media Scanner User Training (PAL)
HP H5433A	Video	HP Media Scanner User Training (SECAM)
HP H5434A/43A	CBT/4 hours	T1 Transmission Basics (3½-in/5¼-in)
HP H5435A/44A	CBT/8 hours	X.25 in Modern Data Communications (3½-in/5¼-in)
HP H5436A/45A	CBT/14 hours	Frame Relay Applications and Technology (3½-in/5¼-in)
HP H5437A/46A	CBT/6 hours	Digital Switching (3½-in/5¼-in)
HP H5438A/47A	CBT/1.5 hours	Computers and Data Communications (3½-in/5¼-in)
HP H5439A/48A	CBT/8 hours	LAN Local Area Networking (3½-in/5¼-in)

Board Test

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HP 44850A	5 days	HP 3065 Advanced User Course
HP 44852A	10 days	HP 3065 Board Test System User Course
HP 44853B	8 days	HP 3065A User Course
HP E1010A	5 days	HP 3070 Board Test Family Concurrent Test Environment Training
HP E1024A	5 days	HP 3070 Family Advanced Digital Training
HP E1027A	7 days	HP 3070 Service Training
HP E1031A	10 days	HP 3070 Family User Fundamentals Training
HP E1123A	3 days	HP 3070 Express Fixturing System Service Training
HP E1191A	10 days	HP 3070 Board Test Family Functional Test Programmer Training

Semiconductor Test

HP 4062C + 24A	3 days	HP 4062C Operating and Programming Training
HP 4062UX + 24A	3 days	HP 4062UX Operating and Programming
HP 94819TU/001	10 days	HP 9480 LSI Operating and Programming Training
HP 94819TU/003	5 days	HP 9480 Maintenance Training
HP 94819TU/T01	10 days	HP 9480 LSI Advanced User Training
HP 94819TU/T08	5 days	HP 9490 User Training
HP 94819TU/T09	5 days	HP 9490 Advanced User Training
HP 94819TU/T10	5 days	HP 9490 Service Training
HP E1288A + 24D	5 days	HP 82000 Introductory User Training
HP E3350A/001	2 days	IC-CAP User Training
HP E3351X	1.5 days	IC-MS User Training
HP E3815A + 24D	5 days	HP 75000 Operating, Programming, and User Training

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Your sales office can also provide the following training literature:

Course data sheets. Every HP class has a data sheet that describes the course in detail. Included are key topics, target audience, course outline, prerequisites, and ordering information.

Education course schedule. HP training schedules are published throughout the world and list class schedules for each area.

Education catalog. The catalog presents information on the entire HP course range, including curriculum flow diagrams, course objectives, outlines, and course content. It is your tool for planning the best possible education for yourself and other members of your organization.

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Hewlett-Packard offers a variety of free publications to help you choose the products that best fill your needs, to help you benefit from applications knowledge acquired by users inside and outside of HP, and to help you maintain your HP products. These publications range from new product announcements, catalogs, product family brochures, and single-product technical data through application notes, product notes, and programming aids to service notes and general maintenance periodicals. The number and types of free publications vary with product family. A summary of available publicaitons is provided here. Brief descriptions of some publications follow the summary.

Instruments and Systems

Product information

- *Test & Measurement News*
- *Hewlett-Packard Journal*
- Data sheets, brochures, and video tapes
- Catalogs
  - HP DIRECT Instruments Now Catalog (5091-3678EUS)
  - HP-IB System DC Power Supplies and Electronic Loads (5091-2424EUS/EN)
  - Microwave Test Accessories Catalog (5091-4269EUS/E)

Application information

- Application Notes (listing begins on page 645)
- Product Notes (listing begins on page 658)
- Application Briefs
- Application Bulletins
- Plotter Notes
- Set-Up Instructions (for plotters)
- Programming Notes

Service information

- Service Notes
- Bench Briefs

Components

Product information

- Catalogs
  - Communications Components (GaAs & Silicon) Designer's Catalog (5091-4574E)
  - Optoelectronics Designer's Catalog (5091-4573E)
  - Modulator & Oscillator Components Catalog (100400)
  - Microwave & Millimeter Wave Amplifiers Catalog (5091-4075E)
- Data sheets
  - *Hewlett-Packard Journal*
  - *Component Update*

Application information

- Application Notes
- Application Bulletins

Periodicals

Test & Measurement News

Six times a year *Test & Measurement News* announces the latest HP electronic measuring instruments and accessories; computer/controller, component, and telecom products; and new product literature such as data sheets, application notes, and catalogs.

Hewlett-Packard Journal

The *Hewlett-Packard Journal* is published six times a year to communicate technical information from the laboratories of HP to all of the fields served by HP. It contains in-depth design descriptions of current hardware and software products, research papers, and more general information such as advances in technology.

Application Informaton

Application Notes, Briefs and Bulletins

These aids to solve your measurement, computation, and design problems offer the benefit of the applications research and experience of both HP customers and HP engineers. Some are tutorial, others describe how-to procedures. All of the publications are oriented to multiple products. A listing of test and measurement application notes begins on page 645.

Product Notes

Product Notes are product-specific aids that supplement the operating and service manuals supplied with HP instruments. They cover applications of the specific instrument. They include analysis of specifications and characteristics with the goal of obtaining improved performance over limited operating conditions and narrower environmental limits.

Programming Notes

Programming Notes provide product-specific information on the use and operation of instruments in HP-IB systems. Some notes address the needs of inexperienced users and cover basic operation of an HP-IB instrument using a specific HP desktop computer. Others address the needs of experienced users.

Service Information

Service Notes

Service Notes contain product-specific service information for HP electronic products. Subjects include product improvements, modifications, and procedures for troubleshooting, maintenance, and repair. Service Notes are published, as appropriate, throughout the life of a product. All new instrument-related Service Notes are announced in Bench Briefs.

Bench Briefs

Bench Briefs provides timely application information for those who repair and calibrate HP instruments. Subjects include troubleshooting tips and descriptions ofnew technologies, components, tools, and equipment. Also, new instrument-related Service Notes are listed in Bench Briefs as they become available.

How to Obtain Free Publications

To obtain any of the publications described on this page, contact your nearest HP office. The listing of HP offices begins page 665. When requesting any of the catalogs listed on this page, please include the number in parentheses following the catalog's title.

APPLICATION & PRODUCT NOTES

Free Literature to Help Solve Your Test and Measurement Problems

Application Notes

Application Notes help you use Hewlett-Packard instruments to solve measurement problems. They are application-specific and typically include generic techniques with families of products. Product Notes describe measurement techniques that are product-specific and often show extensions of performance outside normal lab environments, including performance data and explanations of specifications.

How to Order

To obtain a free copy of any of the Application or Product Notes listed on the following pages, just call your Hewlett-Packard Direct Marketing Organization (DMO). Within the United States call (800) 452-4844 and provide the HP customer service representative with the nine-digit literature number for each application note requested. Please limit your orders to five Application Notes per phone call. If there is not a DMO near you contact your local sales office for Application and Product Note requests (see page 665 for listing).

A to D Converters

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Audio

Analyzing Phase-Locked Loop Capture & Tracking 5952-8007
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Battery Testing 5952-4191
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Application Notes

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ECMA 160

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Error Analysis

Fiber Optics

Fourier Analysis

Frequency

Frequency Modulation

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Application Notes

Spectrum Analyzer Basics 5952-0292
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Frequency Multiplication

Analyzing Phase-Locked Loop Capture & Tracking 5952-8007
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Signal Generator 5952-2019
The Fundamentals of Electronic Frequency Counters 5952-7506
Time Keeping and Frequency Calibration 5952-7874
Voltage Controlled Oscillators Characterization Using the HP 5350B, 5351B, 5352B CW Microwave Frequency Counter 5952-7852

Frequency Standards

Analyzing Phase-Locked Loop Capture & Tracking 5952-8007
Analyzing Phase-Locked Loop Transients in the Modulation Domain 5952-8001
Clock Rate Independent Jitter Measurements for Digital Communications Systems 5952-7999
Fundamentals of Time & Frequency Standards 5952-7870
Measuring Fractional Frequency Standard Deviation (Sigma) Versus Averaging Time (TAU) 5952-7344
Time Keeping and Frequency Calibration 5952-7874

Frequency Synthesizers

Analyzing Phase-Locked Loop Capture & Tracking 5952-8007
Analyzing Phase-Locked Loop Transients in the Modulation Domain 5952-8001
Examine Channel Switching Characteristics of Cellular Radios 5091-0394E
External Frequency Doubling of the HP 8662A Synthesized Signal Generator 5952-8217
Low Leakage Paper 5952-2789
Low Phase Noise Applications of the HP 8662A and 8663A Synthesized Signal Generators 5953-8435
Millimeter Measurements Using the HP 3048A Phase Noise Measurement System 5951-6749
Pre-Trigger Simplifies VCO Step Response Measurements 5952-7998
Pulsed Carrier Phase Noise Measurements Using the HP 3048A Phase Noise Measurement System 5951-6743
Signal Generator 5952-2019
Simplified Analysis of Phase-Locked Loop Capture and Tracking Range 5091-0391E
VCO Step Response Analysis Made Easy 5091-0387E

Group Delay

Floating Measurements and Guarding 5952-2153
Frequency & Phase Profiling Simplified 5952-8023
The Fundamentals of Electronic Frequency Counters 5952-7506
Tools for Digital Microwave Radio Installation and Maintenance 5091-4653E

IC Testing

Analog-to-Digital Converter Testing with the HP 16542A 5091-5448E
Automatic Path Delay Compensation 5091-1935E
Characterizing Digital-to-Analog Converters with the HP 82000 ..... 5091-5118L
Correlation of Timing Measurements 5952-2311
Dynamic Characterization of A/D Converters with the HP 82000M 5091-4693L
High Speed Continuity/Shorts Test on the HP82000 ..... 5091-1364L
High Speed Timing Acquisition and Statistical Jitter Analysis Using the HP 5370B Universal Time Interval Counter 5952-7908
High Speed Wafer Probing with the HP 83000 ..... 5091-5268L
Histograms Simplify Analysis of Random Jitter 5091-0393E
Imaging and DSP Applications for the HP 16542A 5091-5445E
Measuring CMOS Quiescent Power Supply Current (IDDQ) with the HP 82000 ..... 5091-1363L
Monitoring of Ultrasonic Wire Bonding Machines 5952-2143
Quick Identification of Periodic Jitter Sources 5091-0388E
Running HP 82000/83000 Software on Various UNIX Platforms 5091-4338E
Sychronizing to External Equipment 5953-6339
Using the HP 82000 for 1 Gb/s 5952-2301
Video Testing with the HP 16542A 5091-5447E

Impedence

Advanced TDR Techniques for Use with the HP 54120 Family of Digitizing Oscilloscopes 5952-1141
Analysis of Semiconductor Capacitance Characteristics Using the HP 4280A 1 MHz C Meter/C-V Plotter 5953-6939
Balanced Circuit Measurement with an Impedance Analyzer/LCR Meter/Network Analyzer 5091-4480E
Characteristic Impedance Measurement of PC Board Circuit Patterns Using the HP 4194A Impedance/Gain-Phase Analyzer 5950-2908
Constant Current Measurements Using the HP 4194A 5950-2923
Contact Resistance and Insulation Resistance Measurements of Electro-mechanical Components 5091-4132E
Crosstalk and Impedance Measurements of PC Board Patterns— HP 4194A Application Information 5952-7863
Dielectric Constant Measurement of Solid Materials 5950-2390
Direct Radio Frequency Impedance Measurements 5952-8853
Dynamic Component Test Using Vector Modulation Analysis 5954-6367
Effective Electrolytic Capacitors Testing 5091-4783E
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Efficient Evaluation of LISNs and Voltage Probes for EMI Tests Using the HP 4194A 5950-2922
High Accuracy and Fast RF Inductor Testing 5091-1596E
High Frequency Swept Measurements 5952-9200
High Speed Measurement of Semiconductor Devices from Sub-PA to 1A 5950-2930
Impedance Characterization of High Q Devices from 1 MHz to 1000 MHz with 1 Hz Resolution 5952-8872
Impedance Characterization of Resonators Using the HP 4194A Impedance/Gain-Phase Analyzer 5950-2882
Impedance Measurement for Incoming Inspection— HP 4284A Application Information 5950-2952
Impedance Testing Using Scanner 5950-2975
Improve Electric Product Quality and Performance with HP Precision LCR Meters 5090-0233
Improving Time Domain Network Analysis Measurements 5954-2682

Insertion Gain/Loss

Interface Bus (HP-IB)

ISO 7779

Jitter

Jitter Modulation

Logic, Logic Test

Loop Gain

Magnetic Components

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Microprocessors

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Application Notes

Network Analysis

Noise

Oscillators

Oscilloscopes

APPLICATION & PRODUCT NOTES

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Application Notes

Phase Linearity

Analyzing Phase-Locked Loop Capture & Tracking 5952-8007
Analyzing Phase-Locked Loop Transients in the Modulation Domain ... 5952-8001
Characterizing Barker Coded Modulation in Radar Systems 5952-8004
Characterizing Chirp Coded Modulation in Radar Systems 5952-8005
Complete S-Parameter and Distortion Measurement for Wide Band Video Amplifiers 5950-2932
Direct Radio Frequency Impedance Measurements 5952-8853
Frequency & Phase Profiling Simplified 5952-8023
The Fundamentals of Electronic Frequency Counters 5952-7506
Tools for Digital Microwave Radio Installation and Maintenance 5091-4653E
Voltage Controlled Oscillators Characterization Using the HP 5350B, 5351B, 5352B CW Microwave Frequency Counter 5952-7852

Phase Modulation

Analyzing Phase-Locked Loop Capture & Tracking 5952-8007
Analyzing Phase-Locked Loop Transients in the Modulation Domain ... 5952-8001
Characterizing Barker Coded Modulation in Radar Systems 5952-8004
Characterizing Chirp Coded Modulation in Radar Systems 5952-8005
Clock Rate Independent Jitter Measurements for Digital Communications Systems 5952-7999
Frequency & Phase Profiling Simplified 5952-8023
Single Shot BPSK Signal Characterization 5952-8002
The Fundamentals of Electronic Frequency Counters 5952-7506

Phase Shift

Analyzing Phase-Locked Loop Capture & Tracking 5952-8007
Analyzing Phase-Locked Loop Transients in the Modulation Domain ... 5952-8001
Characterizing Barker Coded Modulation in Radar Systems 5952-8004
Characterizing Chirp Coded Modulation in Radar Systems 5952-8005
Clock Rate Independent Jitter Measurements for Digital Communications Systems 5952-7999
Frequency & Phase Profiling Simplified 5952-8023
Jitter and Wander Analysis in Digital Communication with the HP 5371A Frequency and Time Interval Analyzer 5952-7925
The Fundamentals of Electronic Frequency Counters 5952-7506

Phase Stability

Analyzing Phase-Locked Loop Capture & Tracking 5952-8007
Analyzing Phase-Locked Loop Transients in the Modulation Domain ... 5952-8001
Characterizing Barker Coded Modulation in Radar Systems 5952-8004
Characterizing Chirp Coded Modulation in Radar Systems 5952-8005
Clock Rate Independent Jitter Measurements for Digital Communications Systems 5952-7999
Communications Cable Testing 5954-9638
Fundamental of Time & Frequency Standards 5952-7870
Histograms Simplify Analysis of Random Jitter 5091-0393E
Jitter and Wander Analysis in Digital Communication with the HP 5371A Frequency and Time Interval Analyzer 5952-7925
Quick Identification of Periodic Jitter Sources 5091-0388E
Time Keeping and Frequency Calibration 5952-7874

Power Supplies

Battery Charging/Discharging 5952-4033
Biasing Three-Terminal Devices for Test 5952-4193
DC Power Supply Handbook 5952-4020
Power Supply Testing 5952-4190

Process Control

Canning Process Characterization 5954-9640
DA&C/CAT-Environmental/Autoclave 5954-9637
Machine Monitoring and Control 5954-9650
Materials Development 5954-9642
Paper Process Control 5954-9652
Pharmaceutical Process Control 5954-9651
Pilot Plant Monitoring 5954-9645
Plating Line Control 5954-9643
Rolling Mill 5954-9653
Using the HP 3497A to Control Industrial Wastewater Treatment 5953-6921
Waste Water Treatment 5954-9634

Production Test

Appliance Testing 5954-9654
Battery Testing 5952-4191
Battery Testing 5954-9644
Contact Resistance and Insulation Resistance Measurements of Electro-mechanical Components 5091-4132E
DA&C/CAT-Environmental/Autoclave 5954-9637
Disk Drive Servo-Track Writing with Laser Interferometers 5952-7984
Effective Electrolytic Capacitors Testing 5091-4783E
Effective Transformers/LF Coils Testing 5091-4134E
Fan Testing 5954-9632
High Speed Wafer Probing with the HP 83000 ..... 5091-5268L
Insulation Resistance Measurement of the Plate Type Materials 5091-4133E
Jet Engine Controller Testing 5954-9635
Jet Engine Testing 5954-9646
Large Product Characterization 5954-9648
Missile System Testing 5954-9649
Monitoring of Ultrasonic Wire Bonding Machines 5952-2143
Parametric Analysis for Electronic Components and Circuit Evaluation Using the HP 4194A 5950-2856
Peak Deviation and Center Frequency Measurements for CT2 and DECT Radios 5091-1434E
Power Supply Testing 5952-4190
Practical Strain Gauge Measurements 5952-8880
System Interface Guide—High Throughput Synchronization with Auto-Handlers 5091-4135E
The Fundamentals of Electronic Frequency Counters 5952-7506

Protocol Analysis

Conform by Design 5091-2190E
Frame Relay 5091-2003E
ISDN Application Note 5952-3698
ISDN Testing 5091-2141E
Keeping Your Big Blue Network in the Pink 5952-5131
PT500 Protocol Tester 5091-0927E
PT502 Tester/PT302 Tester 5091-2005E
The Care and Feeding of Your X-25 Network 5952-5132

Pulse Measurements

Analyzing Phase-Locked Loop Transients in the Modulation Domain ... 5952-8001
Automatic Frequency Profiling of Chirped Radar Pulses Using the HP 5361A Pulse CW Microwave Counter 5952-7987

Pulse Modulation

Radar

Radar, WE, ECM, ECCM

Receivers

Reflectometers

Remote Control

Rotating Machinery

S-Parameters

Satellite Communications Equipment

APPLICATION & PRODUCT NOTES

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Application Notes

Semiconductors

Analysis of Semiconductor Capacitance Characteristics Using the HP 4280A 1 MHz C Meter/C-V Plotter 5953-6939
Analyzing Phase-Locked Loop Capture & Tracking 5952-8007
Automation of DC Characterization and Analysis of Semicounductor Devices 5090-0299
Contact Resistance and Insulation Resistance Measurements of Electro-mechanical Components 5091-4132E
DC Parametric Analysis of Semiconductor Devices 5950-2928
Effective Electrolytic Capacitors Testing 5091-4783E
Effective Transformers/LF Coils Testing 5091-4134E
Efficient Microwave Bias and Test Using the HP 4142B Modular Source/Monitor 5091-0522E
High Speed Measurement of Semiconductor Devices from Sub-PA to 1A 5950-2930
High Speed Wafer Probing with the HP 83000 ..... 5091-5268L
Histograms Simplify Analysis of Random Jitter 5091-0393E
Insulation Resistance Measurement of the Plate Type Materials 5091-4133E
Monitoring of Ultrasonic Wire Bonding Machines 5952-2143
Multi-Frequency C-V Measurements of Semiconductors—HP 4284A Application Information 5950-2953
Semiconductor Measurements with the HP 4140B Picoammeter/DC Voltage Source 5952-8840
Simplification of DC Characterization and Analysis of Semiconductor Devices 5950-2396
Simplified Analysis of Phase-Locked Loop Capture and Tracking Range 5091-0391E
Sub-Micro Positioning with the HP 5527A Laser Position Transducer System 5952-7942
Techniques and Applications for High Throughput and Stable Characterization 5950-2954
Ultra Low Current Semiconductor DCParameter Measurement System Using HP 4140B 5952-8873
VCO Step Response Analysis Made Easy 5091-0387E

Signal Sources

Analyzing Phase-Locked Loop Capture & Tracking 5952-8007
Characterizing Components with a Microwave Tracking Source 5091-2172E
Configuration of a Two-tone Sweeping Generator 5952-9316
External Frequency Doubling of the HP 8662A Synthesized Signal Generator 5952-8217
Low Leakage Paper 5952-2789
Low Phase Noise Applications of the HP 8662A and 8663A Synthesized Signal Generators 5953-8435
Millimeter Measurements Using the HP 3048A Phase Noise Measurement System 5951-6749
Obtaining Leveled Pulse-Modulated Microwave Signals from the HP 8672A 5952-8251
Obtaining Millihertz Resolution from the 8671A and 8672A 5952-8184
Pre-Trigger Simplifies VCO Step Response Measurements 5952-7998
Pulsed Carrier Phase Noise Measurements Using the HP 3048A Phase Noise Measurement System 5951-6743

Signature Analysis

Guidelines for Signature Analysis: Understanding the Signature Measurement 5952-7595
Troubleshooting with Composite Signatures 5952-7684

Slotted Line Measurements

Frequency & Phase Profiling Simplified 5952-8023

Smith Chart

Designing Impedance Matching Networks with the HP 8751A 5091-1560E
S-Parameter Design 5952-1087
S-Parameter Techniques for Faster, More Accurate Network Design 5952-1130

Sound Intensity, Sound Power & Sound Pressure Level

Sound Power Measurements 5091-4426E

Spectrum Analysis

Better Noise Measurement with the HP 3588A and 3589A 5091-2496E
Complete S-Parameter and Distortion Measurement for Wide Band Video Amplifiers 5950-2932
Frequency & Phase Profiling Simplified 5952-8023
Network, Spectrum, and Impedance Evaluation of IF Circuits—HP 4195A Network/Spectrum Analyzer 5950-2931
Non-contact Measurements with Laser Interferometer 5091-3078E
Optical Spectrum Analysis Basics 5091-3054E
Spectrum Analysis AM and FM 5954-9130
Spectrum Analyzer Basics 5952-0292
Testing Magnetic Disk Read Circuits Using the HP 4195A 5950-2398
The Fundamentals of Signal Analysis 5952-8898

Stripline Device Measurements

Advanced TDR Techniques for Use with the HP 54120 Family of Digitizing Oscilloscopes 5952-1141
TDR Fundamentals for Use with HP 54120T Digitizing Oscilloscope and TDR 5954-2681
TDR Techniques for Differential Systems for Use with the HP 54120 Family of Digitizing Oscilloscopes 5091-0219E

Swept-Frequency Measurements

Amplifier Measurements Using the Scalar Network Analyzer 5954-1599
Analyzing Phase-Locked Loop Transients in the Modulation Domain 5952-8001
Better Noise Measurement with the HP 3588A and 3589A 5091-2496E
Characterizing Barker Coded Modulation in Radar Systems 5952-8004
Characterizing Chirp Coded Modulation in Radar Systems 5952-8005
Characterizing Components with a Microwave Tracking Source 5091-2172E
Configuration of a Two-tone Sweeping Generator 5952-9316
Control System Development Using Dynamic Signal Analyzers 5953-5136
Dynamic Signal Analyzer Applications 5091-2777E
Extending Dynamic Range of Scalar Transmission Measurements Using the HP 8757A, 8756A, or 8755C Scalar Network Analyzers 5953-8882
Frequency & Phase Profiling Simplified 5952-8023
Fundamentals of the z-Domain and Mixed Analog/Digital Measurements 5952-7250
Low Phase Noise Applications of the HP 8662A and 8663A Synthesized Signal Generators 5953-8435
Millimeter Measurements Using the HP 3048A Phase Noise Measurement System 5951-6749
Modulation Domain Techniques for Measuring Complex Radar Signals 5952-8003
Pulsed Carrier Phase Noise Measurements Using the HP 3048A Phase Noise Measurement System 5951-6743
Single Shot Frequency Profiling of Chirped Radars Made Easy 5091-0392E
Spectrum Analyzer Basics 5952-1213

Switching

Synthesizers/Signal Generators

Tape Recording

Telecommunications

Telecommunications Equipment

Television

Temperature Measurement

Throughput Analysis

Time, Timekeeping

Time-Interval

APPLICATION & PRODUCT NOTES

Free Literature to Help Solve Your Test and Measurement Problems

Product Notes

Time Analysis

Transforms

Transistor Parameters

Transmission Lines

Troubleshooting

Vector Measurements

Video Equipment—TV, VTR

Video Detection, Video Receivers

Voltage

Voltage-Controlled Oscillators

Product Notes

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3577A-1/5953-5119—User's Guide to the HP 3577A Network Analyzer

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3850A-7/5952-9344—Noise Figure Measurement

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4954A-1/5952-5138—SNA Network Performance Analysis

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5091-2509E—8350B Sweep Oscillator, and the HP 8756 Scalar Analyzer with an HP Series 200 Computer

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5097-2639—Return-Loss Measurement

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5950-2941—Product Note 363

5952-5103—HP 4972A Product Note

5952-5122—HP18360/61/62 SNA

5952-9626—Arbitrary Test Signals

8175A/5952-9604—Wavemaker SW

8175A/5952-9606—Coder SW

8175A/5952-9608—Learn String Guide

8175A/5952-9622—Link Software

8340-7/5954-8345—Noise Figure Measurements with HP 8340B & 8341B

8349-1/5954-1516—Achieving Calibrated Output Power with the HP 8350 Sweep Oscillator 8349 Broadband Amplifier Combination

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8350-4/5954-1505—Pulse Modulation Characteristics of the HP 83500 Series Sweep Oscillator RF Plug-ins

8350-6/5952-8089—Reducing Harmonics Using Integra TMF-1800H

8350-6/5952-9345—Reducing Harmonics Using Integra

8350-8/5954-1507—Leveling the HP 8350B Sweep Oscillator with an HP 430 Series Power Meter

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8360-1/5952-8089—HP 8340/41 to HP 8360 System Conversion Guide

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8360-4/5091-0227E—Performing Two-Tone Measurements with the HP 8360

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8510-13/5952-4373—Measuring Noninsertable Devices

8510-14/5952-6674—Using Multiple Test Sets with the HP 8510B

8510-15/5952-3524—Lightwave Component Measurements

8510-16/5991-0467E—Test Port Power Flatness

8510-6/5954-1579—On-Wafer Measurements Using Cascade Prober

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8510-8A/5091-3645E—Applying TRL Cal to Non-coaxial Measurements

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8642A/B-2/5953-8452—Using Sweep Functions on the HP 8642A/B

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8644A-1/5951-6729—Phase Noise Measurements with the HP 8644A & 8655A Signal Generators

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8720-2/5091-1943E—In-Fixture Measurements with the HP 8720C

8751A-1/5091-0408E—High Accuracy and High Speed Filter Measurements

8753-1/5956-4361—Amplifier Measurements Using the HP 8753 Network Analyzer

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8753-3/08753-90133—Applications of the Test Sequence Function

8753-4/5952-2776—Antenna Measurements Using the HP 8753

8753-5/5091-1100E—Mixer Measurements with the HP 8753C and HP8625A Synthesized RF Sweeper

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8757-5/5954-1537—Measuring Voltage-Controlled Devices

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8791-5/5952-1901—Tips on External Clock Operation with the HP FASS

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APPLICATION & PRODUCT NOTES

Free Literature to Help Solve Your Test and Measurement Problems

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