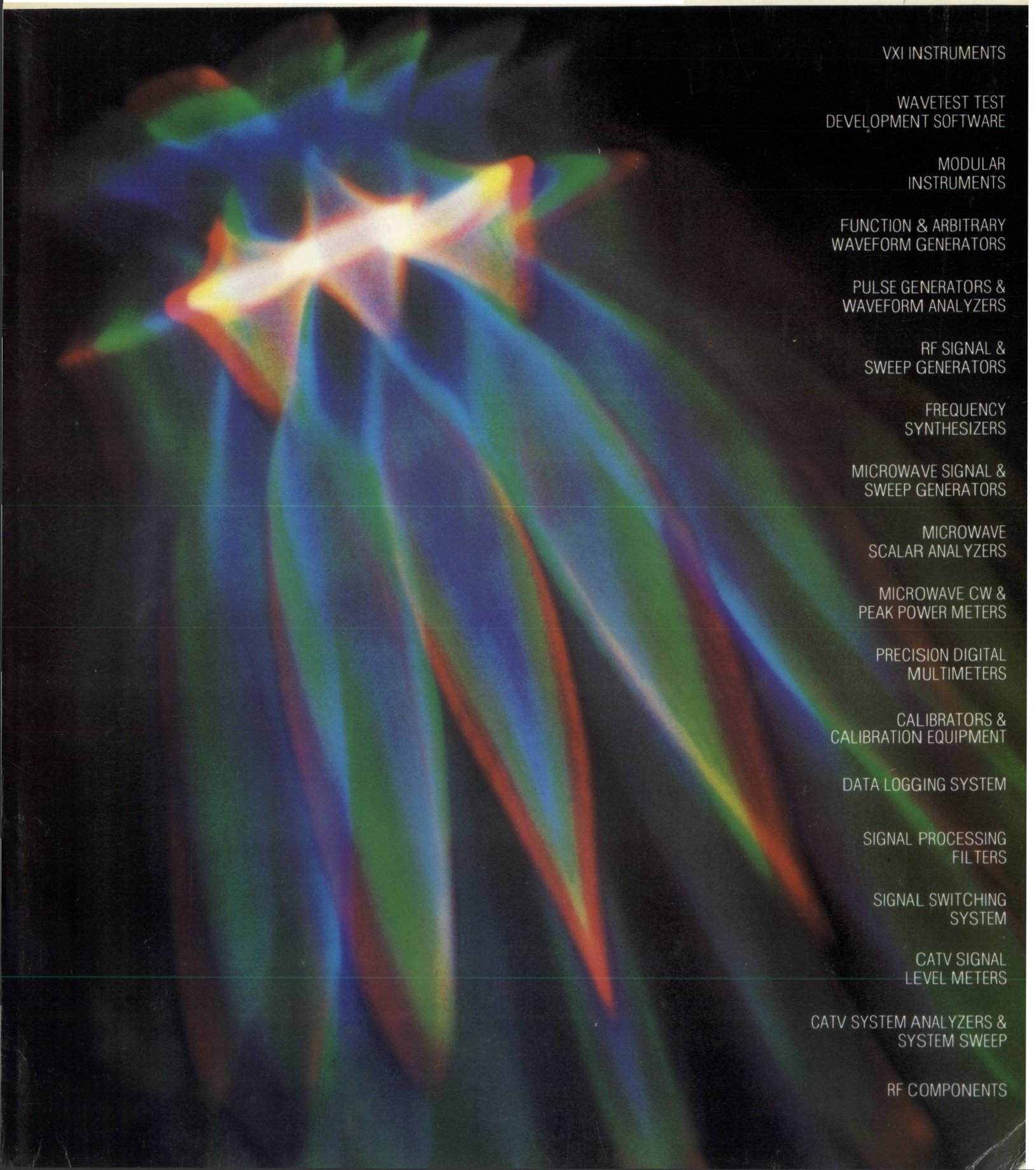
WAVETEK®

TEST & MEASUREMENT
INSTRUMENTATION 1990



VXI INSTRUMENTS

WAVETEST TEST
DEVELOPMENT SOFTWARE

MODULAR
INSTRUMENTS

FUNCTION & ARBITRARY
WAVEFORM GENERATORS

PULSE GENERATORS &
WAVEFORM ANALYZERS

RF SIGNAL &
SWEEP GENERATORS

FREQUENCY
SYNTHESIZERS

MICROWAVE SIGNAL &
SWEEP GENERATORS

MICROWAVE
SCALAR ANALYZERS

MICROWAVE CW &
PEAK POWER METERS

PRECISION DIGITAL
MULTIMETERS

CALIBRATORS &
CALIBRATION EQUIPMENT

DATA LOGGING SYSTEM

SIGNAL PROCESSING
FILTERS

SIGNAL SWITCHING
SYSTEM

CATV SIGNAL
LEVEL METERS

CATV SYSTEM ANALYZERS &
SYSTEM SWEEP

RF COMPONENTS

Test & Measurement On A Global Scale

Wavetek, "the function generator company", has become a worldwide supplier of test and measurement instruments and systems.

Our product offerings have expanded beyond function, pulse and signal generators to meet the requirements of every industry with testing and measurement needs.

Wavetek provides sweepers and innovative signal analyzers to help CATV operators maintain their systems. Wavetek/Datron continues to lead the way with the most accurate digital multimeters and calibrators in the world.

Our engineers are setting new standards in microwave peak power measurement and scalar analyzers, and have developed the world's fastest multi-channel programmable pulse generator.

The WaveTest GPIB programming software has earned wide acclaim, and our new data logging system is setting new standards of performance, portability and plotting capability, at an amazingly low price.

Components from Wavetek include the Ultramin® filters, high performance devices that are small enough to fit in a transistor can, and tough enough to operate in the harshest environments.

To meet today's trend towards "instruments on a card", Wavetek has introduced its first product in the VXI configuration, and has also developed a proprietary modular instrumentation system that compresses eight instruments into the space normally required for one.

As our products have expanded into a global market, so has our commitment to customer service. With plants and offices located in 55 countries on six continents, you can be sure that Wavetek support will always be close at hand.

WAVETEK

How To Use This Catalog

This catalog contains descriptions, specifcations, prices and ordering information for Wavetek's signal sources, measurement equipment and related special equipment and components. Indexes and charts are included to help you readily find specific instruments and features.

- **Types of Equipment** - The table of contents below, thumb index on this page edge and a product index on page 4 will help you find the products you want. The general equipment type is also noted in the upper corner of each page.
- **Equipment Model Numbers** - A model number index is on page 2. Also, instrument types and model numbers can be read in the upper corner as you thumb through the catalog pages.
- **Selection Guides** - Selection guides comparing features of many (but not all) instruments are listed here.

Selection Guides

Contents

FOR ORDER INFORMATION CALL 1-800-223-WVTK or 619/569-9234

GPIB Identifies products that can interface to the General Purpose Interface Bus (IEEE Standard 488-1978)

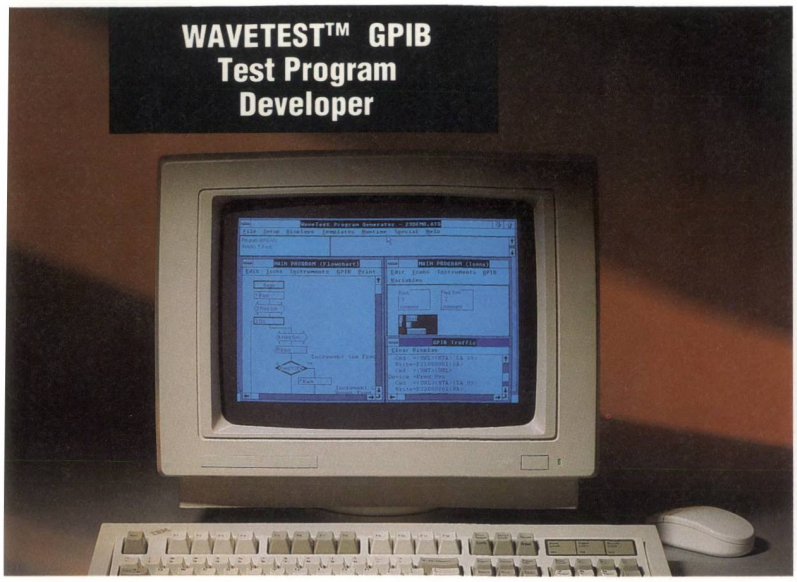
MATE Identifies products that have been MATE verified

NEW Identifies new products

MODEL NUMBER INDEX

New products identified by bold type.

PRODUCT INDEX



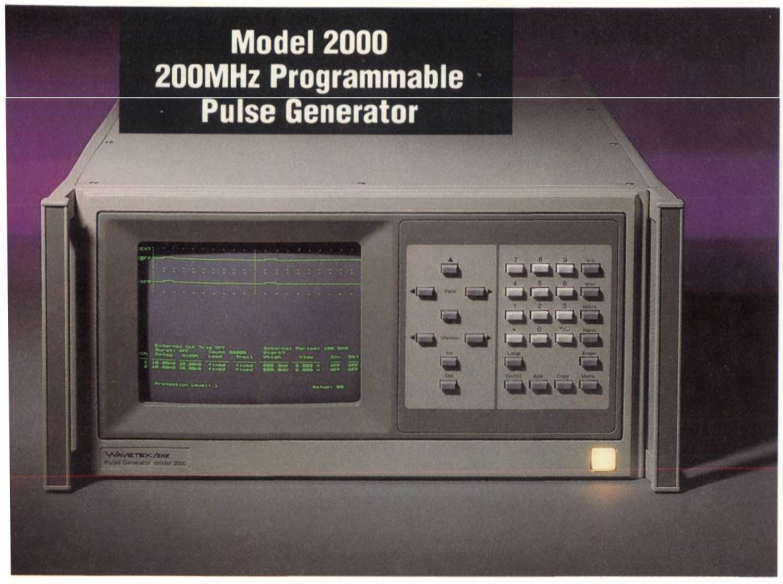
The most efficient way to create IEEE-488 (GPIB) test programs. Program development is as simple as using a mouse to move icons into the desired order. Or you can assemble a flowchart. Either way, WaveTest writes the underlying BASIC code and automatically generates detailed documentation. Users report time savings of greater than 60%. See pages 13-17.

Put as many as eight high performance modular instruments into one 7" chassis. Choices include a 20 MHz Arbitrary/Waveform Generator, 100 MHz Pulse Generator, 6-1/2 digit DMM, and 160 MHz Frequency/ Time Interval Counter. Built-in testing, calibration, and reference plus GPIB and optional MATE-CIIL interfaces for ATE applications. See pages 20-29.

Use a thumbtack and rubber band editing system to "draw" any waveform on a grid of 8,000 horizontal and 4,000 vertical points. Model 75 will reproduce the waveform with digital precision. Computer-generated waveforms can also be downloaded and edited. In addition, there are nine built-in functions. All this capability at a very affordable price. See pages 37-39.

This higly flexible function generator provides ±.005% synthesized accuracy over a 10 MHz to 12 MHz frequency range. A unique clock mode extends the range to 32 MHz for TTL and ECL outputs. Model 23 operates in synthesized, continuous, triggered and gated modes, and is capable of AM, FM and suppressed carrier modulation. A GPIB interface is optional. See pages 68-69.

KEY PRODUCTS

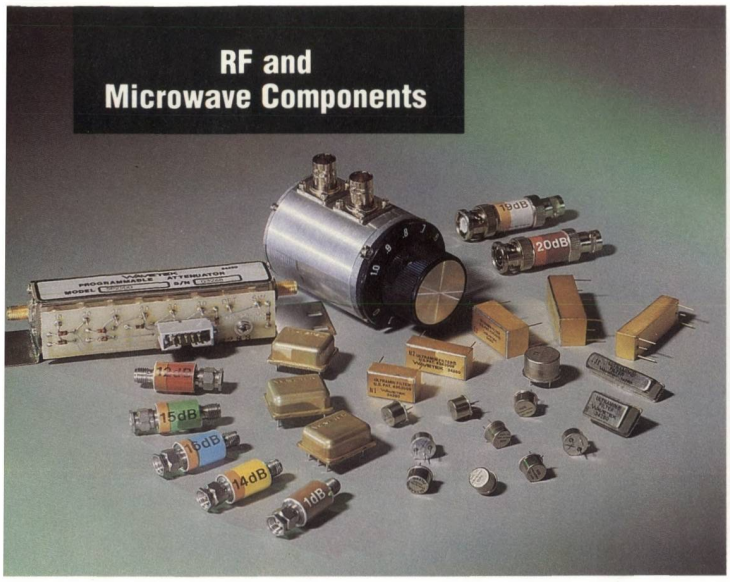


With up to four independent channels and a 200 MHz clock rate, Model 2000 is the world's fastest multi-channel system pulse generator. Its programmable sub-nanosecond edge speeds meet the test requirements of the latest electronic assemblies and devices. Channel types can be mixed (5V and 10V) so that one unit can meet CMOS, ECL, FAST and HCMOS needs. See pages 74-76.

Now CATV system frequency response can be measured in the field, without a sweep generator, and without disturbing subscribers. Model 1882A takes a digital "snapshot" of the desired input signal, then compares that signal to the output in the field. It also performs a full range of distortion tests, carrier to noise, hum, FM deviation, cross modulation and composite triple beat. See pages 188-189.

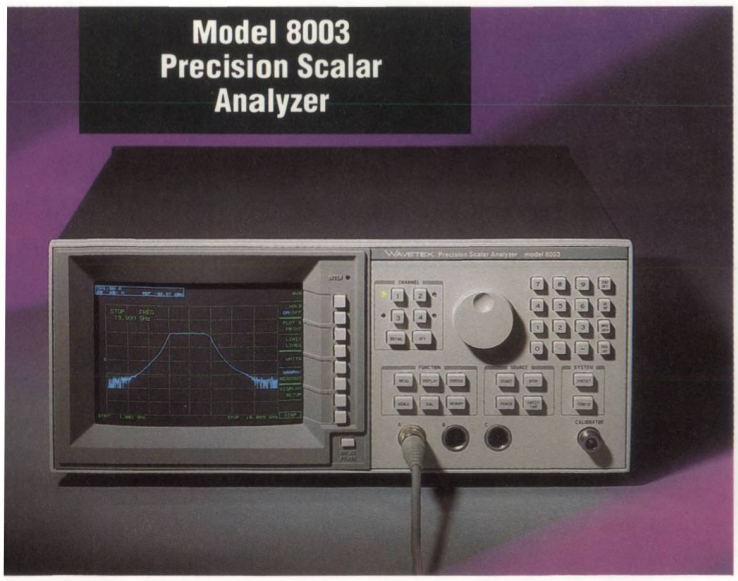
Quick and accurate measurements are made possible by convenient displays and automated functions. Tuning, either by synthesized frequency or channel, is shown in the LCD, along with measurement results. An analog meter is provided for peaking. Automated functions include video minus audio, tilt and pilot level, and carrier to noise. Built-in calibration. See pages 184-185.

The CLM-1000 allows CATV leakage measurements to be made from distances of up to 100 feet. It automatically calcultes the 3-meter value in μV/meter. For FCC data logging, up to 100 measurements can be entered into the instrument's memory. Tuning is over a wide 50 to 550 MHz tuning range, with built-in pre-selection for the critical aeronautical bands. See page 193.

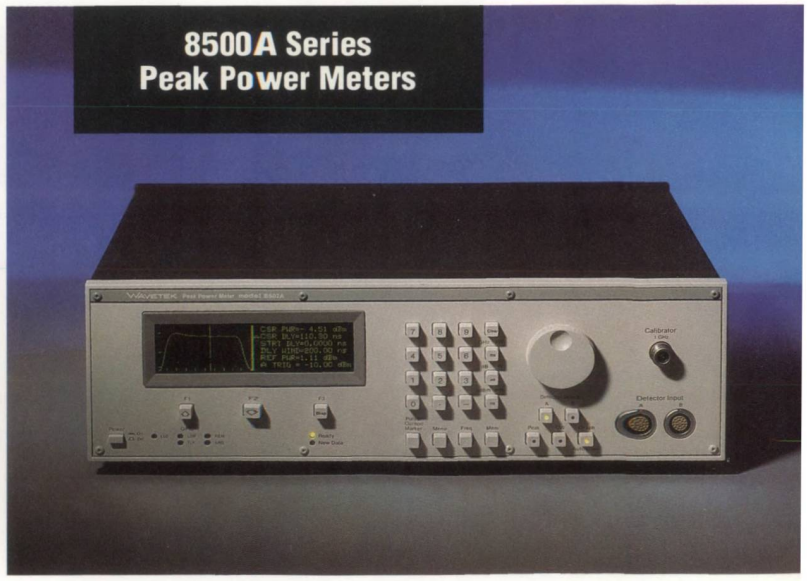


The Wavetek Ultramin® filter series includes the first and only quality, custom-designed filters in a TO-5 transistor can. They cover the 10 to 2000 MHz frequency range and satisfy the most stringent specifications for humidity, shock, vibration and temperature. Other components include programmable attenuators, turret attenuators, RF detectors and many more. See pages 196-207.

The Model 2410 provides a frequency range of 10 kHz to 1000 MHz with 8 digits of resolution and automatic calibration (AUTOCAL®). It has an independent modular design for ease of serviceability. The advanced user interface features a backlit display that gives plain English instructions, eliminating the need to refer to a manual. IEEE-488 interface is standard. See pages 96-97.



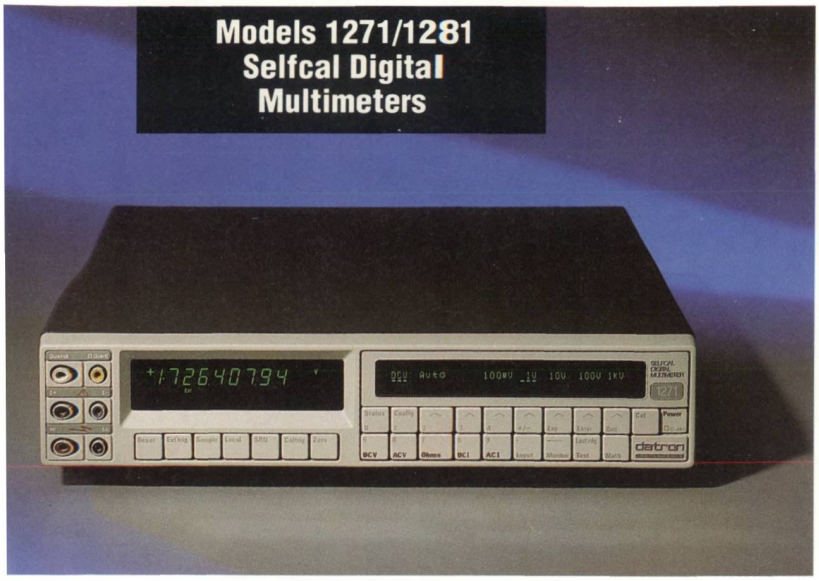
Selectable frequency ranges from 10 MHz to 110 GHz, ±0.03 dB linearity and 90 dB dynamic range make this instrument ideal for precision measurements on passive microwave components. Power measurements with NIST (NBS) traceablility can be made on devices such as amplifiers. Sub-systems and ATE setups benefit from the fast measurement speed and improved accuracy. Ease-of-use results from features such as the color display and compatibility with all popular sweepers including the Wavetek 8910 Series. See pages 122-125.



Make precise peak power measurements at any point on the pulse waveform, with no additional equipment or calculations. A built-in, power sweep-calibrator characterizes the diode detector to a linearity of ±3% (±0.13 dB) for industry leading accuracy. Interchangeable sensors cover 30 MHz to 40 GHz frequency range. Also measure and display risetimes as fast as 15 ns with user selectable reference points. Includes GPIB interface. See pages 130-132.

KEY PRODUCTS

Models 1271/1281 Selfcal Digital Multimeters



These 8-1/2 digit DMM's with Autocal and Selfcal set new standards in accuracy and speed. Model 1271 offers systems users the latest GPIB (IEEE-488.2) interface. Model 1281 is the world's finest 8-1/2 digit DMM and has stability up to ±3ppm for 1 year – ideal for laboratories. Both measure DCV from 10nV to 1100V, true RMS ACV, current, 2- and 4-wire resistance and ratio. See pages 140-143.

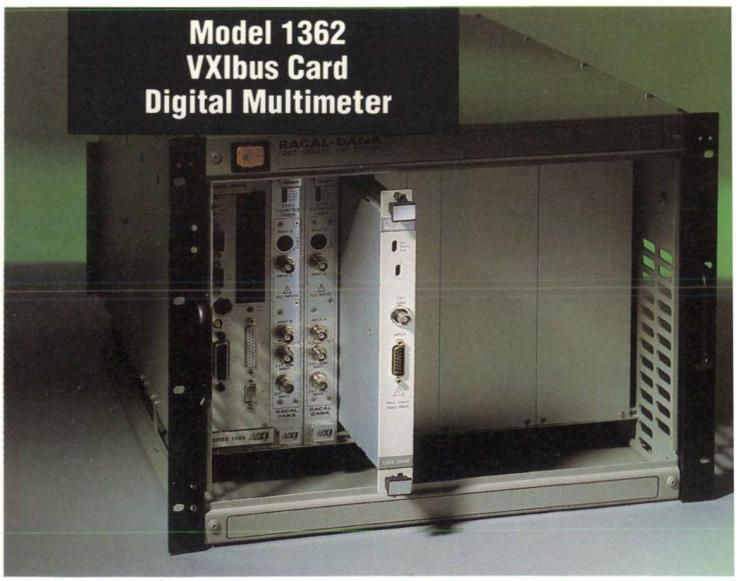
Model 4708 Autocal Multifunction Standard

This is the world's most accurate, fully multifunction, programmable calibrator. It has the stand-alone capability to calibrate today's highest accuracy 7-1/2 and 8-1/2 digit DMM's for up to five functions (DC and AC voltage to 1000V with AC frequencies to 1 MHz, DC and AC current to 10A, resistance to 100MΩ). IEEE-488 compatible. See pages 148-149.

Model 4910 DC Voltage Reference Standard

With a 1-year stability of 1ppm, this is truly a standard to be relied upon. Zener diode reference technology has been combined with a design featuring four totally independent 10V cells. Each cell has its own power supply, heater, and temperature control. For traveling, seven days of internal battery backup are provided. See page 156.

Model 1362 VXIbus Card Digital Multimeter



This 6-1/2 digit DMM offers remarkably high performance while operating within the VXI enviroment. For example, a DC to DC converter design results in a CMMR of better than 146 dB. DCV, ACV and resistance measurement functions are standard, with ratio and current options. Model 1362 is programmable using IEEE-488.2 commands. A MATE (CIIL) version is available. See pages 10-11.

Wavetek and VXI

In July 1987, Wavetek along with four other instrument manufacturers agreed to support a modular instrument standard called the **V**MEbus e**X**tensions for **I**nstrumentation, or **VXI**. Based on the VMEbus, Eurocard, the IEEE-488 (GPIB), and other instrumentation standards, the VXIbus standard was created in response to requests from automatic test equipment (ATE) users to down-size the current rack-and-stack instrumentation systems. The one megabyte per second data transfer rate limitation of the eight bit GPIB, the need for a higher backplane bandwidth for digital test and digital signal processing applications, and a minimized time skew in module triggering were three other important factors driving this interest. The VXIbus concept of a high-speed instrument backplane and card-based plug-in modular instruments are now a reality as the first VXI products are available and integrators begin to build their first VXI based test systems.

Wavetek's VXI Position

Wavetek is committed to VXI. Referring to the other instrument pages in this section you can see that Wavetek has, at this printing, its first VXI product available. Others are in work for the future demands of the VXI environment. This year we will be introducing exciting VXI products complimentary to our current product offering.

The year 1990 will be a key year for both Wavetek and VXI; customers are already consulting with our representatives and our engineers to develop their VXI production test systems of the future.

Benefits of VXI

The VXI standard offers a broad new option for your automatic testing needs. For new system requirements, the overall instrument density has been dramatically increased, allowing more instruments in a downsized system. The tight coupling of source and measurement inherent in these instruments on a card results in improved measurement accuracy in many applications.

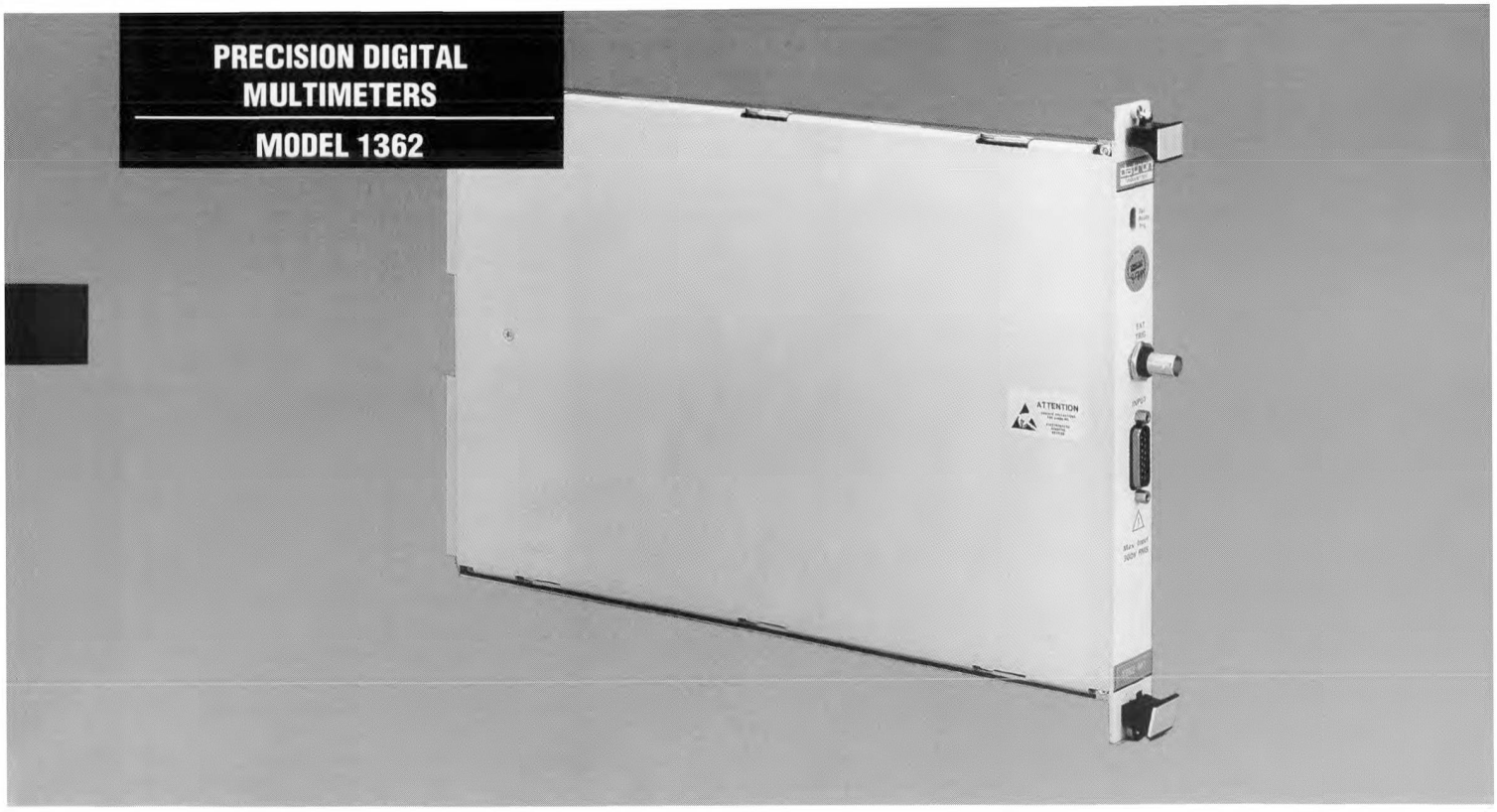
For Additional Information

For additional information you may contact the VMEbus International Trade Association, Wavetek, or your local Wavetek representative.

VITA-USA
10229 N. Scottdale Road
Suite E
Scottdale, Arizona 85253, USA
Tel.: (602) 951-8866

VITA-Europe
P.O. Box 192
5300 AD Zaltbommel, Netherlands
Tel.: 31.4180.14661

For solutions to your automatic testing needs or to find out more about our advanced VXI modules and software tools, call your local representative (pages 211 and 213) or Wavetek (619) 279-2200.



VXI Card Digital Multimeter

- **6 1/2 Digit Resolution**
- **DCV, ACV & Resistance Functions**
- **Ratio & Current Options**
- **1000 Readings/sec**
- **MATE (CIIL) version**

Model 1362 is a message based, single width, C size card DMM conforming to the VXI specification, revision 1.2.

Functionality
DC & AC Voltage and Resistance functions are provided with 4 1/2 to 6 1/2 digits selectable on a 1,999,999 scale. Voltage ranges extend from100 mV to 300V, and Resistance ranges span 100Ω to 10 MΩ.

AC Voltage measurements are True RMS for frequencies from 10 Hz to 1 MHz, with a DC coupled facility also available. Additional options may be ordered to provide a fully isolated second channel input for ratio measurements, and DC & AC Current capability to 2A.

Systems Performance
Various combinations of scale length and speed are programmable giving, for example, up to 1000 readings per second on a 19,999 scale. At high read-rates where the system controller may limit continuous operation, an internal datastore can be set to record a block of 1 to 1000 readings.

Dual triggering is provided, using either an internal system trigger or an external TTL level at the front panel trigger connector. To simplify operation, a range of internal default trigger delays ensures that digitization commences only after analog settling. For special applications, delays from zero to 10 seconds are programmable.

Integrity
The environment of a VXI system mainframe presents a formidable challenge to those wishing to make precision measurements. Within the model 1362 several innovative techniques have been employed to combat the combined effects of line, wideband and common mode noise.

One essential is the isolation of DMM input circuitry from the backplane supplies to produce a floating input amplifier sensitive only to the required input signal. A unique low level DC to DC converter design achieves this, which coupled with the benefits of careful internal guarding, has produced extremely high isolation resulting in a common mode rejection ratio (CMRR) of >146 dB, outclassing most conventional designs.

Switchable active filters together with a range of digital filtering selections produce >20 dB of normal mode rejection (NMR) to line frequency interference. An additional >54 dB is provided by programming the timing circuits of the 1362 to match either a 50 Hz, 60 Hz or 400 Hz environment.

Selftest
Programming a selftest initiates a sequence of 30 key checks on model 1362 operation. The basic ranges of all analog functions are tested for calibration errors, and the digital calibration memory constants are verified against initial values. Successful completion of a selftest gives the user additional confidence in the unit's integrity.

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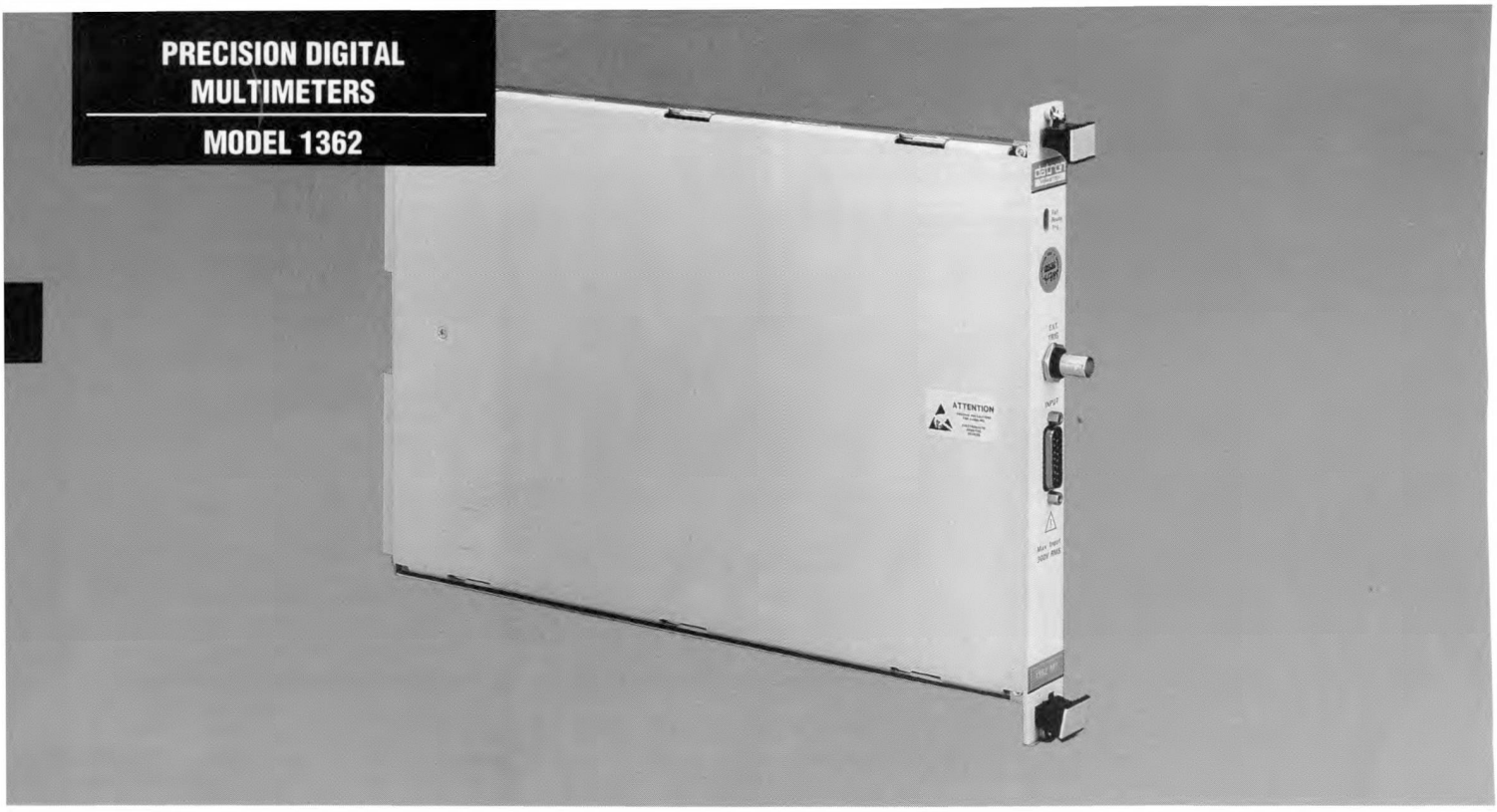
PRECISION DIGITAL MULTIMETERS

MODEL 1362



VXI Card Digital Multimeter

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- **DCV, ACV & Resistance Functions**
- **Ratio & Current Options**
- **1000 Readings/sec**
- **MATE (CIIL) version**

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Dual Language

The native language of the model 1362 uses the IEEE-488.2 command syntax. Model 1362MT, which is identical in measurement capability, is also compatible with MATE Control Interface Intermediate Language. Transfer between IEEE-488.2 and MATE (CIIL) is programmable.

Calibration

Calibration of the model 1362 can be performed on-site using an Autocal all electronic technique which stores calibration constants in a non-volatile memory. The process allows calibration to nominal or special values, and any constant can be recalled for examination. A sealed switch on the model 1362 front panel prevents unauthorized access to calibration routines.

SPECIFICATIONS

DC Voltage

Ranges: 100 mV to 300V in decades.
FS: 2 x Full Range. 100% Overrange. (Except 300V range).
Resolution: 100 nV, 6 1/2 digits.
Accuracy: 90 Days, 23°C ± 5°C, ±(ppmR + ppmFS):

100 mV Range:	30 + 6
1V Range:	20 + 3
10V Range:	20 + 2
100V Range:	30 + 3
300V Range:	30 + 3.

CMRR: (1kΩ unbalance) >146 dB at DC, >(80 dB + NMRR) at 1 Hz - 60 Hz.
NMRR: 54 dB at 50/60 Hz ± 0.1% (Filter out), add 20 dB at 50 Hz (Filter in).
Input Impedance: >10 GΩ from 100 mV to 10V ranges, 10 MΩ ± 1% on 100V and 300V ranges.
Input Protection: Withstands 300V RMS on any range.
Input Current: <50 pA.
Settling Time: (To 10 ppm step size) <5 ms (Filter out), <300 ms (Filter in).
Read Rate: 5/s at 6 1/2 digits, 1000/s at 4 1/2 digits.

True RMS AC Voltage

Ranges: 100 mV to 300V in decades.
FS: 2 x Full Range. 100% Overrange. (Except 300V range).
Resolution: 1 µV, 5 1/2 digits.
Accuracy: 90 Days, 23°C ± 5°C, Signal >1%FS, ±(%R + %FS):

All Ranges

10 Hz-40 Hz:	0.4 + 0.1
40 Hz-20 kHz:	0.035 + 0.01
20 kHz-50 kHz:	0.1 + 0.02
50 kHz-100 kHz:	0.16 + 0.03

Hf Accuracy: (1V and 10V ranges, typical).

100 kHz-300 kHz:	±1%R + 0.1%FS
300 kHz-1 MHz:	±2%R + 1%FS

CMRR: (1kΩ unbalance) >80 dB at DC - 60 Hz.
Input Impedance: 1 MΩ shunted by 100 pF.
Input Protection: Withstands 300V RMS on any range.
Crest factor: 5 :1 at Full Range.
Max Volt-Hertz: 300V x 100 kHz.
Settling Time: (To 0.1% step size), <200 ms (360 Hz filter), <500 ms (40 Hz filter), <2.5s DC coupled.
Read Rate: as DC function.

Resistance

Ranges: 100Ω to 10 MΩ in decades.
FS: 2 x Full Range, 100% Overrange.
Resolution: 10 µΩ, 6 1/2 digits.
Accuracy: 90 Days, 23°C ± 5°C, ±(ppmR + ppmFS):

100Ω Range:	35 + 6
1 kΩ & 10 kΩ Range:	30 + 3
100 kΩ Range:	40 + 3
1 MΩ Range:	80 + 3
10 MΩ Range:	200 + 4.

Open Circuit Voltage: <15V.
4-wire Lead Resistance: Up to 100Ω.
Current Through Unknown:

100Ω	1 mA
1 kΩ	1 mA
10 kΩ	100 µA
100 kΩ	10 µA
1 MΩ	4 µA
10 MΩ	400 nA

Input Protection: Withstands 250V RMS on any range.
Settling Time: Up to 10 kΩ generally the same as DCV.
Read Rate: as DC function.

DC Current

Range: 1000 mA.
FS: 2 x Full Range. 100% Overrange.
Resolution: 1 µA, 6 1/2 digits.
Accuracy: 90 Days, 23°C ± 5°C, ±(ppmR + ppmFS): 200 + 10.
Shunt Resistance: 0.1Ω
Settling Time: As DC Voltage.
Read Rate: as DC Voltage.

AC Current

Ranges: 1000 mA.
FS: 2 x Full Range. 100% Overrange.
Resolution: 1 nA, 5 1/2 digits.
Accuracy: 90 Days, 23°C ± 5°C, ±(%R + %FS):

10 Hz-40 Hz:	0.4 + 0.1
40 Hz-3 kHz:	0.08 + 0.03.

Shunt Resistance: 0.1Ω
Settling Time: As AC Voltage.
Read Rate: As AC Voltage.

Ratio Accuracy

±(net signal accuracy + net reference accuracy).

VXIbus Specification

Module: C size, single slot width.
Device Type: Message based instrument, Word serial protocol, A16 slave only.
Logical address: Manually selectable 1 to 255, address 255 supports dynamic configuration.
Interrupt level: User programmable 1 to 7

GENERAL

Remote Programming:
IEEE-488.2
MATE(CIIL), (1362MT only).
Environmental:
Operating Temp: 0°C to +50°C.
Storage Temp: -40°C to +70°C.
Dimensions: C size card, 234 mm (9.2 in.) high, 340 mm, 30 mm (1.2 in.) wide, (13.4 in.) deep.
Weight: 1.6 kg (3.5 lb.).
Power: 1.5A (5V), 0.5A (±12V) approx.

CONFIGURATIONS

Model 1362: 6 1/2 Digit VXIbus Digital Multimeter (includes DCV, ACV & Resistance).
Model 1362MT: 6 1/2 Digit VXIbus MATE (CIIL) compatible Digital Multimeter (includes DCV, ACV & Resistance).

OPTIONS

30: DCI & ACI Current Converter
40: Comprehensive Ratio

ACCESSORIES

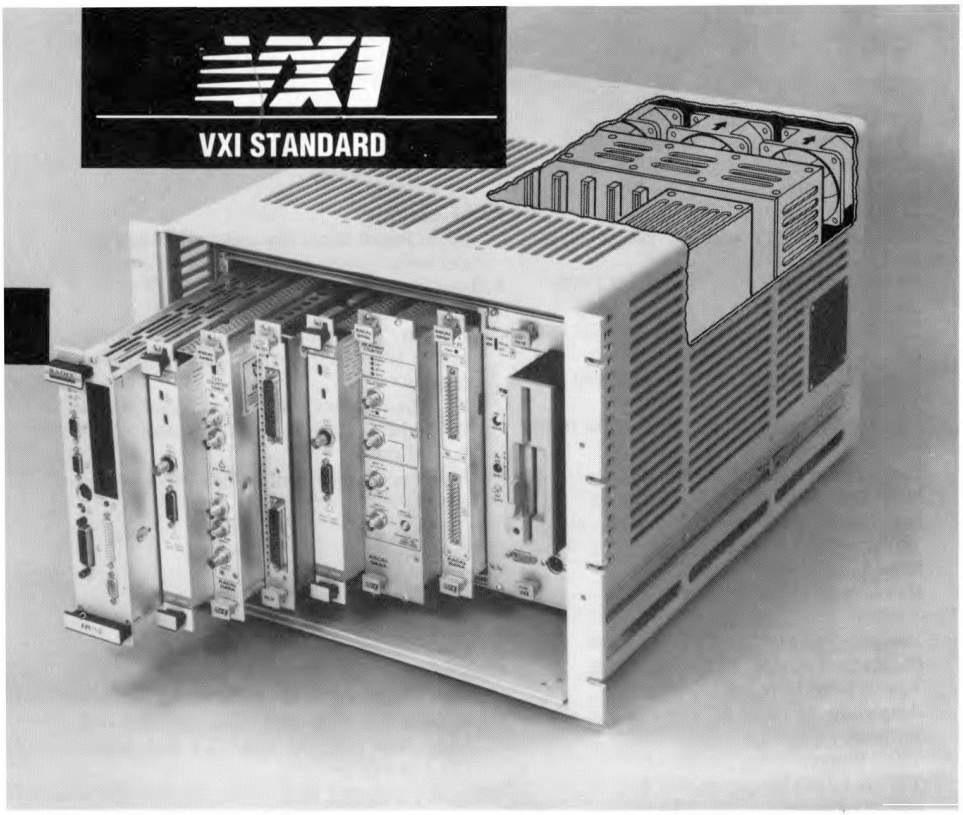
1505: Single Input Lead
1506: Ratio Input Lead

FACTORY/FOB

Indianapolis, IN & Norwich, England

ORDER INFORMATION

Model 1362
Model 1362MT
Option 30
Option 40
Accessory 1505
Accessory 1506



VXI STANDARD

Test Systems
The flexibility of the VXIbus allows a wide range of instruments, interface cards and/or computers from a variety of manufacturers to be installed into the same mainframe chassis. A VXI test system can contain one or more subsystems or mainframes, each of which consists of 13 instrument slots. The first module slot, slot 0, will typically contain:

- Common System Resources (timing generators and so on)
- Controller Functions
- IEEE-488 and/or RS232 communication ports

The slot 0 may also contain an instrument as well. All of the remaining slots are available for system instrumentation with instruments either occupying complete module slots, portions of a module slot or multiple module slots. The VXI specification allows up to 256 instruments to be included in the the same test system.

Instruments can be of two general types, Register based or message based.

Register Based Devices
A register based deviced is generally a slave-only device. Communication with one of these devices is usually via read and writes of its registers. However, register based devices may also utilize interrupts. One example of this type of device is a relay multiplexer device which is switched by writes to specific device registers. Register based devices are the simplest VXIbus devices, and are suitable for low cost implementation.

Message Based Devices
Message based devices support the VXIbus configuration and communication protocols. All message based devices are capable of at least a minimum set of standard communication protocols. Examples of message based devices are any sophisticated devices with local intellegence that require a level of communication capability such as DMMs, spectrum analyzers, display controllers, 488-VXIbus interface devices, switch controllers, etc.

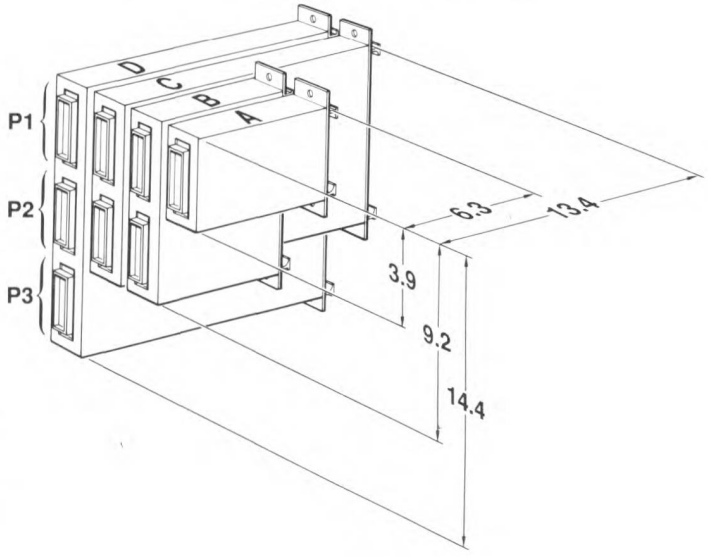
Module Sizes and Interface
The VXI specification refers to four module sizes, all of which are illustrated below. The VME system architecture, on which the VXI specification is based defines module sizes A and B and two 96-pin (3 rows of 32 pins) connectors P1 and P2. The VXI bus specification defines two additional module sizes C and D and a third 96-pin connector P3. The figure also lists the electrical connector functions of P1, P2 and P3. Connector P1 contains a 16-and 24-bit address and 8- and 16-bit data bus as well as all handshaking, arbitration and interrupt support. Connector P2 contains the extra lines needed for the 32-bit address and data bus along with a 10 MHz ECL clock, ECL and analog power supply voltages, ECL and TTL trigger lines, analog summing bus, a module identification line and a daisy chain local bus structure. The VXI P2 connector contains a 12-line in and 12-line out, 24-bit local bus. Connector P3 contains the necessary timing requirements and additional power distribution needed for high performance modules. It contains a 100 MHz clock and sync signal, additional power and ECL trigger lines and an additional 48-bit (24 in/24 out) local bus. A typical D size VXI card cage is illustrated above.

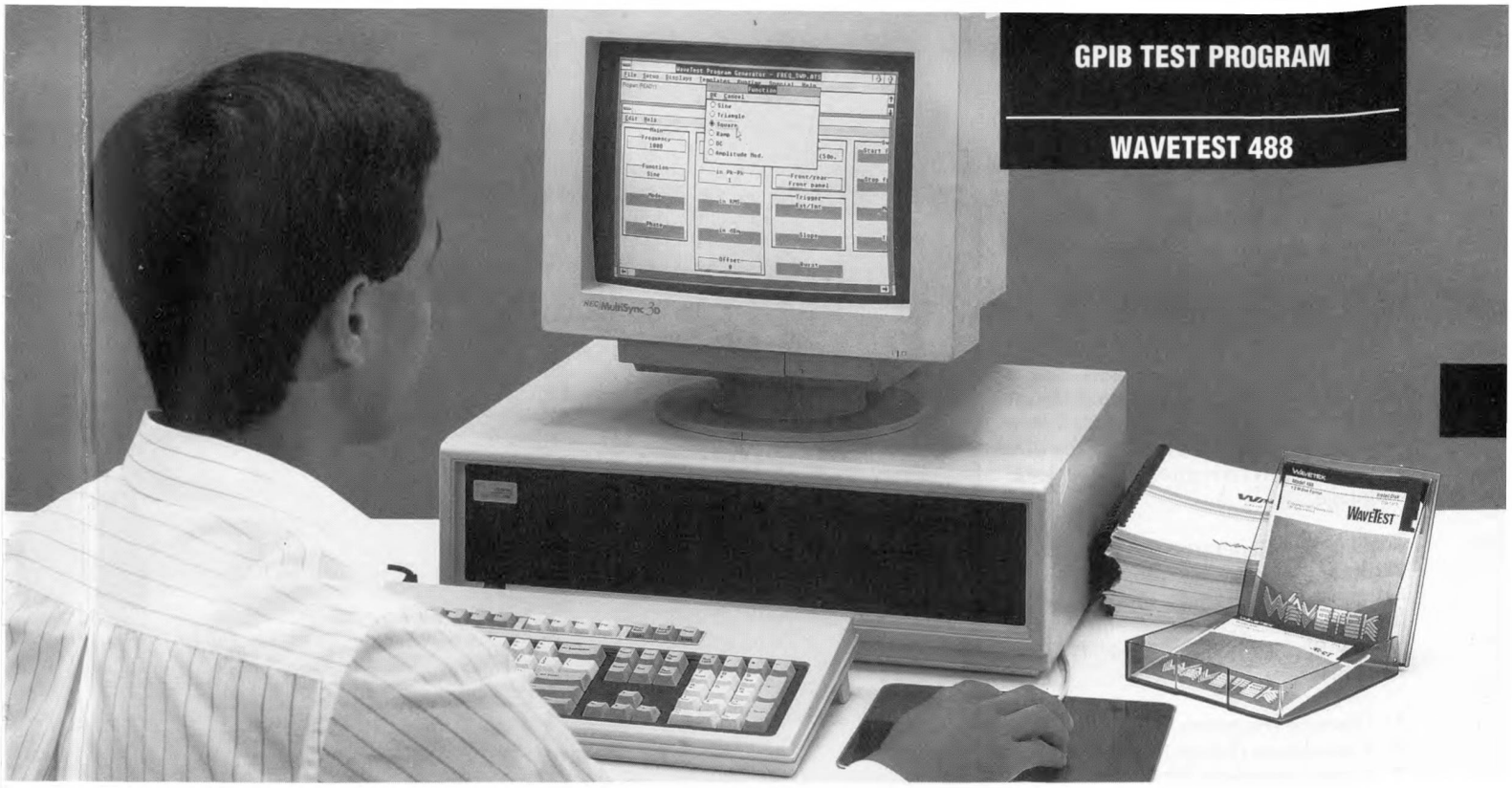
Your Next Step
To find out more about our advanced VXI modules and software tools, call your local representative (pages 211 and 213) or Wavetek (619) 279-2200.

P1 CONNECTOR
16-bit data
16-megabyte addressing

P2 CONNECTOR
VME 32-bit data
4-gigabyte addressing
10-MHz Clock
2 parallel ECL lines
8 parallel TTL lines
Module identification pin
12 local bus lines
Analog summing bus
–5.2V, –2V, ±24V, +5V and ground

P3 CONNECTOR
100-MHz clock
Clock synchronization signal
2 Star lines
4 parallel ECL lines
24 local bus lines
–5.2V, –2V, ±24V, +5V, ±12V and grounds





GPIB Test Program Developer

- **Unique Syntax Free Programming**
- **Program and Edit with Modules or Flowcharts**
- **Turns Your PC/AT® Into a Powerful Instrument Controller**
- **Over 100 GPIB Instruments are Programmed For Immediate Use**

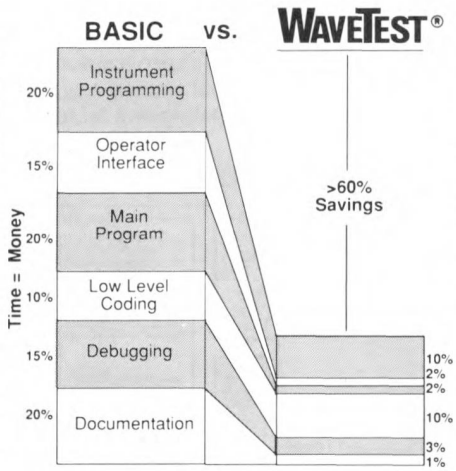
WAVETEST®
GPIB
SOFTWARE

WaveTest® now makes the art of programming IEEE-488 (GPIB) systems easy and understandable. Running under Microsoft Windows™, WaveTest is an Icon based programming environment that lets you focus on your instrument system. If you are writing test programs using BASIC and would like to have syntax-free programming with flowcharts or modules, a software bus analyzer and automatic documentation, then WaveTest is your alternate solution.

WaveTest® from Wavetek, The Key to Your ATE Productivity

A typical test system consumes months of engineering time to write code. WaveTest now provides a software solution that will save you time and money in all aspects of your program development.

Save greater than 60% of the cost of your test program with the efficiencies that WaveTest produces in programming, debugging and documenting.



WaveTest Turns Your PC/AT Into a Powerful Controller

WaveTest, the next generation GPIB software, is compatible with today's faster and more powerful computers. WaveTest, running under Microsoft Windows, enhances 286 or 386 based machines, making them the controllers of the future for GPIB based systems.

WaveTest combines the following tools to create one of the most powerful packages available on the market.

- Instrument Library
- Instrument Library Generator
- Test Program Generator
- BASIC Language
- GPIB Interface Card
- Tutorial and Reference Manuals

Instrument Library

The Instrument Library supplied with WaveTest consists of instrument files for 100-plus instruments. In an instrument file, controls on a "Soft Panel' simulate the actual instrument front panel. Each library contains the look-up table of a particular instrument's GPIB syntax and the corresponding English language descriptions. The file also contains instructions and setup information.

Some of the instruments characterized in this library are function generators, synthesizers, DVMs, counters, scopes, digitizers, and spectrum analyzers from Wavetek, Tektronix, Hewlett Packard,

Fluke, Racal Dana, Datron, EIP and Philips. A partial list of instruments is given on page 17.

Library Generator
The instrument Library Generator allows you to add an instrument file to the library or edit an instrument file. It is easy to use and allows you to build an instrument library in less than 10% of the time it takes using a conventional "lower level' language.

The Library Generator file structure is extremely flexible, allowing characterization of very complex instruments. A hierarchical structure allows instrument library files to contain these types of controls:

- Discrete (Function Controls).
- Continuous (Range Controls).
- Query (Requests for Information).

Instruments may contain an indefinite number of these types of controls. Additionally, instruments may include channels, expansion slots, and the cards that are installed in the slots. A channel may contain an indefinite number of controls as well as sub-channels.

At each level of the hierarchy, the controls may be grouped together to simulate the front panel of the instrument being created.

WaveTest Program Generator — Fast Program Designs That Work
The Test Program Generator (TPG) is an application program that is used to create and edit programs to control and communicate with instrumentation systems.

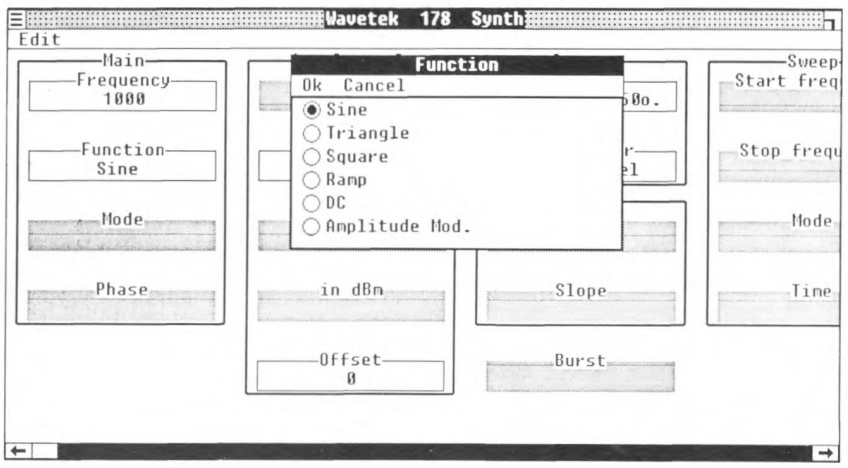
Under TPG you link a series of instrument setups, program modules, operator prompt windows and formatting windows to create a test program.

TPG then executes this as program code, which handles internal timers, triggering, and interrupts. Debugging features are included, such as setting break points, single step, trace variables and monitoring GPIB transactions.

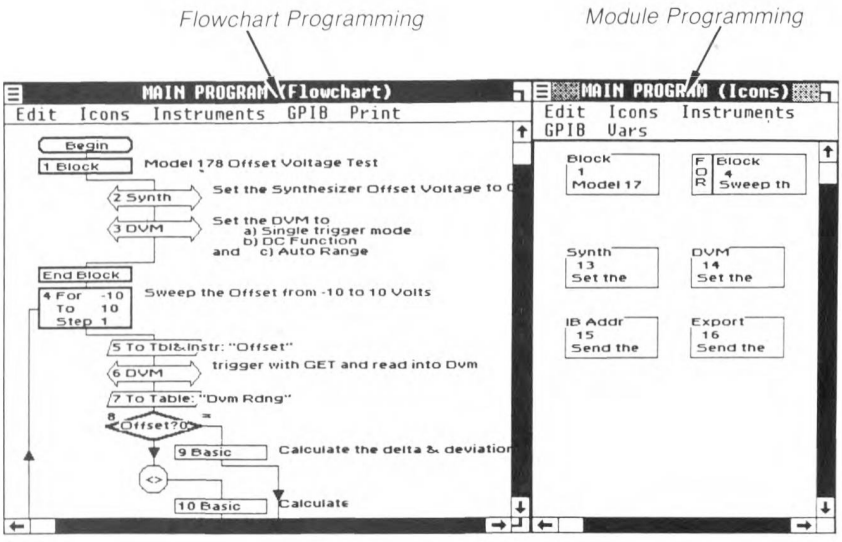
Unique Syntax-Free Programming
You can develop test programs quickly using TPG's graphic interfacing tools such as pulldown menus, program modules, icons, dialog boxes and scroll windows. This considerably reduces both program development and learning time.

Instrument setups can be constants, variables or expressions which allow you to dynamically control the instruments during program execution. This is a major advance in automatic instrument programming. Before WaveTest, only static control was available.

Write Code Using Flowcharts
Integrated Flowchart Programming
- Program by selecting flowchart icons.
- Easy to see the logic flow of a program.
- Edit the program right in the flowchart window.
- Hard copy of the flowchart is available for documentation.
- Any of 19 icons can be used in the flowchart.



Instrument Programming: WaveTest provides an interactive 'Soft Panel' that represents the front panel of an instrument. The user simply positions the pointer on the controls in the 'Soft Panel' and enters the appropriate value to program the instrument. WaveTest, using the instrument libraries, generates the proper GPIB mnemonics and command sequences.



A sample flowchart of a program on the left with its corresponding modular representation on the right.

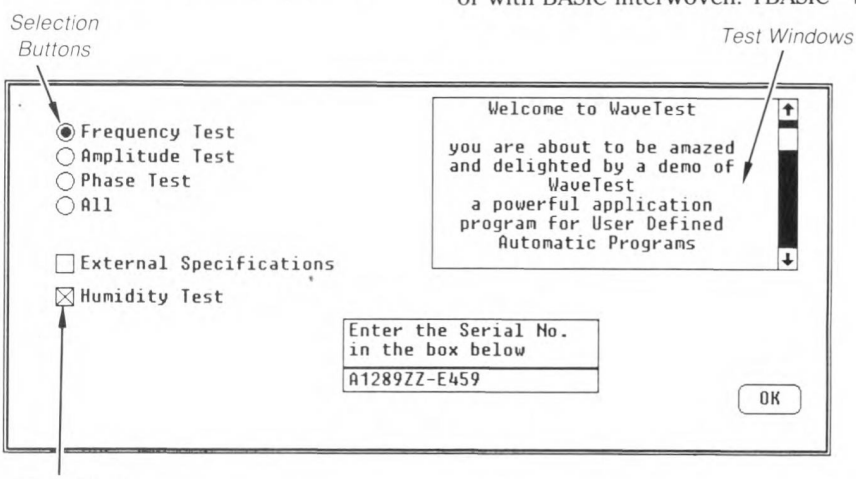
Nineteen Selectable Icons
Block, Call, Do, Exit, For, If, Export, Redirect, Address CMDS, Universal CMD, On SRQ, Serial Poll, BASIC, Debug, On Error, Delay, Operator Window, Output, and Timeout.

Write Code Using Modules
Modular Programming

- Nineteen fundamental building module icons to create a program.
- See program elements and the hierarchy in a compact form.
- No syntax to remember — hence no syntax errors.
- Construct a program step-by-step by selecting the desired module icon.
- Program execution is in the order the icons appear in the program window, from left to right and top to bottom.
- Module icons can be moved around to alter the order of program execution.

Operator Prompts
With the tools provided, the programmer can create dialog boxes, selection menus with buttons, scrollable text windows for help, and other runtime messages without writing any code.

BASIC Programming Included
You can write test programs entirely with WaveTest program modules alone or with BASIC interwoven. TBASIC™ by TransEra is completely integrated with WaveTest. TBASIC is an excellent implementation of the (ANSI Std) BASIC language, allowing you to take advantage of the structured BASIC language as well as the WaveTest modules for program development.



This is a typical operator prompt. The round buttons allow the operator to select from a variety of tests, and the check boxes allow the operator to select test limits. On the right is a scrollable area for the text information. At the bottom center is an area where the operator is instructed to key in the serial number of the device under test.

Powerful Debugging Tools
With the Test Program Generator you can set as many break points as needed. Once the program reaches the break point the debugging environment allows you to single step the program. The user can trace the variables and create cross reference lists. The variable windows allow the user to see the local and global variables in alphabetical order. The GPIB track window alows you to see all the traffic on the bus.

Your Test Program Is Completely Documented
Your program is automatically documented with a very powerful documenting feature. First a flowchart is created that gives you an overview of the logic of the program. Then, a complete description of each program module can be viewed or printed out. This written description of the program is an English language description.

Test Reports
A primary result of automatic testing is the test report. The report lends validity to the fact that the test was performed and the results were obtained. WaveTest lets you design a meaningful test report format for the screen, printer, plotter or file. WaveTest, through its import/export icons and output tables, makes this job as easy as clicking the mouse and typing in the name of the data to be printed.

The results of a test can be displayed on the PC/AT screen, stored in memory, or routed to a printer, plotter or third party applications program such as Lotus 1-2-3™. Formatting the report is simply a matter of selecting the options from the screen.

Other Features

- Expanded Memory - WaveTest supports LIM 4.0 expanded memory standard, which allows development of

```
GPIB Traffic
Clear Display
Device =Synth
  Cmd  =<UNL><TA 21><LA 19>
  Write=F1000C0A0D0P1XP0I<0D><0A>
Device =DVM
  Cmd  =<UNL><TA 21><LA 08>
  Write=F1RAT3<0D><0A>
Device =Synth
  Cmd  =<UNL><TA 21><LA 19>
  Write=D-10I<0D><0A>
Device =DVM
  Cmd  =<UNL><LA 08><GET>
  Cmd  =<UNL><TA 08><LA 21>
  Read =-09.9797E+0<0D><0A>
```

The GPIB trace feature is a built-in software bus analyzer. This unique window displays all the GPIB traffic that occurs between the instruments and the computer. Commands are separated from the device messages and are listed in easy to understand GPIB mnemonics

large application programs. Because your program resides in expanded memory, editing and operation response is faster.

- Create Function Key Interrupts - Fast operator intervention with automatic handlers. With this feature, you can specify the action taken when any of the function keys (F1 thru F12) are depressed.
- Math Co-processor Support - WaveTest supports your math co-processor for faster math performance.

The following hardware configuration is recommended to run WaveTest:

- PC/AT® or compatible with 1 MB RAM (MIN. 640K)
- 1.2 MB Floppy Disk Drive.
- 20 MB Hard Disk.
- Enhanced Color Display.
- EGA Card.
- Windows Compatible Mouse.

Runtime Software Package (488 RT)

The Runtime version of WaveTest allows test programs developed under WaveTest to be run on another test system in addition to the one they were developed on. Included with the Runtime version is the Runtime version of Microsoft Windows and a GPIB card. Use of the Runtime version can be set up two ways, the operator may be allowed to select files and control the actual running of the test, or may be allowed to interact through an Operator Window. The Operator Window is a part of the programming environment of WaveTest which allows keyboard input, test selection, and operator prompting through a scrollable window. Runtime is a cost effective method for distribution of test programs throughout a company.

Runtime Configuration

WaveTest 488 RT consists of:

- WaveTest Runtime software which includes a Runtime version of Micro soft Windows
- Runtime Manual
- GPIB Card

The minimum system requirements are the same as those listed for WaveTest 488.

Maintenance Contract

Now there is a maintenance contract for full support of you and WaveTest. Support includes:

- Telephone contact for assistance on any operational problems with WaveTest.
- Timely response to WaveTest software problems including notification of all verified bugs.
- Program updates and technical notes about WaveTest as they occur.

```
Write - OFFSET.LST
File  Edit  Search  Character  Paragraph  Document
        comment: Model 178 Offset Voltage Test
        * * * * *
        2 Synth: Wavetek  178
            comment: Set the Synthesizer Offset Voltage to 0 Volts
            * * * * *
            Instrument Settings:
              \Main\
                Frequency          1000
                Function           Sine
              \Amp Controls\
                in Pk-Pk           0
                Offset             0
              \Output\
                Off/On             Output on (50ohm)
                Front/rear         Front panel
            Output To Instrument:  "F1000C0A0D0P1XP0I<0D><0A>"
        END Synth
        3 DVM: Hewlett Packard  3478A
            comment: Set the DVM to
        a) Single trigger mode
        b) DC Function and
        c) Auto Range
            * * * * *
            Instrument Settings:
              \
                Me
                Ra
Page 1
```

Sample listing of instrument settings. Note ASCII string that was output to the instrument.

```
Offset Test
Nov 16,1987      9:24:12  AM     Model is 680     Serial # is N7160238

Program Value    Lower Limit      Measured Value   Upper Limit
0.02             -0.049           0.0202           0.0351           Pass
0.04             0.0249           0.0403           0.0551           Pass
0.08             0.0648           0.0804           0.0952           Pass
0.1              0.0847           0.1005           0.1153           Pass
0.2              0.1844           0.2011           0.2156           Pass
0.4              0.3838           0.4023           0.4162           Pass
0.8              0.7826           0.8021           0.8174           Pass
1                0.982            1.0023           1.018            Pass
2                1.979            2.0061           2.021            Pass
4                3.973            4.0132           4.027            Pass
7                6.964            7.0252           7.036            Pass
7.49             7.4525           7.5173           7.5275           Pass
-7.49            -7.5235          -7.4847          -7.4525          Pass
```

A typical test report, uniquely identifying the test and showing measured values between their upper and lower limits.

PARTIAL WAVETEST INSTRUMENT LIBRARY

Manufacturer	Model	Description	Manufacturer	Model	Description
Arbiter Systems	1040C	Panel Meter Calibrator	Phillips	PM6652-5	Program Timer/Counter
Booton	4200	RF Microwatt Meter	PTK	9002	Attn Test Fixture
Booton	9200B	RF Voltmeter	Racal-Dana	1994	Universal Counter
EIP Microwave	451	Pulse Counter	Sencore	LC77	Cap/Inductor Analyzer
EIP Microwave	575	Microwave Counter	Tektronix	2430A	Digital Storage Scope
Elgar	AT8000	Multi-Channel DC P/S	Tektronix	2440A	Digital Storage Scope
Elgar	P9012	PIP	Tektronix	2445	250 MHz 4-Chan Scope
Elgar	P9023	PIP	Tektronix	2465	350 MHz 4-Chan Scope
Fluke	19	Digital Multimeter	Tektronix	5010	Power Supply
Fluke	8506A	Digital Multimeter	Wavetek	23	Synth Function Generator
Fluke	8520A	Digital Multimeter	Wavetek	52A	Data Logging System
Fluke	8840A	Digital Multimeter	Wavetek	75	Arb Waveform Generator
Gigatronics	910-26	Frequency Synthesizer	Wavetek	178	Synth Function Generator
Gigatronics	910-40	Frequency Synthesizer	Wavetek	270	Function Generator
Gigatronics	1018B	Power Meter	Wavetek	271	Pulse/Function Generator
Hewlett Packard	436A	Power Meter	Wavetek	273	Sweep/Func Generator
Hewlett Packard	438A	Dual Power Meter	Wavetek	275	Arb Waveform Generator
Hewlett Packard	3314A	Function Generator	Wavetek	278	Synth Function Generator
Hewlett Packard	3325A	Synth Function Generator	Wavetek	600	Switching System
Hewlett Packard	3437A	System Voltmeter	Wavetek	650	Variable Phase Synth.
Hewlett Packard	3478A	Digital Multimeter	Wavetek	680	Multi-Function System
Hewlett Packard	3488A	Switch Control Unit	Wavetek	680-01	Arb Waveform Module
Hewlett Packard	3561A	Dynamic Signal Anal	Wavetek	680-02	Timing Gen Module
Hewlett Packard	5328A	Universal Counter	Wavetek/Datron	680-05	6 1/2 Dig DMM Module
Hewlett Packard	5334A	Universal Counter	Wavetek/Racal Dana	680-06	Freq/TI Counter Module
Hewlett Packard	5345A	Electronic Counter	Wavetek	816-11	Multi-Channel Filter
Hewlett Packard	6032A	System Power Supply	Wavetek	816-12	Multi-Channel Filter
Hewlett Packard	6038A	System Power Supply	Wavetek	816-13	Multi-Channel Filter
Hewlett Packard	6624A	System Power Supply	Wavetek	859	50 MHz Pulse Generator
Hewlett Packard	8112A	Pulse Generator	Wavetek	907A	Microwave Signal Gen.
Hewlett Packard	8116A	Pulse/Func Generator	Wavetek/EHE	1060	1 GHz Waveform Anal.
Hewlett Packard	8340B	Synth Sweeper	Wavetek/Datron	1061/2	Digital Multimeter
Hewlett Packard	8350B	Sweep Oscillator	Wavetek/EHE	1501A	50 MHz Pulse Generator
Hewlett Packard	8566B	Spectrum Analyzer	Wavetek/EHE	1560/4	100 MHz Pulse Generator
Hewlett Packard	8568A	Spectrum Analyzer	Wavetek/EHE	2000	200 MHz Pulse Generator
Hewlett Packard	8642A	Synth Signal Generator	Wavetek	2500A	RF Signal Generator
Hewlett Packard	8656B	Synth Signal Generator	Wavetek	2500B	RF Signal Generator
Hewlett Packard	8903A	Audio Analyzer	Wavetek	2500C	RF Signal Generator
Hewlett Packard	11713A	Attn/Switch Driver	Wavetek/EHE	3000	1 GHz Waveform Anal.
Hewlett Packard	54100A	1 GHz Waveform Anal	Wavetek/EHE	3900	Prog. Fixture
Hewlett Packard	54111D	500 MHz Waveform Anal	Wavetek/Datron	4800/5/7	Calibrator
Hewlett Packard	54112D	100 MHz Digital Scope	Wavetek	5155A	Synth Freq Generator
Hewlett Packard	59307A	VHF Switch	Wavetek	8502	Peak Power Meter
Hewlett Packard	70001A	Mod Sys Mainframe	Wavetek	8531	CW Power Meter
Interface Tech	RS660	Word Generator			

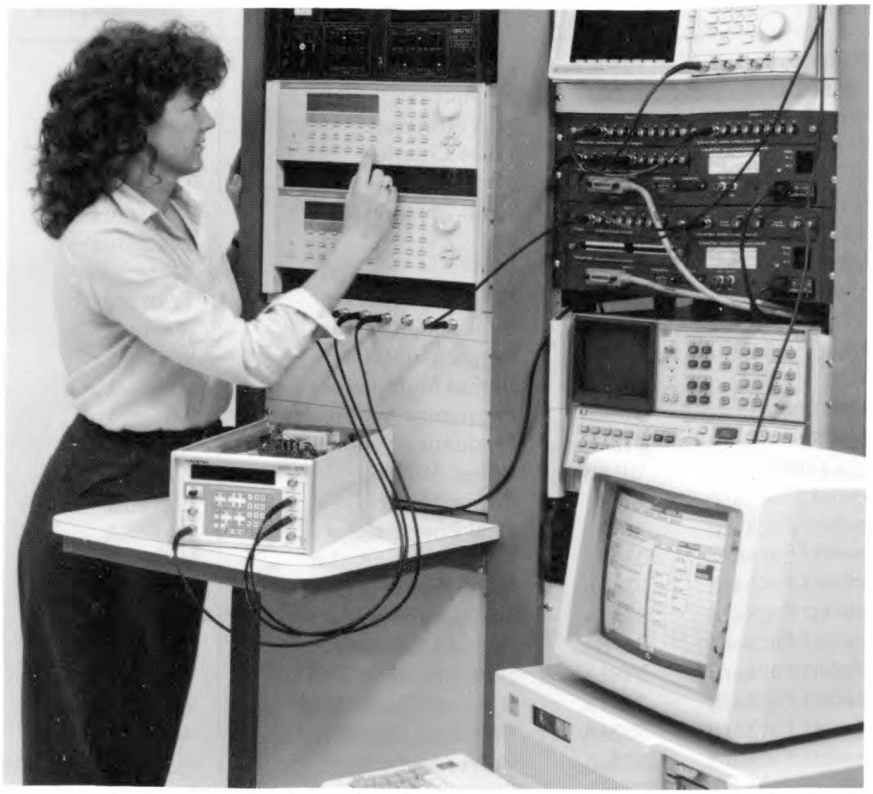
NOTES:
TBASIC is a trademark of TransEra Corporation.
Windows is a trademark of Microsoft Corporation.
Lotus 1-2-3 is a trademark of Lotus Development Corporation.
PC/AT and PC/XT are registered trademarks of International Business Machines, Inc.
Wavetek and WaveTest are trademarks of Wavetek Corporation, Inc.

For a complete list of instruments already characterized in WaveTest, WaveTest specifications, or a demo disk, call your nearest Wavetek representative (pages 211 and 213) or Wavetek (619-279-2200).

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 488
Model 488-RT

General Purpose Interface Bus (GPIB)



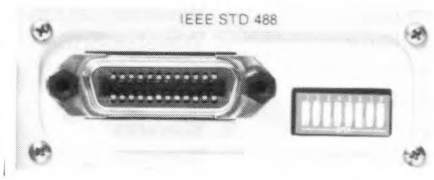
Introduction

Almost every manufacturer, especially electronics manufacturers, uses a variety of test equipment to design, test and service their particular product. This test equipment could be a meter to measure voltage, a function generator to produce a waveform, or even a scale to measure weight. Since each piece of test equipment will only perform the task for which it has been designed, a variety of test equipment is normally required to fully evaluate a product. Rather than use each piece of test equipment one at a time, which is very time consuming, an industry standard was created to allow physical interconnection and signal communication of all test instruments, the product being evaluated and the computer controlling the test. They, in effect, act as one piece of test equipment. The standard is the IEEE-488 Bus Standard and refers to a group of wires, called a bus, and an interface that was electrically, mechanically and functionally defined by the Institute of Electrical and Electronic Engineers (IEEE). The group of instruments are called an Automatic Test System (ATS).

The ATS rapidly performs repeatable tests and generates hardcopy test reports automatically. The most basic test system can consist of a single piece of programmable automatic test equipment (ATE) connected to a computer via an interface bus. But more often, an ATS contains stimulus, measurement, recording and controlling instruments.

Wavetek

For 27 years Wavetek has provided programmable instrumentation in response to a demanding and everchanging test and measurement equipment marketplace. During the early years, remote control of these instruments was accomplished primarily via a serial or parallel interface bus. As the need arose to integrate numerous pieces of different manufacturers' programmable test equipment, so did the need for the industry to standardize an interface bus. In 1975 the IEEE Standards Board accepted the IEEE Standard 488 Digital Interface for programmable instrumentation. Shortly thereafter, Wavetek adopted the General Purpose Interface Bus (GPIB) which is fully compatible with the IEEE Standard 488.



IEEE STD 488 Connector

Today, you will find some Wavetek instruments that offer you the choice of interface bus capability. If your applications require the use of an RS 232 (serial) or GPIB (bit parallel, byte serial) interface bus, it is very possible that the instrument you need is configured for your bus requirement.

The GPIB has become a standard feature of most of Wavetek's programmable instrumentation because of the IEEE Standard 488's worldwide acceptance. Instruments that have the capability to be programmed via the GPIB can be identified by this symbol on their catalog page.

GPIB

This symbol will also appear alongside all GPIB programmable instruments in the Model Number Index on page 2.

The General Purpose (IEEE-488) Interface Bus

The IEEE standard 488 specifies the terms of bus functional, electrical and mechanical characteristics. The operational characteristics of the bus are application dependent and specifically left unaddressed in the original document. IEEE Standard 488-1975 was revised and republished in 1978, (IEEE Standard 488.1-1978), and a supplement was added to the standard in 1980. Most recently, the IEEE has addressed the operational characteristics. IEEE Standard 488.2-1987 has been accepted by the IEEE as the standard for codes, formats, protocols and common commands for programmable instrumentation. Today, the IEEE-488 is the most widely used interface bus in the world for programmable instrumentation systems and has been implemented under brand versions such as GPIB, IEEE Bus and the ASCII Bus.

A GPIB device can perform one or more of the following interface functions: talker, listener, or controller, depending on the intended use of the device. (See figure 1.)

A talker can transmit data to other GPIB devices while a listener can receive data from other GPIB devices. In some cases, an instrument can perform both interface functions. An instrument could also be a controller, managing the operation of the GPIB. Manufacturers of GPIB instruments will typically indicate to what level the interface functions have been implemented on the instruments, e.g., SH1, AH1, SR1, DC1. The eleven different interface functions that could be implemented in a GPIB device are listed in the table below. Sub-characteristics are given as numerical suffixes to the letters.

IEEE 488.2 Interface Function	IEEE 488.2 Subsets
Source Handshake	SH1
Acceptor Handshake	AH1
Talker (Talk Extended)	T5, T6, (TE5, or TE6)
Listener (Listen Extended)	L3, L4, (LE3, or LE4)
Service Request	SR1
Remote Local	RL0 or RL1
Parallel Poll	PP0 or PP1
Device Clear	DC1
Device Trigger	DT0 or DT1
Controller	C0, or C4 with C5, C7, C9 or C11
Electronic Interface	E1 or E2

Bus Components
The GPIB consists of 16 program lines and system common in a 24 pin configuration. As shown in figure 1, the GPIB lines are grouped into three categories: data bus (data), data byte transfer (handshake), and general interface management (control) lines. There are 8 data lines (DIO 1 through 8 or b1 through b8), 3 handshake lines (DAV, NRFD, NDAC) and 5 control lines (IFC, ATN, SRQ, REN, EOI)

DIO1-8	Data In/Out 1-8
DAV	Data Available
NRFD	Not Ready For Data
NDAC	Not Data Accepted
IFC	Interface Clear
ATN	Attention
SRQ	Service Request
REN	Remote Enable
EOI	End or Identify

All GPIB transactions can be divided into command mode or data mode transactions. All lines are low true and are terminated and passively pulled high at each device. A line is asserted (actively pulled low or true) by a device and is not considered released (high or false) until all devices release it.

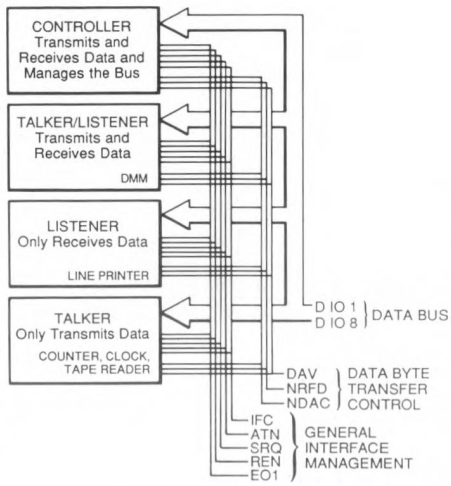


Figure 1. Types of Instruments on the Bus.

There are several bus protocols to ensure that there is no conflict for control on the bus and that each device receives each byte of data sent to it. There can only be one active controller at a time; there can only be one talker at a time; there can be from 1 to 14 simultaneous listeners. Up to 15 instruments may share the bus, each with its own unique address for talking and listening. Talk and listen addresses are both set in a device with the same 5 bit address selector located on the device. The GPIB address selector DIP switch is sometimes found on the internal interface card or on the back panel. The most recent Wavetek instruments allow you to program the talk and listen address through the front panel. The controller adds the higher order bits (6 and 7) to the 5 bit address to differentiate between listen and talk addresses.

GPIB devices can be connected in several arrangements; two of the most common configurations are the star and chain arrangement. (See Figure 2.)

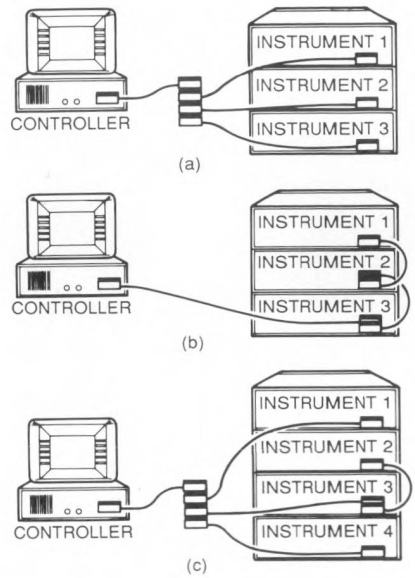


Figure 2. Common instrument connections: (a) the star, (b) the chain, or (c) any combination of the two.

Programming Techniques
Programming GPIB instruments has never been an easy job. You have to be familiar with each instrument's command set, fluent in a high-level programming language and conversant with the operation of the IEEE-488 bus itself. Wavetek now manufactures a software product, WaveTest®, that makes the task of programming GPIB instrumentation easy and understandable.

WaveTest® is an icon-based programming environment that runs under Microsoft Windows™. You focus on defining the logical flow of the test program. WaveTest generates the source code to control and communicate with the GPIB instruments.

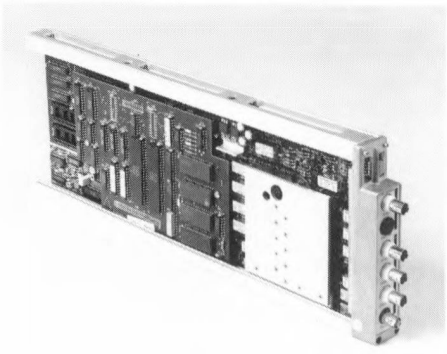
Applications Information
Whether you are designing an automated test system for the first time or updating an existing programmable instrumentation system, Wavetek has factory and field sales and technical support people ready to assist you. Your local Wavetek Sales Representative can provide direct technical assistance or refer you to the appropriate applications engineer.

Wavetek offers a wide variety of literature including data sheets, application notes, and operating and service manuals for your reference.

Your GPIB Solution
For a total solution to your automated test system problems, call your local representative (pages 211 and 213).

Modular Instruments

The next generation of ATE needs high density modular systems, and they are here today in the Wavetek Model 680 Multifunction System. The driving force behind this system is the ever increasing size of ATE stations. The logistics costs associated with adding a bay to a test station are astronomical. With the Model 680 it is now possible to replace equipment that required *28 to 56 inches* of rack space with an instrument that only needs *7 inches* of rack space. That's up to 8 instruments in one 7-inch package.



Typical Modular Instrument

Module systems are not a new concept, but new technology has advanced to where high performance rack and stack instruments can be reduced to a plug-in card. Common instrument resources such as power supply, front panel, cooling fans, and system clock do not have to be duplicated for each instrument. They can be built into the main chassis for all modules to share.

Model 680

With the Model 680, reduced size and operating costs are not the only benefits. System performance is also improved. With the internal trigger bus, all modules can be triggered from the same source, internal or external, with only 1.5 nanoseconds of skew across the backplane (bus) common to all modules. This kind of performance is not attainable with conventional rack and stack instrumentation.

The main components of the 680 mainframe are power supply, front panel, cooling fans, microprocessor, trigger generator, system clock and reference and calibration sub-systems. Beyond those are several features that are not as apparent. The control bus uses a MC68000 controller and the VME bus standard. The VME bus is a very popular computer bus. All the digital signals, triggers, sync signals, clocks and the local bus are contained on one row of connectors. All of the analog signals, analog summing bus, internal DVM and counter lines, and precision ±10V reference lines for self calibration, are on another row of connectors.

The modules currently available for the 680 are a 20 MHz Arbitrary Waveform Generator, a 100 MHz Timing Generator, a 200 MHz Pulse Generator, a 6 Digit DMM and a 160 MHz/1.3 GHz Time Interval Counter. The arb generator, timing generators, pulse generator and the DMM are built by Wavetek. The counter is built by Racal-Dana.

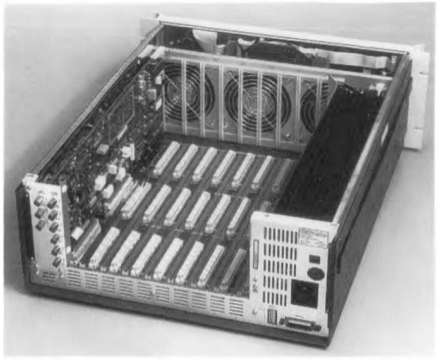
Model 680 uses the VME bus ports P1 and P2, and adds a special analog bus (utilizing P3) for noise-free signal routing. Analog Summing Bus capability along with internal modulation makes possible an unlimited number of complex waveforms. Possible simulations include radar signals, noise, video signals, FLIR, VOR and underwater sonar. Adding one or more DMMs and counters gives complete stimulus and measurement capability in a single package.

Mate Capability

Wavetek has delivered thousands of instruments for systems like HTS, DATSA, LANTRIN, B1B, STRAT RADAR and VAST. Based on this experience, the Model 680 has been built to accommodate the military's stringent high-performance requirements and it has an internal TMA for MATE-CIIL capability.

The push for high-performance designs is reflected in a need for high-performance instruments that take up a lot of bench space. Model 680, however, takes the same room as a single instrument on the bench, yet it has the performance potential of a fully loaded rack of eight instruments.

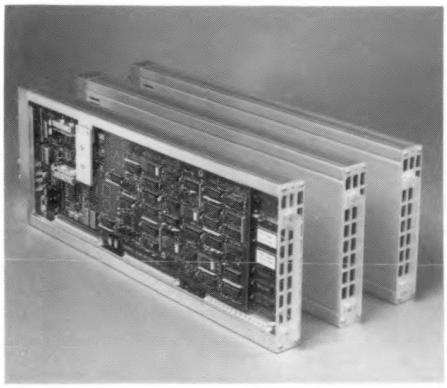
Flexibility
As requirements change, just add or delete modules. In the morning you might be using a Pulse Generator and Counter to check a digital circuit. In the afternoon you discover that you need the DMM and Function Generator to check amplifier response. Just add the new instruments to the mainframe. Each module can be controlled via the front panel, or with GPIB over a single cable from your controller. The Model 680's front panel emulates every instrument inside. Settings can be stored and recalled, not just for an instrument, but for the entire system configuration. Since the Model 680 panel emulates every instrument installed, there are no new controls to learn, so operators can be trained more quickly.



Mainframe with Slots for Modules

Test engineers can take advantage of the same Model 680 features that make it ideal for R&D work. With Model 680, test bays won't become obsolete—just add plug-in modules to add new capabilities.

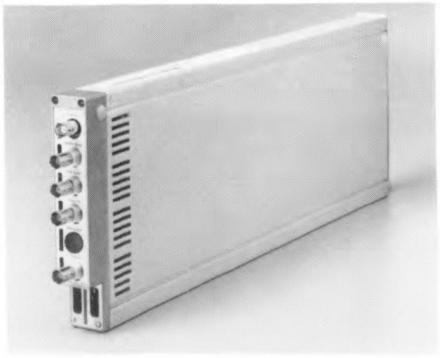
Combining the Model 680's Pulse Generator, DMM, Timing Generator, Arbitrary Waveform Generator, Function Generator and Frequency/Time Interval Counter can produce a wide variety of test stations.



Modules Ready for Installation

Model 680-01
Model 680-01, one of Wavetek's long line of Arbitrary Waveform Generators, gives new meaning to the term "high performance". Its Function Generator mode provides sine, square, triangle, ramp, dc and their inverse. Its Arbitrary Waveform mode allows 12 bits of waveform vertical resolution and 12 K of horizontal memory and a sample rate of up to 20 MHz.

All of the normal operational modes are included—continuous, triggered, gated and burst.

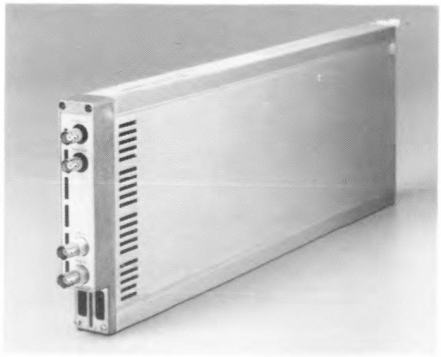


20 MHz Arbitrary Waveform Generator Module

Model 680-01 plus the summing and modulation capabilities available from the 680 mainframe, give you an unbeatable combination.

For specifics, see page 24.

Model 680-02
Model 680-02 is a 10 mHz to 100 MHz Synthesized Timing Generator with 5 digits of resolution. The maximum output voltage available is 32 Vp-p with 4 digits of resolution. Pulse widths can be adjusted from 10 ns to 2,000s with delays from 0 to 2,000s. Both width and delay have resolution of 10 digits or 1 ns.

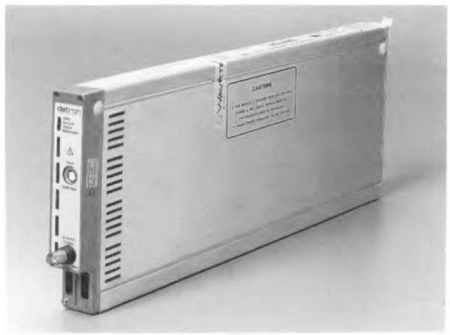


Pulse/Timing Generator Module

Internal I/O consists of the trigger and sync I/O from the 680 mainframe and a modulation input so that an Arb can modulate the pulse output without having to loop back in from the outside.

For specifics, see page 25.

Model 680-05 (Datron Model 1365)
Model 680-05 Digital Multimeter offers



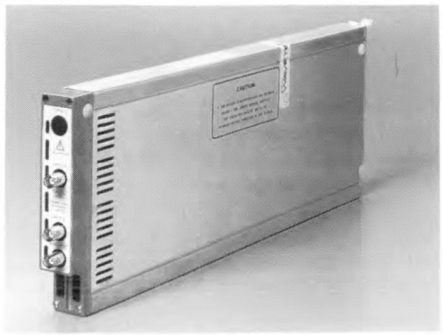
Digital Multimeter Module

the performance of the Wavetek Datron Model 1062, including full Autocal. Key characteristics are:

- 0.006% basic accuracy (90 days) for high precision measurements.
- True RMS measurements either AC or DC coupled with 90 dB common mode rejection.
- Two- and four-wire resistance measurement with switchable filtering.
- Very fast autoranging and high read rates.
- Autocalibration. Manual adjustments are eliminated.

For specifics, see page 26.

Model 680-06 (Racal-Dana Model 1993)
Model 680-06 Universal Counter offers proven Racal-Dana performance in a highly flexible frequency/time interval-counter module. The performance level



Universal Counter Module

matches that of Racal-Dana's Model 1994 including the extensive feature set. The key characteristics are listed below:

- 1 ns single-shot time interval resolution to satisfy the most demanding Radar, EW and ECM applications.
- 160 MHz/1.3 GHz frequency measurement capability and a 9-digit readout updated every second provides precise verification of signal sources.
- Auto Trigger, Peak Signal Measurement, Phase Measurement and Math capabilities are included.

For specifics, see page 28.

Your Next Step
For more details on the Model 680 mainframe and its modules, refer to pages 24 through 29. For a demonstration contact your nearest Wavetek representative (page 211-215) or call Wavetek (619-279-2200)

Multifunction System Mainframe

- **Downsized ATE: Up to 8 Instruments in One 7-inch Chassis**
- **System Buses for Improved Performance Over Rack & Stack Instruments.**
- **Mate-CIIL Interface**

Model 680 is an amazingly compact and intelligent rack, with all the built-in resources any instrument would need, including power, data and signal buses, and calibration and reference subsystems. The display and softkeys emulate each instruments front panel. By sharing common resources, overall system cost is reduced and the station is standard type. Five feet of instruments are reduced to seven inches of rack space.

OUTPUTS

System Sync Output and System Trigger Output: Source selected by Slave/Independent keys.
Signal Level: 0.2 to 1.0V into 50Ω typ.
Transition Time: <10 ns.
Output Impedance: 50Ω.

10 MHz Reference Output: 0.2 to 2.4V into 50Ω (TTL for >10 kΩ).
Transition Time: <10 ns into 50Ω.
Output Impedance: 50Ω.

Discrete Fault Indicator: Contact closure indicates power off, microprocessor failure or over-temperature.

INPUTS

System Sync Input: Selected by Slave mode TTL levels required.
Input Impedance: >1 kΩ.
Bandwidth: >20 MHz.
System Trigger Input: A signal of 1 Vp-p to 10 Vp-p will trigger the system.
Frequency: <20 MHz for Normal trigger and <5 MHz for Delayed and Event trigger.
Transition Time: <50 ms.
Minimum Pulse Width Requirement: 25 ns.
Impedance: >1 kΩ.

10 MHz Reference Input: 1 Vp-p min. to 10 Vp-p.
Bandwidth: >10 MHz ±5%.
Input Impedance: >1 kΩ.

Analog Sum Bus Input
Max Input Voltage: ±5 Vp-p.
Bandwidth: >10 MHz.
Impedance: 50Ω.

Calibration Input: Used to calibrate internal DVM. ±4 Vdc ±0.1 mV.

SYSTEM TRIGGER

External Trigger
Modes: Normal, Time Delay, Event Delay
Range: 100 ns to 10s.
Resolution: 100 ns.
Accuracy: ±(1% + 30 ns).
Event Delay: 2 to 1 x 10^7 events with selectable slope.

Internal Trigger
Frequency Range: 0.01 Hz to 10MHz.
Resolution: 4 digits.
Accuracy: 0.05%.

INTERNAL FREQUENCY REFERENCE

10 MHz Reference
Accuracy: ±1 ppm, +15° to +35°C.
Stability: ±1 ppm/year (typ).

GENERAL

Stored Settings: 99 stored settings are provided by the chassis. These are allocated as needed between the chassis and installed modules.
GPIB Programming: The software interface uses a subset of the IEEE-488.2 Draft Standard.
Environment
Specifications Apply: +25° ± 10°C after 30 minutes warm-up, except stability specifications apply after a 60 minutes warm-up and ambient temperature within ±3°C.
Operating Range: 0° to +50°C.
Dimensions: 44.5 cm (17.5 in.) wide, 17.78 cm (7 in.) high, 54.6 cm (21.5 in.) deep. Supplied with rack mount adapters
Weight: 17.3 kg (38 lb) net; 20.9 kg (46 lb) shipping.
Power: 90 to 126.5 Vac, 200 to 250 Vac, 48 to 66 Hz. <50 watts (chassis only), <500 watts with 8 modules installed.
Extender Cards: Three per module.

MODEL 680MATE

MATE-CIIL capable. Meets MATE-CIIL Std. 2806763 Rev. C.

MODULES

See pages 24-29 for instrument module details.

Model 680-00:Blank Module. Must be ordered to fill each unused slot. Blank modules provide continuity for the interrupt daisy chain and for proper cooling.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 680
Model 680-00
Model 680MATE

For full specifications or a demonstration, contact your nearest Wavetek representative (pages 211 and 213).

20 MHz Arbitrary Waveform Generator

- **Horizontal Memory of 12k**
- **Sine, Square & Triangle in ROM**
- **20 Vp-p Output Capability**
- **MATE-CIIL Interface**

Arbitrary waveforms can be up to 12 bits of vertical resolution and 12k horizontal. Function generator waveforms of sine, triangle, ramp, square, dc and their inverse are ready for you in ROM. In addition to the 680-01 features, the summing and modulation capabilities from the 680 mainframe makes this an unbeatable arbitrary signal source.

ARBITRARY CHARACTERISTICS
Horizontal Resolution: 12k points.
Vertical Resolution: 12 bits (–2047 to +2047).
Waveform Memory: Stores up to 10 waveforms with user defined length from 8 points to memory maximum.
Arb Clock
Sampling Frequency: 1 mHz to 20 MHz.
Resolution: 4 digits or 1 mHz.
Waveform Repetition Rate: 2.5 MHz (clock/No. of waveform points).
Accuracy: 5 ppm.
Stability: 2 ppm in 10 min., ±3°C.

FUNCTIONS
Function Generator Mode: Sine, triangle, ramp, square, DC and the inverse of all waveforms.
Arbitrary Generator Mode: Sin(x), Cos(x), Exp(x), Sin(x)/x and user defined.
Operational Modes: Continuous, triggered, gated and burst.
Burst: Programmable from 1 to 65,535.
Sine Distortion
10 µHz to 99.9 kHz: <0.2%.
To 100 kHz: <0.7%.
No harmonics above –40 dBc from 100 kHz to 4 MHz.
Square Trans. Time: 50Ω into 50Ω, <25 ns.
Square Aberrations
<10 Vp-p: ±(5% + 20 mV).
>10 Vp-p: ±(10% + 20 mV).
Duty Cycle: (Square and ramp) 0.1% to 99.9%. Square defaults to 50% above 1 MHz.

FREQUENCY
Range
Sine: 10 µHz to 4 MHz.
Square: 10 µHz to 10 MHz.
Triangle/Ramp: 10 µHz to 250 kHz.
Resolution: 4 digits or 10 mHz.

AMPLITUDE
Range: 10 mVp-p to 20 Vp-p into 50Ω load.
Resolution: 1 mV to 10 mV depending upon range.
Accuracy: (Into 50Ω, 0.1% load.)
10 to 20 Vp-p: ±1 % of programmed value +5 mV.
1 to 10 Vp-p: ±(1 % + 5 mV).
0.1 to 1 Vp-p: ±(2 % + 2 mV).
10 to 100 mVp-p: ±(3 % + 0.5 mV).
Frequency Response

Range	Response	Filter On
100 µHz to 9.999 kHz	±1%	100 kHz
10 kHz to 49.999 kHz	±3%	100 kHz
50 kHz to 0.9999 MHz	±5%	4 MHz
1MHz to 4MHz	±10%	4 MHz

OFFSET
Range: Minimum amplitude must be:

Offset Range	Min. Ampl. (Vp)
5.001 to 10 Vdc	>0.52
0.501 to 5 Vdc	>0.26
51 to 500 mVdc	>0.026
5 to 50 mVdc	>0.002

Programmable Load Impedance: (Enter mode. This applies for use of loads other than 50Ω.)
Range: 25 to 1 kΩ.
Accuracy: ±5%.

DC VOLTAGE ACCURACY
DC Function Accuracy
Into 50Ω, 0.1% load.
5.001 to 10 Vdc: ±(1% + 40 mV).
0.501 to 5 Vdc: ±(1% + 40 mV).
51 to 500 mVdc: ±(2% + 10 mV).
5 to 50 mVdc: ±(3% + 3 mV).
Resolution: 1 mV from lowest to highest range.

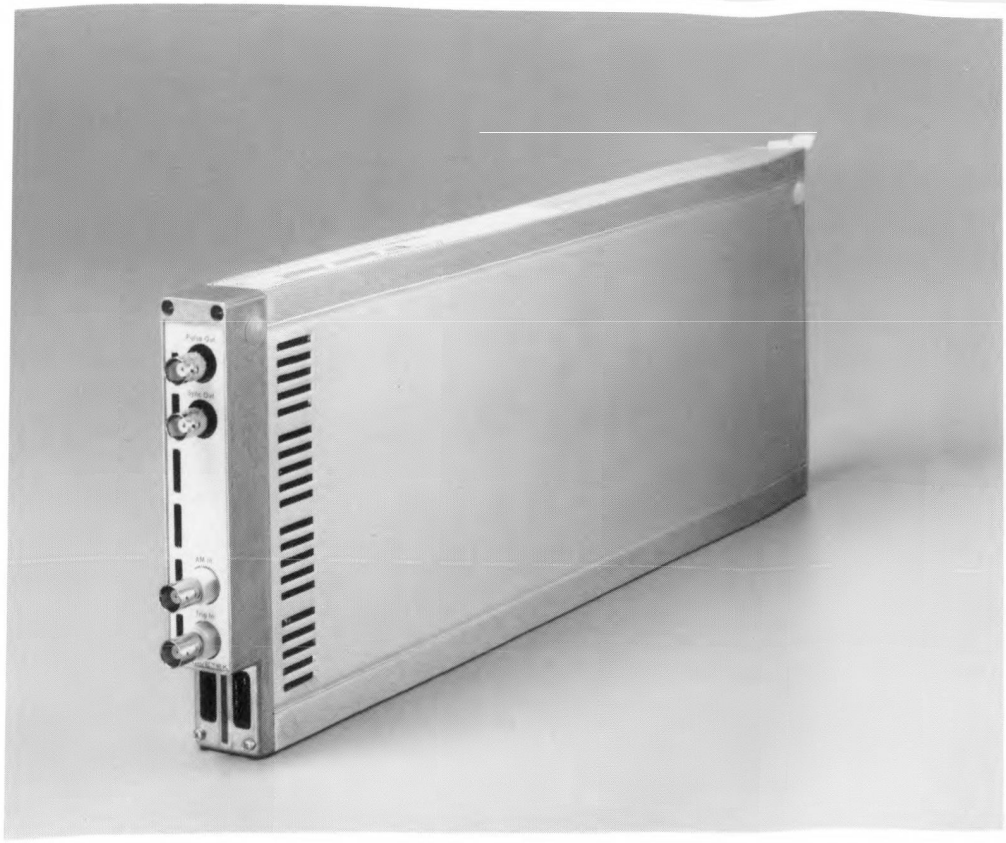
GENERAL
Outputs: Function Output, Waveform Sync Output, and Arbitrary Sync Output.
Inputs: Trigger Input and External Clock.
Internal I/O: System Trigger Bus, System Sync Bus, Analog Summing Bus and Pulse Amplitude Modulation (PAM source for Timing Generator).
Stored Settings: 99 provided by 680 chassis.
Environment: Refer to chassis specifications.
Dimensions: 15.9 cm (6.25 in.) high, 41.9 cm (16.5 in.) long, 3.0 cm (1.2 in.) wide.
Weight: 1.8 kg (4 lb) net.
Power: <32W.

MODEL 680MATE-01
MATE-CIIL capable. Meets MATE-CIIL Std. 2806763 Rev. C.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 680-01
Model 680MATE-01

For full specifications or a demonstration, contact your nearest Wavetek representative (pages 211 and 213).



100 MHz Timing Generator

- **5 PPM Frequency Accuracy**
- **Up to 32 Vp-p Output**
- **MATE-CIIL Interface**

Model 680-02 is a 10 mHz to 100 MHz Synthesized Timing Generator with 5 digits of resolution. The maximum output voltage available is 32 Vp-p with 4 digits of resolution. Pulse widths can be adjusted from 10 ns to 2000s with delays from 0 to 2000s. Both width and delay have a resolution of 10 digits or 1ns.

OPERATIONAL MODES
Continuous, Trig, Synchronized Gate, Async Gate, Burst and External Width.

PULSE FUNCTIONS
Single Pulse: One pulse each pulse period up to 50 MHz repetition rate.
Double Pulse: One pair of pulses each pulse period up to 25 MHz repetition rate.
Square Wave: Up to 30 MHz.
Continuous Timing: Up to 100 MHz.

OUTPUTS
Main Pulse Output: One channel. Independent frequency and parameter control.
Sync Output: During continuous operation, one pulse is time zero reference for each single pulse or pulse pair.
Duty Cycle: 50%. In Gated or Burst mode the Sync Out remains high for the duration of the burst.
Levels: <0.2V, to >1.0V into 50Ω (<0.4V to >2.0V into >10 kΩ).
Transition Time: <5 ns.

INPUTS
External Trigger: Programmable positive or negative slope.
Level Range: ±10V.
Impedance: 1 kΩ.
Signal Requirements
Transition Time: >100 µs.
Pulse Width: >10 ns.
Max Frequency: 25 MHz.
AM Input: Positive pulse, negative pulse and symmetrical pulse.
Bandwidth: >20 kHz.
Input Voltage: ±5V max.
Modulation Level: 0 to 95%.
Input Impedance: >1 kΩ.

INTERNAL I/O
System Trigger Bus, System Sync Bus, Analog Summing Bus and Pulse Amplitude Modulation.

TIME DOMAIN
Repetition Rate/Frequency
Range: 10 mHz to 100 MHz.
Resolution: 5 digits.
Accuracy: ±5 ppm.
Stability: 2ppm.

Burst Count: 2 to 1 x 10^7.
Pulse Width
Range: 10 ns to 2000s.
Resolution: 10 digits or 0.1 ns.
Accuracy: ±(0.5% + 5ns).
Pulse Delay
Range Relative to Sync Out: 0 ns to 2000s.
Resolution: 10 digits or 0.1 ns.
Accuracy: ±(0.5% + 5ns).
Trigger Delay: Measured from trig in to sync out at 50% amplitude.
Triggered: ≤80 ns.
A-Gate: ≤100 ns.
S-Gate: ≤100 ns.
Burst: ≤110 ns.
External Width: 60 ± 10 ns.
Transition Times:
If Upper and Lower Levels Are Equal: 6 ns for ≤10 Vp-p, ≤10 ns for >10 Vp-p.
If Upper and Lower Levels Are Not Equal: ≤10 ns.

AMPLITUDE CHARACTERISTICS
Max. Ampl vs Source Impedance:

Amplitude	Source Imped.
32 Vp-p	93Ω
30 Vp-p	75Ω
20 Vp-p	50Ω
10 Vp-p	All Others

The following specifications are for pulse on/off time >500 ns into a 50Ω load.
Output Upper/Lower Level Range:
1mVp-p to 20 Vp-p.
Resolution: 10 µV.
Accuracy:
When Upper Level = Lower Level:
>5 to 10V: ±(1.0% + 20 mV).
>0.5 to 5V: ±(1.0% + 20 mV).
>50 mV to 0.5V: ±(2.0 + 10 mV).
10 to 50 mV: ±(3.0% + 3mV).
When Upper Level ≠ Lower Level:
>5 to 10V: ±(1.0% + 30 mV).
>0.5 to 5V: ±(1.0% + 30 mV).
>50 mV to 0.5V: ±(2.0% + 15 mV).
10 to 50 mV: ±(3.0% + 5mV).
Waveform Aberrations:
If Upper and Lower Levels Are Equal: <(10% of Vp-p + 100 mV).
If Upper and Lower Levels Are Not Equal: <(12% of Vp-p + 140 mV).
Programmable Load Impedance: (Enter mode). Applies for loads other than 50Ω.
Range: 25 to 1kΩ.
Accuracy: ±5%.
Source Impedance: 50Ω, 75Ω and 93Ω. (Specifications apply to 50Ω only.)

GENERAL
Weight: 1.8 kg (4 lb) net.
Power: <40 W.

MODEL 680MATE-02
MATE-CIIL capable. Meets MATE-CIIL Std. 2806763 Rev. C.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 680-02
Model 680MATE-02

For full specification or a demonstration call your nearest Wavetek representative (pages 211 and 213).

Digital Multimeter

- **Datron Model 1365**
- **6 Digit, 0.006 Basic Accuracy**
- **2/4 Wire Resistance**
- **Exclusive Autocal Circuitry**
- **MATE—CIIL Interface**

Model 680-05 provides an excellent solution for adding multimeter capability to a test station. If all eight slots of the 680 mainframe are not filled then why waste more rack space on a separate multimeter when the 680-05 only takes up one slot in the 680 mainframe? Model 680-05 gives AC volts, DC volts and resistance measurements plus all the features you need for an ATE system.

All of the functions of the 680-05 can be controlled via the GPIB interface and from the front panel of the 680 mainframe.

DC VOLTAGE MEASUREMENT[3]

Range, Accuracy and Impedance: Refer to table 1.

Analog Filter: Selectable, adds 20 dB to NMRR at 60 Hz, increasing by 20 dB/decade.

Settling Time to % of Step Change in Input

Filter Out: 1 ms to 0.01%, <5 ms to 0.001%.

Filter In: 350 ms to 0.1%, <500 ms to 0.001%.

For Range or Function Change: Add 100 ms.

Input Current: <50 pA drifting at <2 pA/°C.

Table 1. DC Voltage Measurement Range, Accuracy and Impedance

Range	Accuracy[1] % Reading	±Zero Drift (Digits) 6 1/2	5 1/2	4 1/2	Impedance
300V	±0.008	4	1	1	10 MΩ
100V	±0.008	4	1	1	10 MΩ
10V	±0.006	4	1	1	10 GΩ
1V	±0.006	6	2	1	10 GΩ
1V[2]	±0.006	4	1	1	10 GΩ
0.1V	±0.007	40	6	1	10 GΩ
0.1V[2]	±0.007	30	4	1	10 GΩ
CMRR at DC and line frequency ±0.1%		130 dB	130 dB	80 dB	
NMRR at line frequency ±0.1%		56 dB	50dB		

AC VOLTAGE MEASUREMENT[3]

Range, Resolution and Impedance: Refer to table 2.

Accuracy: Refer to table 3.

DC Coupling: If DC component is greater than 20% of AC component (rms), double the above error limits and add 500 mV.

Settling Time To % of Step Change in Input

Filter Out: 500 ms to 0.1%.

Filter In: 2.5 sec to 0.1%.

For Range or Function Change: Add 10 ms.

From DC Bias Input (AC Coupled) or Source Overload: Depends on change of DC bias (time constant 0.22s).

Table 2. AC Voltage Measurement Range, Resolution and Impedance

Range	Resolution 6 1/2	Resolution 5 1/2	Resolution 4 1/2	Impedance
300V	1 mV	10 mV	100 mV	1 MΩ//100 pF
100V	100 µV	1 mV	10 mV	1 MΩ//100 pF
10V	10 µV	100 µV	1 mV	1 MΩ//100 pF
1V	1 µV	10 µV	100 µV	1 MΩ//100 pF
0.1V	0.1 µV	1 µV	10 µV	1 MΩ//100 pF

Peak signal should not exceed ±500V; crest factor 5:1 allowed within this range. Signal should not exceed 20 MHz.

Table 3. AC Voltage Measurement Accuracy

Accuracy		
Frequency	% Signal	% Full Range
10 to 30 Hz[4]	±0.5	±0.1
30 to 100 Hz[4]	±0.1	±0.03
100 Hz to 20 kHz	±0.1	±0.03
20 to 100 kHz	±0.3	±0.1
100 to 300 kHz	±3.0	±0.3
300 kHz to 1 MHz	±10.0	±1.0

CMRR >90 dB from DC to 60 Hz with 1 kΩ source imbalance.

Table 4. Reading Rate (Block Mode)

Scale Length	Intergration (msec)	Full Range Read/Sec
1.9999	1.0	1000
1.99999	1 PLC*	45/50**
1.999999	8 PLC*	4/5**

* Power Line Cycles

** Depends on setting of 60 Hz/ 50 Hz switch

Table 5. Resistance Range, Accuracy and Stimulus Current

Range	Accuracy % Reading	± Zero Drift (Digits) 6 1/2	± Zero Drift (Digits) 5 1/2	± Zero Drift (Digits) 4 1/2	Stimulus Current
10M	±0.1	5	2	1	400 µA
1M	±0.05	5	2	1	4µA
100k	±0.02	5	2	1	10 µA
10k	±0.007	5	2	1	100 µA
1k	±0.007	7	2	1	1 mA
0.1k	±0.008	50	7	1	1 mA
0.1k[1]	±0.008	40	5	1	1 mA

Lead Resistance Rejection: Up to 1% full range in any lead as above. Higher resistances are rejected by 60 dB. No lead resistance should exceed 10% or range.

RESISTANCE MEASUREMENT[5]

Range, Accuracy and Stimulus Current: Refer to table 5.

Settling Time: Same as DC voltage up to 10kΩ.

Open Circuit Voltage: 100Ω, 1kΩ, 10kΩ <10V; 100 kΩ, 1 MΩ, 10 MΩ <12V.

Lead Resistance Rejection

100, 1K & 10K Range: Up to 1% full range may be tolerated in any lead. Higher resistance rejected by 80 dB.

100K, 1M & 10M Range: Add 2ppm full range/Ω of lead resistance.

READING RATE

Refer to table 4.

MODEL 680MATE-05

MATE-CIIL capable. Meets MATE-CIIL Std. 2806763 Rev. C.

1 Stability for 1 year, drift ±10°C of calibration temperature, except where stated.

2 Within ±2°C and 24 hours of input zero.

3 Between 1 and 199% of full range (except 1 and 100% of 300V range).

4 Below 100 Hz, filter must be selected. Below 50 Hz, coupling must be DC.

5 4-wire measurement is specified. For 2-wire, degrade by 0.5Ω plus external lead resistance.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 680-05
Model 680MATE-05

For full specifications or a demonstration, contact your nearest Wavetek representative (pages 211 and 213).

160 MHz Frequency/Time Interval Counter (Racal Dana 1993)

- **1 ns Single Shot Time Interval Resolution**
- **Programmable Input/Trigger Levels**
- **Extensive Feature Set; Rise/Fall Times, Peak-to-Peak Input Voltage, Phase, A/B**
- **MATE-CIIL Interface**

Model 680-06 provides full system counter capability in a single module for the 680 chassis. The 680-06 offers twelve measurement functions, including phase and pulse parameters, all with extremely high resolution. Frequency profiling may be performed using minimum gate times and external arming. The extensive measurement capabilities make the 680-06 ideal for ATE applications. An optional 1.3 GHz, fuse-protected third input is available for RF requirements.

INPUT CHARACTERISTICS
Frequency Range
Input A:
DC Coupled: DC to 160 MHz.
AC Coupled: 10 Hz to 160 MHz.
Input B:
DC Coupled: DC to 100 MHz.
AC Coupled: 10 Hz to 100 MHz.

Sensitivity
Sinewave:
25 mVrms to 100 MHz.
50 mVrms to 160 MHz (Input A only).
Pulse: 75 mVpp at 5ns pulse width.
Dynamic Range (x1):
75 mV to 5Vpp to 50 MHz; 36 dB.
75 mV to 2.5 Vpp to 100 MHz; 30 dB.
150 mV to 2.5 Vpp to 160 MHz; 24 dB.
Maximum Input (without damage)
50Ω: 5Vrms.
1MΩ:
x1: 260 V(dc + ac rms), DC to 2kHz, decreasing to 5Vrms at 100 kHz and above.
x10: 260 V(dc + ac rms), DC to 20 kHz, decreasing to 50 Vrms at 100 kHz and above.

TRIGGERING
Trigger Level
Range:
x1: ±5.1V in 20 mV steps.
x10: ±51V in 200 mV steps.
Accuracy (x1): ±1% of trigger level ±30 mV.
Lowpass Filter: 50 kHz nominal.

Auto-trigger
Frequency Range: DC, 50 Hz to 100 MHz.

MEASUREMENT FUNCTIONS
Frequency A & B
Range:
Input A: DC to 160 MHz.
Input B: DC to 100 MHz.
LSD: (1ns/Gate Time) x Freq (that is, 9 digits in 1s).
Resolution: ±2 LSD ±1.4 (Trigger Error/Gate Time) x Frequency.
Accuracy: ±(Resolution) ± (Time Base Uncertainty) x Frequency.
Frequency C
Range: 40 MHz to 1.3 GHz.
LSD: (1ns/Gate Time) x Frequency.
Accuracy: (Resolution) ± (Time Base Uncertainty) x Frequency.
Period A
Range: 6.25 ns to 1.7 x 10^3 s.
LSD: (1ns/Gate Time) x Period (that is, 9 digits in 1s).

Resolution: ±(LSD) ± (Trigger Error/Gate Time) x Period.
Accuracy: ±(Resolution) ± (Time Base Uncertainty) x Period.

Time Interval
Separate Input:
Input A start/Input B stop.
Input B start/Input A stop.
Common: Input A start/Input A stop.
Range: –2 ns to 8 x 10^5 s.
LSD: 1ns (100 ps using average mode).
Resolution: ± LSB ± (1ns) ± (Start Trigger Error) ± (Stop Trigger Error).
Accuracy: ±(Resolution) ± (Time Base Uncertainty) x Time Int. ± (Trigger Level Timing Error) ±2ns.

Totalize A by B
Range: 0 to 100 MHz; 1 to 10^{18} events.
Start/Stop: Input B or manually via Special Function.
LSD: 1 count.
Resolution: LSD.
Accuracy: LSD.

Frequency Ratio A/B
Range, A and B: DC to 100 MHz.
LSD: $\frac{10 \times \text{Ratio}}{(F_A) \times \text{Gate Time}}$

Resolution:
$$\pm\text{LSD} \left(\frac{\pm\text{Trig. Error B} \times \text{Ratio}}{\text{Gate Time}}\right)$$

Accuracy:
$$\pm\text{LSD} \left(\frac{\pm\text{Trig. Error B} \times \text{Ratio}}{\text{Gate Time}}\right)$$

Frequency Range C/B
Input C: 40 MHz to 1.2 GHz.
Input B: DC to 100 MHz.
LSD: $\frac{640 \times \text{Ratio}}{(F_C) \times \text{Gate Time}}$

Rise/Fall Time
Range: 20 ns to 20 ms.
Minimum Pulse Height: 500 mVpp.
Minimum Pulse Width: 20 ns at signal peaks.
LSD: 1ns (100 ps using average mode).

Pulse Width
Range: 5ns to 20 ms.
Minimum Pulse Height: 150 mVpp.
LSD: 1ns (100 ps using average mode).

Phase A Relative B
Range: 0° to 360°.
LSD:
0.1° to 1MHz.
1° to 10 MHz.
10° to 100 MHz.

External Arming: Positive or negative edge, selectable via Special Function.
Input Signal
Sensitivity: 500 mVpp.
Operating Range: –4V to +4V, adjustable.
Minimum Time: 100 ns start-to-stop.

Delay
Time Interval: Programmable 200 µs to 800 ms.
Resolution: 25 µs.
Accuracy: ±50 µs ± 0.1% reading.

Peak Signal Measurement: Indicates pk max, pk min or DC of measurement signal.
Frequency Range: DC, 50 Hz to 20 MHz.
Dynamic Range: 150 mV to 51 Vpp.
Resolution (x1): 20 mV.
Accuracy (Sinewave): ±6% of peak-to-peak voltage ±50 mV.
Accuracy (DC): ±1% of reading ±40 mV.

Average Mode: Applies to all functions except Totalize.

Math: For all counting/timing functions except Trig Level and Gate Time.
Display: $\frac{(\text{Reading} - X)Y}{Z}$,where X, Y and Z are entered and stored.

Constant Range: From 0 to 1.3 GHz with 9 significant digits.

MODEL 680-06-01
Model 680-06 plus a 1.3 GHz input.

MODEL 680MATE-06
MATE-CIIL capable. Meets MATE-CIIL Std. 2806763 Rev. C.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 680-06
Model 680-06-01
Model 680MATE-06
Model 680MATE-06-01

For full specifications and a demonstration, call your nearest Wavetek representative (pages 211 and 213).

DEFINITIONS OF TERMS

1. **Resolution and Gate Time**
a. Refer to the table below. Gate time is set by the selected resolution in frequency, period, ratio, and check functions. However, gate times may also be programmed in increments rounded to the nearest 25.6s using the range of 200s to 99.999s. Default state is determined by the resolution selected (see table), and is 100 ms (8 digits) at power-on. Also, gate time may be extended by:
One period of input signal on Frequency B and Ratio A/B.
Two periods of input signal on Frequency A and Period A.

b. Resolution of phase and totalize is determined by the input signal.

c. Time interval, rise/fall time, and pulse width measurements have the resolution determined by both input signal and resolution set.

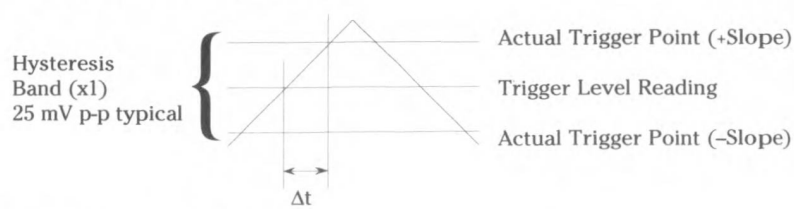
Resolution (No. of selected digits) in Frequency, Period Ratio, and Check	Gate Time	Display	GPIB Code
10	10s	Up Stop	SRS**10
9	1s		9
8	100 ms	Default	8
7	10 ms		7
6	1 ms		6
5	1 ms		5
4 *	*1 ms		4
3 *	1 ms	Down Stop	3

* Measurements of frequency, period, ratio, and check are averaged when these gate times are set.
** SRS = Store the Display Resolution

2. **Trigger Error**
$$\text{Trigger Error} = \frac{\text{SQR}\,(e_i^2 + e_n^2) \text{ seconds rms}}{\text{Input Slew Rate at Trigger}}$$
where e_i = input amplifier rms noise (typically 150 µVRMS in 160 MHz bandwidth)
where e_n = input signal rms noise in 160 MHz bandwidth

3. **Timebase Uncertainty**
The fraction deviation of the timebase frequency due to aging, temperature, voltage variations, etc. (See the Wavetek Model 680 Mainframe data sheet).

4. **Trigger Level Timing Error (x1)**



$$\Delta t = \text{Trig Level Timing Error} = \frac{1/2 \text{ Hysteresis Band}}{\text{Input Slew Rate at Actual Trig Point}} - \frac{1/2 \text{ Hysteresis Band}}{\text{Input Slew Rate at Trig Level Reading}}$$

Function & Arbitrary Waveform Generators

Function Generators have selectable waveforms which include sine waves, square waves, ramps, and triangle waves. Arbitrary waveform generators (Arbs) allow you to create user-defined waveshapes.

You can also select a function or Arb generator that has these additional features:

- Frequency synthesis for high frequency stability.
- Burst, trigger, and gate.
- Logarithmic and linear sweep.
- Variable duty cycle pulses, double pulses and variable rise and fall times.
- Modulation for AM, FM, PM, and SCM.
- Noise and function-with-noise.
- Stored waveform settings in non-volatile memory.
- Selectable output impedances.
- Haverwaves.
- GPIB and RS-232 interface.

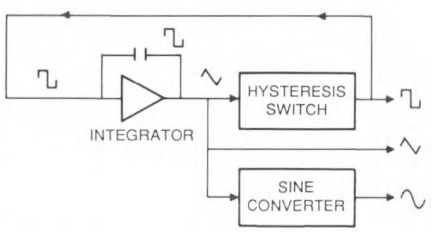
Page 32 contains an easy-to-use Selection Guide. Use this guide to find the general category and maximum frequency you want. The selection guides for each generator category are on page 32 through 36. Use these guides to compare attributes of similar generators. These guides refer you to the individual generator specification pages.

BASIC FUNCTION GENERATORS
Some functional blocks are common to almost all Wavetek function generators regardless of the complexity of the final product. The basic function generator has a nonlinear feedback loop consisting of an integrator and a hysteresis switch and produces the square and triangle waveforms.

The triangle wave is converted to a sine wave through a sine converter. This circuit has been refined over the years at Wavetek and can produce sine outputs with low harmonic content.

From this fundamental loop you can generate a wide variety of waveforms with excellent characteristics. The function generator approach gives you precision control over frequency, slope, rise/fall time and virtually all waveform parameters.

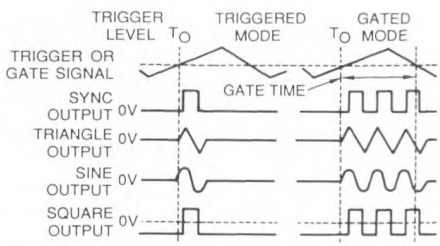
See page 32 for a guide to Wavetek's basic function generators.



Basic Function Generator

External Voltage Control of Generator (VCG)
Wavetek revolutionized low frequency sweep testing with the introduction of the first all solid state voltage controlled generator (VCG). In the voltage controlled generator the frequency is determined by the sum of the inputs from the main frequency control and external input voltages. The majority of Wavetek function generators feature VCG. This feature allows you to perform sweep operations with even the most basic function generators.

Trigger and Gate
Triggering and gating modes allow the function generator to generate exactly one cycle or a burst output. A triggered generator produces one cycle of output for each trigger pulse input. A gated generator gives a burst of output. The burst starts when the external gate voltage exceeds a threshold and stops when the gate voltage falls below that threshold. In many models a trigger-level control determines this level and allows discrimination against undesirable low level pulses when triggering or gating.

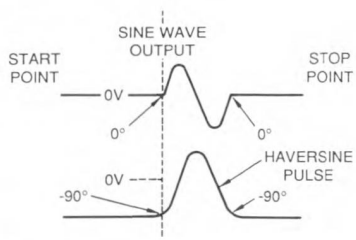


NOTE: Any cycles started during gate time are completed.

Trigger and Gate

Gated signals are also referred to as tone bursts and have their greatest application in testing electro-acoustical devices. Triggered cycles are often used in conjunction with specially shaped low frequency waveforms to simulate physical phenomena such as simple harmonic motion. The majority of Wavetek's function generators are capable of trigger and gated waveforms.

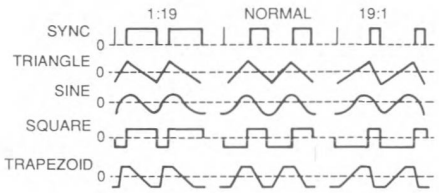
Variable Start/Stop Point
Start/stop point control allows the instrument oscillation to be started and stopped at a given point, or phase, of a waveform. This feature is often used in conjunction with DC level control to create special triggered waveforms, such as the haversine pulse. Wavetek's Models 145 and 148A/001 offer this feature.



Note: One triggered cycle shown.

Effect of Start/Stop Control

Variable DC Offset
DC offset control allows the DC level of the output signal to be varied in order to accommodate given test requirements on many instruments. The control also sets a DC output level in DC mode, which simulates DC power supply operation. Most Wavetek function generators feature DC offset.



Symmetry Control

The normal horizontal symmetry of the output waveform is a 1:1 ratio of positive half cycle to negative half cycle or pulse on time to off time. This cycle ratio may be fully varied from 19:1 thru 1:19 by symmetry control. Triangle waveforms are changed to sawtooth, square waveforms to very narrow pulses of either polarity and the sine waveforms to distorted sinusoidal waveforms.

PULSE/FUNCTION GENERATORS
All Wavetek function generators produce pulses in the form of a square wave. The many generators with symmetry control alter the square wave to produce variable duty cycle pulses. In addition, some models produce controlled width and delay pulses, double pulses, and variable transition times.

Transition (rise and fall) times can be individually tailored for such applications as comparator evaluation, measuring memory drive response and amplifier response time and minimizing switching transients.

See page 33 for a pulse/function generator selection guide.

SWEEP/FUNCTION GENERATORS
Sweep/function generators are actually two generators in one. The main generator is a voltage controlled generator while the secondary generator usually produces a sawtooth waveform whose changing voltages can sweep the frequency of the main generator. The sweep function can be either linear or logarithmic. Sweeping allows a rapid over-view of frequency sensitive characteristics of the device under test. Logarithmic sweeping spends equal time in each decade and gives more review time at the beginning of the sweep period; it is usually used to investigate logarithmically distributed characteristics.

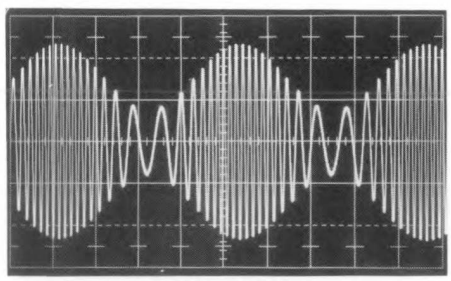
Several of our sweep/function generators feature marker signals for marking a given frequency on a scope display of a frequency swept circuit. The marker allows frequency identification of critical circuit frequency characteristics such as rolloff or other anomalies.

See page 35 for a sweep/function generator selection guide.

MODULATION/FUNCTION GENERATORS

Frequency Modulation
Frequency Modulation (FM) allows you to modulate the frequency of the function generator. All Wavetek's function generators with VCG can be used as a frequency modulation (FM) generator. Several models each contain a second internal generator that allows FM outputs without an external source for VCG input.

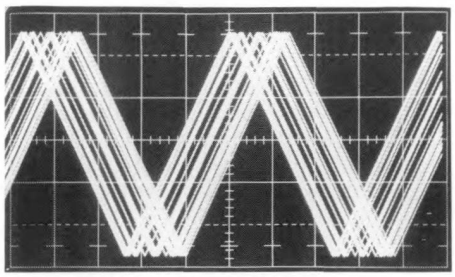
Amplitude Modulation
Amplitude Modulation (AM) allows you to modulate the amplitude of the function generator's output. All Wavetek function generators with an AM input can be used as an amplitude modulated generator. See page 36 for a modulation/function generator selection guide. Models 148A and 193 each contain a second generator that allows AM outputs without an external source for AM input.



Simultaneous AM and FM

Phase Modulation
When phase modulated (PM), the instantaneous generator frequency varies with an external or internal modulating signal, producing a carrier phase shift. PM is useful in evaluating phase lock loop (PLL) performance and phase modulated communications systems.

See page 36 for a modulation/function generator selection guide.



Phase Shifted Triangle Waveform

ARBITRARY WAVEFORM GENERATORS
Arbitrary Waveform Generators allow you to map points of a waveform in digital memory. These points are read out of memory at a given clock rate and converted by digital-to-analog converters (DAC) to analog waveforms. In addition, the Arbs have the standard function generator waveforms (sine waves, square waves, triangle waves and ramps) stored in EPROM for easy access.

There is a function/arbitrary waveform generator selection guide on page 33 to help you select the correct generator.

SYNTHESIZED FUNCTION GENERATORS
By using a crystal stabilized reference signal and a feedback loop for automatic frequency stability, accuracies comparable to expensive frequency synthesizers are available in function generators. For any frequency selected the oscillator has the stability of the reference signal. In function generator mode, the feedback loop is opened, making generator sweep possible.

Phase Lock
Phase locking allows the generator to lock to an external signal frequency and to maintain a given phase relationship to that signal. The phase relationship between the two signals is adjustable by a calibrated control.

See page 34 for a synthesized function generator selection guide.

NOISE/FUNCTION GENERATORS
Noise is the unwanted disturbances superimposed upon a useful signal which

could obscure the signal's useful content. Pure noise provides a constant power spectral density from DC to infinity. The Model 132 Noise/Function Generator synthesizes pseudo-random noise which closely approximates the Gaussian noise distribution. Model 132 can generate white noise by setting the generators bandwidth beyond that of the bandwidth of the test circuit. It also produces pink noise by limiting the generator's bandwidth to less than the bandwidth of the test circuit. In addition, the Model 132's standard waveforms may be summed with noise in signal-to-noise (S/N) and noise-to-signal (N/S) modes with selectable ratios. Noise can be summed with both analog and digital waveforms. It provides a noise output with a peak to rms ratio of 3.2:1. You can use Model 132 to test, for example, phase-lock loops, amplifiers, and power supplies for noise immunity. Model 132 is included in the Modulation/Function Generator Selection Guide on page 36.

CATEGORY AND FREQUENCY GUIDE

Upper Frequency* (in MHz)	2	2.1	4	5	11	12	13	20	50	Selection Guide Page
Category	Instrument Model Number									
Basic Function Generators		20		FG5000**	270			190		32
Synthesized Function Generators	171, 650					23, 278	172B	288	178	34
Pulse/Function Generators						271		145 191	166	33
Sweep/Function Generators			188		22	273		288	166 178	35
Modulation/Function Generators								148A/001 193, 288	166 178	36
Noise/Function Generators	132									36
Arbitrary Waveform Generators	75					275***		680-01		33

* Or Maximum Sampling Frequency For Arbitrary Waveform Generators.
** Not Available in U.S.A.
*** Maximum Sampling Rate In Arbitrary Waveform Generator Mode is 3.7 MHz.

BASIC FUNCTION GENERATOR SELECTION GUIDE

Model	20	FG5000*	270	190
Frequency Range	2 mHz to 2.1 MHz	1 mHz to 4 MHz	0.01 mHz to 12 MHz	2 mHz to 20 MHz
Frequency Accuracy	5%	3%	2%	3%
Frequency Resolution		3 Digits		
Maximum Amplitude	20 Vp-p	40 Vp-p	20 Vp-p	30 Vp-p
Amplitude Resolution				
Output Protected	Yes	Yes	Yes	
Trigger, Gated	Yes	Yes	Yes	Yes
Variable Symmetry				Yes
FM (By external signal)	Yes	Yes	Yes	Yes
Stored Settings			200	
Calib. & Perf. Ver. Aid**			Yes	
Battery Power	Yes			
GPIB		Optional	Yes	
Catalog Page	47	49	46	48

* Not Available in U.S.A.
** Menu Driven Calibration and Performance Verification Procedure.

ARBITRARY/FUNCTION GENERATOR SELECTION GUIDE

Model	75	275	680-01
Maximum Sample Frequency	2 MHz	3.75 MHz	20 MHz
Minimum Sample Frequency	2.4 μHz	3.75 mHz	0.001 Hz
Frequency Accuracy	0.015%	0.2%	0.0005%
Frequency Resolution	4 Digits	3 Digits	4 Digits
Maximum Amplitude	10 Vp-p	20 Vp-p	40 Vp-p
Amplitude Resolution	3 Digits	3 Digits	10 μV to 1 mV**
Output Protected	Yes	Yes	
Trigger, Gated	Yes	Yes	Yes
Haverwave	Yes		
Burst	Yes	Yes	Yes
Modulation		FM	
Variable Phase	Yes		
Stored Settings	4 Waveforms	75	
Calib. & Perf. Ver. Aid*		Yes	
GPIB	Optional	Yes	Yes
RS-232C	Optional		
Catalog Page	37	40	24, 43

* Menu Driven Calibration and Performance Verification Procedure.

** Dependent on range.

*** Includes price of 680 system mainframe and 1 Arb channel.

PULSE/FUNCTION GENERATOR SELECTION GUIDE

Model	271	145	191	166
Frequency Range	0.01 Hz to 12 MHz	0.1 mHz to 20 MHz	2 mHz to 20 MHz	0.1 mHz to 50 MHz
Frequency Accuracy	2%	3%	3%	2%
Frequency Resolution	3 Digits			
Maximum Amplitude	20 Vp-p	30 Vp-p	30 Vp-p	30 Vp-p
Amplitude Resolution	3 Digits			
Output Protected	Yes			
Variable Rise/Fall				Yes
Trigger, Gated	Yes	Yes	Yes	Yes
Haverwave		Yes		Yes
Burst	Yes			Yes
Sweep				Lin, Log
Modulation	FM	FM	FM	AM, FM
Stored Settings*	150			
GPIB	Yes			
Calib. & Perf. Ver. Aid**	Yes			
Catalog Page	53	54	55	52

* Storage of complete sets of instrument setups.
** Menu Driven Calibration and Performance Verification Procedure.

SYNTHESIZED FUNCTION GENERATOR SELECTION GUIDE

Model	171	650	23	278	172B	288	178
Frequency Range	0.1 Hz to 2 MHz	0.1 Hz to 2 MHz	10 mHz to 12 MHz	0.1 mHz to 13 MHz	0.1 mHz to 13 MHz	2 mHz to 20 MHz	1 µHz to 50 MHz
Frequency Accuracy	50 ppm	5 ppm	50 ppm	5 ppm	1%***	0.02%	5 ppm
Frequency Resolution	4.5 Digits	10 Digits	4 Digits	5 Digits	5.5 Digits***	3.5 Digits	8 Digits
Phase Lock		Yes		Yes	Yes	Yes	Yes
Maximum Amplitude	20 Vp-p	50 Vp-p	20 Vp-p	20 Vp-p	30 Vp-p	30 Vp-p	20 Vp-p
Amplitude Resolution		5 Digits	3 Digits	3 Digits	3.5 Digits	3 Digits	3.5 Digits
Output Protected		Yes	Yes	Yes	Yes		
Trigger/Gate		Yes	Yes	Yes	Yes		Yes
Haverwave					Yes		Yes
Burst		Yes		Yes			Yes
Variable Symmetry		Yes			Yes	Yes	
Sweep		Lin, Log			Lin	Lin	Lin, Log
Modulation*		AM, FM, PM, FSK, PSK, PPM	AM, FM, SCM	FM	FM	AM, FM	AM, FM
Variable Phase		Yes				Yes	Yes
Stored Settings**		25	Last Setup	100	240		5 Std, 40 Opt
MATE Compatible		Opt					Opt
GPIB		Yes	Opt	Yes	Yes	Yes	Yes
RS-232C			Opt				
Calib. & Perf. Verification Aid		Auto-cal		Yes†		Yes	
Multi-Output Impedance		Yes	Yes			Yes	
Catalog Page	70	64	68	61	71	45	62

* AM - Amplitude Modulation, FM - Frequency Modulation, PM - Phase Modulation
FSK - Frequency Shift Keying, PSK - Phase Shift Keying, PPM - Pulse Position Modulation
** Storage of complete sets of instrument setups.
*** 5 ppm with Option 002.
† Menu driven calibration and performance verification procedure.

SWEEP/FUNCTION GENERATOR SELECTION GUIDE

Model	650	188	22	273	166	178	288
Frequency Range	0.1 mHz to 2 MHz	4 mHz to 4 MHz	0.1 mHz to 11 MHz	0.01 Hz to 50 MHz	0.1 mHz to 50 MHz	1 µHz to 50 MHz	2 mHz to 50 MHz
Frequency Accuracy	5 ppm	5%	0.09%	2%	2%	5 ppm	0.02%
Frequency Resolution	10 Digits		3.5 Digits	3 Digits		8 Digits	3.5 Digits
Phase Lock	Yes					Yes	Yes
Maximum Amplitude	50 Vp-p	20 Vp-p	20 Vp-p	20 Vp-p	30 Vp-p	20 Vp-p	30 Vp-p
Amplitude Resolution	5 Digits		3 Digits	3 Digits		3.5 Digits	3 Digits
Output Protected	Yes		Yes	Yes			
Trigger, Gated	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Haverwave			Yes		Yes	Yes	Yes
Burst	Yes			Yes		Yes	
Variable Symmetry	Yes						Yes
Sweep	Lin, Log Random, Sine	Lin, Log	Lin, Log	Lin, Log, Sine, Square, Noise, Filtered, User Defined	Lin, Log	Lin, Log	Lin
Frequency Markers				Yes		Yes	
Modulation*	AM, FM, PM FSK, PSK, PPM	FM	FM	FM	AM, PM	AM, PM	AM, FM
Variable Phase	Yes					Yes	Yes
Stored Settings				25		5 Std, 40 Opt	
Calibration & Perf. Ver. Aid	Auto Cal Diagnostics			Yes**		Auto Cal	Auto Cal
MATE Compatible	Optional					Optional	
GPIB	Yes			Yes		Yes	Yes
Catalog Page	64	60	56	58	52	62	45

* AM - Amplitude Modulation, FM - Frequency Modulation, PM - Phase Modulation
FSK - Frequency Shift Keying, PSK - Phase Shift Keying, PPM - Pulse Position Modulation
** Menu driven calibration and performance verification procedure.

MODULATION/FUNCTION GENERATOR SELECTION GUIDE

Model	650	132	148A/001	193	288	166	178
Frequency Range	0.1 mHz to 2 MHz	0.2 mHz to 2 MHz	0.2 mHz to 20 MHz	2 mHz to 20 MHz	0.1 mHz to 50 MHz	0.1 mHz to 50 MHz	1 µHz to 50 MHz
Frequency Accuracy	5 ppm	2%	2%	3%	0.02%	2%	5 ppm
Frequency Resolution	10 Digits				3.5 Digits		8 Digits
Phase Lock	Yes				Yes		Yes
Maximum Amplitude	50 Vp-p	20 Vp-p	30 Vp-p	30 Vp-p	30 Vp-p	30 Vp-p	20 Vp-p
Amplitude Resolution	5 Digits				3 Digits		3.5 Digits
Output Protected	Yes						
Trigger, Gated	Yes		Yes	Yes		Yes	Yes
Haverwave			Yes		Yes	Yes	Yes
Burst	Yes						Yes
Variable Symmetry	Yes		Yes	Yes	Yes		
Sweep	Lin, Log, Random, Sine	FM, Analog Noise, Digital Noise	Lin	Lin	Lin	Lin, Log	Lin, Log
Modulation*	AM, FM**, PM, FSK, PSK, PPM		AM**, FM**, PM	AM**, FM**	AM, FM	AM, FM, SCM	AM, PM
Variable Phase	Yes				Yes		Yes
Stored Settings							5 Std, 40 Opt
Calib. & Perf. Ver. Aid	Auto Cal Diagnostics				Auto Cal		
MATE Compatible	Optional						Optional
GPIB	Yes				Yes		Yes
Catalog Page	64	44	51	50	45	52	62

* AM - Amplitude Modulation, FM - Frequency Modulation, PM - Phase Modulation
FSK - Frequency Shift Keying, PSK - Phase Shift Keying, PPM - Pulse Position Modulation

** Internal modulating signal available.

Arbitrary Waveform Generator

- **2MHz Sampling Frequency with Crystal Controlled Accuracy**
- **Easy-to-Use Waveform Entry, Editing and Storage of User-Defined Waveforms**
- **9 Standard Waveforms Provided in Nonvolatile Memory**
- **Up to 8K Horizontal Points**
- **12 Bit Vertical Resolution for Precise Amplitude Control**

Model 75 is the solution for bench-top or system arbitrary waveform generator applications. "User friendly" advanced waveform editing capabilities make it the easiest arbitrary (Arb) generator to use on the bench.

Waveforms have a vertical resolution of 4095 points and a horizontal resolution adjustable from 2 to 8192 points. Waveform memory is broken up into four blocks of 2048 points. One waveform of up to 8192 points or four different waveforms (one active and three stored) of up to 2048 points each can be in memory at any one time.

The sample frequency is crystal controlled and adjustable from 2MHz to 20 mHz (500 nanoseconds to 50 seconds) allowing a waveform period of from 1 microsecond to 113.8 hours. The sample period can also be controlled by an external clock source having a period of 500 nanoseconds or larger.

Waveforms can be stopped and started at any point in the waveform either with an external signal, front panel pushbutton, or preprogrammed breakpoints.

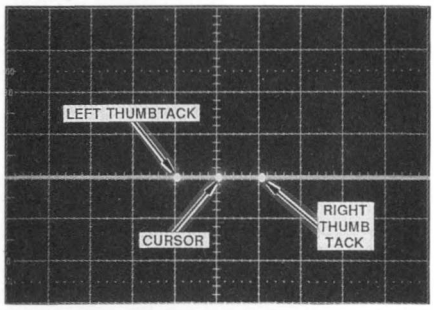
Series Operation
Two or more Model 75s can be connected in series to produce waveforms that are longer than the 8192-point single unit maximum or to produce a sequence of different waveforms such as a burst of "normal" waveforms followed by an "abnormal" waveform.

Parallel Operation
Two or more Model 75's can be connected in parallel to produce multiple waveforms with adjustable phase relationships between them. This can be used in applications such as multi-phase power testing and multi-axis stress and vibration testing.

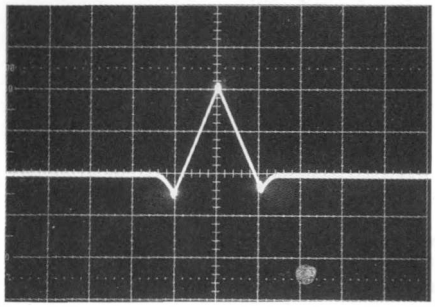
Battery Backed Memory
Instrument state is stored in a battery backed memory, so that when the instrument is turned on it will contain the same setup and waveforms that it had when it was turned off.

Rubber Band Editing
Rubber band editing allows easy editing of waveforms or portions of the waveforms. The principle of this editing method is similar to stretching a rubber band between two "thumbtacks". A "thumbtack" is placed at each end of a waveform portion to be edited and the cursor is placed between them. (Cursor and thumbtacks are intensified for easy oscilloscope viewing.) The cursor can then be moved either horizontally or vertically, and the waveform will automatically follow in real time.

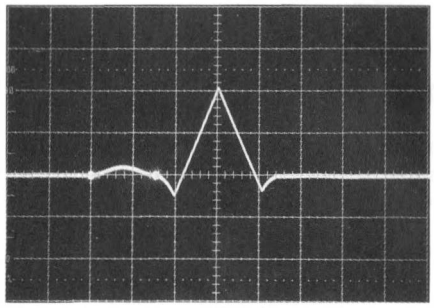
These figures show how you can use the thumbtacks and cursor to create an arbitrary waveform.



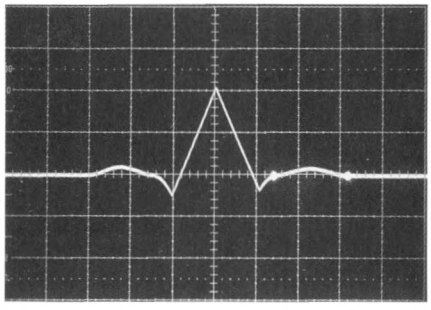
Z-Axis Thumbtacks can be Moved to any Waveform Segment



After Inserting One Cycle of a Selected Standard Waveform Between Thumbtacks, Rubberband Editing Allows the Cursor to Stretch the Waveform in Real-Time



Thumbtacks are Moved to New Location and a Haversine Function is Selected, Reduced in Amplitude and Moved into a New Position with Digital Offset



The EKG Waveform Simulation is Completed by Repeating the Last Editing Sequence. To Create this Waveform from the Front Panel Took Less Than Five Minutes

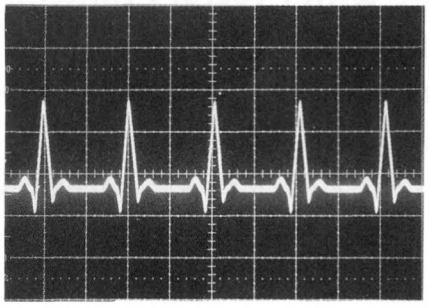
Additional Editing Features
The standard waveforms are inserted between the thumbtacks and can be edited using the editing features.

The amplitude and offset of a portion of the waveform can be changed by placing the thumbtacks at each end of the portion to be changed and using the digital amplitude and digital offset features.

Communications Option
An optional RS-232C or GPIB port is available for entering the waveform data and for external instrument control.

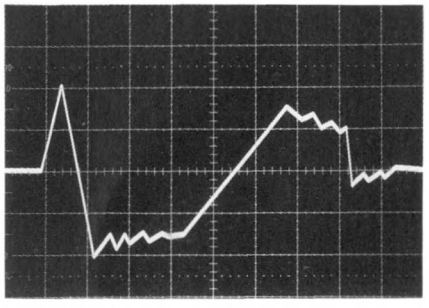
RS-232C or GPIB numeric input is entered in free format (fixed, floating, or exponential notation). The parameters may be entered in any order and interactive error checks occur after the execute command.

Arb Applications
Medical production and R&D applications for the 75 include testing of pacemakers and other medical equipment and simulation of heart-beats, nerve responses and EEG brainwave patterns. The high resolution of the 75 along with the ability to vary the time between waveforms make it particularly useful in these applications.



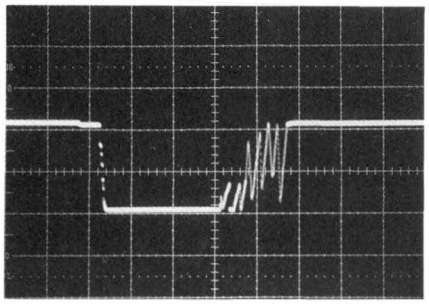
Heartbeat Simulation

Material testing is a traditional application for Arb generators. Hold, return-to-start, waveform counter, and breakpoints are features that make the 75 extremely useful for this application.



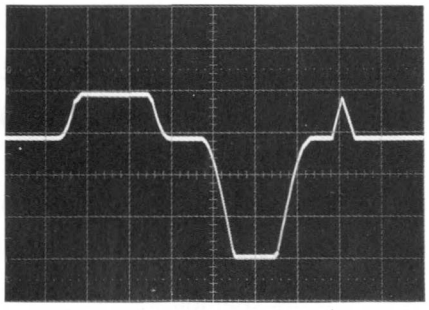
Typical Material Testing Waveform

Simulation of switcher motors, solenoids, and relays require special waveforms which simulate contact bounce. The Model 75 has been used to generate these special types of waveforms.

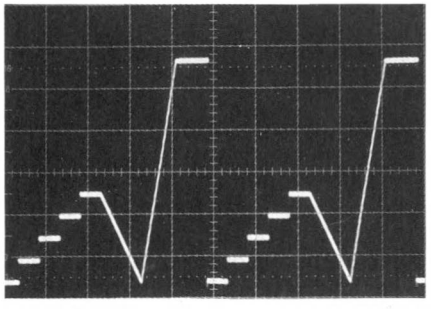


Contact Bounce Simulation

Disk drive manufacturers are using a modulated magnetic pickup technique to locate certain sync points on a spinning platter. Initial testing of these pickup amplifiers was hazardous, since an actual disk spinning at full speed was required for this precision work. The Model 75 simulates the spinning disk by providing the necessary sync waveforms to the pickup amplifiers. Flexibility of the Arb permits precise timing of waveforms through external triggering, as well as full level control and waveform switching.



Typical Disk Sync Waveform



Vibration Analysis Testing

MODEL 75

WAVEFORMS

DC, square, triangle, up-ramp, down-ramp, sine, cosine, inverse sine, and haversine waveforms are provided. Each of these waveforms can be stored into the waveform memory between thumbtacks automatically, and then edited with the waveform editing functions if desired.

MODES

Continuous: Generator runs continuously at selected frequency.

Triggered: Output quiescent until triggered by external signal or front panel pushbutton, then runs until another break point is encountered. Break points can be inserted anywhere in the waveform with the default break point at the beginning of the waveform.

Gated: Same as triggered mode except that the output is continuous for the duration of the gate signal and until the first break point encountered after the gate signal ends.

Burst: As triggered except that a programmable number of waveforms is counted before the waveforms stop. The maximum burst count is 1,048,575.

Toggled: Output is quiescent until triggered. It then runs continuously until another trigger stops the waveform at the next break point.

FREQUENCY

Sample Range: 0.02 Hz to 2.0 MHz (50s to 500 ns).

Waveform Period and Frequency: Actual waveform period is the number of horizontal points (from start to stop address) times the sample time. This can range from 1 µs for a square wave to 113.8 hours for a waveform using all 8192 points.

Frequency Resolution: 4 digits.

Frequency Accuracy: ±0.015%, ≤5ppm/°C.

Normal Waveform: 2048 points horizontal.

Chained Waveform: 8192 points horizontal. Stored waveforms are not available with chained operation.

AMPLITUDE

Range: 0.01 to 5 Vp-p into 50Ω (0.01 to 10 Vp-p into an open circuit). Peak amplitude plus offset may not exceed ±5V into 50Ω (±10V into an open circuit). The display reads out in Vp.

Resolution: 3 digits.

Accuracy: ±2%.

Normal Waveform: 4095 points vertical (12 bits).

Chained Waveform: 4095 points vertical (12 bits).

Rise/Fall Time: <350 ns.

OFFSET

Range: +5V to -5V into 50Ω (-10V to +10V into an open circuit). Absolute amplitude plus offset may not exceed ±5V into 50Ω (±10V into an open circuit).

Resolution: 3 digits.

Accuracy: ±10mV and ±2% of setting.

OUTPUTS

Arb Out (50Ω): Source of primary waveform output.

Sync Out (TTL): Will drive up to 10 LSTTL loads. This is a pulse 1 sample time wide that is usually used to sync an oscilloscope or another Arb generator. Pulse position is adjustable to any point in the waveform.

Burst Done Out (TTL): Will drive up to 10 LSTTL loads. Used primarily to start another Arb generator in series operation.

Ref Out (TTL): Will drive up to 10 LSTTL loads. This pulse train at the sample frequency is used primarily as a reference source for other Arb generators in series or parallel operation.

Z-Axis Out: This signal is a pulse used to modulate the Z-axis of an oscilloscope when using the waveform editing features.

INPUTS

Sum In (50Ω): The signal at this input is added to the arbitrary waveform to produce an output (at Arb out) of the sum of the two. A peak input of ±5V will produce an output equal to the amplitude setting.

SYNC In (100 kΩ): A TTL high input causes the waveform to restart at the start address. Used for synchronizing another Arb in parallel.

Trig In (100 kΩ): A TTL level used to control the generator in the trigger, gate, toggle, and burst modes. Slope polarity is selectable via the front panel.

Ref In (100 kΩ): Used for external sample clock input when external reference is selected.

Hold In (100 kΩ): Provides for real-time waveform interrupt and restart.

Return In (100 kΩ): A TTL level signal causes the output level to ramp back to the waveform start value. Ramp rate is front panel selectable from 0 to 100 ms per point.

COMMUNICATION PORTS (OPTIONAL)

IEEE-488 Port (Option 001)

Type: IEEE-488 1978 compatible, non-isolated, double buffered.

Address: 0-30, internal DIP switch selectable or front panel selectable.

Subsets: SH1, AH1, T6, TE0, L4, SR1, RL1, PP0, DC1, C0, E1.

RS-232C Serial Port (Option 002)

Communication: Full duplex (bi-directional) with CTS/DTR or XON/XOFF handshaking.

Connector: Rear panel mounted DB-25 (female) with DCE or DTE configuration.

Data Format: 8 bits, no parity, one stop bit.

Data Rate: 14 steps internal switch selectable (50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 9600, 19,200).

GENERAL

Output Protection:

Short Circuit: ±10 Vdc.

Line Voltage: 250 Vac or 350 Vdc.

Environmental

Temperature Range: +23° ±5°C for specified operation, operates 0° to +50°C, -20° to +75°C for storage.

Warmup Time: 20 minutes for specified (guaranteed for 1 year) operation.

Altitude: Sea level to 10,000 ft for operation. Sea level to 40,000 ft for storage.

Relative Humidity: 95% at 25°C and at sea level (non-condensing).

Dimensions: 21 cm (8.27 in.) wide, 10 cm (3.94 in.) high, 32.3 cm (12.72 in.) deep.

Weight: 3.55 kg (7.8 lb) net, 4.68 kg (10.3 lb) shipping.

Power: 90 to 128, 180 to 256 rms; 48 to 66Hz; single phase; <25 VA.

OPTIONS

001:IEEE-488 (GPIB) Port. For instrument control or entering waveform data.

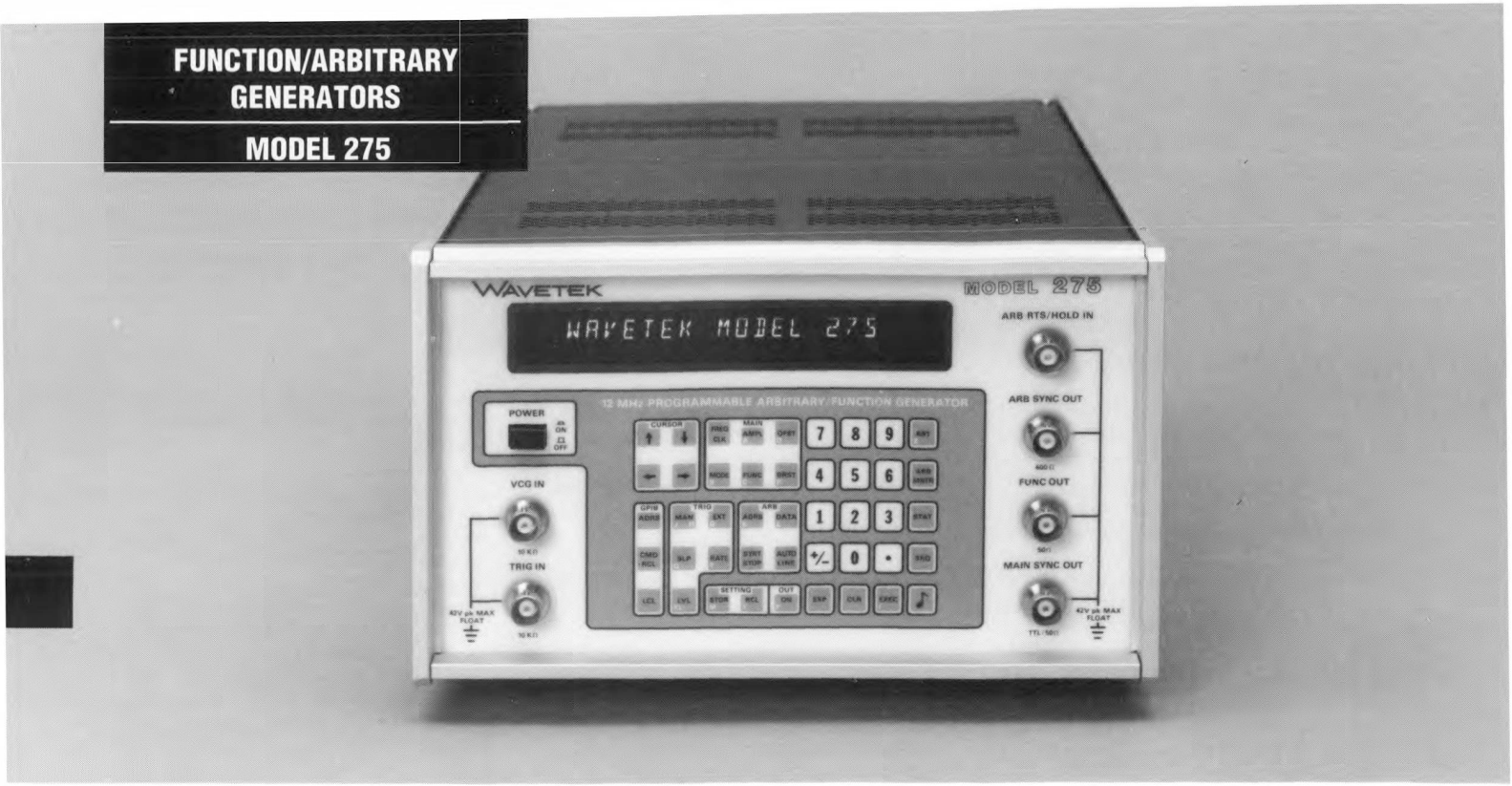
002:RS-232C Serial Port. For instrument control or entering waveform data.

Note: Options 001 and 002 are mutually exclusive.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 75
Option 001
Option 002

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).



12 MHz Arbitrary/ Function Generator

- **0.01 MHz to 12 MHz Frequency Range; 3.75 MHz Arb Sampling Frequency**
- **10 Vp-p Protected Output into 50Ω**
- **Advanced Entry, Editing & Storage of User-Defined Wave Shapes**
- **12 Bit Vertical Resolution for Precise Amplitude Control**
- **Up to 8K Horizontal Points**
- **Burst Mode to Over 1 Million Cycles**
- **75 Stored Settings in Nonvolatile Memory**

Compact and Versatile
Model 275 Programmable Arbitrary/ Function Generator is a light-weight, half-rack instrument for bench or ATE use. The 275 can generate precise sine, triangle, square plus user-defined arbitrary waveforms from 0.01 to 10 Vp-p, and DC offsets within a -5 to +5V range into 50Ω. Waveforms can be continuous, gated, triggered or burst. Eleven useful modes include arbitrary waveform hold and ramp-to-start.

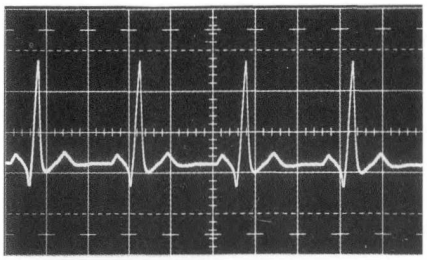
User Defined Waveforms
Any regular or irregular waveform may be easily entered into nonvolatile memory with the front panel keyboard or via GPIB. The auto-line feature greatly simplifies entry of waveforms consisting of straight line segments. Enter the line segment end points and program the auto-line command.

12 Bit Amplitude Resolution
In the ARB modes, 12 bits of amplitude resolution provide unparalleled waveform resolution. Waveforms may be stored in full or partial blocks of 2 to 8,192 horizontal points. Sampling clock speeds from 267 ns to 267 seconds per point provide waveform periods as long as 25 days.

Ease of Programming
The GPIB entry sequence is identical to front panel entry and the ASCII character for GPIB programming appears on most keys on the front panel.

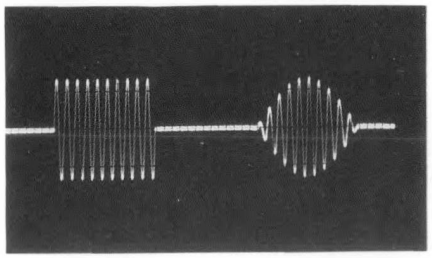
Protected Outputs
Model 275 outputs are protected against short circuits and external voltages between ±15V. The main output is further protected against voltage inputs of up to 140 Vac or ±200 Vdc.

ARB Applications
Medical. Production and R&D applications of the 275 include testing of pacemakers and other medical equipment and simulation of heartbeats, nerve responses, and EEG brain-wave patterns. The high resolution of the 275 along with the ability to vary the time between waveforms make it particularly useful in these applications.



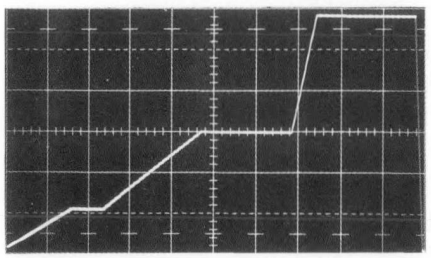
Heartbeat Simulation

Doppler. Doppler applications include under-water sound (sonar), radar IF strips, and ultra-sound (used in mechanical defect testing and medical testing). The ability of the 275 to vary time between waveforms (using the trigger-and-hold-on-breakpoint mode and internal triggering) with the cursor makes it ideal for these kinds of applications.



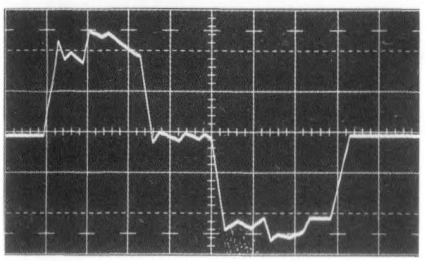
Simulated Doppler Signals

Material Testing. Material testing is a traditional application for Arb generators. Ramp-to-start, hold-on-trigger, panel lockout, and Arb monitor features make the 275 useful for this application.



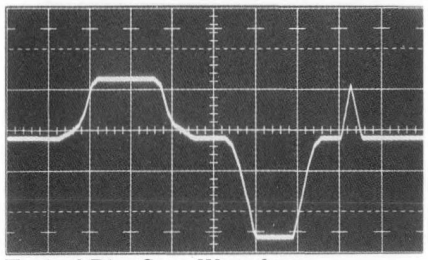
Typical Material Testing Waveform

Electromechanical Switching. Simulation of switcher motors, solenoids and relays require special waveforms which simulate contact bounce. The Model 275 has been used to generate these special types of waveforms.



Contact Bounce Simulation

Computer Disc. Computer peripherals such as disc drives and high speed printers require complex mechanical/electrical interfaces to insure proper alignments for proper data transfer. Disc drive manufacturers are using a modulated magnetic pickup technique to locate certain sync points on the spinning disc platter. The ARB simulates the spinning disc by providing the necessary sync waveforms to the pickup amplifiers. Flexibility of the ARB permits precise timing of waveforms through external triggering, as well as full level control and waveform switching. In the past, initial tune-up of these pickup amplifiers was hazardous, since an actual disc spinning at full speed was required for this precision work.



Typical Disc Sync Waveform

WAVEFORMS

Programmable sine, triangle, square, square complement, DC, external width, arbitrary and filtered arbitrary.

Waveform Characteristics

Sine Distortion (THD at 5 Vp-p): <0.5% 10 mHz to 99.9 kHz. No harmonics above -40 dBc 100 kHz to 999 kHz, -30 dBc 1 MHz to 12 MHz.
Time Symmetry: ±1% ±8 ns.
Square Transition Time: <15 ns.
Square Overshoot: <4% at full amplitude.
Triangle Linearity: 99% to 100 kHz.

Arb Characteristics

Horizontal Resolution: 2048 points standard; 8192 optional.
Vertical Resolution: 4095 points (12 bits).
Auto-line: Draws straight line between two data points.
Programmable Filter (ARB Waveforms)
Non-filtered ARB Waveform: Settling time <1.5 ms.
Filtered ARB Waveform: Settling time approximately 0.6 ms.
Programmable Ramp-to-Start Rate
Fast: Approximately 5 ms/bit;
Slow: Approximately 20 ms/bit.
Programmable Sampling Frequency: Period Ranges from 3.75 MHZ to 3.75 MHZ (267s to 267 ns) with 0.2% accuracy.

MODES (FOR ALL FUNCTIONS INCLUDING ARB)

Continuous: Output continuous at programmed frequency.

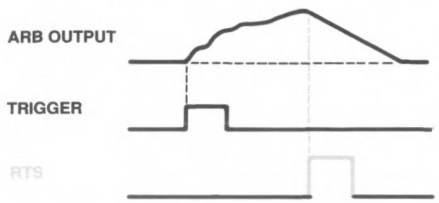
Triggered: Output quiescent until triggered by internal or external signal, GPIB trigger or manual trigger, then generates one cycle at programmed frequency or clock rate.

Gated: As triggered mode except output is continuous for duration of gate signal. Last cycle started is completed.

Burst: As triggered mode for programmed number of cycles between 1 and 1,048,200.

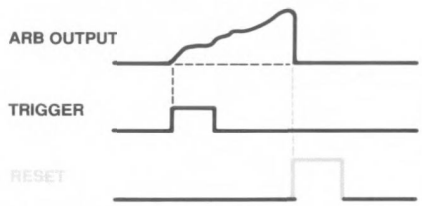
MODES (ARB ONLY)

Triggered Arb with Ramp-to-Start: One cycle of Arb waveform is initiated on first trigger input. Second trigger (at TRIG IN or Arb RTS/HOLD IN) causes Arb output to slowly ramp to start address of Arb waveform. If return-to-start (RTS) trigger is not received before stop address is reached, RTS is initiated at stop address.



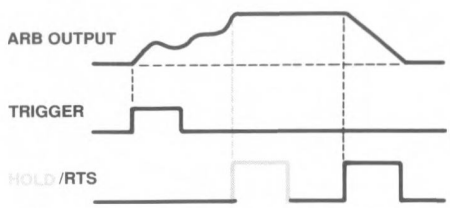
Triggered Arb with Ramp-to-Start

Triggered Arb with Reset: Same as Triggered Arb with Ramp-To-Start except the second trigger (or stop address) causes immediate reset to start address.



Triggered Arb with Reset

Triggered Arb with Hold and Triggered Ramp-to-Start: One cycle of Arb waveform is initiated on first trigger input. Second trigger causes Arb to hold. Third trigger causes ramp-to-start. If stop address is reached before second trigger then stop address causes hold and next trigger causes RTS.

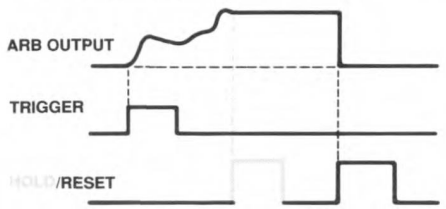


Triggered Arb with Hold and Triggered Ramp-to-Start

FUNCTION/ARBITRARY GENERATORS

MODEL 275

Triggered Arb with Hold and Triggered Reset: One cycle of Arb waveform is initiated on first trigger input. Second trigger causes Arb to hold. Third trigger causes immediate reset to start. If stop address is reached before second trigger, then stop address causes hold and next trigger causes reset.

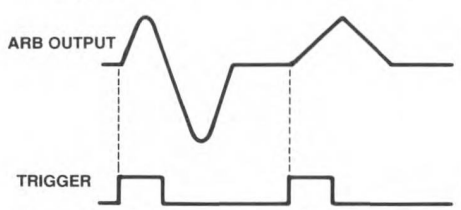


Triggered Arb with Hold and Triggered Reset

Single Step: Same as Continuous mode except when Arbitrary function is selected, Arb clock rate is replaced by trigger input so that Arb clock can be supplied externally or with function generator.

Examine: When Arbitrary function is selected, output will be voltage (data value) present at address specified on address program. This allows Arb waveform to be examined one point at a time by specifying address of desired point.

Triggered Arb with Hold on Breakpoint: Arb waveform is initiated upon trigger input and held at programmed breakpoints. Each successive trigger then causes the instrument to advance to the next breakpoint. Start and stop addresses are ignored in this mode after the first trigger.



Triggered Arb with Hold on Break Point

Arb RTS/Hold Input: Trig input and RTS/Hold input are internally common. Having two inputs provides processing for independently generated trigger and RTS/Hold signals.

FREQUENCY

Range: 10 mHz to 12 MHz for sine, triangle, square, square complement. >24 MHz for external width. Arb range dependent upon sampling frequency and block size. Clock rate 3.75 MHz to 3.75 mHz (267 ns to 267s).
Resolution: 3 digits.
Accuracy: ±2% for non-Arb modes. ±0.2% for Arb modes.

AMPLITUDE

Range: 0.01 to 10 Vp-p into 50Ω (0.02 to 20 Vp-p into ≥50 kΩ) from main output. Absolute peak amplitude plus offset may not exceed 5V into 50Ω (10V into ≥50 kΩ).
Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset >0.5V; 3 digits or 1 mV when absolute peak amplitude plus offset ≤0.5V.
Accuracy
For 0.1 to 1V (Peak Amplitude + Offset <0.5V): ±2% of programmed value and ± 5 mV.
For 1.01 to 10V: ±2% of programmed value and ±20 mV.
For All Others: ±2% of programmed value and ±50 mV.
Flatness (At 5 Vp-p): 0.1 dB to 100 kHz, 1.5 dB to 12 MHz.

OFFSET

Range: DC or offset programmable from 5V to +5V into 50Ω (-10V to +10V into ≥50 kΩ). Absolute peak amplitude plus offset may not exceed 5V into 50Ω (10V into ≥50 kΩ).
Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset >0.5V, 3 digits or 1 mV when absolute peak amplitude plus offset ≤0.5V.
Accuracy: ±40 mV in DC function.

OUTPUTS

Function Out (50Ω): Source of primary waveforms.
Program Control Provides: Output On, (50Ω source impedance); Output Off, High Z (>500 kΩ); Output Off, Low Z (approx 50Ω termination).
Protection: Output protected to 140 Vac or 200 Vdc without internal damage.
Sync Out (50Ω): Sync signal is at programmed frequency and TTL level.
Over/Undershoot: <10% into 50Ω.
Arb Sync Out (600Ω): 0 to +5V, programmable phase control.

INPUTS

External Trigger.
Level: -10 to +10V.
Resolution: 20 mV.
Accuracy: ±500 mV. (For signal slew rate <10V/µs.)
VCG In.
Range: 0.01 to ±12V or 1200:1 frequency range.
Impedance: 10 kΩ.

INTERNAL TRIGGER

Non-Arb Functions
Range: 3.75 mHz to 3.75 MHz.
Resolution: 4 digits.
Accuracy: 0.2%.
Arb Functions
Range: 10 mHz to 3.75 MHz.
Resolution: 3 digits.
Accuracy: 0.2%

GPIB PROGRAMMING

IEEE-488 1978 compatible. Non-isolated. Double buffered.
Address: 0-30, keyboard or internal switch selectable.
Subsets: SH1, AH1, T6, TE0, L4, SR1, RL1, PP0, DC1, C0, E2.

GENERAL

Stored Settings: 75 setups.
Environment
Temperature Range: +25° ± 10°C for specified operation, operates 0° to +50°C,
-50° to +75°C for storage.
Warm-up Time: 20 minutes for specified operation.
Altitude: Sea level to 10,000 ft for operation. To 40,000 ft for storage.
Relative Humidity: 95% at +20°C and at sea level (non-condensing).
Dimensions: 21.7 cm (8.54 in.) wide (half-rack); 13.3 cm (5.25 in.) high; 39.4 cm (15.5 in.) deep.
Weight: 5.9 kg (13 lb) net; 7.2 kg (16 lb) shipping.
Power: 90 to 105, 108 to 126, 198 to 231, or 216 to 252 Vac; 48 to 66 Hz; 1 phase; <40 watts.

OPTIONS

002: Rear Panel Connectors. BNCs relocated to rear panel.
004: Extended Block Size. Extends block size to 8192 points.

ACCESSORIES

Style 12: Single Rack Adapter Kit
Style 13: Dual Rack Adapter Kit

FACTORY/FOB

San Diego, CA

ORDER INFORMATION

Model 275
Option 002
Option 004

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

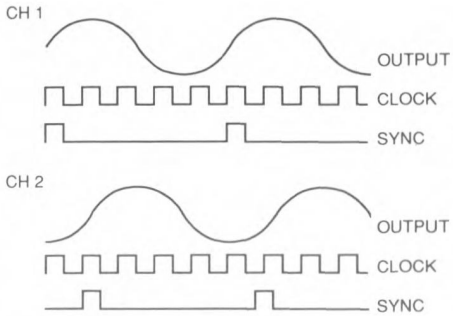
ARBITRARY GENERATORS

MODEL 680/ARB

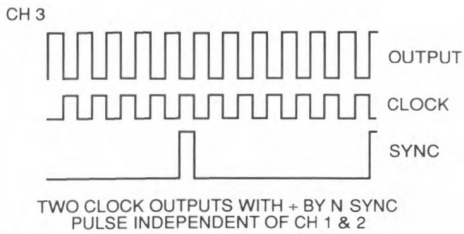
Eight Channel 20 MHz Arbitrary Waveform Generator

- **Multi-channel – Up to Eight Channels Possible**
- **Independent Channel Programming**
- **Phase Related or Independent Signals**
- **20 MHz Sample Rate**
- **Pre-stored Function Generator Waveforms**
- **Timing Generator, DMM or Counter Options also available.**
- **MATE-CIIL Version Available**

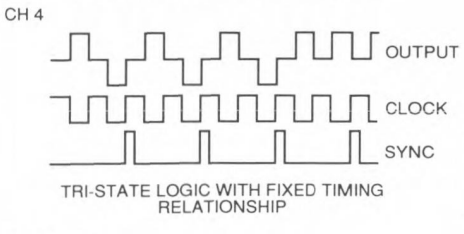
Model 680/Arb brings a new dimension to Arbitrary Waveform generators. The 680/Arb allows independent programming of eight signal channels. When you add the waveform sync and clock signal sync outputs from each channel, a total of 24 simultaneous outputs are possible. The channels can be programmed to be independent or time related. The signal outputs can be combined by a common clock or they can be added by means of the summing bus. The Model 680/Arb offers an almost unlimited source of waveforms for your testing needs; some examples are shown.



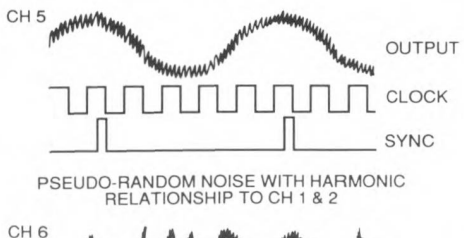
PHASE SHIFT RELATIONSHIP BETWEEN CH 1 & 2



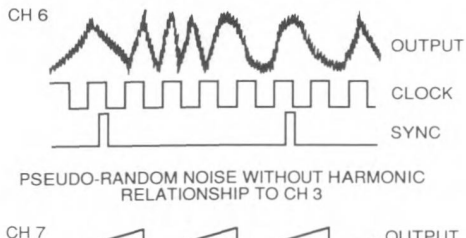
TWO CLOCK OUTPUTS WITH ÷ BY N SYNC PULSE INDEPENDENT OF CH 1 & 2



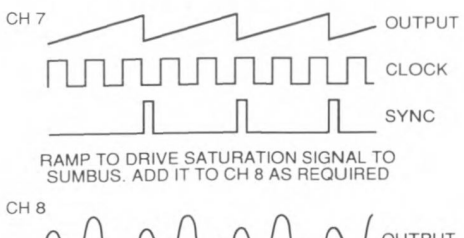
TRI-STATE LOGIC WITH FIXED TIMING RELATIONSHIP



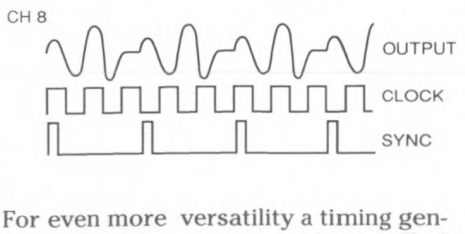
PSEUDO-RANDOM NOISE WITH HARMONIC RELATIONSHIP TO CH 1 & 2



PSEUDO-RANDOM NOISE WITHOUT HARMONIC RELATIONSHIP TO CH 3



RAMP TO DRIVE SATURATION SIGNAL TO SUMBUS. ADD IT TO CH 8 AS REQUIRED



For even more versatility a timing generator, DMM or counter can be installed to enhance operation.

FACTORY/FOB
San Diego, CA

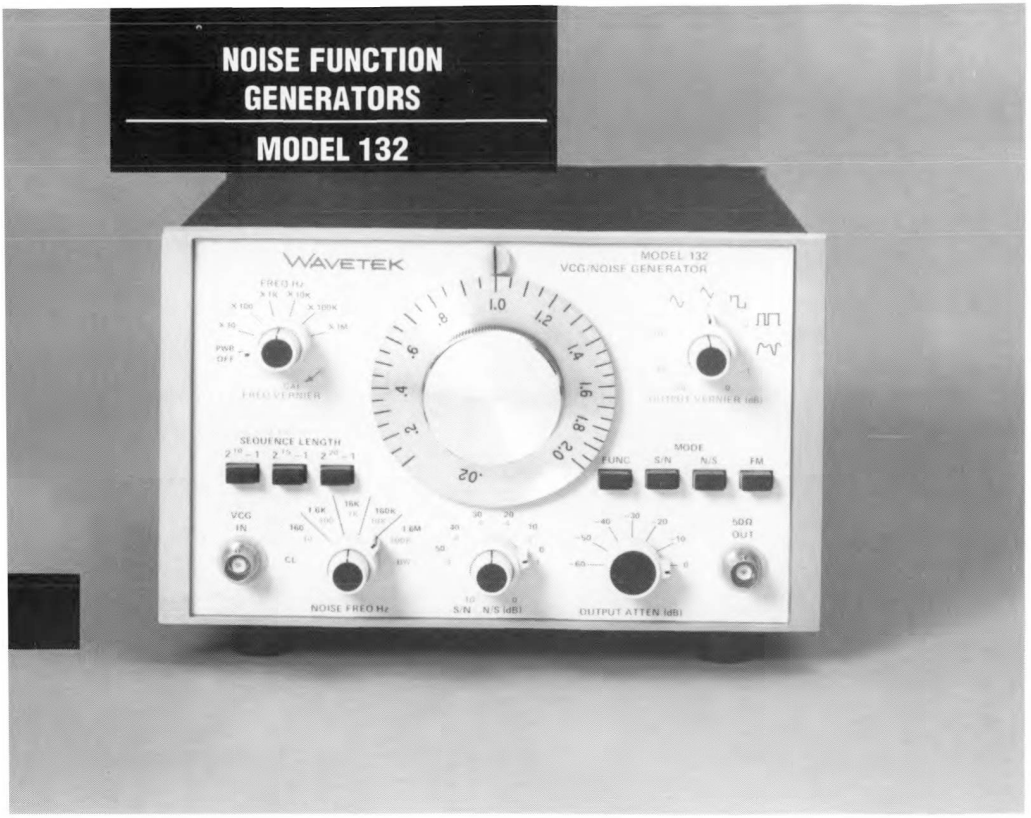
ORDER INFORMATION
Model 680 Chassis
Model 680-01 Arb (per channel)

For more details on the Model 680 Arbitrary Waveform generator see pages 20-24.

For full specifications or a demonstration contact your local Wavetek representative (pages 211 and 213).

NOISE FUNCTION GENERATORS

MODEL 132



VCG/Noise Generator

- **Pseudo-Random Analog and Digital Noise**
- **Calibrated Signal-to-Noise Ratios**
- **0.2 Hz to 2 MHz Frequency Range**
- **Adjustable Incidental FM**

Model 132 is a 0.2 Hz to 2 MHz Voltage Controlled Function Generator (VCG) and a noise generator. As a noise generator, it produces both analog and digital pseudo-random noise in several modes for electrical and mechanical testing. Besides a noise mode, Model 132 has a variable signal-to-noise mode for testing modem performance, noise immunity and system performance in the presence of noise. Model 132 also produces random frequency modulation for random jitter or incidental FM to test discriminator circuits or phase lock loops in the presence of noise.

WAVEFORMS
Sine, square, triangle, digital noise, analog noise, signal-on-noise and noise-on-signal selectable

Sine Distortion
<0.5% for 0 to 20 kHz.
<1.0% for 20 kHz to 200 kHz.
All harmonics 30 dB down on X1M range.

Square Wave Rise and Fall Time: <50 ns terminated into 50Ω

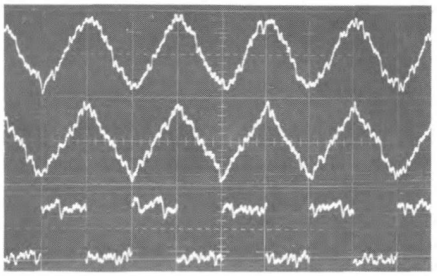
MODES
Function: The selected waveform.
Signal-on-Noise: Adds noise to a selected signal of constant amplitude. Signal-to-noise ratio is variable from 0 to 60 dB.
Noise-on-Signal: Adds a selected signal to a constant amplitude noise. Noise-to-signal ratio is variable from 0 to 60 dB.
Frequency Modulation: Provides random modulation of generator frequency. The S/N-N/S ratio control controls the amount of frequency deviation.

FREQUENCY
Range: For sine, square and triangle, 0.2 Hz to 2 MHz.
Dial Accuracy: ±2% of full scale for 1 Hz to 2 MHz.
Time Symmetry: ±1% through X100K range.

AMPLITUDE
Range: To 20 Vp-p (10 Vp-p into 50Ω).
Amplitude Change With Frequency
Sine variation:
<±0.1 dB for 0.2 Hz to 200 kHz.
<±0.5 dB for 0.2 Hz to 2 MHz.
Step Attenuator Accuracy: ±0.25 dB per 10 dB step.

OFFSET
Waveform offset selectable through 50Ω output. Adjustable between ±5V max (±2.5V into 50Ω load).

OUTPUT
Main Out (50Ω): Source of primary waveforms and noise.
Sync Out (600Ω): 1Vp-p square wave into open circuit.
Digital Noise: A digital sequence of pseudo-random width pulses with a selectable, repeating sequence length of 2^{10}–1, 2^{15}–1 or 2^{20}–1 clock counts; minimum pulse width is one clock count. Noise clock frequency is selectable from 160 Hz to 1.6 MHz in 4 ranges. A sync pulse occurs at the beginning of each sequence.
Analog Noise: Band-limited white noise with bandwidth adjustable from 10 Hz to 100 kHz in 4 ranges.
Signal and Analog Noise Mix: In N/S mode signal amplitude can be varied from 0 to –60 dB in five 10 dB steps and 10 dB vernier. In S/N mode the noise can be varied as above. Total signal amplitude controlled by output attenuator.



Signal with Analog Noise

INPUT
VCG—Voltage Controlled Generator: Frequency change up to 1000:1 with external 0 to ±5V signal. Upper frequency limited to maximum of selected range.

GENERAL
Stability: Amplitude, frequency, DC offset.
Short Term: ±0.05% for 10 min.
Long Term: ±0.25% for 24 hours.
Environment: Specifications apply at 23° ±5°C. Operation from 0° to +50°C.
Dimensions: 21.6 cm (8.5 in.) wide; 13.3 cm (5.25 in.) high; 29.2 cm (11.5 in.) deep.
Weight: 3.6 kg (8 lb) net; 5.4 kg (12 lb) shipping.
Power: 105 to 125V or 200 to 250V; 50 to 400 Hz; less than 55 VA.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 132

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

20 MHz Synthesized Function Generator

- **Synthesized Frequency Accuracy**
- **AM, FM, Sweep, Phase Lock**
- **Balanced/Unbal Ouput To 30 Vp-p**
- **Programmable Phase Angle**
- **GPIB Programing**

Model 288 is one of the most versatile, rugged and easy to use function generators available. Dedicated pushbuttons for each mode makes the Model 288 simple to setup and operate.

Model 288 has a Synthesized 2mHz to 20 MHz, up to 30 Vp-p output. The output can be balanced or unbalanced with selectable impedances of 50, 75, 135 and 600 ohms.

Model 288's numerous operating modes makes it extermely versatile; it produces continuous, AM, FM, sweep and phase locked outputs. The phase angle in phase lock mode can be varied ±180°.

An extensive internal self adjustment, calibration, and fault analysis utility reduce maintenance costs.

WAVEFORMS (FUNCTIONS)
Sine, triangle and square; variable symmetry for pulse/ramp waveforms and DC.

OPERATIONAL MODES
Continuous, AM, FM, VCF, Sweep and Phase Lock.

WAVEFORM QUALITY
Sine Distortion: Unbalanced output.
Total Harmonic Distortion:
2 mHz to 20 Hz: -40 dB.
20 Hz to 100 kHz: -46 dB.
100 kHz to 1 MHz: -40 dB.
1 MHz to 6 MHz: -34 dB.
6 MHz to 20 MHz: -26 dB.
Time Symmetry: Programmable from 5% to 95% in 1% steps to 2 MHz.
Accuracy: <±(0.1% + 20 ns).
Square Wave Transition Time: <13 ns.
Square Wave Abberations: Overshoot and ringing <(5% + 20 mV) of p–p amplitude.

FREQUENCY
Range: 2 mHz to 20 MHz.
600Ω or Balanced Output: 2 mHz - 1 MHz.

SYNTHESIZED FUNCTION GENERATORS
MODEL 288

Resolution: 4 digits (200 to 2000 counts in the display).
Accuracy: (Percent of setting.)
2 mHz to 20 Hz and FM or Sweep Modes: ±3%.
20 Hz to 20 MHz: ±0.02%.

AMPLITUDE
Range:
Open Circuit: 2 mVp-p to 30 Vp-p.
Impedance Terminated: 1 mVp-p to 15 Vp-p.
Accuracy: (% of setting.)
Sine:
To 999 mVp-p: ±2% + 2mV.
To 30 Vp-p: ±2% + 10 mV.
Triangle and Square:
To 999 mVp-p: ±3% + 4 mV.
To 30 Vp-p: ±3% + 20 mV.
Flatness: (To accuracy percent of setting.)
For 100 kHz to 1 MHz: Additional ±2%.
To 5 MHz: Additional ±3%.
To 20 MHz: Additional ±10%.

OFFSET
Range: ±10V (±5V terminated).
Accuracy:
0.5V to 10V: ±1% of setting + 20 mV.
1 mV to 500 mV: ±1% of setting + 5 mV.

OUTPUTS
Sync (Trigger) Output: Pulse at frequency of and in phase with square wave.
Horizontal Output: Ramp indicates sweep position.
Unbalanced Outputs: 600Ω and 50Ω.
Balanced Outputs: 135Ω and 600Ω.

GENERAL
MIL-T-28800 Class 5 qualified.
GPIB programming.
Temperature Range: 0 to +50°C, operation.
Humidity: 0° to +25°C at 95% RH.
Altitude: 3050m (10,000 ft.), operation.
Dimensions: 35.6 cm (14.00 in.) wide, 13.3 cm (5.22 in.) high and 43.2 cm (17.00 in.) deep.
Weight: Approximately 11.4 kg (25 lb) net; 13.6 kg (30 lb) shipping.
Power: 90 to 108, 108 to 126, 198 to 231, or 216 to 252 Vac; 48 to 440 Hz; 1 phase; <60 VA.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 288

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

BASIC FUNCTION GENERATORS

MODEL 270

12 MHz Function Generator

- **0.01 Hz to 12 MHz Frequency Range**
- **10 Vp-p Protected Output into 50Ω**
- **Bench Top or ATE System Operation**
- **200 Stored Settings in Nonvolatile Memory**
- **Internal Calibration Procedure Minimizes Calibration Time**

Model 270 is a small, versatile function generator that you can use on a bench or in an ATE system. In addition to the standard sine, triangle, DC and square waves, Model 270 produces a complement square wave and an external width. It generates these waveforms up to 12 MHz with outputs up to 10 Vp-p. A separate sync output produces a TTL signal synchronized to the main output.

Stored Settings
Model 270 allows you to store up to 200 complete instrument setups in battery-backed memory for fast recall.

WAVEFORMS
Programmable sine, triangle, square, square complement, external width, or DC.

Sine Distortion (at 5 Vp-p): THD<0.5%, 10 mHz to 99.9 kHz.
No Harmonics Above:
-40 dBc, 100 kHz to 999 kHz.
-30 dBc, 1 MHz to 12 MHz.
Time Symmetry: ±1% ±8 ns.
Square Transition Time: <15 ns.
Square Over/Undershoot: <5% of pk-pk amplitude ±20 mV.
Triangle Linearity: 99% to 100 kHz.

MODES
Continuous, triggered, gated.

FREQUENCY
Range: 10 mHz to 12 MHz.
Resolution: 3 digits.
Accuracy: ±2%
Repeatability: ±1% for 24 hr.
Jitter: ≤0.1% ±100 ps.

AMPLITUDE
Range: 0.01 to 10 Vp-p into 50Ω (0.02 to 20 Vp-p into ≥50 kΩ).
Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset >0.5V; 3 digits or 1mV when absolute peak amplitude plus offset ≤0.5V.
Accuracy: ±2% of programmed value and ±5 mV for 0.1 to 1V (peak amplitude + offset <0.5V), ±20 mV for 1.01 to 10V, ±50 mV for all other.
Repeatability: ±1% ±10 mV for 24 hr.
Flatness: 0.1 dB to 100 kHz, 1.5 dB to 12 MHz for output at 5 Vp-p.

OFFSET
Range: -5 to +5V into 50Ω (-10 to +10V into ≥50 kΩ).
Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset >0.5V, 3 digits or 1 mV when absolute peak amplitude plus offset ≤0.5V.
Accuracy: ±40 mV in DC function.
Repeatability : ±1% ±20 mV for 24 hr.

OUTPUTS
Function Out (50Ω): Source of primary waveforms.
Sync Out (50Ω): TTL level square wave at programmed frequency.
Timing: Concurrent with square; lags sine and triangle by 90°.
Over/Undershoot: <10% into 50Ω.

INPUTS
VCG In: 0.01 to 12V into 10 kΩ for up to 1200:1 frequency change.
Trig In: Level programmable –10 to +10V.

GENERAL
Protection: Output protected to 140 Vac or ±200 Vdc without replacement of internal fuse.
GPIB Programming: IEEE-488 1978.
Stored Settings: 200 setups.
Environmental
Temperature Range: +25°C ±10°C for spec operation, operates 0°C to +50°C, -50°C to +75°C for storage.
Dimensions: 21.7 cm (8.54 in.) wide (half-rack); 13.3 cm (5.25 in.) high; 39.4 cm (15.5 in.) deep.
Weight: 5.9 kg (13 lb) net; 6.8 kg (15 lb) shipping.
Power: 115 or 230 Vac; 48 to 66 Hz; 1 phase; <40 watts.

OPTIONS
002: Rear Panel Connectors. Front panel BNCs relocated to rear panel.
003: Burst Option: Programmable number of waveform cycles in a burst.
Burst Length: 1,048,200 max.
Burst Rate: 12 MHz.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 270
Option 002
Option 003

For full specifications or a demonstration, contact your nearest Wavetek representative (pages 211 and 213).

2 MHz Function Generator

- **Multiple Power Options**
- **Portable, Versatile and Easy to Use**
- **Output Protected**

Model 20's low cost, compact size, and light weight make it an ideal function generator for a wide variety of operating environments. Power sources can be low AC or DC voltages, line voltages or internal batteries.

Simple Operation
All knobs, switches, buttons, and connectors needed to set up and operate the Model 20 are on its front panel. There are no complex remote commands to learn.

WAVEFORMS
Sine, triangle, square and DC.
Sine Distoration: <0.5% on X1K and X10K ranges; 1% on X1, X10, X100 and X100K ranges to 100 kHz.
All harmonics 25 dB below fundamental from 100 kHz to 2.1 MHz.
Triangle Linearity: 99% to 210 kHz.

Square Wave Rise and Fall Time: At function output, <150 ns for 10 Vp-p into 600Ω termination, with ≤3 of 50Ω cable.
Time Symmetry: Square wave variation from 0.1 to 2.1 on dial <1% to 100 kHz; <5% to 2.1 MHz.

MODES
Continuous, triggered, and gated.

FREQUENCY
Range: 0.002 Hz to 2.1 MHz.
Dial Accuracy: 5% of full scale.

AMPLITUDE
Range: To 20 Vp-p (10 Vp into 600Ω). -20dB and -40dB attenuaters provided.
Sine Variation with Frequency:
<±0.2 dB on all ranges through 100 kHz, referenced to 1kHz;
<±3 dB to 2.1 MHz (terminated into 600Ω and ≤3 ft of 50Ω cable).

OFFSET
Waveform offset and DC output selectable and continuously variable ±10V (±5V into 600Ω) with calibrated zero offset OFF position.

BASIC FUNCTION GENERATORS
MODEL 20

OUTPUTS
Function Out (600Ω): Sine, square, and triangle 600 Ω source impedance.
Sync Out: TTL square wave at generator frequency. Drives up to 20 TTL loads.

INPUTS
VCG In: Up to 1000:1 frequency change with external 0 to ±2.1V signal.
Trigger and Gate: External analog or TTL compatible signal. Triggers on positive-going transition and gates on during positive portion of triggering signal. Maximum trigger repetition rate is 2 MHz and minimum pulse width is 50 ns.

GENERAL
Output Protection
Short Circuit: ± Vdc
Line Voltage: 250 Vac or 350 Vdc.
Environment
Temperature Range: +23° ±5°C for specified operation, operates 0° to +50°C, -40° to +75°C (+60°C max when batteries are installed) for storage. 20 minutes warm-up for specified operation.
Dimensions: 211 mm (8.3 in.) wide; 85 mm (3.4 in.) high; 305 mm (12 in.) deep.
Weight: 3 kg (6.6 lb) net; 4 kg (8.8 lb) shipping.
Power:
Wall Transformer (Option 50-120 or 50-220). Less than 10VA.
External AC Source of 10 to 18 Vrms. Less than 10W at lower input values.
External DC Source of 12 to 25 Vdc. Less than 10W at lower input values.
Rechargeable Batteries (user supplied), six "C" size Nickel-Cadmium with standard 1800 mAHr. Gives approximately 4hr operation from full charge.

OPTIONS
Model 20 must be ordered with an option (no charge). Batteries not included.
50-120: Line Transformer. 90 to 132 Vac, 50/60 Hz.
50-220: Line Transformer. 180 to 260 Vac, 50/60 Hz.

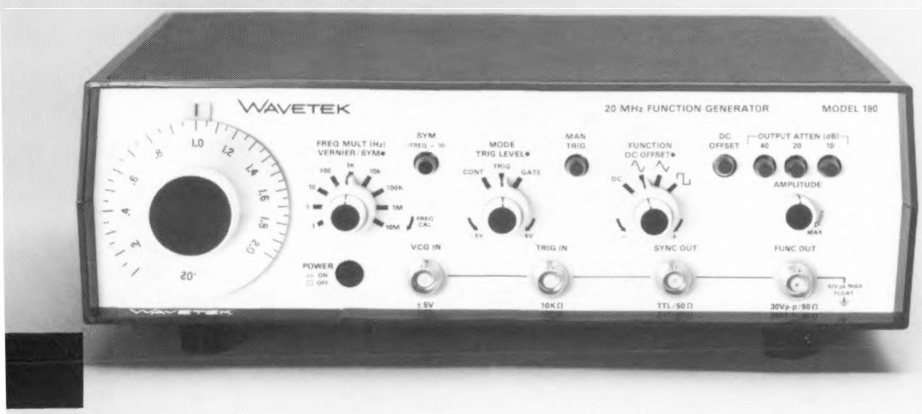
FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 20
Option 50-120
Option 50-220

For full specifications or a demonstration contact your Wavetek representative (pages 211 and 213).

BASIC FUNCTION GENERATORS

MODEL 190



20 MHz Function Generator

- **0.002 Hz to 20 MHz Frequency Range**
- **15 Volt Peak-to-Peak Output into 50 Ω**
- **Triggered and Gated Modes**
- **DC Offset with Calibrated Zero**
- **Symmetry Control over a 19:1 Range**
- **VCG — Voltage Controlled Generator**

Model 190 is a small versatile generator that is an ideal bench instrument. Besides the standard square, triangle, and sine waveforms to 20 MHz, a symmetry control allows you to create pulses and ramps by varying the square triangle duty cycle up to 19:1. Output is up to 30 Vp-p and a TTL output is sync'd to the main output. Furthermore, the Model 190 can be triggered, gated, frequency swept and modulated.

Simple Operation
The Model 190 is one of a family of bench generators that Wavetek has specifically produced with a simple to to use front panel. All knobs, switches, buttons, and connectors needed to set up and operate the Model 190 are on its front panel.

WAVEFORMS
Sine, triangle, square, and dc with TTL sync.

Sine Distortion (All harmonics)
x1K and x10K Ranges: <0.5%.
x0.1 to x100, and x100K Ranges: <1.0%.
x1M Range: 30 dB below fundamental.
x10M Range: 25 dB below fundamental.

Square Wave
Rise/Fall Time: <15 ns (10% to 90%).
Total Aberrations: 5% of full amplitude (each peak of waveform).

Time Symmetry
Square Wave Variation From 0.1 to 2 on Dial: <±1% to 200 kHz; <±10% to 20 MHz.

Triangle Linearity
0.002 Hz to 200 kHz: <99%.

MODES
Continuous, triggered and gated.

OUTPUTS
Function Out (50Ω): Source of primary waveforms.
Sync Out (50Ω): A TTL level pulse at generator frequency. Duty cycle varies with symmetry.

INPUTS
VCG—Voltage Controlled Generator: Up to 1000:1 frequency change with external 0 to ±5V signal. Upper frequency is limited to maximum of selected range.
Impedance: 10 kΩ.

Trigger (and Gate) Input
Input Range: ±0.5 Vp to ±10 Vp.
Trigger Level Adj: -5V to +5V.
Impedance: 1.5 kΩ shunted by 1.5 pF.
Pulse Width: 25 ns min.
Repetition Rate:

InputMax	Rep Rate
±1V	1 MHz
±2.5V	10 MHz

FREQUENCY
Range: 0.002 Hz to 20 MHz in 9 overlapping decade ranges with approximately 1% of full scale vernier control.

Dial Accuracy
x0.1Hz to x1MHz Range: 3% of full scale.
x10M Range: 5% of full scale.

AMPLITUDE
Range: To 30Vp-p (to 15 Vp-p into 50 Ω).
Attenuation: All waveforms and DC can supply 150 mA peak current and may be attenuated in 10 db steps to 70 dB with 10 dB vernier for overall attenuation of 80 dB.

Sine Amplitude Variation with Frequency.
x0.1 through 100K: <±0.2dB.
x1M Range: <±0.5 dB.
x10M Range: <±1.5 dB.

OFFSET
Range: To ±15Vdc (to ±7.5 Vdc into 50Ω). Signal peak plus offset limited to ±15 Vdc (±7.5 Vdc into 50Ω). DC offset and output waveform attenuated proportionately by the 0 to 70 dB output attenuator.

GENERAL
Stability: Amplitude, frequency and dc offset after 2 hour warm up.
Short Term: ±0.05% for 10 minutes.
Long Term: ±0.25% for 24 hours.
Environment: Specifications apply at +23° ±5°C. Operates from 0° to +50°C.
Dimensions: 28.6 cm (11.25 in.) wide; 8.9 cm (3 in.) high; 28.6 cm (11.25 in.) deep.
Weight: 3.5 kg (7.7 lb) net; 4.5 kg (10 lb) shipping.
Power: 100/120/220/240 Vac (+5%, -10%), 48 Hz to 66 Hz, 70 VA.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 190

For full specifications or a demonstration, contact your nearest Wavetek representative (pages 211 and 213).

BASIC FUNCTION GENERATORS

MODEL FG-5000A

5 MHz Function Generator

- **0.001 Hz to 5 MHz Frequency Range**
- **Trigger and Gate Modes**
- **40 Volt Peak-to-Peak Output**
- **LCD Display**
- **GPIB and RS-232 Interface (Options)**

Wide Frequency Range
The Model FG-5000A low cost function generator is a universal signal source which covers a wide 1 mHz to 5 MHz frequency span in nine overlapping ranges. Each multiplier setting gives a full 100:1 frequency band. You can externally modulate or sweep the generator frequency in each of the ranges with dc or ac signals. The multiturn potentiometer gives a maximum resolution in frequency setting.

Trigger and Gate
In trigger mode, your manual or external TTL-signal initiates a single waveform cycle with normal or inverted output. Gate mode is similar except that there is a burst of waveform cycles for the duration of the signal.

High Output Level
High level output is a full 40 volts peak-to-peak from a 50 or 600 ohm source (20 volts peak-to-peak into a 50 or 600 ohm load). In addition to high level output a four-step attenuator gives a low level output with 90 dB dynamic range.

LCD Display
In conjunction with the multi-turn potentiometer the LCD display guarantees an exact and reproducable frequency setting.

Robust
All inputs and outputs are fully protected against short circuit and overload. The robust metal housing with its functional design makes the FG-5000A fulfill all demands which everyday use presents especially for the educational market.

VERSATILITY
Waveforms: Sine, square, triangle, and DC.
Operational Modes: Continuous, Triggered, and Gated.
Frequency Range: 0.001 Hz to 5 MHz in 9 overlapping decade ranges.

Function Output: Sine, triangle and square selectable and variable to 40Vp-p (20 Vp-p into 50 or 600Ω). All waveforms and DC may be attenuated in 4 steps to 60 dB with 30 dB vernier for overall attenuation of 90 dB. 50 and 600Ω source impedance.
DC Output and DC Offset: Selectable through function output BNC. Controlled by front panel control with calibrated zero. Adjustable between ±20 Vdc (±10 Vdc into 50 or 600Ω) with signal peak plus offset limited to ±20 Vdc (±10 Vdc into 50 or 600Ω). DC offset and output waveform attenuated proportionately by the 0 to 60 dB out-put attenuator.
Sync Output: A TTL level pulse when terminated with 50Ω.
VCG—Voltage Controlled Generator: Up to 100:1 frequency change with external ±5V signal. Upper frequency is limited to maximum of selected range.
Impedance: 4.7 kΩ.
Trigger and Gate Input
Input: TTL compatible levels.
Input Impedance: 4.7 kΩ.

FREQUENCY PRECISION
Resolution: 3 digits in all modes.
Accuracy: 3% of full scale ±1 digit to 200 kHz; ±5% of full scale ±1 digit to 5 MHz.

AMPLITUDE PRECISION
Sine Variation with Frequency: <±0.2 dB from 1 mHz to 50 kHz, <±1.5 dB to 2 MHz.

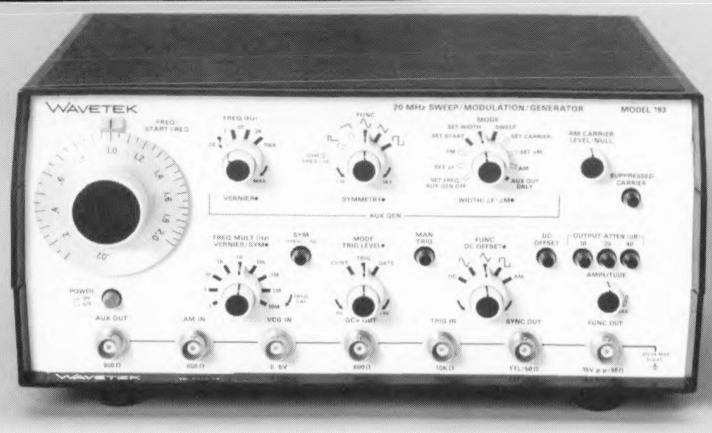
WAVEFORM CHARACTERISTIC
Sine Distortion: 1%, 1 mHz to 200 kHz, ±25 dB to 5 MHz.
Square Wave Rise and Fall Time: 70 ns (10% to 90%).
Total Aberrations: <5% (at 10 Vp-p, 50Ω load).
Triangle Linearity: 99% to 50 kHz.

GENERAL
Protection: All inputs and outputs are fully protected against short circuit and overload.
Environment: Specification applies at 25° ±5°C. Instrument operates from 0° to 50°C.
Dimensions: 25.5 cm (10 in.) wide; 9.0 cm (3 1/2 in.) high; 26.0 cm (10.2 in.) deep.
Weight: 3.5 kg (7.7 lb) net; 4.4 kg (10 lb) shipping.
Power: 110/220V ±10%; 50/60 Hz; less than 55 watts.

OPTIONS
001: Carrying Handle/Support Arm.
002: GPIB Interface.
003: RS-232 Interface.

FACTORY/FOB
Munich, Federal Republic of Germany

ORDER INFORMATION
Model FG-5000A



20 MHz Sweep/ Modulation Generator

- **0.002 Hz to 20 MHz Frequency Range**
- **Independent Auxiliary Function Generator for AM, FM and Sweep Operation**
- **Static Setting of Modulation Parameters**
- **30 Volt Peak-to-Peak Output**

Model 193 contains two separate generators in one package: a 20 MHz, 30 Vp-p main generator and a 100 kHz, 10 Vp-p modulation generation. Each generator operates independent of the other, each has its own set of easy-to-use front panel controls for set up and operation. The modulation generator can sweep the main generator between front panel controlled start and stop points. External sources can also trigger, gate, sweep, and modulate the main generator.

Easy-to-Use
All knobs, swithces, buttons, and connectors needed to set up and operate the Model 193 are on its front panel. An easy-to-use Manual provides additional information on the operation of the instrument's many features.

WAVEFORMS
Selectable sine, triangle, square, AM sine and DC.

Sine Distortion
x1K and x10K Ranges: <0.5%.
x0.1 and x100 Ranges: <1.0%.
x100K, x1M Range: All harmonics 30 dB below fundamental.
x10M Range: 25 dB below fundamental.

Square Wave
Rise/Fall Time: <15 ns (10% to 90%).
Total Aberrations: 5% of full amplitude (each peak of waveform).

Time Symmetry
Square Wave Variation From 0.1 to 2 on Dial:
<±1% to 200 kHz.
<±10% to 20 MHz.

Triangle Linearity
0.002 Hz to 200 kHz: 99%.

MODES
Continuous, triggered, gated and internal auxiliary generator used as the modulation source for FM, AM and sweep.
FM: Operation and two setup modes: Set-freq/aux-gen-off, set ΔF.
Sweep: Operation and two setup modes: Set start, set width.
AM: Operation and two setup modes for double sideband or suppressed carrier operation: Set carrier, set ΔM, AM.
AM: 0 to 100% AM or suppressed carrier modulation of main generator.

FREQUENCY
Range: 0.002 Hz to 20 MHz.
Dial Accuracy
x0.1 Hz to x1 MHz: ±3% of full scale.
x10M Range: ±5% of full scale.

AMPLITUDE
Range: To 30 Vp-p (to 15 Vp-p into 50Ω).

OFFSET
Range: To ±15 Vdc (to ±7.5 Vdc into 50Ω).

OUTPUT
Function Out (50Ω): Source of primary waveforms.
Carrier Level (0 to 100% AM): Adjustable 10 to 50% of full amplitude at function output.
Carrier Null (Suppressed Carrier AM): Adjustable ±2% of full amplitude at function output.
Sync Out: TTL level pulse into 50Ω.
GCV Out: 0 to +5V open circuit.
Aux Out Only: For independent operation of auxiliary generator.

INPUTS
AM In: 5 Vp-p gives 100% modulation; 10 Vp-p gives suppressed carrier operation. 600Ω input impedance.
VCG—Voltage Controlled Generator: Up to 1000:1 frequency change with external 0 to ±5V signal.
Trigger In
Input Range: 1 Vp-p to ±10V.
Trigger Level Adj: -5V to +5V.
Pulse Width: 25 ns minimum.

AUXILIARY GENERATOR
Frequency Range: 0.1 Hz to 100 kHz.
Auxiliary Output: Variable to 10 Vp-p (5 Vp-p into 600Ω).
Auxiliary Sync Output: TTL level pulse.
Auxilliary VCG Input: Up to 33:1 frequency change with external ±5V signal.

GENERAL
Environment: Specifications apply at 23° 5°C. Operates 0° to +50°C.
Dimensions: 28.6 cm (11.25 in.) wide; 13.3 cm 5.25 in.) high; 28.6 cm (11.25 in.) deep.
Weight: 4.6 kg (10 lb) net; 6.4 kg (14 lb) shipping.
Power: 100/120/220/240V (+5%, -10%), 48 to 66 Hz, ≤70 VA.

FACTORY/FOB
San Diego, CA

ORDER INFOMATION
Model 193

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

20 MHz AM/FM/PM Generator

- **0.0002 Hz to 20 MHz Frequency Range**
- **15 Volt Peak-to-Peak Output into Ω**
- **Two Complete Generators**
- **Internal or External AM, FM and PM**
- **Sweep, Trigger and Gate**

Modulation and Sweep Generator
The Model 148A/001 contains two separate generators in one package: a 20 MHz, 30Vp-p main generator and a 100 kHz, 10Vp-p modulation generator. Each generator operates independently of the other, using its own set of easy-to-use front panel controls for set up and operation. The modulation generator can be internally connected to the main generator which will amplitude, frequency, or phase modulate the main generator output. The modulation generator also can be used to sweep and to trigger or gate the main generator. External sources can also trigger, gate, sweep, and modulate the main generator.

WAVEFORMS
Sine, triangle, square, positive square, negative square, TTL pulse and DC.

Sine Distortion (Main Generator)
<0.5% on x100 to x10K ranges.
<1.0% on x0.01 to x10 and x100K ranges.

Square Wave Rise/Fall Time: At FUNCTION OUT <25 ns for 15 Vp-p into 50Ω load.

MODES

Operation: Continuous, external trigger and gate, and internal trigger and gate.

Modulation
AM: Internal or external
FM: Internal modulation or external AC or DC signal.
Sweep: Frequency sweeps to 1000:1
PM: Internal or external modulation signal.

FREQUENCY

Range
Main Generator: 0.0002 Hz to 20 MHz.
Modulation Generator: 0.1 Hz to 100 kHz.

MODULATION/FUNCTION GENERATORS
MODEL 148A/001

Dial Accuracy (Main Generator)
±(1% of setting +1% of full range) on x100 thru x1M ranges.
±(2% of setting 2% of full range) on x.01 thru x10 and x10M ranges.

Time Symmetry (Main Generator)
±0.5% on x100 thru x100K ranges and from 0.2 to 2.0 on dial.
±5% on all other ranges and from 0.02 to 2.0 on dial.

AMPLITUDE

Range
Main Generator: To 30Vp-p (to 15 Vp-p into 50Ω).
Modulation Generator: 10 Vp-p fixed level into 600Ω. Sawtooth 0 to +5V into open circuit.

Amplitude Change With Frequency
Sine variation:
<±0.1 dB through x100K ranges;
<±0.5 dB on x1M range;
<±3 dB on x10M range.

OFFSET

Range: ±15 Vdc (±7.5 Vdc into 50Ω).

OUTPUTS

Function Out (50Ω): Source of primary waveforms.

Modulation Generator Out (600Ω): Source of modulation generator waveforms.

Sync Out (TTL): TTL level pulse at generator frequency.

INPUTS

External Modulation Input
AM: Sensitivity of 3 Vp out/Vp (1.5V into 50Ω). Input impedance is >2.5 kΩ.
FM: Sensitivity 20% of frequency range/Vp. Input impedance is 5 kΩ.
PM: Sensitivity of 10° phase shift/Vp. Input impedance is 10 kΩ.

Trigger and Gate
Input Range: 1V p-p to ±10V.
Impedance: 10 kΩ, 33 pF.
Pulse Width: 25 ns min.
Repetition Rate: 10 MHz max.
Adjustable Triggered Signal Start/Stop **Point:** Approximately –90° to +90°.

GENERAL

Environment: Specifications apply at 23° ±5°C. Operates from 0° to +50°C.

Dimensions: 28.6 cm (11 in.) wide; 13.3 cm (5 in.) high; 27.3 cm (10 in.) deep.

Weight: 4.5 kg (10 lb) net; 5.9 kg (13 lb) shipping.

Power: 90 to 105V, 108 to 126V, 198 to 231V and 216 to 252V selectable; 48 to 400 Hz; less than 40 VA.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 148A/001

For a full set of specifications or a demonstration, contact your local Wavetek representative (page pages 211 and 213).

50 MHz Pulse/ Function Generator

- **0.0001 Hz to 50 MHz Frequency Range**
- **15 Volt Peak-To-Peak Output into 50Ω**
- **Lin/Log Sweep Plus AM and FM**
- **Pulse Width and Transition Time Control**
- **Independent Pulse Width and Rate**

Multipurpose Generator
Model 166 combines the features of a function generator, a sweep generator and a pulse generator into one package.

The function generator supplies both normal and inverted sine, triangle, and square waves over a wide 0.0001Hz to 50 MHz frequency range. Waveforms can be continuous, triggered, double triggered, and gated, as well as triggered and gated haverwaves. Voltage Controlled Generator (VCG) inputs permit you to shift or sweep the generator's frequency over a full 1000:1 range. Plus, Voltage Controlled Amplitude inputs permit amplitude modulation to 200%.

The sweep generator varies the main generator's output up to full 1000:1 limit of each frequency range. Sweep can be linear or logarithmic. The sweep modes are continuous sweep, triggered sweep, and sweep and hold.

The pulse generator produces pulses with independent variable transition times, and widths. These pulses can be continuous, triggered, double triggered, and gated as well as swept. Its outputs can be fixed TTL output as well as variable outputs with DC offsets to 30Vp-p.

WAVEFORMS
Sine, triangle, square and ramp. Variable amplitude positive or complementary pulses and TTL pulses simultaneous with main pulse.
Sine Distortion (Test at 10 Vp-p):
<0.5% for 10 Hz to 50 kHz.
All harmonics greater than:
30 dB down for 100 kHz to 5 MHz; 20dB down for 5 to 50MHz.
Square Wave Aberrations (Test at 10 Vp-p):
<5% of p-p voltage.

MODES
Modes: Continuous, triggered, double triggered, triggered haverwave, gated, gated haverwave, continuous sweep, triggered sweep, sweep and hold, and external width.
External Width: The trigger input determines the output pulse width and period.

FREQUENCY
Range: 0.0001 Hz to 50 MHz. Maximum sweep 1000:1 in lin or log.
Dial Accuracy
±2% of full scale for 0.0005Hz to 5MHz.
+15%, -6% of full scale for 5 to 50MHz.
Sweep Time Range: 100s to 100 µs.

AMPLITUDE
Range: To 30 Vp-p (15 Vp-p into 50Ω).
Amplitude Change With Frequency
Sine and square variations:
<±0.1 dB to 100 kHz;
<±0.2 dB to 1 MHz;
<±3 dB to 50 MHz.

OFFSET
DC offset of all waveforms is adjustable to ±10V (±5V into 50Ω).

OUTPUTS
Function Out (50Ω): Source of primary waveforms.
GCV Out: 0 to +5V. Proportional to generator frequency.
Sweep Out (600Ω): 0 to +5V ramp.

INPUTS
VCG (FM)—Voltage Controlled Generator: Up to 1000:1 frequency change with external 0 to +5V signal.
Voltage Controlled Amplitude (VCA): 0 to ±5V gives 0 to 30V amplitude change.

PULSE
Pulse Period Range: Pulse period is selectable from 20 ns to 10,000s.
Pulse Width: 10 ns to 100 ms. Maximum duty cycle is 70% for periods to 200 ns.
Transition Time: 7 ns to 50 ms.
TTL and TTL Pulses: Transition times < 4 ns into 50Ω termination.

GENERAL
Environment: Specifications 23° ±5°C after 30 min warm-up. Operates 0° to ±50°C.
Dimensions: 36.2 cm (14 in.) wide; 13.3 cm (5 in.) high; 38.1 cm (15 in.) deep.
Weight: 8.4 kg (18.5 lb) net; 10.9 kg (24 lb) shipping.
Power: 90 to 105V, 108 to 126V, 198 to 209V and 216 to 252V; 50 to 66 Hz; 50 VA.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 166

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

12 MHz Pulse/ Function Generator

- **0.01 Hz to 12 MHz Frequency Range**
- **10 Vp-p Protected Output into 50Ω**
- **Pulse Delay, Width, Complement & Double Pulses**
- **150 Stored Settings in Nonvolatile Memory**
- **Burst Mode to Over 1 Million Cycles**
- **Internal Calibration Procedure Minimizes Calibration Time**

Model 271 is a small, versatile 12 MHz pulse/function generator that you can use on a bench or in an ATE system. In addition to the standard sine, triangle, DC and square waves, Model 271 produces pulses with independently variable delay and width, double pulses and pulse width controlled by an external signal. The burst mode provides triggered burst from 1 to 1,048,200 cycles over the entire frequency range. A separate sync output produces a TTL signal synchronized to the main output.

Stored Settings
Model 271 allows you to store up to 150 complete instrument setups in battery backed memory for fast recall.

WAVEFORMS
Programmable sine, triangle, square, square complement, external width, pulse, double pulse or DC.
Sine Distortion (at 5 Vp-p): THD <0.5%
10 mHz - 99.9 kHz.
No Harmonics Above:
-40 dBc 100 kHz-999 kHz.
-30 dBc 1 MHz-12 MHz.
Time Symmetry: ±1% ±8 ns.
Square Transition Time: <15 ns.
Square Over/Undershoot: <5% of pk-pk amplitude ±20 mV.
Triangle Linearity: 99% to 100 kHz.

MODES
Continuous, triggered, gated and burst.

FREQUENCY
Frequency Range: 10 mHz to 12 MHz.
Resolution: 3 digits.

PULSE/FUNCTION GENERATORS
MODEL 271

Accuracy: ±2%.
Pulse Delay and Width
Delay: 80 ns to 0.1s.
Width: 40 ns to 0.1s.
Resolution: 3 digits.
Accuracy: ±3% of programmed value ±10 ns.

AMPLITUDE
Amplitude Range: 0.01 to 10 Vp-p into 50Ω (0.02 to 20 Vp-p into ≥50kΩ).
Resolution: 3 digits or 10 mV when absolute peak ampl plus offset >0.5V.
Accuracy: ±2% of programmed value and ±5 mV for 0.1 to 1V (pk ampl + ofst <0.5V), ±20 mV for 1.01 to 10V, ±50 mV for all other.
Flatness: 0.1 dB to 100 kHz, 1.5 dB to 12 MHz for output at 5 Vp-p.

OFFSET
Range: -5 to +5 V into 50Ω (-10 to +10V into ≥50 kΩ)
Resolution: 3 digits or 10 mV when absolute peak ampl plus offset >0.5V, 3 digits or 1 mV when absolute peak ampl plus offset ≤0.5V.
Accuracy: ±40 mV in DC function.

OUTPUTS
Function Out (50Ω). Source of primary waveforms.
Sync Out (50Ω): TTL level square wave at programmed frequency.

INPUTS
VCG In: Up to 1200:1 frequency change.
Trig In: Level programmable: -10 to +10V.

GENERAL
GPIB Programming: IEEE-488 1978.
Stored Settings: 150 setups.
Environment
Temperature: 25° ±10°C for spec operation, operates 0° to +50°C; -50° to +75°C for storage.
Dimensions: 21.7 cm (8.5 in.) wide (half-rack); 13.3 cm (5.25 in.) high; 39.4 cm (15.5 in.) deep.
Weight: 5.9 kg (13 lb) net; 7.3 kg (16 lb) shipping.
Power: 90 to 105, 108 to 126, 198 to 231, or 216 to 252 Vrms; 48 to 66 Hz; 1 phase; <40 watts.

OPTIONS
002: Rear Panel Connectors

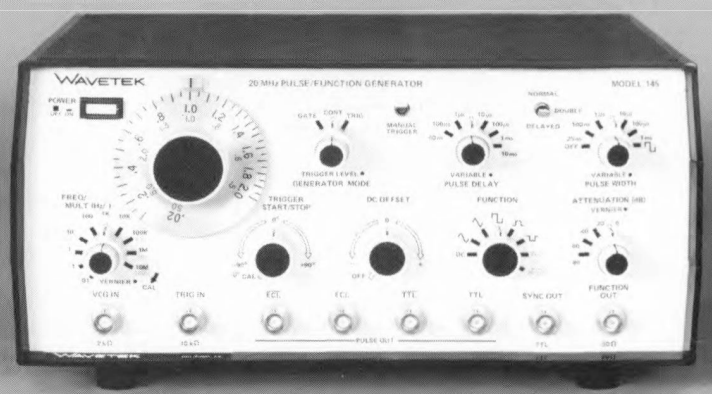
FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 271
Option 002

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

PULSE/FUNCTION GENERATOR

MODEL 145



20 MHz Pulse/ Function Generator

- **0.0001 Hz to 20 MHz Frequency Range**
- **15 Volt Peak-to-Peak Output into 50Ω**
- **Continuous, Triggered and Gated Operation**
- **Fixed TTL and ECL Outputs**
- **Delayed and Double Pulse Outputs**

Two Instruments for the Price of One
The Model 145 combines the features of a function generator and a pulse generator in a single, compact unit.

Function Generator
As a function generator it provides sine, triangle, and square wavesover a wide 0.0001Hz to 20 MHz frequency range. Each waveform can be triggered or gated, as well as continuous. The variable trigger start/stop control allows you to select a haversine or other special waveform outputs. Its Voltage Control Generator (VCG) input permits you to shift or sweep the generator's frequency over a full 1000:1 range.

Pulse Generator
As a pulse generator, the Model 145 produces pulses with independent variable delays and widths; these pulses can be triggered, gated, and continuous. Pulse generator outputs can be both fixed output (TTL and ECL) as well as variable outputs with DC offsets.

WAVEFORMS
Selectable sine, square, triangle, positive square, negative square, ECL and TTL pulses and DC.

Sine Distortion
x100 Hz to x10 kHz: <0.5%.
x.01 to x10 Hz and x100 kHz: <1.0%.

Rise/Fall Time: At Function Out <20 ns for 15 Vp-p output into 50Ω load.

MODES
Continuous, triggered and gated and normal, delayed and double pulse.

FREQUENCY
Range: 0.0001 Hz to 20 MHz.
Dial Accuracy
From x.01 Hz to x1 MHz: ±3% of full range.
x10 MHz: ±5% of full range.
Time Symmetry: Square wave variation.
0.001 Hz to 200 kHz: <±1%.
20 Hz to 20 kHz: <±0.5%.

AMPLITUDE
Range: Functions to 30 Vp-p (15 Vp-p into 50Ω). Pulses to 15 Vp-p (7.5 Vp-p into 50Ω)
Amplitude Change With Frequency: Sine variation.
0.001 Hz to 200 kHz: <±0.1 dB.
200 kHz to 2 MHz: <±0.5 dB.
2 to 20 MHz: <±3.0 dB.

OFFSET
±15 Vdc (±7.5 Vdc into 50Ω) with signal peak plus offset limited to ±15 Vdc (±7.5 into 50Ω).

OUTPUTS
Function Out (50Ω): Source of primary functions and pulses.
Sync Out (50Ω): A TTL level pulse.
GCV—Generator Controlled Voltage (600Ω): 0 to 2V. Proportional to generator frequency.

INPUTS
VCG—Voltage Controlled Generator: 0 to 2V for 1000:1 frequency change.
Trigger and Gate
Input Range: 1 Vp-p to ±10V.
Impedance: 10 kΩ, 33 pF.
Adjustable Triggered Signal Start/Stop Point: Approximately -90° to +90°.

PULSE GENERATOR
Pulse Period Range: 50 ns to 10,000s.
Pulse Width: 25 ns to 1 ms.
Pulse Delay: 50 ns to 10 ms.
Duty Cycle: Duty cycles to 70% for periods >100 ns.

GENERAL
Environment: Specifications apply at 25° ±5°C. Operate 0° to +50°C.
Dimensions: 28.6 cm (11 in.) wide; 13.3 cm (5 in.) high; 27.3 cm (10 in.) deep.
Weight: 5 kg (11 lb) net; 5.9 kg (131 lb) shipping.
Power: 90 to 105V, 108 to 126V, 198 to 231V and 216 to 252V selectable; 48 to 400 Hz; less than 30 VA.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 145

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 to 213).

20 MHz Pulse/ Function Generator

- **0.002 Hz to 20 MHz Frequency Range**
- **Versatile Pulse and Burst Modes**
- **Full Function Generator Performance**
- **Triggered, Gated Bursts, Rate & Width Control**
- **15 Volts Peak-to-Peak Output into 50Ω**

Model 191 is a 0.002 Hz to 20 MHz multifunction instrument. It is a function generator with precision waveforms, a pulse generator with variable width and delay, and a burst generator with continuous, triggered and gated waveform bursts.

As a function generator, Model 191 provides sine, triangle, and square waves in continuous, triggered, and gated operating modes at output levels to 30 Vp-p.

As a pulse generator, Model 191 produces pulses with variable delay (up to 100 ms) and width (20 ns to 100 ms).

As a burst generator, Model 191 can be triggered, gated, or run at a 1 Hz to 5 MHz continuous rate.

WAVEFORMS
Selectable sine, triangle, square, pulses, double pulses and DC.

Sine Distortion
<0.5% on x1K and x10K Ranges.
<1.0% on x0.1 to x100, and x100K ranges.
All harmonics 30 dB below fundamental on x1M range, and 25 dB below fundamental on x10M range.

Square Wave and Pulse
Rise/Fall Time at Function Output BNC: <15 ns (10% to 90%).

Total Aberrations: 5% of full amplitude (each peak of waveform).

MODES
Function: Continuous, triggered, gated and burst.
Burst Rate: 1 Hz to 5 MHz in 7 ranges.
Burst Width: 20 ns to 100 ms in 7 ranges.
Normal Pulse: Adjustable width pulse in phase with pulse sync output.
Pulse Delay: Pulse delayed with respect to pulse sync output. Pulse delay and pulse width adjustable.
Double Pulse: Two pulses for every period. Time between pulses and pulse width adjustable.

PULSE/FUNCTION GENERATORS
MODEL 191

FREQUENCY
Range: 0.002 Hz to 20 MHz.
Dial Accuracy
±3% of full scale from x0.1 Hz to x1 MHz.
±5% of full scale on x10M range.

AMPLITUDE
Range: To 30 Vp-p (to 15 Vp-p into 50Ω).
Baseline: To 15 Vp-p (to 7.5 Vdc into 50Ω).
Amplitude Change with Frequency
Sine variation with frequency:
<±0.2 dB on all ranges through x100K.
<±0.5 dB on x1M range.
<±1.0 dB on x10M range.

OFFSET
Range: ±15 Vdc (±7.5 Vdc into 50Ω).

OUTPUT
Function Out (50Ω): Source of waveforms.
Sync Out (50Ω): TTL level pulse when terminated with 50Ω.
Pulse/Burst Sync Out: TTL level pulse when terminated with 50Ω.

INPUT
VCG—Voltage Controlled Generator: Up to 1000:1 frequency change with external 0 to ±5V signal.
Trigger (and Gate) In
Input Range: 1 Vp-p to ±10V.
Trigger Level Adj: –5V to +5V.
Impedance: 1.5 kΩ shunted by 1.5 pF.

PULSE GENERATOR
Pulse Sync Delay: Pulse sync output delayed with respect to pulse output.
Pulse Period Range: 50 ns to 500s in 9 decade ranges.
Pulse Width: 20 ns to 100 ms in 7 ranges.
Pulse or Sync Delay: 0 ns to 100 ms in 7 ranges.
Duty Cycle: Up to 75% for pulse widths >100 ns and 50% for pulse widths of 20 ns to 100 ns.

GENERAL
Stability: Main generator amplitude, frequency and dc offset. After 2 hour warm-up:
±0.05% for 10 minutes.
±0.25% for 24 hours.
Environment: Specifications apply at +23° ±5°C. Operates 0° to +50°C.
Dimensions: 28.6 cm (11.25 in.) wide; 13.3 cm (5.25 in.) high; 28.6 cm (11.25 in.) deep.
Weight: 4.6 kg (10 lb) net; 5.9 kg (13 lb) shipping.
Power: 100/120/220/240V (+5%, –10%), 48 Hz to 66 Hz, ≤70 VA.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 191

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

11 MHz Stabilized Sweep Generator

- **100 μHz to 11 MHz Frequency Range**
- **10 Vp-p Protected Output into 50Ω**
- **Crystal Stabilized to 0.09%**
- **Linear and Logarithmic Sweep**
- **LCD Display**

Model 22 is a versatile and accurate stabilized sweep generator with low frequency waveform synthesis. Its small size and descriptive display makes the Model 22 easy to use.

Crystal Stabilized Operation
Model 22 features frequency stabilized operation. Stabilization extends tight short-term specs (0.01% of range) to indefinite periods throughout the entire 100 μHz to 11 MHz range.

LCD Display
A 3 1/2 digit LCD display monitors the generator's frequency. Display annunciators point to selected parameters to show at a glance the instrument's setup.

Low-Frequency Waveform Synthesis
Waveforms below 1.1 kHz are synthesized digitally. Digitally created ramps are also available in this range.

Linear and Logarithmic Sweep
Model 22 offers linear and logarithmic sweep with selectable sweep times of 0.01 to 10 seconds, and adjustable sweep width up to 1100:1.

20 Vp-p Amplitude
Output is 20V peak-to-peak (10 Vp-p into 50Ω) at the primary output. A second output is attenuated 20 dB with the respect to the first. Both outputs can be varied 20 dB, which gives a full 40 dB output range.

WAVEFORMS
Sine, triangle, square and DC; and; below 1100 Hz, ramp up and ramp down .

Sine Distortion
1.00 to 11.00 kHz Range: <0.5% THD.
10.0 to 110.0 kHz Range: <1% THD.
0.100 to 1.1 MHz Range: <-40 dBc.
1.0 to 11.0 MHz Range: <-28 dBc.

Triangle Linearity
To 110 kHz: >99%.

Square Wave Rise and Fall Times
<22 ns at Function Out with 10 Vp-p into 50Ω.

Square Wave Total Aberrations
Each peak <5% of peak-to-peak amplitude.

Stability
Amplitude, Frequency (Nonstabilized) and DC Offset After 30 Minutes Warm-up: ±0.1% of range for 10 minutes. ±0.5% of range for 24 hours.
Frequency (Stabilized): ±0.1% of range for ≥10 minutes, 0° to +50°C.

SWEEP FUNCTION GENERATORS

MODEL 22

MODES

Continuous: Generator runs continuously at selected frequency.

Triggered: Generator is quiescent until triggered by external signal or manual trigger, then generates one complete waveform cycle at selected frequency.

Gated: Generator output is continuous for duration of external or manual trigger.

Set: Generator runs continuously at sweep stop frequency set by Sweep Set control. Sweep stop frequency is displayed.

Sweep: Generator frequency is swept from lower frequency limit set by Frequency control to upper frequency limit set by Sweep Set control in a continuously occurring low to high sweep. Sweep time and choice of linear or logarithmic sweep are selectable.

Triggered Sweep: Generator is quiescent until triggered, then produces a single low to high sweep at selected rate and width.

FREQUENCY

Range: 100 µHz to 11 MHz in 9 overlapping decade ranges. Each range capable of 1100:1 frequency change.

Frequency Display Accuracy

±1 count of 1100 counts, which is 0.09% of range. Stabilizer maintains same reading indefinitely.

Time Symmetry

Square Waveform Variation From 100 to 1100 Counts On Display:

To 1100.00 Hz (Bottom 5) <±0.1%.

To 110.00 kHz: <±1%.

To 11.00 MHz: <±5%.

AMPLITUDE

Range: 20 dB range up to 20 Vp-p (10 Vp-p into 50Ω) at Func Out (50Ω). Additional output attenuated 20 dB with respect to Func Out (50Ω) for total amplitude range of 40 dB.

Sine Variation with Frequency

Referenced to 1 kHz.

To 110.0 kHz Range: <±0.2 dB.

To 11.00 MHz: <±1.5 dB.

OFFSET

Variable up to ±10V maximum (±5V into 50Ω). Calibrated zero offset position. Signal peak plus offset limited to ±10V (±5V into 50Ω).

OUTPUTS

Func Out (50Ω): Main waveform output.

Func Out (-20 dB): 20 dB down with respect to main output.

Sync Out: TTL pulse (50% duty cycle) at generator frequency. Will drive 10 LS TTL loads.

Sweep Out: Voltage proportional to instantaneous generator frequency.Source Impedance: 600Ω for driving horizontal axis of oscilloscope or recording equipment. Voltage of 0 to +5V (open circuit) for frequency change from bottom to top of selected range.

INPUTS

VCG In: Up to 1100:1 frequency change with external 0 to ±5V signal applied to VCG input connector. Upper and lower frequencies limited to maximum and minimum of selected range. VCG input is disconnected when stabilizer is engaged.

Trig In: BNC input accepts TTL compataible signal to trigger or gate the generator. Generator triggers on positive edge of input or gates on for duration of high level input. External signal pulse width is 50 ns minimum with a maximum repetition rate of 5 MHz.

SWEEP GENERATOR

Sweep Mode: Linear or logarithmic, up to 3 decades.

Sweep Time: Selectable 0.01, 0.1, 1.0 and 10 seconds.

Sweep Width: Up to 1100:1 linear or logarithmic.

GENERAL

Stabilizer

When stabilizer is selected, generator frequency is stabilized at displayed frequency to a crystal-controlled reference. Stabilizer improves long term frequency stability for all durations to be equal to the 10 minute short term value.

Display

1100 count LCD frequency display with frequency ranging units (mHz, Hz, kHz and MHz) and decimal point. Annunciators indicate selection of modes and functions.

Output Protection

Function outputs are protected against a short circuit to any voltage between ±10 Vdc and have internal fused protection (both output and common conductors) against accidental application of up to 250 Vac or 350 Vdc.

Environment

Temperature Range: +23° ±5°C for specified operation, operates 0° to +50°C, -20° to +75°C for storage.

Warm-up Time: 20 minutes for specified operation.

Altitude: Sea level to 10,000 ft for operation. Sea level to 40,000 ft for storage.

Relative Humidity: 95% at +25° C at sea level (noncondensing).

Dimensions

211 mm (8.3 in.) wide; 85 mm (3.4 in.) high; 305 mm (12 in.) deep.

Weight

3.4 kg (7.5 lb) net; 4.5 kg (10 lb) shipping.

Power

90 to 128, 180 to 256 Vac, 48 to 66 Hz, <35 VA.

FACTORY/FOB
San Diego, CA

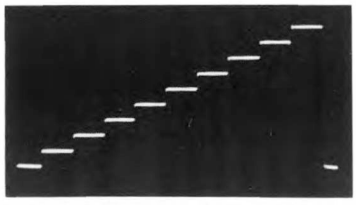
ORDER INFORMATION
Model 22

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

12 MHz Sweep/ Function Generator

- **0.01 Hz to 12 MHz Frequency Range**
- **10 Vp-p Protected Output into 50Ω**
- **6 Sweep Shapes, 12 Sweep Modes**
- **User Definable (1000 Point Arb) Sweep Shape**
- **3 Frequency Markers**
- **25 Stored Settings in Nonvolatile Memory**

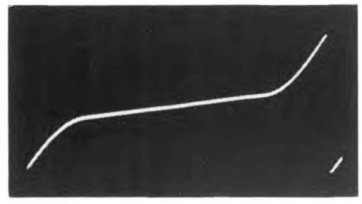
User Defined Sweep Function
This feature allows you to define your own unique sweep shape. It provides you with a 12 bit by 1K memory and is programmable over the GPIB.



Example of "User Defined'" Sweep

Applications: This capability is very useful in such applications as tone testing, digital frequency modulation, vibration testing and providing trigger signals to measurement devices.

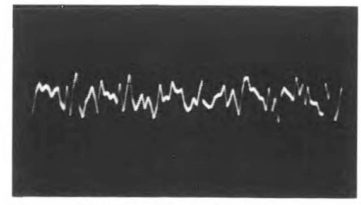
Filter Sweep Function
Provides a slower sweep rate near the midfrequency point for higher resolution when sweeping high-Q circuits.



Filter Sweep Function

Applications: This sweep shape can save you valuable time when testing very narrow filters where the sweep must be slowed dramatically in order to describe the characteristics.

Noise Sweep Function
A noise pattern with a Gaussian distribution characteristic is used to FM modulate the generator signal.



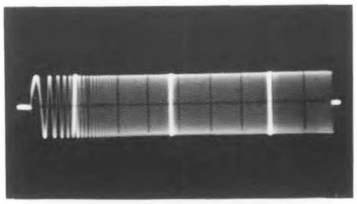
Noise Sweep Function

Applications: Jitter testing is greatly simplified when using this mode. The built-in pseudo-random noise pattern allows you to test for FM noise rejection and jitter susceptibility.

Other Sweep Functions
Linear, Logarithmic, Sine and Square.

Frequency Markers
Three simultaneous, individually programmable frequency markers are present at the Marker Output. These selectable polarity markers allow conven-

ient identification of filter center frequency and upper and lower cutoff frequencies. Up to 500 markers can be generated with the User Defined sweep shape.



Swept Waveform with Markers

WAVEFORMS (FUNCTIONS)
Programmable sine, triangle, square, external width, and dc.
Sine Distortion (THD at 5 Vp-p): <0.5% 10 mHz to 99.9 kHz. No harmonics above –40dBc 100 kHz to 999kHz, -30dBc 1 MHz to 12 MHz.
Time Symmetry: ±1% ±8 ns.
Square Transition Time: <15 ns.
Square Overshoot: <4% at full amplitude.
Triangle Linearity: 99% to 100 kHz.

MODES
Continuous, Triggered, Gated, Burst and 12 selectable sweep modes.
Burst Count Range: 1 to 1,048,200.
Burst Rate: 12 MHz maximum.

FREQUENCY
Range: 10 mHz to 12 MHz (>15 MHz in external width mode).
Resolution: 3 digits.
Accuracy: ±2%.
Repeatability (24 hr): ±1%.
Jitter: ≤0.1% ±100 ps.
Control: Frequency may be controlled by programmed value or external VCG input.

AMPLITUDE
Range: 0.01 to 10 Vp-p into 50Ω (0.02 to 20 Vp-p into ≥50 kΩ).
Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset >0.5V; 3 digits or 1mV when absolute peak amplitude plus off-set ≤0.5V.
Accuracy: ±2% of programmed value and: ±5 mV for 0.1 to 1V (peak amplitude + offset <0.5V), ±20 mV for 1.01 to 10V, ±50 mV for all other.
Repeatability (24 hr): ±1% ±10 mV.
Flatness (At 5 Vp-p): 0.1 dB to 100 kHz, 1.5 dB to 12 MHz

OFFSET
Range: DC or offset programmable from -5V to +5V into 50Ω (-10V to +10V into≥50 kΩ). Absolute peak amplitude plus offset may not exceed 5V into 50Ω (10V into ≥50 kΩ).
Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset >0.5V, 3 digits or 1mV when absolute peak amplitude plus off-set ≤0.5V.
Accuracy: ±40 mV in DC function.
Repeatability (24 hr): ±20 mV.

OUTPUTS
Function Out(50Ω): Source of primary waveforms.
Sync Out(50Ω): TTL level square wave at programmed frequency.
Level: ≤0.4V to ≥2.4V into 50Ω, ≤0.8V to ≥4.8V into ≥50 kΩ.
Timing: Concurrent with function output in square; lags sine and triangle by 90°.
Over/Undershoot: <10% into 50Ω.
Marker Out (600Ω): Three independent, simultaneously active markers. 0 to 5V.
Horizontal Out (600Ω): 0 to +5V ±5%. 250 point synthesized ramp.
GCV Out (600Ω): 0 to +6V ±10%. 1000 point synthesized GCV the same wave shape as that sweeping the main generator. GCV output voltage level is proportional to main generator frequency.

INPUTS
Trig In: Trigger of input circuit is programmable for a + or - signal slope and required threshold level.
Level: -10 to +10V.
Resolution: 20 mV.
Accuracy: ±500 mV.
Input Impedance: 10 kΩ.
Maximum Trigger Rate: 12 MHz (15 MHz for External Width).
Minimum Trigger Width: 40 ns.
Minimum Amplitude: 500 mVp-p to 1MHz, 1 Vp-p to 15 MHz.
VCG In: Voltage control of generator frequency.
Range: 0.01 to 12V.
Impedance: 10 kΩ.

INTERNAL TRIGGER
Range: 0.0025 Hz to 2.5 MHz.
Resolution: 4 digits.
Accuracy: 0.2%.
Continuous or Triggered Sweep with:
Reverse, reset, reset with burst, reset with burst on markers, reset with gate on markers.
Triggered Sweep with:
Hold with triggered reset, hold with triggered reverse.

SWEEP CHARACTERISTICS
Sweep Time: 400µs to 400,000s, 3 digits resolution, 0.2% accuracy.
Start/Stop: Maximum ratio 1200:1. Both start and stop frequency must be contained within a single sweep range. Sweep ranges are listed below.
Markers: 0.01 Hz to 12 MHz, 3 digits resolution, 3% of programmed value +0.2% of top of sweep range selected.

SWEEP FUNCTIONS
Linear: Linear variation of frequency with respect to time during active sweep.
Log: Logarithmic variation of frequency with respect to time during active sweep.
Sine: Sinusoidal variation of frequency with respect to time. Sweeps from -90° to +90°.
Square: Impulse variation of frequency between start and stop during active sweep.
Noise: Pseudo-randomized Gaussian variation of frequency between start and stop during active sweep. Start and stop are 2.5 standard deviations from mid-frequency point.
Filter: Sweep rate slows towards mid-frequency point allowing higher resolution.
User Defined: User programmable variation of frequency between start and stop during active sweep.

GENERAL
GPIB Programming: IEEE 488-1978 compatible. Non-isolated. Double buffered.
Address: 0—30, keyboard or internal switch selectable.
Subsets: SH1, AH1, T6, TE0, L4, SR1, RL1, PP0, DC1, C0, E2.
Protection: Output protected to 140 Vac or 200Vdc without internal damage.
Stored Setting: 25 setups.
Environment
Temperature Range: 25° ±10°C for specified operation; operates 0° to 50°C; -50° to +75°C for storage.
Dimensions: 21.7 cm (8.54 in.) wide (half-rack); 13.3 cm (5.25 in.) high; 39.4 cm (15.5in.) deep.
Weight: 5.9 kg (13 lb) net; 7.2 kg (16 lb) shipping.
Power: 90 to 105, 108 to 126, 198 to 231, or 216 to 252 volts rms; 48 to 66 Hz; 1 phase; <40 watts.

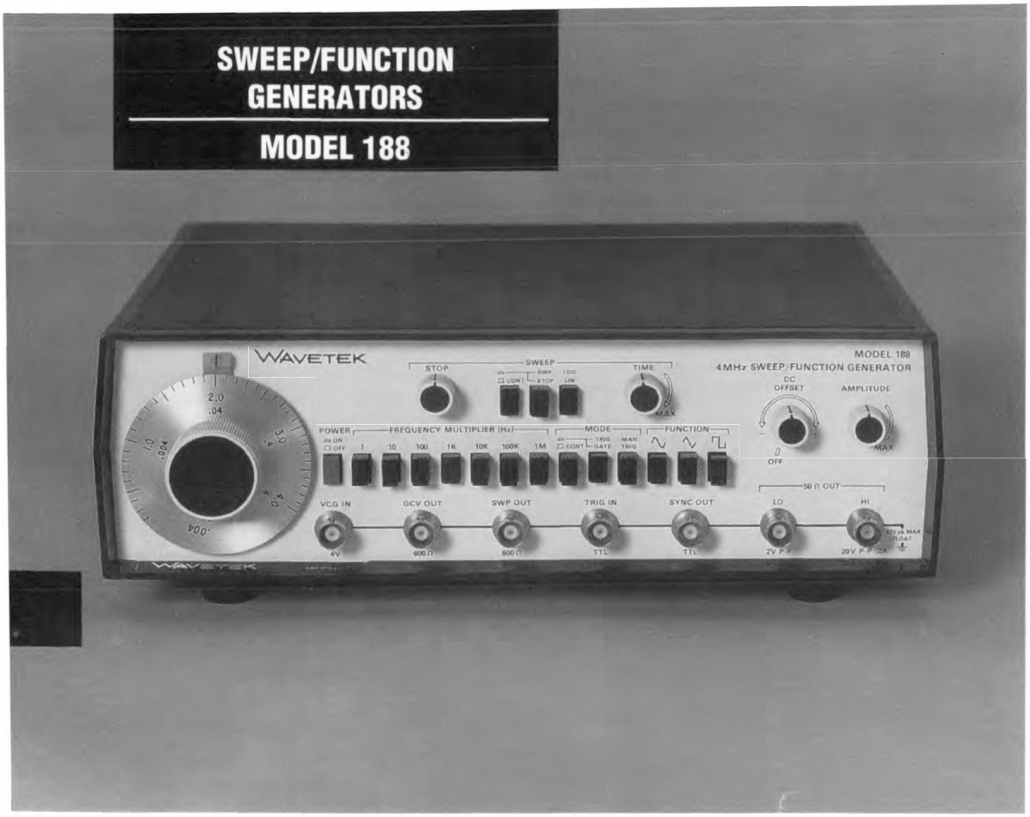
OPTIONS
002: Rear Panel Connectors. Front panel BNCs relocated to rear panel.

ACCESSORIES
Style 12: Single Rack Adapter Kit: Allows any 270 series instrument to be right or left mounted in a standard 19 inch rack. 5.25 inches high.
Style 13: Dual Rack Adapter Kit: Allows any 270 series instrument to be mounted side-by-side in a standard 19 inch rack. 5.25 inches high.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 273
Option 002

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).



4 MHz Function Generator

- **0.004 Hz to 4 MHz Frequency Range**
- **Trigger and Gate Modes**
- **20 Volt Peak-to-Peak Output**
- **DC Offset with Calibrated Zero**
- **1000:1 Lin/10,000:1 Log Sweep**
- **VCG — Voltage Controlled Generator**

Model 188 is a low cost, small, versatile sweep function generator. Its frequency range is 4 mHz to 4 MHz, its high voltage output is 20 Volts peak-to-peak, and its waveforms are sine, triangle, and square, plus DC. Model 188 can be triggered or gated. A Voltage Controlled Generator (VCG) input allows you to vary or sweep the output using an external signal. When sweeping with its internal oscillator, Model 188 sweeps the output from a start to a stop frequency either linearly or logarithmically. Logarithmic sweeping allows you to review frequency changes at the beginning of the sweep period more closely.

Simple Operation
All knobs, switches, buttons, and connectors needed to set up and operate the Model 188 are on its front panel, and there are no complex commands to learn. An easy-to-read manual explains any feature not immediately obvious.

WAVEFORMS
Sine, triangle, square, TTL pulse and DC.
Sine Distortion:
x1K and x10K Ranges: <0.5%.
x1, x10, x100 and x100K: <1%.
x1M: All harmonics 25 dB below fundamental.
Triangle Linearity: >99% to 200 kHz.
Square Wave Rise and Fall Time: At HI output, <50 ns for 10 Vp-p output into 50Ω termination.

MODES
Continuous, triggered, gated, sweep, and sweep stop.
Sweep: Recurring low-to-high frequency oscillation.
Sweep Stop: Frequency sweeps to high sweep limit. Used to set high frequency limit.

FREQUENCY
Range: 0.004 Hz to 4 MHz.
Dial Accuracy: ±5% of full scale.
Time Symmetry: Square wave variation from 0.2 to 4.0 on dial:
To 100 kHz: <±1%.
To 4 MHz: <±5%.

AMPLITUDE
Range: To 20 Vp-p (10 Vp-p into 50Ω) HI output, and to 2 Vp-p (1 Vp-p into 50Ω) LO output.
Sine Variation (Referenced to 1 kHz) with Frequency
On All Ranges Through x100K: <±0.2 dB.
To 4 MHz: <±1.0 dB.

OFFSET
DC offset at HI output is ±10V max (±5V into 50Ω). LO output is ±1V max (±0.5V into 50Ω).

OUTPUT
Function Out: Source of primary waveforms.
TTL Pulse Out: TTL pulse at generator frequency.
GCV—Generator Controlled Voltage: 0 to 4V open circuit output from 600Ω source impedance. Proportional to frequency of main generator.
Sweep Out: Ramp waveform output with 4V peak into open circuit.

INPUT
VCG—Voltage Controlled Generator: With external 0 to ±4V signal:
Linear Mode: Up to 1000:1 frequency change.
Log Mode: Up to 10,000:1 change.
Trigger and Gate
Input: TTL compatible levels.
Pulse Width: 50 ns minimum.
Repetition Rate: 4 MHz maximum.

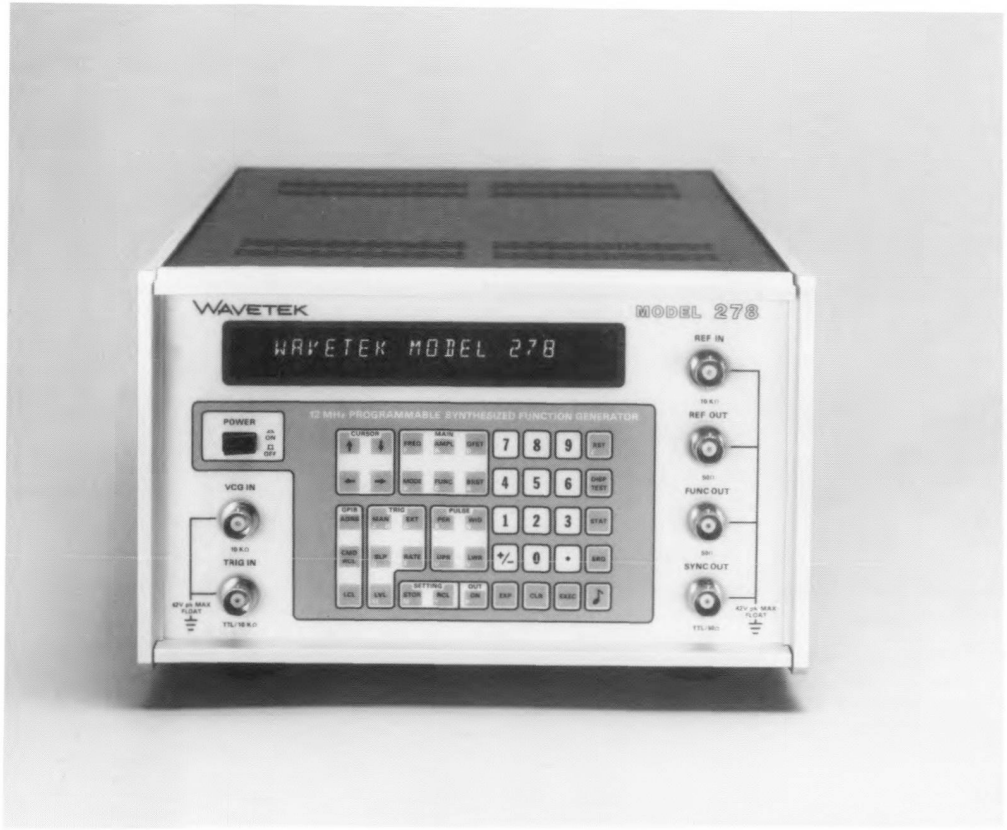
SWEEP
Main generator is frequency modulated by internal sweep generator.
Sweep Mode: Linear or logarithmic.
Sweep Rate: 30 ms to 1 min (nominal) continuously adjustable.
Sweep Width: Up to 1:1000 (linear) or 1:10,000 (logarithmic) continuously adjustable.

GENERAL
Environment: Specifications apply at 23° ±5°C. Instrument will operate from 0° to +50°C ambient temperatures.
Dimensions: 28.6 cm (11.25 in.) wide; 8.9 cm (3.5 in.) high; 26.7 cm (10.5 in.) deep.
Weight: 2.5 kg (5.4 lb) net; 3.6 kg (8 lb) shipping.
Power: 90 to 128V or 198 to 256V (selectable); 48 to 66 Hz; less than 15 VA.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 188

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).



SYNTHESIZED FUNCTION GENERATORS

MODEL 278

12 MHz Synthesized Function Generator

- **0.01 Hz to 12 MHz Frequency Range, 0.0005% Accuracy**
- **10 Vp-p Protected Output into 50Ω**
- **Pulse Capability**
- **100 Stored Settings in Nonvolatile Memory**
- **Burst Mode to Over 1 Million Cycles**

Model 278 is a small, versatile synthesized function generator that you can use on a bench or in an ATE system. In addition to the standard sine, triangle, DC and square waves, the Model 278 produces pulse, pulse complement square wave and pulse whose widths are controlled by an external signal. Besides the function generator modes, its synthesizer mode gives you improved frequency accuracy (5ppm). It generates these waveforms up to 12 MHz with outputs up to 10Vp-p into 50Ω. A separate sync output produces a TTL signal synchronized to the main output.

Stored Settings
Model 278 allows you to store up to 100 complete instrument setups in battery backed memory for fast recall.

WAVEFORMS
Programmable sine, triangle, square, square complement, pulse, pulse complement, external width, or DC.

Sine Distortion (at 5 Vp-p): THD <0.5%, 10 mHz to 99.9 kHz.
No Harmonics Above:
-40 dBc, 100 kHz to 999 kHz.
-30 dBc, 1 MHz to 12 MHz.

Square Transition Time: <15 ns.

Square Over/Undershoot: <5% of pk-pk amplitude ±20 mV.

Triangle Linearity: 99% to 100 kHz.

Internal Trigger Rate
Accuracy: 5 ppm + 1 mHz.
Range: 1 Hz to 12 MHz (24 MHz in external width).

Pulse Period
Accuracy: 0.005% (50ppm).
Range: 90 ns to 1s.

Pulse Width
Duty Cycle: ≤50%.
Accuracy: 3% >500 ns; 5% < 500 ns.
Range: 45 ns to 500 ms.

MODES
Continuous, triggered, gated, burst, synthesizer, external reference and external phase lock.

FREQUENCY
Range: 10 mHz to 12 MHz.
Resolution: Synth/Ext Ref modes: 5 digits. Other Modes: 3 digits.
Accuracy (Synthesizer Mode): 5 ppm ±1mHz.

AMPLITUDE
Range
0.01 to 10 Vp-p into 50Ω.
0.02 to 20 Vp-p into ≥50 kΩ.
Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset >0.5V.
Accuracy: , ±20 mV for 1.01 to 10V.
Flatness: 0.1 dB to 100 kHz, 1.5 dB to 12MHz for output at 5 Vp-p.

OFFSET
Range: -5 to +5V into 50Ω.
-10 to +10V into ≥ 50 kΩ.
Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset >0.5V, 3 digits.
Accuracy: ±40 mV in DC function.

OUTPUTS
Function Out (50Ω): Source of primary wave forms.
Sync Out (50Ω): TTL level square wave into 50Ω.
Ref Out: TTL level pulse.

INPUTS
VCG In: Up to 1200:1 frequency change.
Trig In: Level programmable -10 to +10V.
Ref In: TTL level. 10 MHz for Ext Ref mode; 10 Hz to 12 MHz for Phase Lock mode.

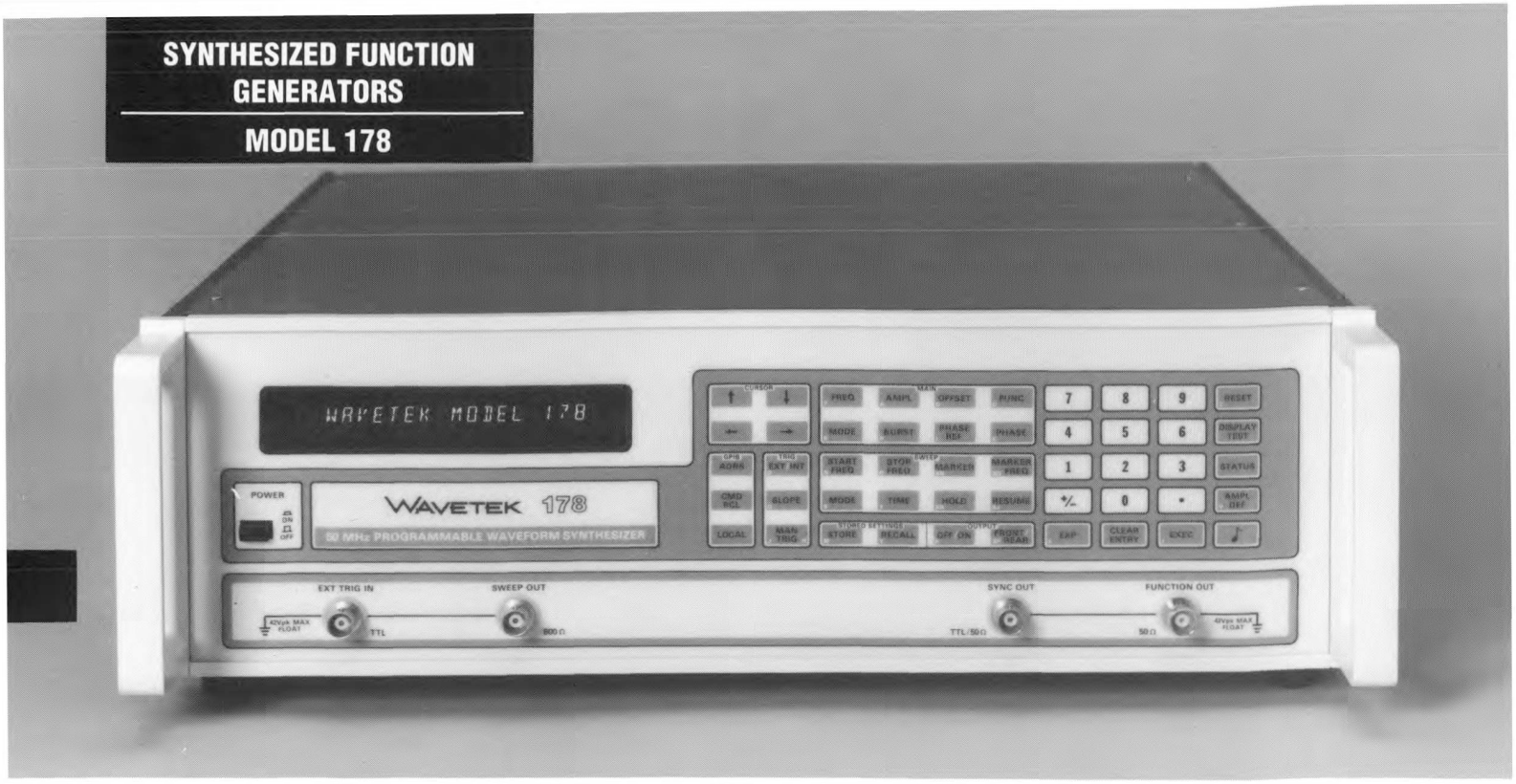
GENERAL
Stored Settings: 100 Setups.
GPIB Programming: IEEE-488 - 1978.
Temperature Range: 25° ± 10°C for spec operation; operates 0° to 50°C; -50° to +75°C for storage. 20 minute warm-up.
Dimensions: 21.7 cm (8.54 in.) wide (half-rack); 13.3 cm (5.25 in.) high; 39.4 cm (15.5 in.) deep.
Power: 115 or 230 Vac, 48 to 66 Hz; 1 phase; <50 watts.

OPTIONS
002: Rear Panel Connectors

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 278
Option 002

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).



Programmable Waveform Synthesizer

- **50 MHz Synthesizer with Function Generator Versatility**
- **20 Volt Precision Output into 50Ω**
- **Two Very Wide Sweep Bands**
- **AM and Phase Modulation**
- **Optional MATE Interface**

Synthesizer with Versatility
Model 178 is a 50 MHz waveform synthesizer whose versatility and 8 digit resolution gives you the output you want - with a spectrally pure and accurate signal. Its outputs include a wide variety of waveforms including sine and square waves to 50 MHz, triangles to 500 kHz, and ramps to 20 kHz. Haverwaves extend precision performance to include low frequency medical and mechanical simulations up through high frequency pulse applications.

Precision Output
Model 178 outputs allow you to drive 50Ω loads from 1 millivolt to a full 20 volts peak-to-peak with 3 digits of accuracy. Outputs can be DC offset to ±10 volts. In addition, the amplitude can be entered and displayed in either Vp-p, Vrms, or dBm for any waveform.

Wide Band Sweeper
As a sweeper, Model 178 allows you to choose from linear or true logarithmic frequency sweeps up or down at virtually any sweep rate. Model 178 sweeps two wide frequency bands: 1μHz to 500 kHz and 5kHz to 50 MHz.

AM and Phase Modulation
In addition to all these features, the Model 178 may be externally phase modulated at any time. Also, it can be externally amplitude modulated up to 200 percent.

Optional MATE compatible interface provides for CIIL programming, status output and confidence test via its internal TMA.

WAVEFORMS
Sine, square, triangle, ramps, haversine, havertriangles, AM (sine), and DC.

Sine Distortion: Harmonically related signals specified for 1Vrms (2.82 Vp-p) sine wave.
<-55 dBc to 50 kHz.
<-40 dBc to 500 kHz.
<-30 dB to 50 MHz.

Square Wave Rise and Fall Time:
1.01 to 10.00 Vp-p: <10 ns.
>10 Vp-p: <12 ns.

Square Wave Aberrations: ≤5% ±50mV of p-p voltage.

MODES
Operational Modes: All modes are synthesized. Continuous, triggered, gated, triggered haverwave, gated haverwave, triggered burst, triggered haverwave burst, and frequency sweep.

Sweep Modes
Continuous Sweep: Sweep generator sawtooth runs continuously.
Triggered Sweep: Incoming trigger causes a single sweep and reset to start frequency.

Triggered Sweep/Triggered Reset: As in triggered sweep, but sweep ends at stop frequency. Next trigger returns frequency to start.

MAIN GENERATOR FREQUENCY

Range: 1μHz to 50 MHz.

Continuous Mode: Sine, square, and AM to 50 MHz; Triangle to 500 kHz; Ramps to 20 kHz.

Triggered Gated and Burst Modes: Sine, square, triangle and AM to 200 kHz. Ramps to 20 kHz.

Frequency Resolution: 8 digits or 1μHz.

Accuracy: Better than 0.0005% of program setting, ±0.01 μHz.

Stability

Long Term: 1 x 10^{-6} of frequency per month.

Temperature: 1.2 x10^{-7} per °C.

Signal to Phase Noise: >46 dB in a 30 kHz band centered on carrier but excluding a ±1 Hz band around the carrier.

Spurious

1μHz to 200 kHz: -60 dBc or 30 μV whichever is greater.

>200 kHz to 500 kHz: -54 dBc or 30 μV whichever is greater.

>500 kHz to 50 MHz: -44 dBc or 30 μV whichever is greater.

AMPLITUDE

Range: All waveforms to 20 Vp-p maximum into 50Ω load. Combined amplitude/DC offset not to exceed ±10V peak into 50Ω. Output voltage into an open circuit is double indicated voltage when <±5V peak is selected.

Resolution and Accuracy

Amplitude Range	Accuracy (Amplitude)
10.02 to 20.00 Vp-p	±1% ±20 μV
1.01 to 10.0 Vp-p	±1% ±10 μV
0.101 to 1.00 Vp-p	±3% ±2 μV
10.1 to 100 mVp-p	±4% ±100 μV
1.00 to 10.0 mVp-p	±5% ±20 μV

Specified for 1kHz sine wave, or for DC output into a precision 0.1% 50Ω load. DC offset range is 0 to ±10 Vdc.

Resolution: 3 digit, ≤10.0 Vp-p. 4 digit (20 mV), >10Vp-p.

NOTE: Amplitude and DC Offset share the output attenuator.

Frequency Response: Specified relative to 1kHz sine wave and 0V offset into 50Ω.

>100 mV to 6Vp-p:

Frequency Range	Response
1μHz to 20 kHz	±1%
>20 kHz to 500 kHz	±3%
>500 kHz to 25 MHz	±7%
>25 MHz to 50 MHz	±15%

>6V to 10 Vp-p:

Frequency Range	Response
1μHz to 20 kHz	±1%
>20 kHz to 500 kHz	±3%
>500 kHz to 7MHz	±7%
>7MHz to 20 MHz	±12%
>20 MHz to 50 MHz	±20%

For Square and Triangle add 1%. For Ramps add 5%.

Stability: Measured at room temperature.

Short Term: 0.1% ±1mV for 10 min.

Long Term: 0.5% ±5mV for 6 months.

Amplitude Conversion: Permits entry and display of amplitude for all waveforms in units of Vrms, Vp-p and dBm.

OFFSET

0 to ±10 Vdc into 50Ω. Voltage is double into open circuit when <±5 Vdc selected.

Accuracy: ±1% of setting ±40 mV (worst case).

Stability: Same as amplitude stability.

OUTPUTS

Function Out (50Ω): Source of primary waveforms. Output available at front or rear (selectable).

Phase Offset: Output phase to any angle in 0.01° resolution steps to 500 kHz; 0.1° (or better) resolution steps above 500 kHz.

Sync Out (50Ω): At generator frequency 50% duty cycle. <5 ns transition time.

Reference Out (50Ω): 10 MHz, 1Vp-p sine.

Sweep Out (600Ω): 0 to +5V ramp synthesized to 2000 steps per sweep. 600Ω output impedance.

Frequency Marker Out: TTL levels. One of the ten preset markers can be selected. Output is low when the main generator frequency is below marker frequency; output is high when above.

INPUTS

Trigger: A TTL level transition can trigger or gate both main generator and internal sweep generator. Triggering slope up or down is selectable.

Reference (1kΩ): An external 0.5V to 10 Vp-p sine or pulse clock of ±5 ppm or better stability and accuracy automatically locks the internal reference. Ext clock may be 1, 2, 3, . . . 9 or 10 MHz.

Amplitude Modulation (600Ω): Rates from DC to 10 MHz minimum. Input impedance is 600Ω. 5Vp-p input gives 100% modulation. 200% modulation permitted. Main output halved with no modulation. Sync output not affected by modulation.

Phase Modulation: Rates from DC to 10 kHz minimum. Input impedance is 10 kΩ. ±5V input delivers approx. ±360° shift. Output deviation is ÷100 for main output frequencies 500 kHz and below.

SWEEP GENERATOR

Fully synthesized. For independent use or for frequency sweeping and triggering the main generator. Sweep linear or logarithmic, and up or down. Sweep may be triggered, gated, burst, interrupted with hold, and continued with resume.

Sweep Time: 0.01 to 600.00s. 0.01s resolution.

Maximum Sweep Range

Low Band: 1μHz to 500 kHz.

High Band: 5kHz to 50 MHz.

Minimum Sweep Range

Log: Any start and stop frequencies with ratio greater than 2.

Linear: Any start and stop frequencies with a minimum separation of
Low Band: 200 mHz/s of sweep time.
High Band: 2 Hz/s of sweep time.

Sweep Resolution: Includes start, stop and hold markers.

Frequency Resolution: 8 digits or 1μHz.

Frequency Update: Every 5μs (lin and log).

Log Slope Update: Every 2ms.

PULSE GENERATOR

Fully synthesized. Pulse period and width parameters entered by sweep time and main generator frequency respectively. Includes continuous, single, burst, gated and complement pulses.

Period: 10 μs to 600s (10 min.). 4 digit resolution (sweep time control); <1% jitter.

Width: 5μs to 500,000s (5 days); 8 digit resolution (frequency control); <0.05% jitter. Width usable to 1μs.

GENERAL

Stored Settings: Up to 5 complete instrument setups can be stored and recalled by number from volatile (RAM) memory.

GPIB Programming: Standard Purpose Interface Bus (GPIB) programming per IEEE Standard 488 1978.

Environment: Accuracy applies for 25° ±10°C after 30 minutes warm-up unless otherwise noted. Operates from 0° to 50°C to 10,000 ft altitude, and to 90% relative humidity. Storage temperature from -25° to +65°C.

Dimensions: 44.5 cm (17.5 in.) wide; 13.3 cm (5.25 in.) high; 53.4 cm (21 in.) deep. Supplied with rack mount adapters.

Weight: 14.7 kg (32.4 lb) net; 18.2 kg (40 lb) shipping.

Power: 90 to 105V, 108 to 126V, 198 to 231V or 216 to 252V; 48 to 67 Hz; <180 W.

MODEL 178MATE

MATE certified 178 with MATE-CIIL Standard 2806763, Rev. B.

OPTIONS

001: Additional Stored Settings. Nonvolatile, battery backed memory for 40 additional stored settings.

002: High Stability Frequency Reference. An additional frequency reference crystal for greater accuracy. Standard or High Stability crystal selectable by rear panel switch.

Accuracy: ±5 x10^{-8}.

Aging Rate: 5 x10^{-9}/day (average), <4 x10^{-8}/week.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 178
Model 178MATE
Option 001
Option 002

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

SYNTHESIZED FUNCTION GENERATORS

MODEL 650

2 MHz Variable Phase Synthesizer

- **0.0001 Hz to 2 mHz Frequency Range**
- **High Accuracy Output up to 50 Vp-p into 0Ω**
- **10 Digit Frequency Resolution, 5ppm Accuracy**
- **0.005° Phase Accuracy at Low Frequencies**
- **2 or 4 Channel Output with up to 40 Channels Cascadable**
- **Flexible Phase and Frequency Sweep Modes**

Model 650 combines superb phase accuracy, synthesizer frequency accuracy, high output amplitude capability and excellent stability. The standard model has two channels which can be expanded to four. As many as ten Model 650s can be cascaded to obtain 40 channels of phase controlled signals. In addition to sine waves, each output can be independently programmed to square, triangle and variable duty-cycle square and ramp waveforms.

Model 650 is fully programmable via GPIB (IEEE-488). Many operating and sweep modes make it suitable for a multitude of applications related to analog and digital design work, phase meter calibration, phased arrays, avionics, industrial robotics and communications.

Quick-cal allows you to instantly calibrate (typically <5 sec.) the Model 650 in its operating environment; this provides optimum instrument accuracy at the current instrument setup (for example, amplitude, offset, and phase at the current frequency).

WAVEFORMS

Programmable sine, square, triangle, ramp, DC and variable-duty-cycle square and ramp.

Range

Sine, Square: 0.1 mHz to 2 MHz.
Ramp, Triangle: 0.1 mHz to 200 kHz.
Resolution: 10 digits or 0.1 mHz.
Accuracy: ±5 ppm.
Stability: ±3 ppm.

Waveform Quality

Sine Wave

Frequency	Spurious	Harmonics
≤10 kHz	≤–70 dBc	≤–60 dBc
≤100 kHz	≤–60 dBc	≤–50 dBc
≤2 MHz	≤–50 dBc	≤–40 dBc

Square Wave

Rise/Fall Time: ≤100 ns.
Aberrations: ≤5%.
Duty Cycle: 20 to 80% ±3% ±15 ns.

Triangle/Ramp

Linearity: ≥99% ≤10 kHz; ≥90% <200 kHz.
Duty Cycle: 0 to 100% ±3% ±15 ns.

PRIMARY MODES

Continuous, triggered, gated and burst.
Burst Count: 1 to 65,535.

SECONDARY MODES

Phase Shift: Phase of each channel can be programmed with respect to the main generator.
Phase Resolution: 10 millidegrees.
Phase Accuracy:

	Sine Wave Phase Accuracy For	
Frequency	Equal Ampl Angle	Unequal Ampl Angle
<1 kHz*	0.005°	0.020°
<10 kHz	0.030°	0.100°
<100 kHz	0.100°	0.500°
<1 MHz	0.500°	2.000°
<2 MHz	1.000°	5.000°

*At phase settings equal to 360/n where n is an integer in the range 1 thru 8192.

Phase Delay: Phase offset of a channel may be programmed in delay time rather than in degrees. Model 650 will automatically compute phase in degrees (for any frequency) for a given delay.

Delay Resolution: 3 digits.
Delay Range: –2 to +2 ms.

Phaselock: In phaselock mode, Model 650 will lock onto an external reference in the frequency range of 40 Hz to 2 MHz. The main generator frequency will then be kept to the initial reference frequency. If the reference frequency changes in excess of ±10%, Model 650 will reset its main generator frequency to the new frequency.
Phaselock Range: 40 Hz to 2 MHz.
Initial Lock Time: ≤4 sec.
Re-lock Time: 100 periods +100 ms.

Delta Frequency: One channel at a time can run at a frequency that differs up to ±1000 Hz from the main frequency.
Range: –1000 to 1000 Hz.
Resolution: 3 digits but max 0.1 mHz.

Accuracy: 0.1%.

TRIGGERING

The 650 can be triggered via its internal trigger generator or an external trigger signal. In external trigger mode, trigger level and signal polarity are selectable.

Internal Trigger Signal
External Availability: Present at Marker Out connector in non-sweep modes.
Range: 2.5 mHz to ≥200 kHz.
Resolution: 3 digits.
Accuracy: 0.1%.

External Trigger Signal
Frequency Range: 0 to ≥200 kHz.
Amplitude Range: +10 to –10V.
Level Setting Resolution: 0.1V.
Level Accuracy: ±0.3V.

MODULATION

Amplitude Modulation
Range: 0 to 100%.
AM Bandwidth: 0 to 20 kHz.
Modulation Gain (VCG): 10.
AM Input Impedance: >10 kΩ.
Protection: ±50 Vdc (Momentary).

Phase Modulation
Range: Programmable 0 ±1080°.
PM Bandwidth: 25 kHz.
Voltage Controlled Phase Modulation (VCPM): –1V to +1V for full modulation between programmed start and stop phase with 8-bit resolution.
PM Input Impedance: ≥1 MΩ.
Protection: ±50 Vdc momentary.

Frequency Modulation: Programmable start and stop frequency in range 0.1 mHz to 2 MHz.
FM Bandwidth: 20 kHz.
Voltage Controlled Frequency Modulation (VCFM): –1V to +1V for full modulation between programmed start and stop frequency values with 8-bit resolution.

Frequency Shift Keying: Asynchronous (Async FSK) and Synchronous (Sync FSK).
Max Rate of FSK: 40 kHz (25 µs per step).
Max No. of Different Frequencies in FSK Mode: 100.
Switching Time Between Frequencies: ≤500 ns.

Phase Shift Keying
Max Rate of PSK: 65 kHz.
Phase Shift Keying Capabilities: Dual Phase Shift Keying (DPSK) and Quadrature Phase Shift Keying (QPSK) through sequenced phase sweep mode.
Max No. of Different Phase Values in PSK Mode: 100.

Pulse Position Modulation
Max Rate of PPM: 65 kHz.
Max No. of Different PPM Values: 99.

Table 1. Amplitude Range, Resolution and Accuracy

Output Impedance	Range (Vp-p)	Resolution	Accuracy ≤100 kHz	Accuracy ≤1 MHz	Accuracy ≤2 MHz
0Ω	2.5-50	1 mV	±0.5% ±2 mV (typ: ±0.2% ±1 mV)	±1.5% ±2 mV (typ: ±0.3% ±1 mV)	±3% ±2 mV (typ: ±1.5% +1 mV)
50Ω	0.025-0.25	10 µV			
	0.25-2.5	100 µV			
	2.5-25	1 mV			

Table 2. Offset Range, Resolution and Accuracy

Output Impedance	Range (Vp)	Resolution	Accuracy
0Ω	±25	1 mV	0.5% ±30 mV
50Ω	±12.5V	1 mV	0.5% ±20 mV
	±1.25V	0.1 mV	0.5% ±10 mV
	±0.125V	10 µV	0.5% ±5 mV (typ: 0.1% ±3 mV)

Table 3. DC Range, Resolution and Accuracy

Output Impedance	Range	Resolution	Accuracy
0Ω	±25V	1 mV	0.3% ±10 mV
50Ω	±12.5V	1 mV	0.3% ±5 mV
	±1.25V	0.1 mV	0.3% ±2 mV
	±0.125V	10 µV	0.3% ±1 mV

CHANNEL OUTPUTS

Each channel can individually be programmed for the following parameters.

Function: Sine, square, triangle, DC, ramp or programmable duty cycle square or ramp.
Amplitude Range, Resolution and Accuracy: Refer to table 1 and figure 1. Range is restricted by DC offset as shown in figure 2.
Offset Range, Resolution and Accuracy: Refer to table 2. Range is restricted by AC amplitude as shown in figure 2.

DC
Maximum Range: 12.5 mV to 25V.
Range, Resolution and Accuracy: Refer to table 3.

Frequency Ratio: Each channel can be set at a ratio of 1 to 99 times the main frequency.
Output Impedance: Output impedance can be programmed to be either 0Ω or 50Ω or the output can be turned off (output relay open). In the 50Ω mode a 50Ω termination is assumed. With 0Ω and FUNC OUT terminated with >100Ω load, the cable length must be <6 ft. in length.

SWEEP

Frequency Sweep: 12 modes.
Range: 0.1 mHz to 2 MHz.
Resolution: 10 digits but max 0.1 mHz.
Accuracy: 5ppm ±10 µHz.
Sequenced Sweeps (Modes 9, 10, 11): No. of Programmable Steps (Index): 1 to 100.
Frequency Switching Time: ≤500 ns.

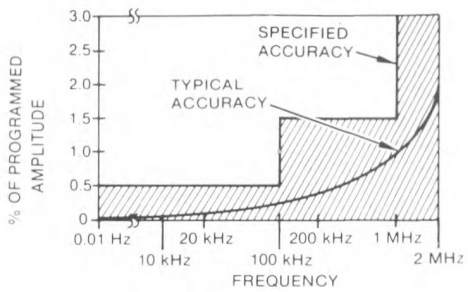
Phase Sweep: 11 modes.
Range: -10^6 to $+10^6$ degrees continuous.
Resolution: 10 millidegrees.
Accuracy: Refer to table.
Sequenced Sweeps (Modes 19, 20, 21): No. of Programmable Steps (Index): 1 to 100.
Phase Switching Time: ≤500 ns.

Combined Frequency and Phase Sweep: 6 modes.
Range, Resolution and Accuracy: Same as for Frequency Sweep and Phase Sweep.
Sequenced Sweeps (Modes 26, 27, 28): No. of Programmable Steps (Index): 1 to 100.
Switching Time: ≤500 ns.

Sweep Functions: Linear, Log, Random and Sine.

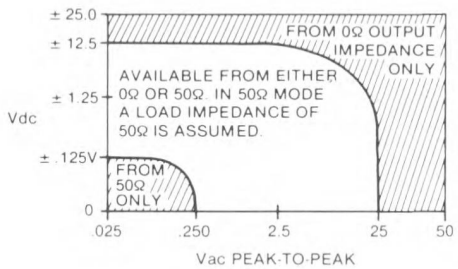
Sweep Times and Resolution: Greatly depend on the chosen sweep function (linear, log, sine or random), the swept parameter (frequency, phase or both) and whether or not compensation of parameters is required. The fastest sweep time of 10 ms allows for 100 sweeps per second. In compensated mode, the fastest sweep time of 200 ms allows for 5 sweeps per second. The longest sweep time is 10^7 seconds or approximately 116 days. Compensation is generally only necessary if sweeping in frequency ranges over 100 kHz.

Sweep Time:
Range: 10 ms to 10^7 sec.
Resolution: 3 digits but max 1 ms.
Accuracy: 0.1%.
Sweep Resolution: Phase and frequency sweep resolution can be derived using the following fixed step rate table.



NOTES:
1. All accuracies ±2 mV.
2. 0Ω output impedance into high impedance load or 50Ω output impedance into 50Ω. 0.001% accurate load.
3. Triangle and ramp to 200 kHz only.

Figure 1. Amplitude Accuracy vs. Frequency



NOTES:
1. Maximum output current in 0Ω modes ±0.5A.
2. Output voltage ≤250 mVp-p or ±125 mVdc are available from 50Ω impedance only.

Figure 2. Available and Permissible DC Offset and AC Amplitude Combinations.

Fixed Step Rates: (For combinations of sweep function, swept parameter and compensation.) Refer to the following table.

Sweep Function	Compensation On (Steps/sec)	Compensation Off (Steps/sec)
Frequency Sweep		
Linear	1443	13,333
Log	962	4,167
Sine	1053	6,667
Random	1156	15,400
Phase Sweep		
Linear	1176	20,000
Log	1010	5,263
Sine	1064	7,143
Random	1183	22,200
Combined Frequency and Phase Sweep		
Linear	1053	6,667

Modulation Sampling Speed

Module Mode	Compensation On	Compensation Off
12: Ext FM	1.21 kHz	20.8 kHz
23: Ext PM	1.22 kHz	25.0 kHz
29: FM + PM	1.03 kHz	5.1 kHz

MASTER/SLAVE CAPABILITIES

Up to 10 Model 650's, each with up to 4 channels can be cascaded for a total of 40 phase-coherent, phase-controlled signals. Model 650 can be programmed to be either the master unit or a slave unit. Phase accuracy of slave units is equal to 2x the tolerance levels specified under Phase Accuracy.

CALIBRATION

Model 650 has internal calibration facilities that render classical calibration procedures obsolete. The calibration procedure is stepped through via a "plain English" menu built into Model 650. Complete calibration of a four channel Model 650 can be accomplished in a matter of minutes without the need for a manual or lengthly procedure.
Once the calibration is completed, an autocal procedure is initiated which performs a self-characterization of analog circuitry within 1 minute for a two channel unit (2 minutes for a 4 channel unit). The autocal procedure requires no external measurements or additional instruments. The results of the self-characterization are stored in battery protected memory.

STORED SETTINGS

Model 650 can store up to 25 complete instrument setups including every parameter for every channel you have seleced. Moreover the 650 also stores the current setup automatically so you may turn the unit off and return the next day, week or month and with 4 keystrokes restore any of 25 setups exactly the way you stored them.

GPIB INTERFACE

Model 650 has a built-in alphabetical syntax list allowing you to start programming within minutes after unpacking the unit. The built-in "HELP" file can be printed out via a computer to give you your own syntax list. The 650 is extremely flexible in accepting GPIB commands.
Moreover, the 650 will detect programming errors. Syntax errors and parameter errors are detected, identified and categorized by the 650. The Input and SRQ buffers, each 256 characters long, can be displayed via the front panel or read by a computer. So all programing problems can be displayed, allowing easy program debugging. SRQ masks can be defined and, for example, even low battery voltage (for memory protection) will generate a service request. In short, the 650 reflects Wavetek's experience in providing easy to use, yet sophisticated programmable products.

Address Range: 0 to 30 switch selectable. If enabled via rear panel switch, address can also be changed from front panel.
Subsets: SH1, AH1, TE0, L4, RL1, PP0, DC1, C0, E2.

I/O CONNECTIONS

Reference Out
Impedance: 50Ω source.
Level: TTL, <0.4V, >2.4V into 50Ω.
Fanout: 10 reference inputs.
Frequency: 10 MHz, ±5 ppm.
Protection: ±5 Vdc momentary.

Reference In
Impedance: >1kΩ, AC coupled.
Level: >500 mVp-p, <50 Vdc.
Frequency: 10 MHz ±1%.
Protection: ±50 Vdc momentary.

Trigger Input
Impedance: >5 kΩ.
Level: >500 mVp-p, <10 Vdc.
Input: 0 to >200 kHz, 20 ns min.
Protection: ±50 Vdc momentary.

Hold Input
Impedance: <1 kΩ.
Level: TTL, active low.
Protection: ±20 Vdc momentary.
Function: selectable sweep or waveform hold.

FM/PM Input
Impedance: >1 MΩ.
Level: –1 to +1V (for full range).
Protection: ±50 Vdc.

Sampling Speed

Mode	Comp Off	Comp On
Ext FM	20 kHz	1 kHz
Ext PM	25 kHz	1 kHz
Ext FM/PM	5 kHz	1 kHz
Resolution	8 mV	
Accuracy	±5%	

Marker Out
Impedance: 50Ω source.
Level: TTL, <0.4V, >2.4V into 50Ω.
Output: Low when freq/phase < marker.
Protection: ±20 Vdc momentary.

2.048 V Out
Impedance: 1 kΩ.
Level: 2.048V ±5 mV.
Output: Internal V ref cal test point.
Protection: ±50 Vdc momentary.

Phase Cal Input: The Phase Cal input is intended to externally calibrate a master/slave pair or group, or to measure phase shift through external circuits. When these measurements are not being made a relay disconnects the BNC from internal circuits.
Impedance: >300Ω.
Level: 40 Vp-p max.
Input: Slave channel for multi-unit cal.

Protection: Unprotected when calibrating, protected to ±100 Vdc otherwise.

Horizontal Out
Impedance: 1 kΩ.
Level: 0 to +10 Vdc.
Output: % of sweep.
Accuracy: ±2%.
Resolution: 40 mV.
Protection: ±50 Vdc momentary.

Phase Out
Impedance: <50Ω.
Level: TTL.
Output: Sync pulse for master/slave configuration.
Protection: None.

Phase Clear
Impedance: <50 ohm.
Level: TTL.
Output: Clear pulse for master/slave configuration.
Protection: None.

Note: Phase Out and Phase Clear are only used to lock units together in a master/slave pair or group.

Channel Func Out
Impedance: 50Ω, 0Ω selectable. With 0Ω and FUNC OUT terminated with >100Ω load, the cable length must be <6 ft. in length.
Level: –25 V to +25 V.
Output: Main function output.
Protection: Current limit at 500 mA. Withstands ±60 Vdc indefinitely.

Sync Out
Impedance: 50Ω source.
Level: TTL, <0.4, >2.4 V into 50Ω.
Output: Sync in phase with sine wave. Phase accuracy not specified.
Protection: ±20 Vdc momentary.

AM Input
Impedance: >10 kΩ.
Level: 0 to +5 V.
Input: Modulation signal up to 20 kHz BW.
Protection: ±50 Vdc momentary.

GENERAL

Environmental
Temperature Range: 0° to +50°C. +25° ±8°C for specified performance.
Warm-up Time: 20 minutes for specified performance.
Relative Humidity: 95% at +25°C and sea level (non-condensing).
Altitude: Sea level to 10,000 ft for operation. Sea level to 40,000 ft for storage.
Dimensions: 42.9 cm (16.9 in.) wide; 13.3 cm (5.25 in.) high; 54.6 cm (21.5 in.) deep.
Weight: 16.3 kg (36 lb).
Power: 90 to 126, 190 to 252 Vac, 48 to 66 Hz, ≤250 watts.

MODEL 650MATE
MATE-CIIL capable. Meets MATE-CIIL Std. 2806763.

OPTIONS
001: Two Additional Channels. Two additional channels and the associated RAM board mount in the chassis for a total of four channels.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 650
Model 650MATE
Option 001

For full specifications or a demonstration, contact your Wavetek representative (pages 211 and 213).

SYNTHESIZED FUNCTION GENERATOR

MODEL 23

12 MHz Synthesized Function Generator

- **10 mHz to 12 MHz Frequency Range with ±0.005% Accuracy**
- **TTL, ECL Out to 32 MHz ±0.005% Accuracy**
- **Trigger, Gate, AM, FM, SCM**
- **Optional Output Impedance of 50, 75 or 600Ω**
- **Optionally Programmable via GPIB or RS232**

Wide Frequency Range
Model 23 Function Generator operates from 0.01 Hz to 12 MHz in synthesized, continuous, triggered and gated modes with output levels of 10 mV to 20 volts peak-to-peak. Frequencies as low as 100 mHz are obtainable in the VCG mode. The synthesizer circuit extends frequency range at the ECL and TTL outputs to 32 MHz. In addition, the synthesized mode has 4 digits of frequency resolution with 0.005% (50 ppm) accuracy.

FM, AM and SCM
Inputs are provided for external frequency and amplitude modulation. Suppressed carrier modulation (SCM) is also obtainable by programming zero amplitude. Carrier suppression is initially at least 40 dB, and may be improved to typically 70 dB (to 1MHz) by using the NULL control.

Low-Frequency Waveform Synthesis
Waveforms below 1kHz are synthesized digitally to extend the frequency range down to 0.01 Hz while maintaining high speed phase locking in the frequency synthesized mode. The waveform synthesizer also provides the additional features of up and down ramps and triggered and gated haverwaves.

Friendly Controls
Parameters are selected by front panel keys, and the numeric values are incremented or decremented with the rotary encoder knob. All parameters are displayed on a 16-character by 2 line LCD display. Microprocessor control makes possible frequency and amplitude units conversion, internal calibration and test procedures, and optional remote programming.

Non-Volatile Memory
Instrument set up parameters are stored in memory for return to exact setup. Memory is maintained after power-down with a long-life lithium battery.

WAVEFORMS
Sine, triangle, square, (below 1000 Hz) ramp up and ramp down, (in triggered or gated modes) haverwaves, and DC.

Sine Distortion (THD at 5Vp-p)
0.01 Hz to 9.99 kHz: <0.5%.
10.0 kHz to 99.9 kHz: <1.0%.
No Harmonics above:
-40 dBc, 100 kHz to 999 kHz,
-27 dBc, 1MHz to 12 MHz (50Ω).*

SYNTHESIZED FUNCTION GENERATORS

MODEL 23

Time Symmetry: ±1% ±8 ns.
Square Transition Time (50Ω)*: <25 ns.
Square Pk-to-Pk Aberrations (50Ω)*: <4% at full amplitude.
Triangle Linearity: 99% to 100 kHz.
Stability
Amplitude, Frequency (Non-synthesized) and DC Offset: (After 30 minute warm-up) ±0.10% of range for 10 minutes. ±0.50% of range for 24 hours.
Frequency (Synthesized): ±1 ppm/° for 0 to 50°C. Crystal is 6.144 MHz with 0.005% accuracy and aging rate of 20 ppm/year.
Spurious Signals (At Func Out): In synthesizer mode only.
To 1MHz: 70 dB below fundamental typical.
To 12 MHz: 40 dB below fundamental typical.
Integrated Signal to Phase Noise: Typically 40 dB below the signal to 1MHz measured over ±15 kHz bandwidth excluding carrier ±10 Hz (in synthesizer mode only).

MODES

Continuous, Triggered, Gated, Continuous Synthesized and Clock.

FREQUENCY

Range: 0.01 Hz to 12 MHz at Function Output. 0.01 Hz to 32 MHz at TTL and ECL outputs. Down to 100 µHz with VCG.
Control: Programmed value or VCG.
Value: Frequency value is manually or bus programmable with automatic range selection.
VCG (Voltage Controlled Generator): AC or DC input controls frequency. Input disabled in synthesized mode. 0 to ±12V into 10 kΩ for up to 1200:1 frequency change in each of 9 frequency ranges (ranges must be programmed).
Slew rate is limited to 0.1 V/µs.
Frequency Zero: In non-synthesized modes, front panel key or bus command sets frequency to bottom of current range for 1000:1 VCG change (1200:1 for 12 MHz range).
Resolution: 4 digits in synthesized modes. 3 digits in all other modes. Additional .25 digit for frequencies above 10 MHz.
Accuracy: 50 ppm in synthesized mode; in others, ±1% of setting ±1% of range.
Synthesized Mode Lock Time: <300 ms for within 0.01% of new programmed frequency.
Repeatability (24 hr): 0.0003% in synthesized mode. ±1% in all other modes.
Jitter: ≤0.1% ±100 ps.

AMPLITUDE

Range: 0.01 to 10.2 Vp-p into termination matching output impedance (0.02 to 20.4 Vp-p into ≥50 kΩ). Units of measure are displayed in Vp-p, Vp, Vrms, or dBm (into selected impedance).
Resolution

Abs Pk Ampl + Offset	Ampl and Offset Resolution
>0.5V	3 digits or 10 mV
≤0.5V	3 digits or 1mV
≤0.05V	3 digits or 0.1 mV

Amplitude Accuracy: ±1% of selected value and:
±1 mV for 0.01 to 0.1 Vp-p (peak amplitude + offset ≤0.05V).
±10 mV for 0.1 to 1Vp-p (peak amplitude + offset <0.5V).
±100 mV for 1.01 to 10.2 Vp-p.
Repeatability (24 hr): ±1% ±10 mV.
Flatness (50Ω)*: For 5Vp-p sine wave.
To 100 kHz: 0.2 dB.
To 12 MHz: 1.5 dB.
Reference: 1kHz.

OFFSET

Range: –5.1V to +5.1V into termination matching output impedance (-10.2V to +10.2V into ≥50 kΩ). Absolute peak amplitude plus offset may not exceed 5.1V into termination matching output impedance (10.2V into ≥50 kΩ).
Accuracy (In DC Function)
<50 mV: ±1 mV.
≥50 mV to <0.50V: ±6 mV.
≥0.50V: ±60 mV.
Repeatability (24 hr): ±1% ±20 mV.

OUTPUTS

Function Out: Source of primary waveforms. Source impedance is 50, 75 or 600Ω; user or option selected.* Peak output current is 100 mA max.
TTL Output: TTL compatible pulse with 50% duty cycle at selected frequency. Level is ≤0.4V to ≥2.0V into 50Ω, ≤0.4V to ≥4.0V into ≥50 kΩ.
ECL Output: Same characteristics as TTL output except levels are ECL compatible when loaded by 50Ω.

INPUTS

VCG In: BNC input for voltage control of generator frequency in non-synthesized modes. Accepts up to ±12V into 10 kΩ.
Trig In: BNC input accepts TTL compatible signal to trigger or gate the generator. Positive or negative edge triggering or high or low level gating is selectable. External signal pulse width is 50 ns minimum with a maximum repetition rate of 5 MHz.
AM In: BNC input for external ac modulating signal for AM or suppressed carrier modulation (SCM) envelope. Accepts ±5V into 600Ω.
Repeatability (24 hr): ±1% ±20 mV.

GENERAL

Output Protection
Short Circuit: ±10 Vdc.
Line Voltage: 250 Vac or 350 Vdc.
Environmental
Temperature Range: 23° ±5°C for specified operation, operates 0° to +50°C, -20° to +75°C for storage.
Warm-up Time: 20 minutes.
Altitude: Sea level to 10,000 ft for operation. Sea level to 40,000 ft for storage.
Relative Humidity: 95% up to 60°C storage; operating 45% to 50°C and 75% to 25°C at sea level (non-condensing).
Vibration: 5 to 55 Hz. 2G at 55 Hz max.
Shock: 30G, 11 ms half sine.
Dimensions: 211 mm (8.3 in.) wide; 85 mm (3.4 in.) high; 305 mm (12 in.) deep.
Weight: 4.0 kg (8.8 lb) net; 5.0 kg (11 lb) shipping.
Power: 90 to 110V, 105 to 125V, 180 to 220V, or 210 to 250V, 48 to 66 Hz, less than 50 VA.

OPTIONS

001: GPIB Programming. IEEE 488-1978 compatible. Non-isolated. Double buffered.
Subsets: SH1, AH1, T6, TE0, L4, SR1, RL1, PP0, DC1, C0, E1.
Address: 0-30, internally switched.
Factory installed.
002: RS-232-C Serial Port. DB-25 female connector. DCE or DTE config. Full duplex with CTS/DTR or XON/XOFF handshaking. Format is 8 bits with no parity and one stop bit. Data rate from 50 to 9600 Baud. Factory installed.
003: 75Ω Output. A 75Ω Func Out source impedance can be installed at the time of purchase or by the user in the field. All displayed amplitude values are correct when the output is terminated with 75Ω.
004: 600Ω Output. A 600Ω Function source impedance can be installed at the time of purchase or by the user in the field. All displayed amplitude values are correct when the output is terminated with 600Ω.

NOTE: All specifications apply for programmed amplitude of 10 Vp-p into 50Ω.

*Higher installed impedances will have derated high frequency performance subject to variation due to output cable length.

FACTORY/FOB

San Diego, CA

ORDER INFORMATION

Model 23
Option 001
Option 002
Option 003
Option 004

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

SYNTHESIZED FUNCTION GENERATORS

MODEL 171

Synthesizer/Function Generator

- **0.1 Hz to 2MHz Frequency Range**
- **0.005% Frequency Accuracy**
- **4 Digit or 1000:1 Dial Control**
- **70 dB Spurious Noise Reduction**

Model 171 provides the convenience of an easy to use function generator and the frequency accuracy of a synthesizer. The function generator mode controls the instrument by dial or by an external signal at the Voltage Controlled Generator (VCG) input which can sweep the output frequency. The synthesizer mode has 0.005% frequency accuracy to 2 MHz. In either the synthesizer or function generator mode, Model 171 outputs, both 600Ω and 50Ω, allow you to generate waveforms to 10 Vp-p.

WAVEFORMS

Sine, triangle, square and DC selectable. TTL pulse and 1MHz reference pulse.

Sine Distortion

<0.5% for 0.1 Hz to 20 kHz.
<1.0% for 20 kHz to 200 kHz.
All harmonics 30 dB below fundamental.

Spurious Signals: Typically 70 dB below fundamental to 20 kHz and 40 dB below fundamental to 2MHz (in synthesizer mode only).

Integrated Signal to Phase Noise: Typically 30 dB to 200 kHz measured over ±15 kHz bandwidth excluding carrier ±10 Hz (in synthesizer mode only).

Triangle Linearity: >99% to 200 kHz.

Square Wave Rise and Fall Time: <75 ns.

MODES

Synthesizer: Outputs are locked to the synthesizer frequency. Digital switch is operable between 0.1000 and 1.9999 on all ranges above the x1 range.

Function Generator: Frequency is controlled by the dial, multiplier and external voltage on all ranges.

FREQUENCY

Range: 0.1 Hz to 2MHz.

Synthesizer Mode

Accuracy: 0.005% of setting.

Function Generator Mode

Dial Accuracy: ±3% of full scale for 0.1 Hz to 200 kHz. ±5% of full scale to 2MHz.

AMPLITUDE

Range: To 20Vp-p (to 10 Vp-p into matching load).

Sine Variation with Frequency:

<±0.1 dB for 0.1 Hz to 200 kHz.
<±0.5 dB for 200 kHz to 2MHz.

Step Attenuator Accuracy: ±0.3 dB per 20 dB step.

OFFSET

DC offset of waveform and DC output are selectable and variable through ±10V (±5V into matching load).

OUPUTS

Main Outputs (50Ω & 600Ω): Sine, triangle, and square variable to 20 Vp-p (10 Vp-p with matching load at either 50Ω or 600Ω output).

TTL Pulse Out: TTL pulse has an approximately 50% duty cycle at generator frequency and can drive up to 20 TTL loads.

GCV—Generator Controlled Voltage: 0 to +2V (nominal, open circuit) proportional to frequency of main generator.

Synthesizer Reference Out: TTL 1MHz pulse train in synthesizer mode only.

INPUTS

VCG—Voltage Controlled Generator: VCG in function generator mode only. Up to 1000:1 frequency change with external 0 to +2V signal.

External Synthesizer Reference In: 1MHz.

GENERAL

Synthesizer Stability

Frequency: 1ppm/°C.

Internal Crystal Frequency: 4MHz.

Aging Rate: 20 ppm/year.

Environment: Specifications apply at 23° ±5°C. Operates from 0° to +50°C.

Dimensions: 28.6 cm (11.25 in.) wide; 13.3 cm (5.25 in.) high; 27.3 cm (10.75 in.) deep.

Weight: 3.9 kg (8.5 lb) net; 5.5 kg (12 lb) shipping.

Power: 90 to 110V, 105 to 125V, 180 to 220V or 210 to 250V; 50 to 400 Hz; less than 20 VA.

FACTORY/FOB

San Diego, CA

ORDER INFORMATION

Model 171

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

Programmable Signal Source

- **0.0001 Hz to 13 MHz Frequency Range**
- **500 Settings Per Second**
- **5 1/2 Digit Synthesizer Option**

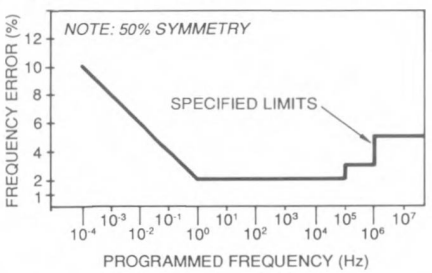
Model 172B is an extremely versatile 13 MHz programmable signal source which functions as an oscillator, a waveform generator, a synthesizer, and a pulse generator. It produces sine, triangle and square waves, plus pulses, ramps haversines and haverwaves, and DC to maximum output of 30 Vp-p. VCG (Voltage Controlled Generator) inputs allow you to sweep or modulate the frequency with an external signal. Outputs can be triggered and gated as well as continuous.

WAVEFORMS
Sine, square, triangle, pulses, ramps, haversine, havertriangle and DC.
Sine Distortion: Total harmonics referenced to carrier are 46 dB to 30 kHz.
<-40 dB to 1MHz, 30 dB to 13 MHz.
Square Wave Rise and Fall Time: <20 ns.

MODES
Continuous, Triggered, Gated, Synthesized and Phase Lock.

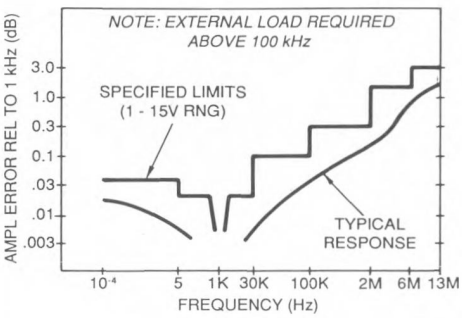
FREQUENCY
Range: 0.0001 Hz to 12.99 MHz.
Resolution: 3 digits. Also see Option 002.
Stability:
Short Term: 0.3% for 15 min.
Long Term: 1.0% for 8 hrs (to 1 MHz).
See Option 002 for synthesizer.

Open Loop Accuracy



AMPLITUDE
Range: To 30 Vp-p (15 Vp-p into 50Ω load).
Accuracy: (1kHz sine wave or DC voltage output, internal 50Ω load and 1MΩ external impedance.) ± 0.2 dB at -56 dBm; <± 0.05 dB at >4 dBm.
Ampl Res: 3 digits to 9.99V, 4 digits ≥10.00V.
Ampl Output Conversion: Vp-p, Vrms, dBm.
Stability:
Short Term: 0.025 dB for 15 min.
Long Term: 0.05 dB for 6 months.

Frequency Response



OFFSET
Range: 0 to 7.5 Vdc into 50Ω. 3 digit resolution.
Stability: Same as Amplitude.

OUTPUT
Main Out (50Ω): Source of primary waveforms.
Auxiliary Output: TTL pulse.

INPUT
Phase Lock In: TTL level, 10 Hz to 13 MHz.
VCG—Voltage Controlled Generator: Up to 1000:1 frequency change for sweep or FM.

GENERAL
GPIB Programming: IEEE-488 1978.
Stored Settings: 240 complete setups.
Environmental: Specifications apply for +25° ±10°C after 1hr unless otherwise noted. Operates from 0° to +45°C.
Dimensions: Fits standard 48.3 cm (19 in.) rack. 43.2 cm (17 in.) wide; 13.3 cm (5 in.) high; 58.4 cm (23 in.) deep. Has rack mount adapters.
Weight: 26.3 kg (58 lb) net; 30.8 kg (68 lb) shipping.
Power: 90 to 110V, 105 to 125V, 180 to 220V or 210 to 250V; 48 to 67 Hz; <200 watts.

OPTIONS
001: Display and Control Front Panel
002: 5 1/2 Digit Synthesizer
Frequency: 10 Hz to 12.9999 MHz.
Freq Res: 5 digits <10 MHz, 6 digits >10 MHz.
Accuracy: Better than 0.0005% of setting.
Frequency Stability
Short Term: ±1 $x10^{-7}$ of freq/day.
Long Term: ±1 $1x10^{-6}$ of freq/month.
Temperature: $1.2x10^{-7}$ per °C.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 172B
Option 001
Option 002

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

Pulse Generators

The Pulse Generator product line offered by Wavetek has been expanded by the acquisition of EHE Instruments. The EHE pulse generator product line is recognized for its technical innovations and uncompromisable ability to meet the test requirements of the latest assemblies and devices. These new products added to the Wavetek family extend the established Wavetek reputation with additional technical capability and higher performance.

Model 801 Bench Top Pulse Generator
The Model 801 bench top pulse generator offers low cost solutions at 50 MHz. Its pulse transition times range from 7 nanoseconds to 250 milliseconds.

Programmable Pulse Generators
The various models of programmable pulse generators provide multiple output channels, repetition rates up to 200 MHz, variable transition times from less than 1 nanosecond and variable amplitude/offset levels to greater than 20 volts. The output formats, normal and complement, and a variety of different, programmable operating modes such as burst and double pulse, give the instruments the flexibility to easily solve many test applications.

Ease of Use
Front panel controls are self explanatory and easy to use. To assist the operator and/or programmer in error-free use, the programmable instruments have an error detection feature. The ability to store pulse parameter setups enables a nonskilled operator to implement a test procedure simply by stepping through a sequence of pre-programmed states. This feature can also be used to reduce programming times and increase system throughput when repetitive tests are required.

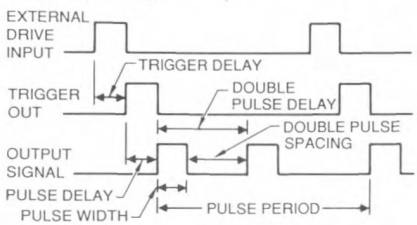
All of the programmable instruments offer IEEE 488 interfaces that allow quick and easy integration with other instruments when forming a test system. Additionally, the Model 859 is MATE compatible.

Pulse Parameter Definitions

Pulse Frequency: (Also called Repetition Rate.) Number of pulses per second.

Pulse Period: Time between the leading edges of two consecutive clock outputs. The reciprocal of frequency, T=1/f.

Pulse Delay: Time between the trigger out (sync pulse) and the leading edge of the output pulse. (Typically measured at the 50% points.)



Pulse Timing Relatonships

Trigger Delay: Time between an input stimulus signal triggering point and the leading edge of the trigger output. Applies to external drive, gate, burst and external width inputs.

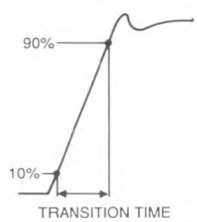
Pulse Width: Duration of time between the leading edge and trailing edge of a pulse. Measured at the 50% points.

Double Pulse: Two pulses occurring within the same clock period.

Double Pulse Delay: Duration of time between the 50% point of the first pulse leading edge and the 50% point of the second (double) pulse leading edge.

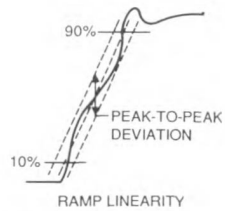
Double Pulse Spacing: Duration of time between the 50% point of the first pulse trailing edge and the 50% point of the second pulse leading edge.

Transition Time: Also referred to as risetime and falltime. The time measured between two reference points on the leading or trailing edge. Typically measured between the 10% and 90% points. With ECL signals the transition time is typically measured between the 20% and 80% points.



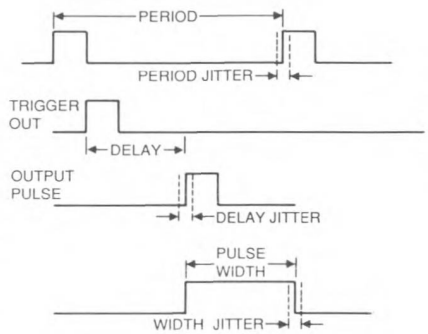
Transistion Time

Ramp Linearity: Peak-to-peak amplitude deviation of an edge from a straight line through the two measurement reference points. This is expressed as a percentage of the pulse amplitude.



Ramp Linearity

Jitter: Measurement of short term timing instability of one event with respect to another event. Jitter applies to repetition, period, delay and width. The measurement is expressed in percent of the primary parameter.

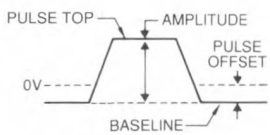


Period, Delay & Width Jitter

Pulse Amplitude: Voltage difference between the pulse baseline and the midpoint of the pulse top.

Pulse Offset: Biasing of the pulse baseline, in either polarity, to a DC level other than zero.

Pulse Levels: Expressed in terms of V_{High} and V_{Low} within a specified voltage range. Pulse amplitude is the voltage difference between these two levels.

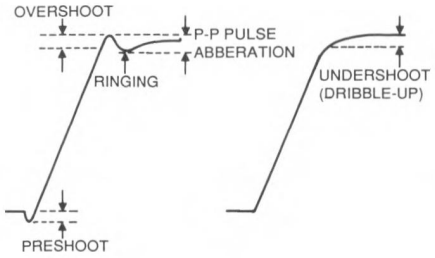


Voltage Levels

Duty Cycle: Ratio of pulse width to pulse period expressed as a percentage.

Waveform Distortion: Peak-to-peak pulse aberrations occurring at the four corners of a pulse. Also referred to as overshoot, undershoot (dribble-up), preshoot and ringing. These are expressed as a percent of amplitude.

INTRODUCTION

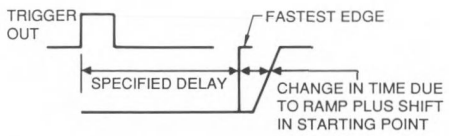


Waveform Distortion

Variable Transition Pulse Generators

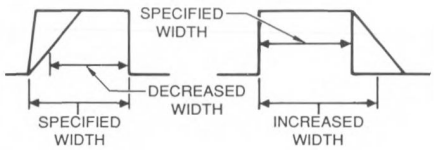
Ramp Generator: Pulse generator with variable rise and fall times.

Pulse Delay: Pulse delay is specified with the ramp generator set for the fastest leading edge transition. When the leading edge is changed to a slower time, the actual observed delay is the summation of specified delay, change in time of the 50% point of the edge and any shift in the edge starting point.



Pulse Delay

Pulse Width: Pulse width is specified with the ramp generator set for the fastest transitions of both leading and trailing edges. As the ramp times are changed, the observed pulse width will change, either increasing or decreasing depending upon the change in ramp time.

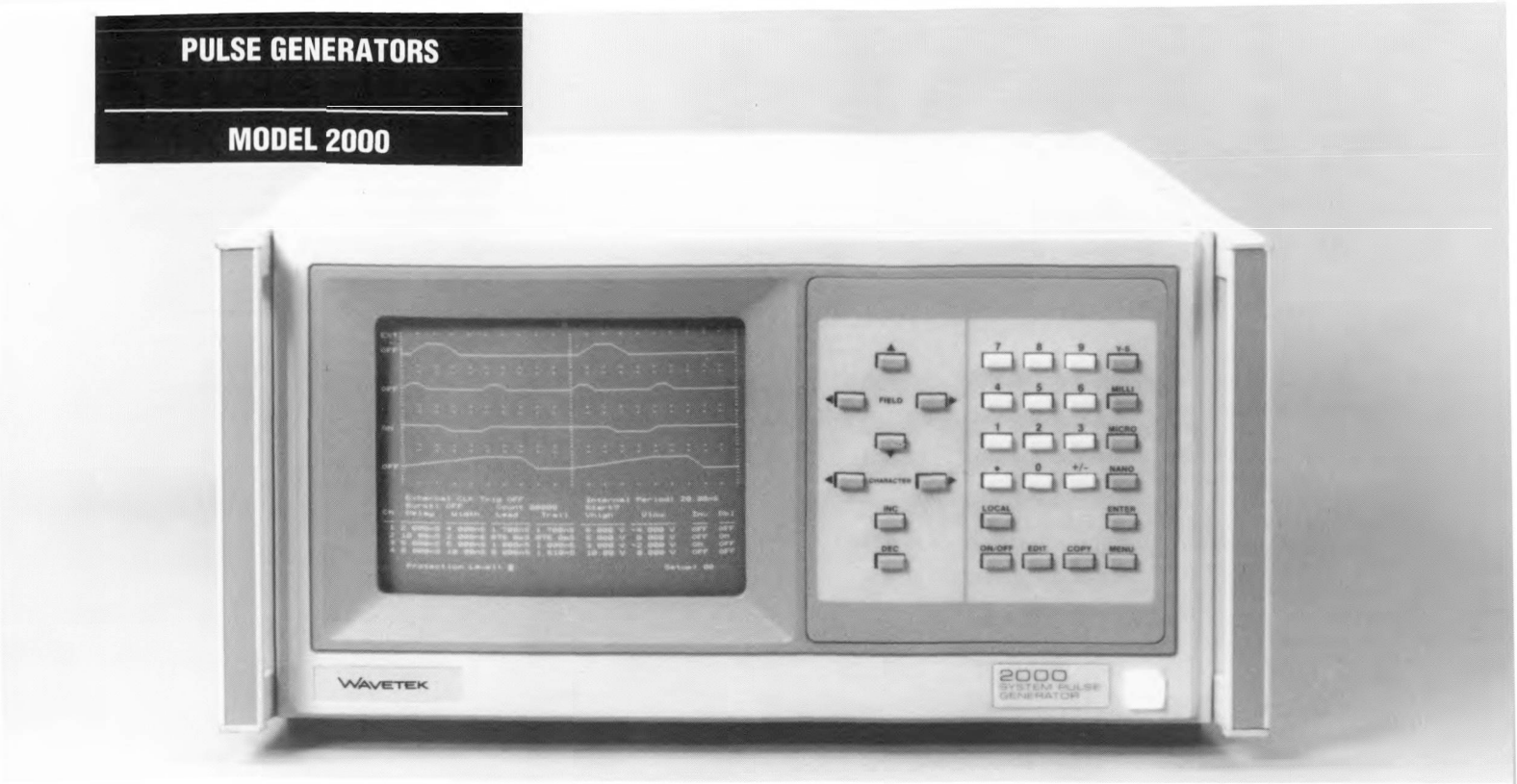


Pulse Width

PULSE GENERATORS SELECTION GUIDE

Model	801	859	1560	2000*
Freg Range	5Hz - 50 MHz	5Hz - 50 MHz	1Hz - 100 MHz	1Hz - 200 MHz
Transistion Time	7ns - 250ms	5.5ns - 25ms	<3ns - 800µs at <10V 5ns - 400µs at 20V	<320ps (2V Fxd Edge) <550ps (5V Fxd Edge) <1ns - 2.0µs (5V Var Edge) <2ns - 2.0µs (10V Var Edge)
Delay	20ns - 100ms	0ns - 999ms	3.3ns - 10ms	2ns - 1sec
Width	10ns - 100ms	10ns - 999ms	3.3ns - 10ms	2ns - 1sec 4ns - 1 sec (10V Var Edge)
Amplitude	0.5 - 10V	40mV - 20V	40mV - 22V	0.301 - 3V (2V Fxd Edge) 625mV - 5V (5V Fxd) 313mV - 5V (5V Var Edge) 625mV - 10V (10V Var Edge)
Offset	±20V	±20V	±22V	±4V (2V Fxd Edge) ±10V (5V Fxd & Var Edge) ±15V (10V Var Edge)
Number of Outputs	1	2	1	4
Other Outputs	TTL, ECL, $\overline{\text{ECL}}$	TTL, Clock		
Format	Normal & Complement	Normal & Complement	Normal & Invert	Normal & Invert
Duty Cycle	70%	90%	<50% Normal >50% Invert	<50% Normal >50% Invert
Trigger In	±10V	±5V	5V Max	
External Drive	Yes			
Gate	Gate On	Gate On	Gate On Gate Off	
Burst		1 - 10K		1 - 65K
Double Pulse	Yes			
Trigger Out			1.5V	1.0V
Clock Out	Yes			
Single Cycle	Yes			
Square Wave	Yes			
External Width	Yes			
Programmable	Yes			
Catalog Page	77	78	80	74

* With optional output channel modules:
5V variable edge pulses
10V variable edge pulses
2V fixed edge pulses
5V fixed edge pulses



200 MHz Programmable Pulse Generator

- **200 MHz Clock Rate**
- **Sub-nanosecond RiseTimes**
- **Complete Menu Driven Program Display**
- **Up to 4 Channels in a Single Mainframe**
- **5 and 10V Variable Edge, 2 and 5V Fixed Edge Plug-In Options**

Model 2000 is a versatile multichannel system pulse generator with repetition rates up to 200 MHz and programmable subnanosecond edge speeds.

Model 2000 is uncompromising in its ability to meet the test requirements of the latest electronic assemblies and devices, while still retaining the accuracy, stability and repeatability required by the most demanding test applications.

Output Channels
With several configurations available, the Model 2000 provides cost effective solutions to a wide variety of test problems. To furnish a variety of required pulses the mainframe may contain a mix of up to four independent channels. Six types of output channels are available. Modules that output fixed edge pulses and modules that produce variable edge pulses can be mixed in a single mainframe.

Channel Independence
The high and low voltage levels of a pulse may be specified on a channel by channel basis, allowing one mainframe to supply both the high voltage transitions required by CMOS logic families and the fast edge speeds and high repetition rates required by ECL, FAST and HCMOS. This depth of performance, all programmable, gives the Model 2000 an unequaled level of capability to provide solutions to the most demanding test applications.

Ease of Use
The suitability of the Model 2000 as a laboratory instrument is further enhanced through the use of clear and concise menu driven software and a CRT display. The display simultaneously carries a representation of the programmed waveform of each of the channels as they appear at the output connector, as well as a readout of all pulse parameters.

To modify a parameter, the cursor is moved to the field to be changed, and the value to be programmed is entered on a numeric keyboard or stepped by the increment/decrement keys. As each parameter is changed, the graphic display of the output waveforms will change accordingly, eliminating the need for the user to make time-consuming interpretations of purely numerical displays. Setups can be edited without affecting the output pulse being generated at that time.

Modes
A burst mode allows a stream of between 1 and 65,535 pulses to be generated. An inverted pulse mode allows duty cycles approaching 100% to be realized. The double pulse mode will output the first pulse at the start of the pulse repetition period and the second after the specified delay. The user has access to 40 stored setups, 5 of which are stored in non-volatile memory.

NEW

Fixed-Edge Modules
Model 2000 multi-channel system pulse generator has become even faster with the addition of two channel modules: P2002FE and P2005FE.

P2002FE expands the capability of the Model 2000 with a wide dynamic amplitude pulse range — pulses from 3V down to 300 mV over a V_{HI} range of –3 to +4V. The transition time is <320 ps.

P2005FE gives a larger amplitude and offset voltage range than the P2002FE. The P2005FE can test higher voltage logic devices with very fast transitions and ECL devices requiring input edge speed in the 500 ps range.

These output modules (P2002FE and P2005FE) and the variable ramp modules (P2005 and P2010) can be mixed in any combination within the Model 2000 chassis. For example, to satisfy your testing needs the configuration might consist of a single P2005 (5V variable ramp channel), a P2005FE (5V fixed-edge-speed channel) and two P2002FE (2V fixed-edge-speed channels). All programmable pulse parameters can be different for each channel. Internal clock rate is the same for all channels; however, each channel can be driven by independent external channel drive inputs. A word/pattern generator could be used as the signal source.

This combination of edge speed, range of amplitude/offset, and pulse timing gives unequaled ability to meet the test requirements of the latest generation of electronic assemblies and devices. And, the Model 2000 still retains the accuracy, stability and repeatability required by the most demanding test applications.

OUTPUT CHANNELS
Variable Transition
Options P2005, P2005E, P2010, P2010E. Refer to tables 1 and 2.
Fixed Edge Speed
Options P2002FE, P2005FE. Refer to tables 1 and 2.

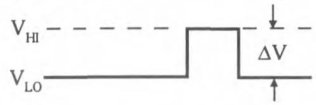
AVAILABLE PULSE VOLTAGE
Refer to table 1. To select the proper module:

Table 1. Available Pulse Voltages

Output Channel Module	Pulse Amplitude ΔV	Available Range for V_{HI}
P2005, P2005E	2.501 to 5.000 1.251 to 2.500 0.626 to 1.250 0.313 to 0.625	–5.00 to 10.00 –2.50 to 5.00 –1.25 to 2.50 –0.625 to 1.25
P2010, P2010E	5.001 to 10.00 2.501 to 5.00 1.251 to 2.50 0.625 to 1.25	–5.00 to 15.00 –2.50 to 7.50 –1.25 to 3.75 –0.625 to 1.87
P2002FE	0.301 to 3.00 [1]	–3.000 to 4.000
P2005FE	0.500 to 5.00 [2] 0.250 to 2.50 [3] 0.125 to 1.250 [4] 0.0625 to 0.625 [5]	–5.00 to 10.00 –2.50 to 5.00 –1.25 to 2.50 –0.625 to 1.25

Waveform specifications apply to:
[1] 1.000 to 2.000
[2] 2.501 to 5.000
[3] 1.251 to 2.500
[4] 0.626 to 1.250
[5] 0.313 to 0.625

1) Find your pulse amplitude in the Pulse Amplitude column.
2) Check that your required V_{HI} is available.
3) Calculate V_{LO} with $V_{LO}=V_{HI}$ - ΔV.
Values are given in volts.



CLOCK
External Clock Input: Positive edge triggering, levels <0.3V, >1.0V, 50Ω termination. Max level 5.5V. Max frequency 200 MHz.
Output: Positive edge, typically T_0 –12 ns, is +1.0V into 50Ω, >2.0V into high impedance.

TRIGGER/GATE
External Trigger Input: ECL level inputs, –1.6V to –0.8V typical (0V and –2V max). Max frequency 200 MHz.
Trigger Output: Positive edge at time T_0: +1.0V into 50Ω, >2.0V into high impedance. (Must be terminated during use.)

BURST
Pulses Per Burst: 1 up to 65,535. Maximum is frequency range dependent.
Start Input: TTL compatible, positive edge triggered.
Burst Complete Output: 0V for duration of burst, >+1.0V on completion.

GENERAL
Jitter: <0.1% of setting ±25ps.
Applicable to pulse repetition period, delay and width parameters.
Signal Connectors: Pulse outputs are SMA; all others are BNC.
Power: 100/120 Vac ±10%, 60Hz; 200/240 Vac ±10%, 50 Hz; 350W max.
Operating Temp: 0° to +50°C (Accuracy specifications apply at +20°C. Apply derating factor of 0.05%/°C to period, V_{HI}, V_{LO}. Add 0.1%/°C to width and delay).
Storage Temp: –40° to +70°C.
Dimensions: 22.3 cm (8.75 in.) high, 43.2 cm (17 in.) wide, 58.4 cm (23.1 in.) deep.
Weight
Chassis: (With front panel and no outputs) 34 kg (75 lb) net.
Output Channel: 1.6 kg (3.5 lb) net.
Shipping: (With 4 Channels) 50 kg (110 lb).

OPTIONS
P2002FE: 2V Fixed Edge Output Channel Module. Has extended width and delay ranges.
P2005: 5V Variable Transition Output Channel Module.
P2005E: P2005 with extended width and delay ranges.
P2005FE: 5V Fixed Edge Output Channel Module. Has extended width and delay ranges.
P2010: 10V Variable Transition Output Channel Module.
P2010E: P2010 with extended width and delay ranges.

ACCESSORIES
350-31273: Rack Mount Slides.
350-31092: Rack Mount Ears.

Table 2. Output Channel Module Specifications

	VARIABLE EDGE [4]		FIXED EDGE [4]	
	5V P2005, P2005E [3]	10V P2010, P2010E [3]	2V P2002FE [3]	5V P2005FE [3]
PULSE REPETITION **Period** **Frequency** **Program Accuracy**	5ns to 1s 1Hz to 200 MHz ±2% of setting			
PULSE WIDTH [1] **Range** **Extended Range** [3]	2ns to 26 µs 2ns to 1s	4ns (2.5 typ.) to 26 µs 4ns (2.5 typ.) to 1s	2ns to 1s	
Program Accuracy	±2% ±1ns (<26 µs) ±5% (≥26 µs)			
TRANSITION TIMES	<1ns to 2µs at 5V (10 to 90% of ampl.)	<2ns to 2µs at 10V (10 to 90% of ampl.)	<320 ps, 1 to 2V (20 to 80% of ampl.)	<550 ps, 2.5 to 5.0V (10 to 90% of ampl.)
Program Accuracy	±2% ±1ns		Not applicable	
PULSE DELAY [1] **Range** **Extended Range** [3]	2ns to 26 µs 2ns to 1s			
Program Accuracy [2] **Referenced to T_0**	±2% ±1ns (<26 µs) ±5% (≥26 µs)			
DOUBLE PULSE MODE SPACING	>5ns or 2x width (Pulse period >10 ns)	>10 ns or 2x width (Pulse period >20 ns)	>5ns or 2x width (Pulse period >10 ns)	
PULSE LEVEL **Program Accuracy**	±2% of Vp-p ±25 mV	±2% of Vp-p ±50 mV	±2% of Vp-p ±15 mV	±2% of Vp-p ±25 mV
WAVEFORM DISTORTION	±5% ±175 mV	±5% ±350 mV	±10% ±100 mV	±5% ±175 mV
RAMP LINEARITY [2]	±5% of pulse amplitude		Not applicable	

1 Delay and width parameters are not calibrated beyond >50% of period. Duty cycles approaching 100% may be implemented using Inverted Pulse mode. Add a constant delay of 4.5 ns to delay specifications for chassis with mixed variable and fixed-edge modules.

2 For transition times ≥10 ns.

3 Extended width and delay module specifications (P2005E, P2010E, P2002FE and P2005FE).

4 All timing specifications apply only at full amplitude and fastest rise/fall times.

FACTORY (FOB)
San Diego, CA

ORDER INFORMATION
Model 2000
Option 2002FE
Option 2005
Option 2005E
Option 2005FE
Option 2010
Option 2010E
Access. 350-31273
Access. 350-31092

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

50 MHz Pulse Generator

- **5 Hz to 50 MHz Frequency Range**
- **Variable Rise and Fall Times**
- **20 Volt Output**
- **Single and Double Pulses with Pulse Burst**

With five simultaneous outputs, a top frequency of 50 MHz, variable rise and fall times, amplitudes up to 20 volts and many operating modes, Model 801 is an excellent low cost pulse generator.

Multiple Outputs
Outputs are ECL, $\overline{\text{ECL}}$, TTL, sync and a variable amplitude pulse. The upper and lower levels of the variable pulse are independently adjustable from -20 to +20 volts. The maximum output is a full 20 volts peak-to-peak.

Triggering
Trigger and gate can be on the rising or falling edge of the trigger signal. The trigger signal acceptance level can be adjusted.

Variable Rise and Fall
Rise and fall transition times of the variable amplitude pulse can be independently adjusted.

Modes
Operating modes include Continuous, Triggered, Gated, Double Pulse, External Width and Trigger Burst.

TIME DOMAIN
Period: <20 ns to >200 ms in 7 overlapping ranges.
Jitter: <0.1% plus 50 ps.
Width: <10 ns to 100 ms in 7 overlapping ranges.
Max Duty Cycle: 70% for periods down to 200 ns, decreasing to 50% for 20 ns periods. Switch has a square wave detent.
Square Wave Duty Cycle: 50 ±4% to 2 µs period changing to 50 ±15% at 20 ns period.
Jitter: <0.1% plus 50 ps.
Delay: <20 ns to >100 ms in 7 overlapping ranges.
Max Duty Cycle: 70% for periods down to 200 ns, decreasing to 30% for 20 ns periods.
Jitter: <0.1% plus 50 ps.
Transition Time: For variable amplitude pulse only. Independently adjustable leading and trailing edges from <7 ns (5 ns typical) to 250 ms (10 to 90%) in 7 overlapping decade ranges.
Linearity: ±5% for transition >10 ns, measured between 10 and 90% points on pulse.

MAIN OUTPUT PULSE
Variable Amplitude: Upper and lower pulse levels are independently adjustable.
Source Impedance: 50Ω.
Normal/Complement (Invert) Control: Normal pulse or its complement is selectable.
Dynamic Range
Into Open Circuit: ±20V.
50Ω Terminated: ±10V.
Max Amplitude
Into Open Circuit: 20 Vp-p.
50Ω Terminated: 10 Vp-p.
Min Amplitude
Into Open Circuit: 1 Vp-p.
50Ω Termination: 0.5 Vp-p.
Overshoot and Ringing: <±(5% of amplitude setting +100 mV) into 50Ω load.
Preshoot: <±(5% of amplitude setting + 100 mV) into 50Ω load.

SYNC OUTPUTS
Fixed TTL Outputs
Pulse Levels into 50Ω: <0.4 to >2.4V.
Transition Time: <10 ns.
Fixed ECL and ECL Outputs
Pulse Levels with 50Ω Termination: -0.9 to -1.8V.
Transition Time: <6 ns.
Sync Output: 0 to ≥+1V from 50Ω source.

TRIGGER
Front panel pushbutton or external signal.
External Trigger: Triggering is selected to occur at either rising or falling edge of trigger signal; triggering level is adjustable to be between ±4V.
Min Amplitude: 200 mVp-p to 5 MHz increasing to 600 mVp-p to 50 MHz (from 50Ω source).
Max Amplitude: ±10V.
Min Width: 10 ns.
Impedance: 1 kΩ in parallel with 22 pF.

GENERAL
Temperature: Specifications apply at +23° ±5° C after 1 hour warm-up. Instrument will operate from 0° to +50° C.
Dimensions: 28.6 cm (11.25 in.) wide; 13.3 cm (5.25 in.) high; 29 cm (11.25 in.) deep.
Weight: 5.4 kg (12 lb) net; 6.8 kg (15 lb) shipping.
Power: 90 to 130 Vac or 180 to 250 Vac; 50 to 400 Hz; 60 watts nominal.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 801

For full specifications or a demonstration contact your nearest Wavetek representative (pages 211 and 213).

MODEL 859

50 MHz Pulse Generator

- **0.5 Hz to 50 MHz Frequency Range**
- **Full 20 Volt Output**
- **Variable Transition Times**
- **Second Channel Output Option**
- **GPIB and Stored Settings**

Model 859 is fully programmable for systems applications. Pulse widths, delays, transition times and output levels can be varied with 3 digit resolution. Extreme accuracy and microprocessor assisted programming ensure that the generator is producing exactly the pulse you want without having to verify its output. Output may be one pulse per period, double pulses or symmetrical square. Pulses may also be complemented.

Modes
Operating modes include continuous, triggered, gated burst, external width mode to reconstruct or shape an external signal, and unique time interval mode for extremely long pulses.

Trigger Status
Trigger status is always shown. Front panel annunciators indicate manual or GPIB trigger selection, external rising or falling edge triggering, and trigger presence.

Channel Independence
An optional second channel output is independent of the first channel parameters except a common repetition rate and mode.

GPIB Programmable
Model 859 is fully compatible with the IEEE-488 1978 standard for your GPIB system. The combination of LED annunciators and alphanumeric display easily verifies your setup, and in case of a programming error, an error message is displayed and the bus controller is informed.

Parameter Independence
You can vary a pulse parameter with full assurance that the other parameters remain exactly as programmed. If your new parameter value is not compatible with the existing setup you are informed by an error message on both the display and the bus. Error checking is delayed until the entire set of new parameters has been entered and executed. There are no false errors due to the order in which you program a setup.

Stored Settings
You can store and recall up to 25 complete setups in battery-backed RAM.

Rapid Incrementing
You can increment or decrement a single parameter value by vernier. Increment rate is determined by the digit selected to be incremented; i.e., unit digit, tens digit, etc.

FUNCTIONS
Single: One pulse each pulse period. Up to 50 MHz repetition rate.
Double: One pair of pulses each pulse period. Up to 25 MHz repetition rate. Both pulses have programmed width. Position of 2nd pulse set by delay control.
Square: Pulse is fixed-symmetry (50% duty cycle) up to 50 MHz repetition rate with variable transition times to 5.5 ns. 50% ±2% ±2 ns to 25 MHz. 50% ±10% ±2 ns for >25 MHz.
Inhibit: Disconnected output and no error checking on channel.

MODES
Continuous, Triggered, Gated, Burst, External Width and Time Interval.

MODEL 859

Burst: Programmed number of pulse periods from 1 to 10,000.
External Width: Trigger duration and rate sets pulse width and repetition rate.
Time Interval: Trigger causes one pulse with programmed width.
Width: 20 ns to 9999s.
Resolution: To nearest 20 ns for width <100 µs; to 4 digits for width ≥100 µs.
Accuracy: 2 % ±2 ns.
Duty Cycle: 90% limited by 100 ns off time.

TIME DOMAIN

Repetition Rate
Frequency Range: 0.5 Hz to 50 MHz.
Period Range: 20 ns to 2s.
Resolution: 3 digits of programmed value.
Accuracy: 2% ±1ns.
Repeatability: 2% ±1 ns.
Jitter: ±0.1% ±50 ps.

Width: Main channels only.
Range: 10 ns to 999 ms.
Resolution: 1 ns from 10 ns to 19.999 µs; 3 digits of programmed value from 20 µs to 999 ms.
Accuracy: ±1% ±2 ns.
Repeatability: ±1% ±1 ns.
Duty Cycle: 90% limited by 10 ns minimum off time.
Jitter:
±0.1% ±50 ps width <1µs;
±0.05% width 1 to 10 µs;
±0.005% width >10 µs.

Delay: Main channels only.
Range: 0ns to 999 ms.
Resolution: 1 ns from 0 to 19.999 µs; 3 digits of programmed value from 20 µs to 999 ms.
Accuracy: ±1% ±2 ns.
Repeatability: ±1% ±1 ns.
Duty Cycle: 90% limited by 10 ns minimum off time for delay <25 ns and by 20 ns minimum off time for delay ≥25 ns.
Jitter:
±0.1% ±50 ps delay <1 µs.
±0.05% delay 1 to 10 µs.
±0.005% delay >10 µs.

Transition Time: Main channel pulses leading and trailing edge transition times independently adjustable from 5.5 ns to 25 ms (10% to 90% points of programmed amplitude).
Ranges: Six ranges. Leading and trailing edge times must be in the same range.
Resolution: 3 digits of programmed value when both transitions are in the first 10:1 portion of their transition time range, decreasing to 2 digits at 50:1.
Accuracy: ±5% ±2 ns.
Linearity: ±3% for transitions >50 ns.
Repeatability: ±1% ±1 ns.

System Delays: Fixed trigger input to sync output delays for each mode.
Triggered: 60 ±10 ns.
Gated: 100 ±10 ns.
Burst: 100 ±10 ns.
External Width: 40 ±10 ns.
Time Interval: 80 ±10 ns.

MAIN OUTPUT PULSE

Pulse Characteristics: Refer to table 1. Upper and lower pulse levels are independently programmable. Pulses of either output channel may be normal or complement.

SYNC OUTPUT

A square wave of approximately -0.6 to 3V from 50Ω source at lowest frequency in generator system.

CLOCK

Output: Approximately -0.6 to 3V pulse from 50Ω source, 50% duty cycle and with programmed repetition rate in continuous, gate and burst modes.

TRIGGER/GATE

Manual Trigger: Front panel key. In Gate and External Width modes, output active while key depressed.
External Trigger Input: Arbitrary trigger signals accepted. Rising or falling edge triggering selectable.

GPIB

Convention: IEEE-488 1978 compatible. Optical isolation.
Capabilities: AH1, L4, SH1, T6, SR1, RL1, DC1, and DT1.
Trigger: ASCII "J". In Gate and External Width modes, "H" signals end of active interval.

GENERAL

Features
Trigger Indicator: Indicates triggering, burst or time interval is in progress.
Nonvolatile Stored Settings: 25 complete front panel setups can be stored and recalled from internal memory. 30 day back-up time.

Temperature/Environment: Specifications apply for +25° ±5° C after 30 minute warm-up. Instrument operates from 0° to +50° C.
Dimensions: Fits standard 48.3 cm (19 in.) rack. Dimensions behind front panel are 43.2 cm (17 in.) wide; 13.3 cm (5.25 in.) high; 58.4 cm (23 in.) deep. Supplied with rack mount adapters.
Weight: 26.3 kg (58 lb) net; 30.4 kg (67 lb) shipping.
Power: 90 to 105V, 108 to 128V, 198 to 231V or 216 to 252V; 48 to 66 Hz. Single channel, 200 VA. Dual channel, 250 VA.

MODEL 859MATE

MATE certified 859 with MATE CIIL Standard 2806763 Rev. B.

OPTION

001: Additional Channel. Channels share operating mode and internal clock period only. All other functions and parameters are channel independent.

NOTE: Specifications apply with transition time set to minimum and the 50Ω source driving a 50Ω load.

FACTORY/FOB

San Diego, CA

ORDER INFORMATION

Model 859
Model 859MATE
Model 859MATE/001
Option 001

For full specifications or a demonstration, see your local Wavetek representative (pages 211 and 213).

Table 1. Pulse Characteristics[1]

Characteristics	SOURCE[2]	
	Hi Impedance	50Ω
Upper Level Range	-12.00 to +20.00V	-9.96 to +10.0V
Lower Level Range	-20.00 to +12.00V	-10.0 to +9.96V
Resolution (digits of programmed value)	3 digits (20 mV)	3 digits (10 mV)
Amplitude	8.00 to 20.00V	40 mV to 10V
Accuracy	3% of Level programmed value (either Upper or Lower Level) ±1% of Amplitude ±100 mV	2% of Level programmed value (either Upper or Lower Level) ±1% of Amplitude ±50 mV
Repeatability	(Highly dependent upon cable length and load impedance)	±1% of Amplitude ±50 mV
Preshoot		±3% of Amplitude ±10 mV
Overshoot & Ringing		+5%, -3% of Amplitude ± 10 mV

[1]Specified with 50Ω load impedance.
[2]Source impedance (Hi or 50Ω) is selected automatically.

100 MHz Programmable Pulse Generators

- **Microprocessor-Controlled CMOS and Bipolar Pulse Driver**
- **100 MHz Capability**
- **Variable Rise Time From 3 ns to 800 μs**
- **22 Volt Output With High and Low-Limit Settings**
- **IEEE-488 and RS-232C Interfaces Standard**

Model 1560 is a fully programmable, fast rise time, general purpose pulse generator, useful for automatic test equipment (ATE) applications. Typical uses include fast discrete device testing, integrated circuit testing, module, subassembly, and subsystem testing.

Local or Remote Control
With programmable pulse generator techniques developed in over 20 years of test equipment design and manufacture, Model 1560 provides a wide range of pulse parameters which are completely programmable with either IEEE-488 or RS-232C interfaces. Front panel controls allow easy setup and full manual control for troubleshooting.

Adjustable Pulse Shape
Full control of pulse shape gives the Model 1560 the capability to match and test signal requirements precisely, or to adjust output rise time and amplitude to meet changing bandwidth requirements in the system.

All Parameters Displayed
An LED display shows values of the current program or stored programs for each pulse parameter including single and double pulse modes, external trigger, and inverted pulse. A unique feature of this instrument is that all parameters are displayed simultaneously within each program. Through the use of the internal microprocessor and error checking, common problems with pulse setup have been eliminated.

Stored Settings
Up to 80 independent programs can be stored in the internal registers. These programs can then be called up at random from the front panel, or by the remote controller.

MODES
Normal and inverted.

TIME DOMAIN
Repetition Frequency: 10 ns (100 mHz) to 1s (100 MHz) internal period. Continuously variable. External trigger source 0 to 100 MHz.
Jitter: <0.1% of setting.
Width: 3.3 ns to 10 ms in 7 decade ranges.
Duty Factor: Typically >50%. Effective duty factors approaching 100% in inverted polarities.
Jitter: <0.1% of setting.
Delay: 3.3 ns to 10 ms in 7 decade ranges with respect to T_0.
Duty Factor: Typically <50%. Effective duty factors approaching 100% in inverted polarities.
Jitter: <0.1% of setting.

MODEL 1560

MAIN OUTPUT

Amplitude: Programmed as V_{HI} and V_{LO}. See baseline offset.

Baseline Offset: ±39 mV to ±22V into 50Ω. With 50Ω internal backmatch selected, the 1560 will deliver up to 10V into a 50Ω terminated line. With backmatch switched out the output current source can deliver up to 22V into 50Ω. High and low levels may be set anywhere between the two limits so long as one level is within 5V of ground. For ΔV_{HI} and V_{LO} >10V, high and low-level polarities must be opposite.

Ramp Linearity (measured between 10% and 90% points):
From 10 ns to 100 ns: <±5%.
Above 100 ns: <±1.5%.

Rise/Fall Times: <3 ns to 800 µs for amplitudes <10V; for amplitudes ≥10V, 5 ns to 400 µs. Separate rise and fall verniers.

Waveform Distortion: <5% p-p for all amplitudes and for rise and fall times >3 ns.

TRIGGER/GATE

External Trigger Input: Input drive signal must go from <0.3V to >+1.3V into a 50Ω load. Maximum. input 5V. Maximum frequency 100 MHz.

Trigger Output: >+1.5V into 50Ω; >+3V into high impedance. Width 5 to 100 ns depending on frequency. Two additional clock outputs available. Output levels same as trigger output. Clock outputs are nominally 25 to 30 ns early with respect to trigger output.

Synchronous Gate: Input drive signal must go from <+0.3V to >+1.3V into a 50Ω load. Both Gate On and Gate Off modes are under program control.

Asynchronous Gate: Input drive signal must go from <+0.75V to >+1.5V into a 50Ω load. Gate Off operation only.

DOUBLE PULSE OPERATION

Single or double pulse selectable under program control. Minimum double pulse period 20 ns. Minimum pulse spacing (leading edge to leading edge) 10 ns or 2 times programmed width, whichever is greater.

CONTROL

Programming Accuracy: (Includes all programming options.)
Period: ±1% of setting. ±1% of full scale.
Delay and Width: ±5% ±3 ns (Delay and width programmed to fastest ramps).
V_{HI} and V_{LO} Levels: ±5% ±5mV of setting for output >±40 mV.
Rise/Fall Times: ±5% ±3 ns.

Logic Levels: Conforms to IEEE standards.

Settling Time: <2.5 ms for attenuation and polarity; <750 µs when going to or from ramp ranges 0 and 1.

Repeatability: ±1% of setting.

GPIB

IEEE-488 Interface: Rear panel switch for address selection.

Subsets: SH1, T0, TE0, AH1, L4, LE0, SR0, PP0, RL2, DC1, DT0.

GENERAL

Indicators: Remote, Channel Number, Program Number, Edit Designator and Pulse Parameters.

Rear Panel Signal Connectors: Clock Out (2 each), Trigger Out, External Drive, Async Gate, Sync Gate, Delayed Output, Remote (Slave), RS-232, GPIB I/O and GPIB Address. All BNC.

Operating Temperature: 0° to 55° C.

Temperature Coefficient of Pulse Parameters
Period: ±0.05%/°C.
Width and Delay: ±0.1%/° C.
V_{HI} and V_{LO}: ±0.05%/° C.

Dimensions: 48.2cm (19 in.) wide, 13.3cm (5.25 in.) high, 48.2cm (29 in.) deep.

Power: 100, 117, 200, 217, or 234 Vac ±10%, 50 to 60 Hz, approx. 200W.

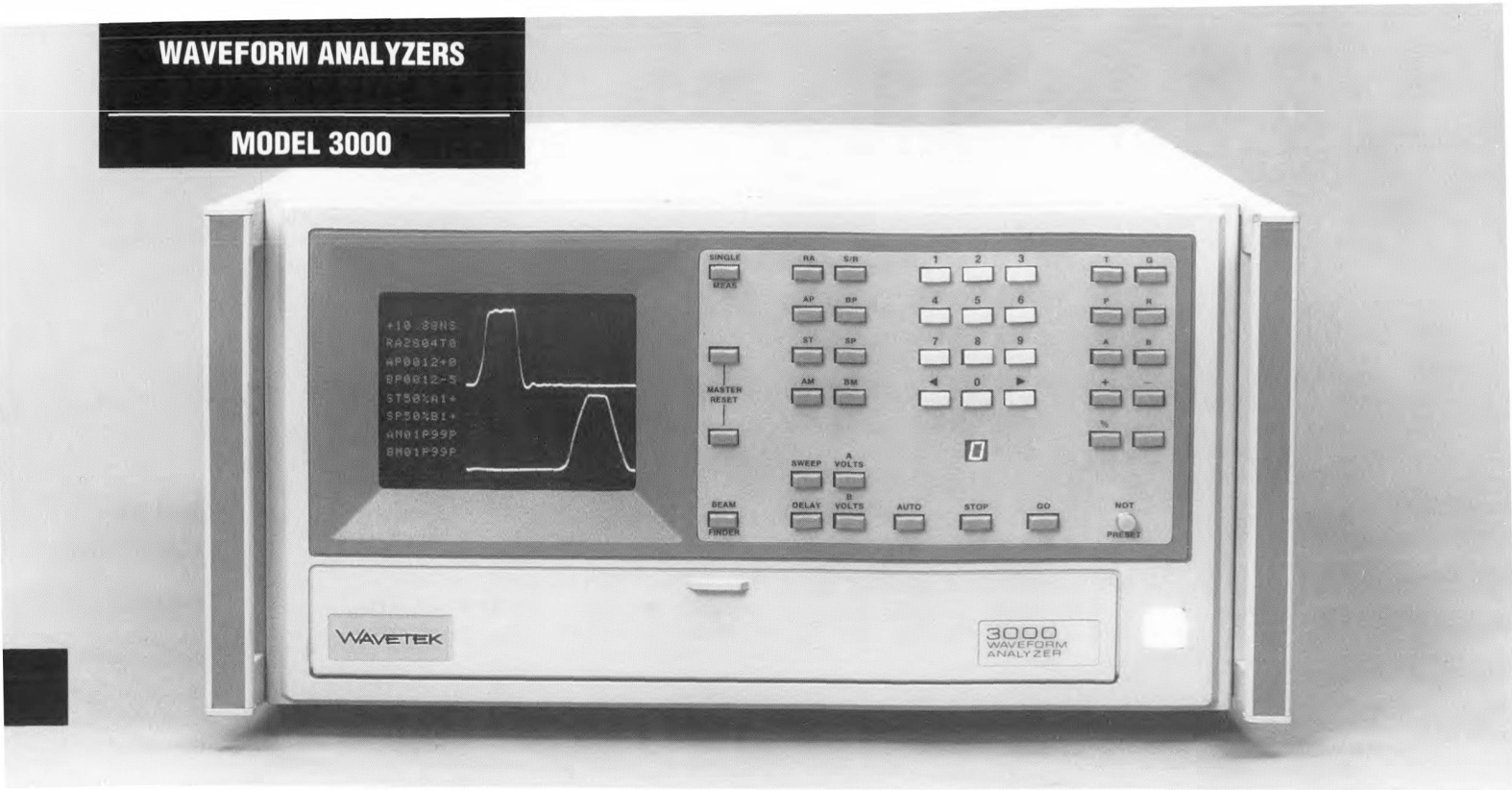
OPTIONS
003: Bench Mount
004: Chassis Slide Kit
005: Extender Board
007: Burst Mode

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 1560
Option 003
Option 004
Option 005
Option 007

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

MODEL 3000



1 GHz Programmable Waveform Analyzer

- **100 Measurement Points with Full 1 GHz Bandwidth**
- **1000 Dots Digital Waveform Storage on Both Inputs (Waveform Recording)**
- **Autoscan™: Automatic Search for the Signal of Interest**
- **IEEE-488 Interface Standard**
- **Microprocessor-Controlled Waveform Analyzer**

Model 3000 Waveform Analyzer is excellent for applications calling for the automated test and characterization of multi-pin, high speed semiconductor devices or assemblies. When configured with Model 3020 Probe Multiplexers, Model 3000 becomes a 100 channel, 1 GHz bandwidth, digital readout sampling oscilloscope. Innovative design of the Waveform Analyzer, Probes and Multiplexers allows a unique combination of measurement speed, resolution and accuracy, with unequalled system throughput, repeatability and dependability. Flexible control of this performance — both on the bench and via the IEEE-488 interface — allows automated determination of parameters such as transition times, propagation delays, pulse widths, overshoot, undershoot and other pulse aberrations. To meet future test requirements, Model 3000 is modular and can be expanded or upgraded.

Sampling Method
Sequential Equivalent Time Sampling offers a cost effective, high accuracy, fast, multi-channel solution for repetitive signals in a typical automated test environment.

Very fast measurements, up to 40 per second, with high repeatability, provide high speed and accuracy, enhancing both measurement confidence and system throughput.

Very Low Jitter
The timebase accuracy of 1.2% of full scale is made possible by the exceptionally low trigger to sample jitter introduced by Model 3000. The 3000 is particularly suited for measurements on fast pulse trains.

Measurements
Voltage levels are made with 12-bit digital resolution. Stability is better than ±2 mV per day, and noise is less than 1 mVp-p for the duration of a sweep. Absolute voltage measurements may be made in the reference mode. A reference is used for only the first 10 samples (i.e., 1%) of the measurement cycle. Voltage measurements may then be made relative to these ten samples. The high stability of the measuring circuitry will introduce no significant drift during the time period. Model 3000 allows the user to specify the start and stop points for time domain measurements as a percentage of a transition, an absolute voltage level, or a combination of both.

Pulse distortions such as glitches, overshoot and undershoot may adversely affect measurements. Model 3000 has the ability to eliminate these aberrations, enhancing the quality of the test. However, these distortions may be of interest since they could impair the the circuit. Model 3000 offers the ability to examine the waveform specifically for these properties, either in the time or voltage domain. The measurement method does not depend on the accurate positioning of markers or cursors. Therefore the results from one test cycle to the next will be repeatable, even if the horizontal and vertical positions of the waveform are not constant.

Frequency Synchronization

Model 3000 is able to synchronize to an unattended trigger from DC to 225 MHz; if the frequency is changed, it is not necessary to adjust stability controls.

Additional Features

Other programmable features include the averaging of ten measurements, the Autoscan facility to automatically find a waveform and the short sweep mode. Short sweep allows the instrument to stop taking samples once the measurement has been completed, increasing system throughput still further.

Stored Settings

The user has access to 10 stored setups (16 over the IEEE-488 interface), each of which may be recalled, edited and stored — either by a series of front panel keystrokes or from a remote controller.

Probe Multiplexer

Model 3020 Probe Multiplexer accepts up to 20 signal inputs, and multiplexes them for use by the Model 3000. Up to 5 Model 3020's can be used at a time, increasing the number of input signals accepted by the Model 3000 from 2 to 100.

TIMEBASE

Ranges: 200 ps per division to 100 ms per division, (Full scale = 10 div) in a 1-2-5 sequence. (Real time sampling in effect at >0.5 ms/div.).
Resolution: 1/1000 of full scale (2ps at 200 ps/div.).
Delay Programming: (Only available in Equivalent Time mode.) 0% to 99% of full scale in 1% increments.
Measurement Accuracy: ±1.2% of full scale.
Sampling Rate: 50 Hz to 80 kHz.

VOLTAGE

Ranges: 2 mV/div. to 10 V/div., in a 1-2-5 sequence. (>100 mV/div. requires use of probe tip attenuators.)

Table 1. Probe Input Characteristics

Probe & Attenuator Options	Capacitance	Resistance	Dynamic Range	Overload
Without Attenuator	1.5 pF	>10 MΩ	±1.0V	±3.0V
With X1 Attenuator Tip	2.5 pF	100 kΩ	±1.0V	±3.0V
With X5 Attenuator Tip	2.5 pF	1 MΩ	±5.0V	±15.0V
With X10 Attenuator Tip	2.5 pF	1 MΩ	±10.0V	±30.0V
With X100 Attenuator Tip	2.5 pF	1 MΩ	±100V	±200V

Resolution: 12 bits (1 in 4096) with full scale signal. (Full scale = 10 div.)
Offset Programming: ±0% to ±90% of full scale in 10% increments.
Measurement Accuracy: ±2% of full scale (relative measurements). ±2% of full scale ±10 mV (absolute, reference mode).

TRIGGERING

Unattended Trigger Rate: DC to 225 MHz, >2 ns pulse width.
Trigger Jitter: Typically 5 ps with optimum trigger level and slew rate >1V/ns. Typical figure, only applicable at minimum delay and fastest sweep settings. <20 ps to 20 MHz, <50 ps to 225 MHz.
Input Impedance: 50Ω nominal.
Threshold Level: To ±2.5V manually set, preset to ±0.5V.
Maximum Level: ±5.0V.

GENERAL

Environment: 0° to +45°C operation, -40° to +70°C storage.
Power: 100V/120V ±10%, 60 Hz. 200V/240V ±10%, 50 Hz.
Power Consumption: 250W.
Dimensions: 22.2 cm (8.75 in.) high, 48.3 cm (19 in.) wide, 63.5 cm (25 in.) deep.
Weight: 24.52 kg (54 lb) net, 31.34 kg (69 lb) shipping.

MODEL 3010 1 GHz SAMPLING PROBE

Input Characteristics: See Table 1.
Bandwidth: DC to >1 GHz, at -3dB (risetime <350 ps).
Error in Transient Response: <3%.
Coincidence: <±75 ps error between probe 00 and any other probe connected to the Model 3020.
DC Stability: 2 mV per day, after 30 min warm-up.
Noise: <200 µV tangential (1 mVp-p).

MODEL 3020 PROBE MULTIPLEXER

Probe Connections: 20 rear panel connectors. Accepts up to 20 Model 3010 Remote Sampling Units.
Probe Time Coincidence: ±75 ps maximum error between probe 00 and any other probe connected to the same Model 3020 (each probe adjusted to the given port).
Power Requirements: 100V/115V ±10%, 50-60 Hz, 0.75 Amp or 230V ±10%, 50-60 Hz, 0.5 Amp.
Dimensions: 48.3 cm (19 in.) wide, 8.9 cm (3.5 in.) high, 63.5 cm (25 in.) deep. Replacement only.
Weight: 11.4 kg (25 lb).
Control Cable: 1.5 m long (5 ft).
DCM: 37P Connector with Slide-Lock at each end.

TRIGGER SPLITTER (OPTION 340-300 11)

Provides 1 to 5 trigger signals for Model 3020 multiplexer/s. All 5 SMA outputs must be terminated to Model 3020 multiplexer/s or provided 50Ω terminator.
Trigger splitter is required when using Model 3020 multiplexer/s.
Trigger Cables: 1.5 m long (5 ft) RG-58AU; SMA connector at one end, BNC female at other end (5 ea.).
Probe Connector Terminator: 50Ω terminator for unused probe connector on Model 3000 when using trigger splitter.

OPTIONS

340-30011: Trigger Splitter
693-41521: X1 Probe Tip Attenuator
693-31857: X5 Probe Tip Attenuator
693-41522: X10 Probe Tip Attenuator
693-41523: X100 Probe Tip Attenuator

ACCESSORIES

350-31273: Rack Mount Slides
350-31092: Rack Mount Ears

FACTORY/FOB

San Diego, CA

ORDER INFORMATION

Model 3000
Model 3010
Model 3020
Option 340-30011
Option 693-31857
Option 693-41521
Option 693-41522
Option 693-41523
Access. 350-31092
Access. 350-31273

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

Introduction to the Wavetek Signal Generators

The 2500 family of synthesized signal generators presently consists of our models, the 2500A, 2500C, 2510A and 2520A. These instruments have many features in common that make them the easiest signal generators available to use.

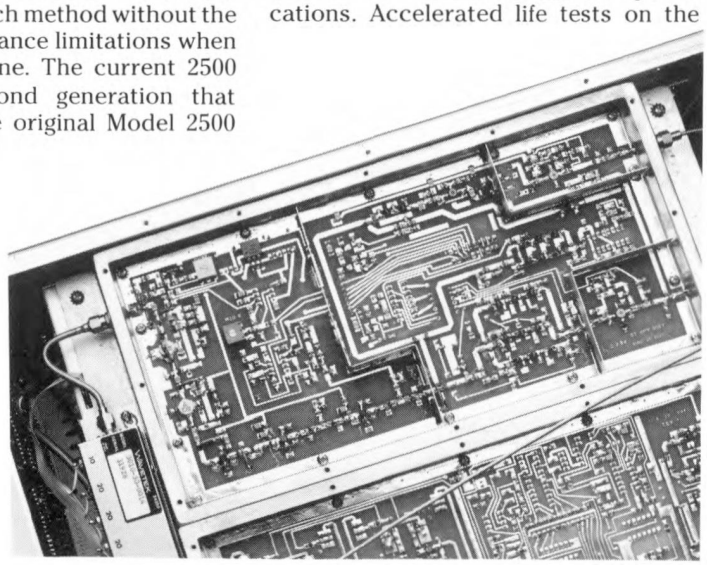
- Bright easy to read display
- Data entry by keypad or analog type spin knob
- Spin knob control of any displayed digit selected by cursor
- RF on/off switch
- ±1 dB output accuracy (2500A, 2500C, 2510A)
- <60 dBc spurious typically
- 64 non-volatile front panel stored settings
- 50 watt reverse power protection
- Automatic start-up verification test
- Extensive diagnostic package
- Software assisted AutoCal routine
- 10 Hz resolution
- +13 to -137 dBm RF output

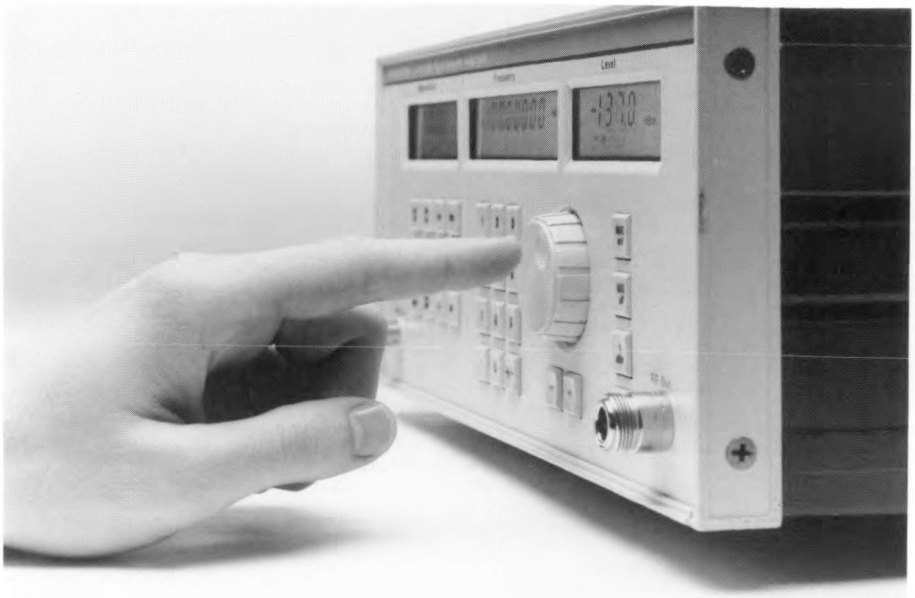
General

Wavetek RF Products Division produced the first solid state multi-loop, phase locked synthesized signal generator, which was introduced in 1974. For many years the 3000 series generators were the standard for in channel receiver tests and other applications requiring accurate frequency and output levels and moderate signal purity.

In 1986 Wavetek introduced the Model 2500, which was the first of a new family of microprocessor based signal generators utilizing a combination of phase lock loop technology and direct digital synthesis. This combination resulted in the benefits of each method without the inherent performance limitations when each is used alone. The current 2500 family is a second generation that evolved from the original Model 2500 and offers a wide selection of instruments to fit the application.

Extensive use is made of SMDs throughout the RF sections of the 2500s. Use of these devices provides excellent RF performance, low parasitics, small size, low weight, low power consumption and a high resistance to damage from shock and vibration. All 2500 models meet MIL-T-28800 Class 5 Environmental Specifications. Accelerated life tests on the





Model 2500A show MTBF figures in excess of 25,000 hours. Because the 2500 family is so durable we back it with a two year service warranty.

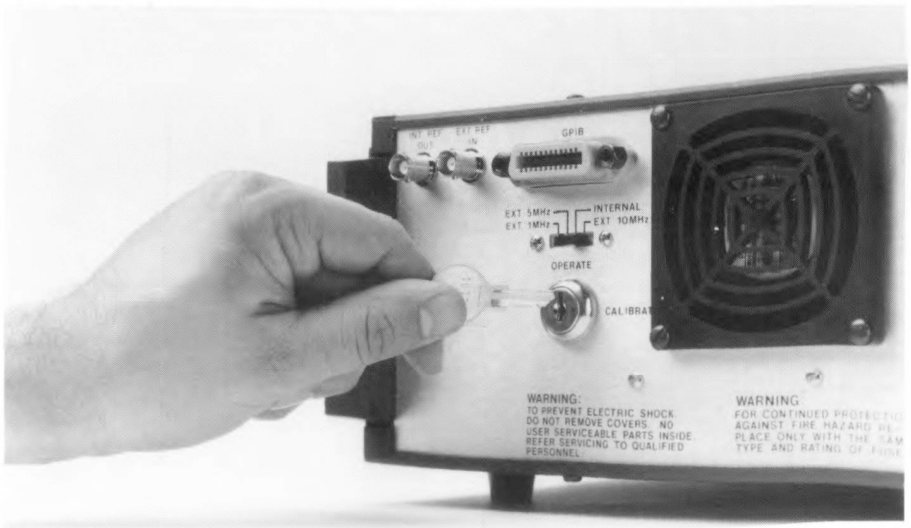
The 2500A, and 2500C are three quarter rack size, ideal for field service or bench use where size and weight are a premium. The 2510A and 2520A are full rack size. The additional front panel room allows for several more keypad buttons for control of numerous optional features, as well as frequency and level step size control and one key stroke increment-decrement of all variable parameters, including stored settings.

Spin Knob
A feature normally found only on very expensive signal generators but standard on the 2500 series is a spin knob. This provides an analog type control that is very useful when testing receiver sensivity and squelch level; and for locating 3 dB points on frequency response curves.

Calibration Made Easy—AutoCal®
You can easily calibrate a 2500 series signal generator without sending it to the lab or ever removing covers.

Instead, you may activate AutoCal® by inserting a key into the rear panel. then select either frequency or level by pushing the FREQ or LVL key when prompted to do so.

The entire FREQ routine takes less than fifteen minutes and is entirely software driven. The FREQ software calibrates the oscillators and generates a look-up table that will automatically correct FM modulation accuracy.

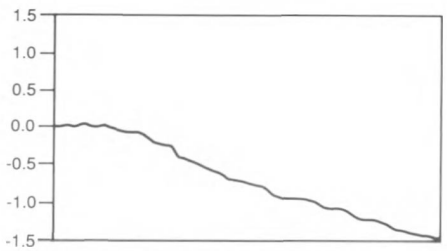


The LVL routine takes less than two minutes and requires only an external power meter.

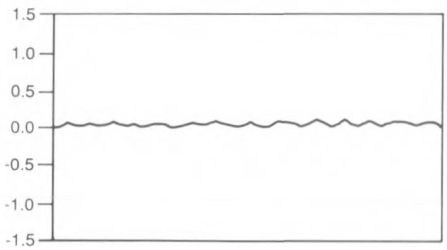
AutoCal® provides optimum oscillator tracking, minimum switching speed, calibrated RF output level.

All just by turning a key.

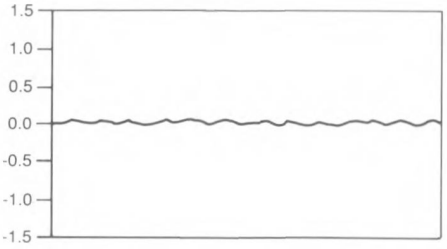
Compensation for Cable Loss
Level calibration is normally measured at the front panel RF output connector. The same calibration procedure can be done with a power meter at the D.U.T., thus correcting frequency response and insertion loss of cables and connectors and allowing more accurate D.U.T. measurements.



Level Measured at end of a 6 foot cable uncompensated



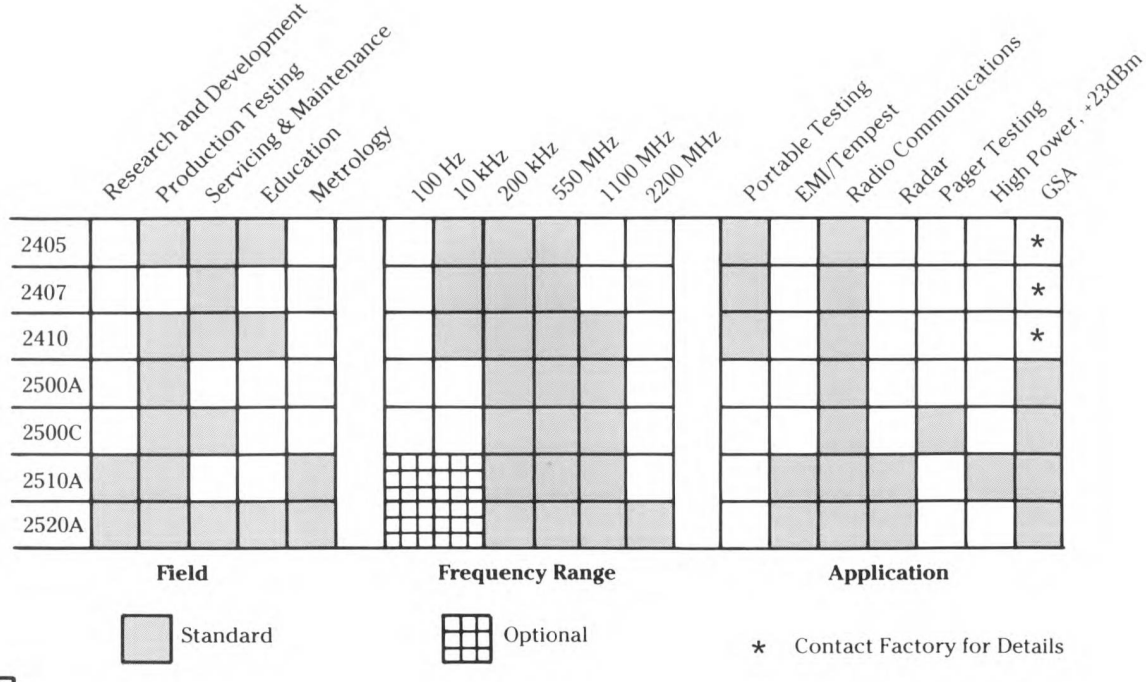
Level cal at RF Output Connector



Level Calibrated and Measured at end of 6 foot cable

SIGNAL GENERATOR SELECTION GUIDE

Model	Salient-Specifications	Key Features
2405	Frequency Range: 0.01 - 550 MHz Frequency Resolution: 10 Hz RF Out: -127 to +13 dBm RF Resolution: 0.1dB RF Level Accuracy: ±1.5dB Modulation: AM, FM Internal Source: 400 Hz, 1 kHz External FM: 50 Hz to 100 kHz RFI Leakage: <1.0µV Harmonics: <-30 dBc Spurious: <-50 dBc	Dual Microprocessor Control Fully Independent Modular Design AutoCal® thru Front Panel or GPIB SPC of Calibration Data to Predict Maintenance
2407	Same as 2405 Plus: Deviation Meter Range: 0-500 kHz Frequency Input: 30-500 MHz Polarity: Selectable Positive or Negative	Same as 2405 Plus: FM Deviation Meter
2410	Same as 2405 Except: Frequency Range: 0.01-1100 MHz	Ruggedized Version Available
2500A	Frequency Range: 0.2 to 1100 MHz Frequency Resolution: 10 Hz R.F. Out: -137 to +13 dBm R.F. Resolution: 0.1 dB R.F. Level Accuracy: ±1.0dB>1 MHz Modulation: AM, FM Internal: 400 Hz and 1 kHz External FM: 20 Hz to 100 kHz RFI Leakage: <0.5 µV Harmonics: <-30 dBc Spurious: <-60 dBc >137.5 MHz	Self Diagnostics and AutoCal® routine High MTBF of >20,000 Hours Spin Knob and Keypad Control Bright LCD Display Simple, straight forward operation Small Size Light Weight Low R.F.I.
2500C	Same as 2500A Plus: FSK Modulation Very Low RFI of 0.1µV typical 0.5 ppm Reference	Digital Receiver testing with no Carrier drift (FSK) Over/Under Modulation Indicator
2510A	Same as 2500A with Improved performance SSB Phase Noise: -117 dBc/Hz10 kHz offset Typical at 500 MHz: -123 dBc/Hz 20 kHz offset Residual FM: 0.3-3 kHz PDBW Typical Worst Case at >137.5 MHz: 4 Hz	Non Dedicated keypads allow more option flexibility Programmable frequency and level step Increment up/down keypads for all parameters Simultaneous display of stored setting location and settings
2520A	Same as 2500A and 2510A Plus: Extended Frequency Range: 0.2 to 2200 MHz. RF Level Accuracy: ±1.5 dB; >-37 dBm ±1.5+(0.1/10 dB step decrease) dB; <-36.9 dBm>1100 MHz ±1.5+(0.2/10 dB step decrease) dB; <-36.9 dBm >1100 MHz RF Flatness: ±1.2 dB	Same as 2510A



2500 Family Options

There are many diverse applications that require more features and improved performance than the standard instruments provide. To address these needs Wavetek currently offers a wide range of options and special features that can be added to the basic instrument.

Several options affect the modulation capability of the generators. In addition to AM, FM and Phase, Pulse and FSK modulation are available. A high stability time base option is offered. High output power (+23 dBm) is available for Model 2510A. The low frequency extension and variable modulation source are available in the 2510A and 2520A.

There are many more minor modifications that Wavetek has made to adapt our instruments to specific customer applications. If there is a special need please call. If it is not already available Wavetek welcomes the opportunity to produce a unit to meet your requirements.

Call 1-800-428-4424.

Option Description

RO2: (0.1 ppm Reference) The RO2 option uses a high stability DCXO (Digitally Compensated Crystal Oscillator). No warm up time required.
Frequency Stability: 0.1 ppm
Aging: 0.5 ppm per year

NA: (No attenuator) The NA option is applicable when cost is a consideration and only levels between +13 and -7 dBm are needed. Reverse Power Protection and DC Block are removed from the instrument.
RF Output
SWR: <2.0:1
Level Range: -7 to +13 dBm
Resolution: 0.1 dB
Reverse Power Protection: None
No DC Block

PUL: (Pulse Modulation) The PUL pulse modulator is a unique combination of hybrid and GaAs FET technologies providing an excellent on/off ratio and repetition rate. PUL is enabled either by the rear panel switch or by a DC voltage at the pulse enable connector.
RF Output: +10 dBm to -137 dBm
On/Off Ratio: 80 dB Minimum
Rise and Fall Time: 25 ns (15 ns typically)
Pulse Enable: TTL: +5V = "ON" state (switches at 1.5 V)
0 V = "OFF" state (switches at 1.4 V).
Negative drive available; contact factory.
Note: Option PUL is not compatible with Option XP or LEX.

RPC: (Rear Panel RF OUT & MOD IN). RPC moves the MOD IN and RF OUT front panel connectors to the rear panel.

XP: Option XP available on the Model 2510A features a +23 dBm to -127 dBm RF output, over a frequency range of 1 MHz to 1100 MHz. With Option XP harmonics become <-25 dBc and level accuracy is ±1.5 dB.
Note: Option XP is available with Option PUL at reduced power +20 dBm.

LEX: Low frequency extension option provides output over the frequency range of 100 Hz to 200 kHz, limits RF output to +10 dBm.
NOTE: Option LEX is not available with Option PUL.

VAR: Variable Modulation Source.
Replaces internal 400 Hz and 1 kHz tones by using a variable source with capability from 1 Hz to 100 kHz in 1 Hz steps with a six digit readout.

K-0278: Rack Mount Kit, Fixed (2500A, 2500C).
K-0295: Rack Mount Kit, Fixed (2520A, 2510A).
K-0279: Rack Mount Kit with Slides (2500A, 2500C).
K-0294: Rack Mount Kit with Slides (2520A, 2510A). The fixed mount kits (K-0278 and K-0295) contain the hardware to mount a 2500A/2500C, 2510A or 2520 in a standard 19 inch rack in a fixed position. The rack mount kits with slides (K-0279 and K-0294) contain additional hardware that allows the units to be extended from the rack and tilted for easy servicing. Complete instructions are supplied with each kit.

0.2 to 1100 MHz Signal Generators

- **+13 dBm to -137 dBm**
- **Simplified Front Panel with Spin Knob**
- **64 Front Panel Stored Settings**
- **Self-Check and AutoCal®**

Advanced PLL/DDS Hybrid Synthesis
The Wavetek Models 2500A/2500C are microprocessor controlled synthesized signal generators utilizing an advanced hybrid synthesis technique. Combining fractional division phase lock loop and direct digital synthesis technologies provide outstanding performance at a modest cost. This eliminates multiple-loops or low reference frequencies and the associated problems of spurious levels. The Model 2500A and 2500C each have a resolution of 10 Hz, and have an RF output range of +13 to -137 dBm with accuracy of ±1 dB. Standard features include: very broad peak FM deviation; a software controlled self-calibration for frequency and amplitude; 64 nonvolatile stored settings; GPIB interface; reverse power protection; and external clock input/output.

Choice of Internal References
The Models 2500A and 2500C use a stable temperature compensated crystal oscillator (TCXO) to achieve standard frequency stability of .0005% (0.5 ppm) and frequency aging of <1 ppm/year. A high stability reference is offered as an option: the RO2, which is a digitally compensated crystal (DCXO) with 0.1 ppm stability and a 0.5 ppm aging rate. Neither of these references require warm-up time, eliminating warm-up delays associated with ovenized crystals. All three retain accuracy over a temperature range from 0 to 50°C.

Self-Check and AutoCal®
The Models 2500A/2500C are simple to maintain through extensive self-checks and a unique AutoCal® system. At power-on, the 2500A/2500C routinely perform diagnostic checks of their microprocessors and other digital control circuitry, then perform basic operational checks on phase lock circuitry, frequency standard, output level and stored data. Initiating the AutoCal® provides optimum oscillator tracking, minimum switching speed, calibrated FM deviation, and a calibration routine for RF output level.

The 2500C incorporates a totally new and unique FSK (frequency-shift keying) modulator built especially for digital paging and binary-coded squelch applications. The 2500C FSK process is an optimal hybrid of digital and analog modulation techniques. This results in complete elimination of code distortions and carrier frequency drift common in conventional synthesized signal generators. Complex data waveforms are accurately reproduced, and the generator is actually capable of dwelling indefinitely in a MARK or SPACE condition.

Low RF Leakage (0.1mV typical)
The exceptionally low RF leakage of the Model 2500C allows accurate tests of the most sensitive radiopaging receivers.

Simultaneous Digital and Analog Modulation Capability
The 2500C handles all popular digital paging formats such as GSC, NEC/DC, and POCSAG. In addition, its unique simultaneous digital FSK and analog FM capability simplifies testing of binary coded squelch systems such as DPL.

Automatic Return to Center Frequency (RTC)
Especially useful in automated test systems, the RTC feature allows the sequential transmission of digital data and analog tone or voice information without requiring external mode switch. The RTC system is triggered by the arrival of the code waveform at 0 volts and returns the synthesizer to its center frequency in less than 50 ms.

Over/Under Modulation Level Indicators
Front panel LED indicators make setting external input signal levels easy. The lower LED illuminates when the analog or digital input level is less than 90% of the required level. The upper LED illuminates if the input exceeds the correct level.

Spin Knob or Keypad Entry of all Parameters
The Models 2500A/2500C provide the user with a choice of keypad or spin knob for data entry of the following functions: Frequency, RF Output Level and Modulation. The spin knob provides for a continuous analog-type control over all variable parameters.

Programmability
A full-functioning GPIB that conforms to IEEE-488 1978 is standard in the Model 2500A. It is both a "listener" and a "talker" and utilizes minimum uniqueness characteristics in its programming. The minimum uniqueness format allows for flexible programming of the Model 2500A operational parameters. This feature will allow the Model 2500A to conform easily to any ATE system.

FREQUENCY
Range: 0.2 to 1100 MHz.
Resolution: 10 Hz.
Frequency Stability (0-50°C): 0.5 ppm.
Frequency Stability (Aging): <1 ppm/year.
Switching Speed: 200 ms typically.

RF OUTPUT
Impedance: 50Ω(SWR<1.5:1, typically <1.4:1 at Output Levels <-7 dBm).
Output Connector: Type "N".
Output Level Range: +13 to -137 dBm.
Output Resolution: 1 dB
Level Accuracy:±1.0 dB; (>1 MHz), ±1.5 dB; (<1 MHz).
EMI/RFI Leakage: 2500A <0.5μV, 2500C <.1 μV into a 2-turn 1 inch diameter loop, 1 inch from any surface at 1100 MHz.

SPECTRAL PURITY
Harmonics:<-30 dBc.
Sub-Harmonics: (in a 550-1100 MHz band only)
<-25 dBc.
Non Harmonics Spurious: (>5 kHz from carrier):
<-50 dBc (<137.5 MHz).
<-60 dBc (137.5 MHz)<70 dBc typical.
<-5 kHz typically <-40 dBc.

PHASE NOISE at 500 MHz:
<-107 dBc/Hz guaranteed
Typically <-110 dBc/Hz (10 kHz offset)
Typically <-115 dBc/Hz (20 kHz offset)

RESIDUAL AM: <-65 dBc (.05-15 kHz post-detected bandwidth).

RESIDUAL FM: (.05-15 kHz PDBW)
<30 Hz rms (<137.5 MHz).
<10 Hz rms (137.5-275 MHz).
<20 Hz rms (275-550 MHz).
<40 Hz rms (550-1100 MHz)(2500A)
For .3-3 kHz PDBW -Typical
<15 Hz rms (<137.5 MHz).
<7 Hz rms (137.5-275 MHz).
<10 Hz rms (275-550 MHz).
<20 Hz rms (550-1100 MHz) (2500A)

REMOTE PROGRAMMING
Interface: GPIB IEEE-488 1978. Controls all functions except power on/off, calibration and diagnostics.
Functions: Listens and talks, gives error status and instrument status, SH1, AH1, T6, TE0, L4, LE0, RFl, PP0, DC1, DT1, C0, E2, SR1.

FEATURES
64 nonvolatile stored settings (all parameters).
Power-on instrument check for correct basic operation.
AutoCal® full calibration of oscillator centering, FM deviation, level, switching speed.

MODULATION
Types: AM, FM, FSK (2500C only)
Internal Source: 400 Hz, 1 kHz.
External Source: AM Frequency Response (0-50%). DC to 15 kHz (Typically to 20 kHz).
AM Resolution: 0.1%.
AM Accuracy: (0-90%) ±(1% F.S. +5% of reading).
AM Range: 0 to 99.9%.
AM Distortion at 1 kHz:
<5% (<90% AM).
<3% (<70% AM).
<1.5% (<30% AM).
FM Rate: 20 Hz to 100 kHz (3 dB BW).
FM Resolution:
10 Hz (dev. <10 kHz).
100 Hz (dv. <100 kHz).
1 kHz (dev. <1 MHz).
FM Accuracy: ±6% at internal rates.
FM Deviation Range (1 kHz rate):
1 MHz peak (3-137.5 MHz).
500 kHz peak (137.5-275 MHz).
1 MHz peak (275 MHz).
FM Distortion: <2% for internal rates and <100 kHz deviation, not including residual
FM: 0.5% for external FM <100 kHz deviation, not including residual FM.

FSK SPECS
Deviation: ±4.95 kHz max.
FSK: FSK and FM may not exceed 9.99 kHz.
Resolution: 10 Hz.
Baud Rate: 0-20 Kbps can dwell indefinitely on mark or space.
Waveshape: Corresponds to input waveshape.
Response: 20 Hz to 100 kHz.
Deviation Accuracy: ±5% of setting with ±1 Vp code input.
Carrier Frequency Stability: Same as frequency reference.
Code Input: ±1 V; 0 ±10 mV Zero state 600L unbalanced.

REVERSE POWER PROTECTION
Maximum Reverse RF Power: 50 Watts.
Trip Level: 0.7 Watts.
Trip Time: <2 ms.
Maximum Reverse DC Voltage: 50 Volts.

OPTIONS
RO2: 0.1 ppm.
RPC: RF in, Ext Modulation.
Systems Only: Blank Back Panel
K0278: Rack Mount Ears (2500A, 2500C).
K0279: Rack Mount Slides (2500A, 2500C).
For full descriptions of options, see 2500 family options on page 86.

GENERAL
Dimensions: 13.3 cm (5.25 in.) high; 31.8 cm (12.5 in.) wide;
53.3 cm (21 in.) deep.
Weight:12.7 kg (28 lb).
Power: 100 or 120, 220 or 240 VAC.
50-400 Hz; 75 Watts.
Environment: MIL-T-28800C Class 5.
Operating Temperature Range: 0 to 50°C.

NOTE: All specifications apply to both units except where noted.

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model 2500A
Model 2500C

2200 MHz and 1100 MHz Signal Generators

- **64 Front Panel Stored Settings**
- **Keypad or Spin Knob Control**
- **AutoCal® of Frequency & Output Level**
- **GPIB & Pulse Modulation Options**
- **200 kHz Low End/10 Hz Resolution**

The Wavetek Model 2520A, 2.2 GHz and 2510A, 1.1 GHz signal generators are the first to use modern phase lock technology and a low frequency direct digital synthesizer to provide outstanding performance at a modest cost. The new 2520A/2510A offers the frequency accuracy, stability, and programmability previously available only in laboratory type synthesizers costing much more.

+13 dBm Output Power and 1 ppm Frequency Accuracy
A broad range of output power from -137 dBm to +13 dBm makes the 2520A suitable for driving high level mixers or making low level receiver sensitivity tests with a resolution of 0.1 dB throughout the full range of output level. A temperature compensated crystal reference provides frequency accuracy of 1 ppm over a 0° to 50°C operating range. Higher stability reference of .5 ppm is available as an option.

Self Diagnostics and Operation
At power up the Models 2520A/2510A automatically steps through twelve self diagnostic programs to verify proper operation. If a problem is detected, additional diagnostics assist the operation in pinpointing the fault.

Activating a key switch on the rear panel will place the 2520A/2510A in the AutoCal® mode. The AutoCal® mode accesses a machine prompted calibration procedure for frequency, FM deviation, and output level that can be completed on site in approximately 15 minutes. The AutoCal® procedure extends the laboratory calibration interval to the allowable drift of the crystal reference. This could easily be a two year interval. Level calibration can be made at the R.F. output connector or at the device under test to compensate for cable or fixture frequency response.

Flexible Modulation Capability
Internal and external AM and FM modulation capability are standard. Internal rates of 400 Hz or 1000 Hz may be combined with an external source for AM on FM or FM on AM complex modulation. FM deviation of 1 MHz or greater is available over most of the frequency range of the 2520A/2510A. Several standard modulation options provide for phase, pulse, and FSK modulation.

64 Nonvolatile Front Panel Stored Settings
Frequently used test parameters may be stored and recalled from 64 nonvolatile RAM locations. Each location contains information for a complete front panel

test set-up. Settings may be recalled at random or sequentially using either the spin knob or the up-down keys. The stored or recalled location is displayed adjacent to the frequency display.

Simple but Versatile Operation

The Models 2520A/2510A use the straight forward front panel control system found on all Model 2500 series signal generators. Parameters may be set using a numerical keypad or using an analog type spin knob. The additional convenience of incrementing or decrementing in programmable steps, using either the spin know or up-down keys, has been added to the Model 2520A/2510A. Increment/decrement for both frequency, level, and stored settings is standard.

FREQUENCY
Range:
0.2 to 2200 MHz (all specs apply); usable to 0.1 MHz (2520A).
0.2 to 1100 MHz (all specs apply); usable to 0.1 MHz (2510A).
Resolution:
10 Hz<1100 MHz.
20 Hz>1100 MHz (2520A).
Frequency Stability (0°to 50°C): 2.5 ppm.
Frequency Stability (Aging): <1ppm/year.
Switching Speed 200 ms, typically.

RF OUTPUT
Impedance: 50 Ω (SWR <1.6:1 at output levels <-7 dBm).
Output Connector: Type "N".
Output Level Range: -137 to +13 dBm.
Output Resolution: 0.1 dB.
Level Accuracy:
±1.5 dB;>-37 dBm.
±1.5 + (0.1/10 dB step decrease) dB; <-36.9dBm>1100 MHz.
±1.5 + (0.2/10 dB step decrease) dB; <-36.9 dBm>1100 MHz.
Flatness: ±1.2 dB (typically ±0.7 dB).
EMI/RFI Leakage: <0.5µV into a 2-turn 1 inch diameter loop, 1 inch from any surface (at 1100 MHz) and MIL-T-28800C Class 5.

SPECTRAL PURITY
Harmonics:
<-27 dBc <0.4 MHz.
<-30 dBc <1100 MHz.
<-25 dBc <1100 MHz (2520).
Sub-Harmonics:
<-25 dBc above 550 MHz.
Non Harmonics Spurious:
(>5 kHz from carrier).
<-50 dBc (<137.5 MHz).
<-60 dBc (137.5 to 1100 MHz)<70 dBc typical.
<-54 dBc (>1100 MHz)(2520).

PHASE NOISE AT 500 MHz
10 kHz Offset:<-117 typical dBc/Hz (guar. <-110 dBc/Hz).
20 kHz Offset: Typ <-123 dBc/Hz.

RESIDUAL AM:
<-65 dBc (.05 to 15 kHz post-detected bandwidth).

2510A/2520A RESIDUAL FM:
(0.05-15 kHz post-detected bandwidth.)

Spec	Typ (Hz rms)
<30	<12 (<137.5 MHz)
<4.5	<2.5 (137.5-275 MHz)
<9	<5 (275-550 MHz)
<18	<10 (>550 MHz)
	<80 (>1100 MHz).

(0.3-3 kHz post-detected bandwidth.)

<20	<8 (<137.5 MHz)
<2	<1 (137.5-275 MHz)
<3.5	<2 (275-550 MHz)
<7	<4 (>550 MHz)
	<40 (>1100 MHz).

MODULATION
Types:
AM, FM, Std.
FSK, Opt.
Pulse Mod, Opt.
Internal Source: 400 Hz, 1 kHz.
External Source:
AM Frequency Response (0 to 50%):
DC to15 kHz (typical to 20 kHz).
AM Resolution: 0.1%.
AM Accuracy: ±(1% F.S. +5% of setting).
AM Range: 0 to 100%.
AM Distortion at 1 kHz:
<5% (70 to 90% AM).
<3% (30 to 70% AM).
<1.5% (0 to 30% AM).
FM Rate: 20 Hz to 100 kHz.
FM Resolution:
Freq <1000 MHz.
10 Hz (dev. <10 kHz).
100 Hz (dev. <100 kHz).
1 kHz (dev. <1 MHz).
Freq >1100 MHz (2520).
20 Hz (dev. <10 kHz).
200 Hz (dev. <100 kHz).
2 kHz (dev. <1 MHz).
FM Accuracy: ±6% at internal rate (typ ±3%).
FM Deviation Range (k kHz rate).
1 MHz peak (3 to 137.5 MHz).
500 kHz peak (137.5 to 275 MHz).
1 MHz peak (275 to 1100 MHz).
1.999 MHz peak (>1000 MHz) (2520).
FM Distortion: <2% for internal source and <100 kHz deviation, not including residual
FM: 0.2% for external source, typically.

FRONT PANEL CONTROL
Type: Push buttons, Spin Knob.

REVERSE POWER PROTECTION
Maximum Reverse RF Power: 50 watts.
Trip Level: 0.7 watts.
Trip Time: <2 ms.
Maximum Reverse DC Voltage: 50V.

REMOTE PROGRAMMING
Interface: GPIB IEEE-488-1978. Controls all functions except on/off AutoCal® and diagnostics.
Functions: T6, L4, SH1, AH1, RL1, DC1, DT1, E2, SR1, TE0, LE0, PP0, C0.

FEATURES
64 nonvolatile stored settings.
Front Panel programming of GPIB address.
Settable Frequency Step.
Stored setting increment.
Power-on Confidence Check.
AutoCal®

GENERAL
Environment: MIL-T-28800C Class 5.
Operating Temperature Range: 0" to 50"C.
Dimensions: 13.3 cm (5.5 in.) high; 43.2 cm (17 in.) wide; 53.3 cm (21 in.) deep.
Weight: 16.3 kg (36 lb).
Power: 100 or 120, 220 or 240 Vac. 50 to 400 Hz; 75 watts.

OPTIONS
FSK: Frequency Shift Keying.
PUL: Pulse Modulation, On/Off ratio >80 dB t_r and t_f <15 ns typical.
LEX: Low frequency extension 10 Hz to 200 kHz
VAR: Variable modulation source replaces internal 400 Hz and 1 kHz sources with a variable source from 1 Hz to 100 kHz.
XP: +23 dBm maximum RF output 1 to 1100 MHz (2510A only).

RO2: 0.1 ppm reference option.
RPC: RF In, Ext Modulation Rear Panel Connector.
Systems Only: Blank front panel.
K0295: Rack Mount Ears (2520A).
K0294: Rack Mount Slides (2520A). For full descriptions of options, see 2500 family options on page 86.

NOTE: All specifications apply to both units except where noted.

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model 2510A
Model 2520A

Introduction to the 2400 Family of Signal Generators

The 2400 family of synthesized signal generators presently consist of three models, the 2405, 2407, and 2410. This line of instruments is specifically designed to help increase the productivity of ATE and field service applications. The 2400 Series is the most economical solution for general purpose RF testing.

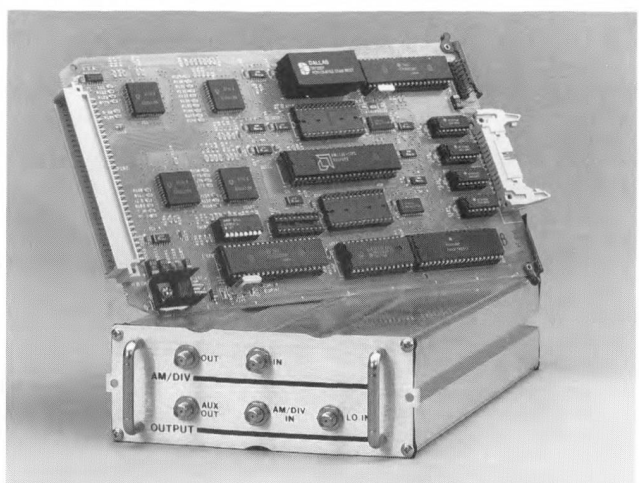
These instruments are similar in many specifications, such as:

- Bright, easy to read display
- Data entry by keypad
- RF on/off switch
- Independent modularity
- IEEE-488 interface standard
- 50 watt reverse power protection
- Extensive diagnostic package
- Autocal routine
- Calibration data tracking

The 2405 and 2407 have similar specifications and cover the frequency range from 10 kHz to 550 MHz. In addition, the 2407 comes standard with an FM deviation meter which makes it ideal for testing both the transmitter and receiver sections of tranceivers. The model 2410 has a frequency range of 10 kHz to 1100 MHz. The 2400 Series is also available in a special ruggedized case for those trips that demand it.

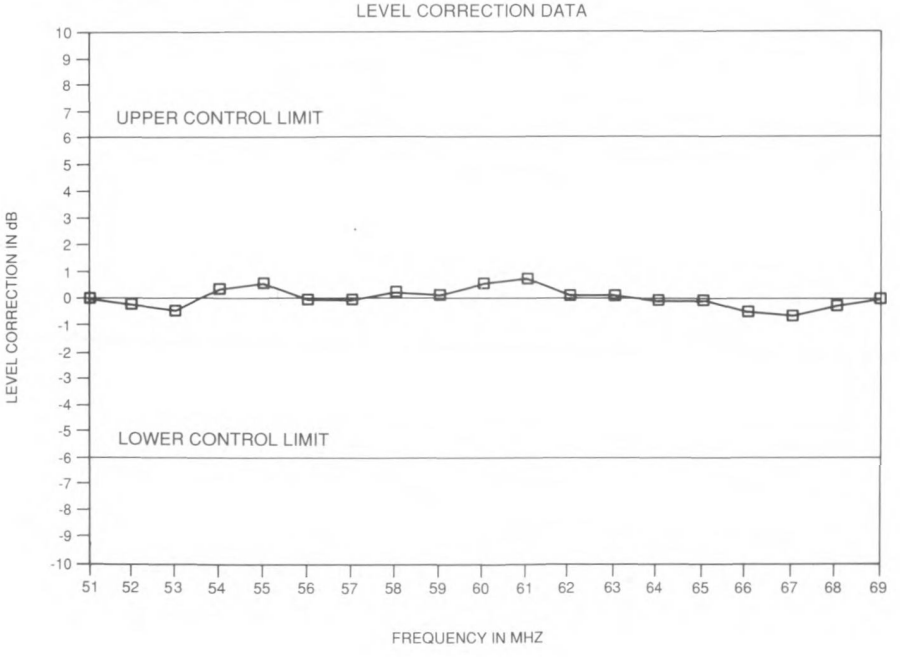
In keeping with the Wavetek tradition of user friendly interfaces, we employ an English style bus control lanquage. The alphanumeric display enhances the human compatibily with crisp, clear directions on how to operate the diagnostic and calibration routines.

In general, the family is well suited for field service applications. The internal modular construction allows for field installable options, as each module is fully interchangeable. If repairs are ever required after our two year warranty period, they can be made at the module level in approximately 15 minutes.

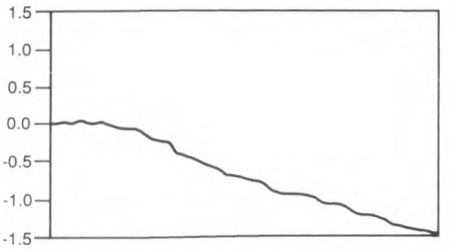


A state of the art autocalibration is provided with the 2400 family. This includes the ability to initiate the calibration over the IEEE-488 control bus for an entirely automatic operation and service process. Autocal provides optimum oscillator tracking, minimum switching speed, calibrated FM deviation and calibrated RF output level. Access to internal error correction data is provided through the bus to track aging and to allow scheduled maintenance.

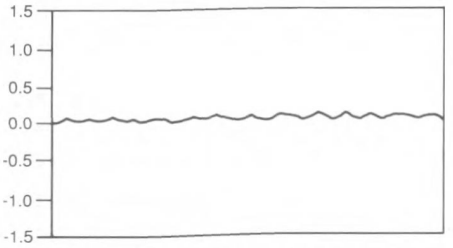
• CALIBRATION DATA TRACKING–SPC readout of calibration ROM for accurate scheduling of maintenance



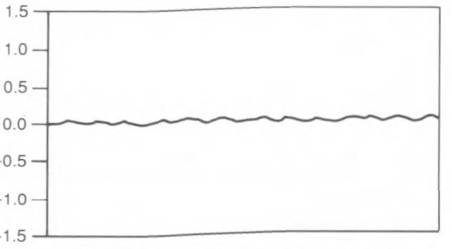
Compensation for Cable Loss
Level calibration is normally measured at the front panel RF output connector. The same calibration procedure can be done with a power meter at the D.U.T., thus correcting frequency response and insertion loss of cables and connectors and allowing more accurate D.U.T. measurement.



Level Measured at end of a 6 foot cable uncompensated



Level cal at RF Output Connector



Level Calibrated and Measured at end of 6 foot cable

RF SIGNAL GENERATOR

MODEL 2405/2407

10 kHz to 550 MHz Signal Generator With FM Deviation Meter

- **Erogomic User Interface**
- **Extensive Self Diagnostics and AutoCal®**
- **Modular Contruction**
- **IEEE 488 Interface: Standard Feature**

Advanced User Interface
The Wavetek Model 2405/2407 is a dual microprocessor controlled synthesized signal generator that both increases productivity and decreases learning curves through its sophisticated user interfaces. The GPIB programming language is in an English language format utilizing the Wavetek minimum uniqueness format. An extensive set of internal diagnostic features allows isolation of potential trouble spots down to the board level without opening up the instrument.

Advanced PLL/DDS Hybrid Synthesis
The Wavetek 2405/2407 combines fractional division phase lock loop techniques with direct digital synthesis for a wide variety of frequency step sizes. The 2405/2407 covers the frequency range of 10kHz to 550 MHz, has an RF output range of +13 to -127 dBm, and exhibits an output accuracy of ±1.5 dB. The user is free to fine tune the level accuracy by adding more level calibration points through a GPIB diagnostic feature. Other standard features include very broad peak FM deviation; 16 standard stored settings optionally to 100 settings, wide AM bandwidth of 50 kHz, reverse power protection, and external clock input/output.

Easy Service Construction
Construction of the instrument is based around a fully modular design. Each module can be replaced or upgraded with no dependent interaction with the surrounding modules. This provides the simplest of field service programs and allows customer upgrades and options to be installed on site. There is no need to return a unit for extensive and expensive upgrade kits.

Enhanced Calibration
AutoCal® of the instrument can be initiated both from the front panel and through the IEEE-488 bus. Once the instrument is put in an application, it is intended to stay in place. A state-of-the-art error tracking system allows user read out of the calibration error correction data. This provides statistical process control of the instrument's aging cycle to predict and schedule maintenance instead of handling maintenance on an emergency basis.

Meter
The FM Deviation Meter measures deviations from 0 to 500 kHz.

Long Term Warranty
The Wavetek 2405/2407 comes standard with a two year warranty. Wavetek is committed to supply their customers with the most reliable instrumentation available on the market today.

RF SIGNAL GENERATOR

MODEL 2405/2407

SPECIFICATIONS
Frequency
Range
0.01 - 550 MHz
Resolution
8 digits
10 Hz
Frequency Stability (0-50° C)
2.5 ppm standard
0.5 ppm optional
0.1 ppm optional
Frequency Stability (Aging)
<1ppm/year
Switching Speed
200 ms ±100 Hz of final value in CW, changes <10 kHz in FM, typ. 100 ms
Warm-Up Time
1 hour
External Reference
10 MHz
RF OUTPUT
Impedance
50 Ω (SWR <1.4:1 @ output level <-3dBm
75 Ω (2475 Only)
Output Connectors
Type "N"
Type BNC (2475 Only)
Output Level Range
-127 to +13 dBm
MODULATION
Types
AM, FM
Internal Source
400 Hz, 1 kHz
External Source
AM Frequency Response (0-50%)
10 Hz to 50 kHz
AM Resolution
0.1%
AM Accuracy,(0-90%)
±1% Full Scale(+5% of Reading)
AM Range
0-99.9%
AM Distortion
<5% (<90% AM)
<3% (<70% AM)
<1.5% (<30% AM)
Output Resolution
0.1 dB
Level Accuracy
±1.5 dB
Flatness
±1 dB
EMI/RFI Leakage
<1.0 µV into a 2 turn 1 inch diameter loop, 1 inch from any surface (@ 550 MHz)

SPECTRAL PURITY
Harmonics
For CW > 10 MHz <-30 dBc
For CW < 10 MHz <-26 dBc
Sub-Harmonics
None
Non-Harmonics
Spurious (>5 kHz from carrier)
<-50 dBc
Phase Noise @ 500 MHz
10 kHz offset:
-107 dBc guaranteed
20 kHz offset:
-113 dBc guaranteed
Residual AM, Mod Off
<-60 dBc, 50 Hz to 15 kHz
Residual FM, Mod Off
<50Hz RMS, 50 Hz to 15 kHz
FM Rate
50 Hz to 100 kHz (3dB BW)
FM Resolution
100 Hz for FM <100 kHz
1 kHz for FM >100 kHz
FM Accuracy
±5% of indicated setting at 1 kHz or 400 Hz rate excluding residual FM
FM Deviation Range
0.01 MHz <CW <1 MHz:0 to10 kHz
1MHz<CW<3 MHz: 0 to 100 kHz
3 MHz <CW <137.49999 MHz: 0 to 1 MHz
137.49999 MHz <CW <275 MHz:
0 to 500 kHz
CW >275 MHz:0 to 1 MHz
FM Distortion
Internal Source
<2% harmonic distortion at 1 kHz or 400 Hz rate, FM <100 kHz peak
External Source
<0.5% at 1 kHz or 400 Hz rate, FM <100 kHz peak
Front Panel Control
Type
Push buttons, GPIB
Reverse Power Protection
50 watts
GPIB (Standard)
Interface
GPIB IEEE-488-1978,1987
Functions
T6,L4,SH1,AH1,RL1,DC1,DT1,E2,SR1,TE0, LE0,PP0,C0

FEATURES
16 nonvolatile stored settings standard
Optional 100
Front Panel Programming Prog of GPIB address
Power-on Confidence Check
AutoCal®
GENERAL
Dimensions
13.2 cm (5.2 in) High;
31.8 cm (12.5 in) Wide;
53.3 cm (21 in) Deep.
Weight
12.7 kg (28 lb)
Power
100, 115, 215 or 230 VAC ±10%
Environment
MIL-T-28800C
Class 5
95% Humidity, non condensing
Operating Temp. Range 0-50° C

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model 2407 with Deviation Meter
Model 2405 without Deviation Meter
Model 2475 75Ω without Deviation Meter
Option R01 0.5 ppm
Option R02 0.1 ppm

Specifications are subject to change.

RF SIGNAL GENERATOR

MODEL 2410

10 kHz to 1100 MHz Signal Generator

- **Ergonomic User Interface**
- **Extensive Self Diagnostics and AutoCal®**
- **Modular Construction**
- **IEEE 488 Interface: Standard Feature**
- **Historical Tracking of Calibration Data**

Advanced User Interface
The Wavetek Model 2410 is a dual microprocessor controlled synthesized signal generator that both increases productivity and decreases learning curves through its sophisticated user interfaces. The GPIB programming language is in a English language format utilizing the Wavetek minimum uniqueness format. An extensive set of internal diagnostic features allows isolation of potential trouble spots down to the board level without opening up the instrument.

Advanced PLL/DDS Hybrid Synthesis
The Wavetek 2410 combines fractional division phase lock loop techniques with direct digital synthesis for a wide variety of frequency step sizes. The 2410 covers the frequency range of 10 kHz to 1100 MHz, has an RF output range of +13 to -127 dBm, and exhibits an output accuracy of ±1.5 dB. The user is free to fine tune the level accuracy by adding more level calibration points through a GPIB diagnostic feature. Other standard features include very broad peak FM deviation; 16 standard stored settings optionally to 100 settings, wide AM bandwidth of 50 kHz, reverse power protection, and external clock input/output.

Easy Service Construction
Construction of the instrument is based around a fully modular design. Each module can be replaced or upgraded with no dependent interaction with the surrounding modules. This provides the simplest of field service programs and allows customer upgrades and options to be installed on site. There is no need to return a unit for extensive and expensive upgrade kits.

Enhanced Calibration
AutoCal® of the instrument can be initiated both from the front panel and through the IEEE-488 bus. Once the instrument is put in an application, it is intended to stay in place. A state-of-the-art error tracking system allows user read out of the calibration error correction data. This provides statistical process control of the instrument's aging cycle to predict and schedule maintenance instead of handling maintenance on an emergency basis.

Long Term Warranty
The Wavetek 2410 comes standard with a two year warranty. Wavetek is committed to supply their customers with the most reliable instrumentation available on the market today.

RF SIGNAL GENERATOR

MODEL 2410

SPECIFICATIONS

FREQUENCY
Range
0.01 - 1100 MHz
Resolution
8 digits
10 Hz
Frequency Stability (0-50° C)
2.5 ppm standard
0.5 ppm optional
0.1 ppm optional
Frequency Stability (Aging)
<1ppm/year
Switching Speed
200 ms ±100 Hz of final value in CW, changes <10 kHz in FM, typ. 100 ms
Warm-Up Time
1 hour
External Reference
10 MHz

RF OUTPUT
Impedance
50 W (SWR 1.5:1 @ output level <-3dBm
Output Connectors
Type "N"
Output Level Range
-127 to +13 dBm
Output Resolution
0.1dB
Level Accuracy
±1.5 dB
Flatness
±1 dB
EMI/RFI Leakage
<1.0 µV into a 2 turn 1 inch diameter loop, 1 inch from any surface (@ 550 MHz)
SPECTRAL PURITY
Harmonics
For CW > 10 MHz <-30 dBc
For CW < 10 MHz <-26 dBc
Sub-Harmonics
<25 dbc >550 MHz
Non-Harmonics
Spurious (>5 kHz from carrier)
<-50dBc
Phase Noise @ 500 MHz
10 kHz offset:
-107 dBc guaranteed
20 kHz offset:
-113 dBc guaranteed
Residual AM, Mod Off
-60 dBc, (50 Hz to 15 kHz Post det BW)
Residual FM, Mod Off
<30Hz (<137.5 MHz)
<12.5 Hz (137.5 - 275 MHz)
<25 Hz (275 - 550 MHz)
<50 Hz (550 - 1100 MHz)

MODULATION
Types
AM, FM
Internal Source
400 Hz, 1 kHz
External Source
AM Frequency Response (0-50%)
10 Hz to 50 kHz
AM Resolution
0.1%
AM Accuracy,(0-90%)
(0 to 90%) ±(1% Full Scale+5% of Reading)
AM Range
0-99.9%
AM Distortion
<5% (<90% AM)
<3% (<70% AM)
<1.5% (<30% AM)
FM Rate
50 Hz to 100 kHz (3dB BW)
FM Resolution
100 Hz for FM <100 kHz
1 kHz for FM >100 kHz
FM Accuracy
±5% of indicated setting at 1 kHz or 400 Hz rate excluding residual FM
FM Deviation Range
0.01 MHz <CW <1 MHz: 0 to 10 kHz
1 MHz<CW<3 MHz: 0 to 100 kHz
3 MHz <CW <137.49999 MHz:
0 to 1 MHz
137.49999 MHz <CW <275 MHz:
0 to 500 kHz
CW >275 MHz: 0 to 1 MHz
FM Distortion
Internal Source
<2% harmonic distortion at 1 kHz or 400 Hz rate, FM <100 kHz peak
External Source
<0.5% at 1 kHz or 400 Hz rate, FM <100 kHz peak

FRONT PANEL CONTROL
Type
Push buttons, GPIB

REVERSE POWER PROTECTION
50 watts
GPIB (Standard)
Interface
GPIB IEEE-488-1978,1987
Functions
T6,L4,SH1,AH1,RL1,
DC1,DT1,E2,SR1,TE0,
LE0,PP0,C0

FEATURES
16 nonvolatile stored settings standard
Optional 100 stored settings
Front Panel Programming of GPIB address
Power-on Confidence Check
AutoCal®, Frequency and Level Calibration

GENERAL
Dimensions
13.2 cm (5.2 in) High;
31.8 cm (12.5 in) Wide;
53.3 cm (21 in) Deep.
Weight
12.7 kg (28 lb)
Power
100, 115, 215 or 230 VAC ±10%
Environment
MIL-T-28800C
Class 5
95% Humidity, non condensing
Operating Temp. Range
0-50° C

OPTIONS
R **Ruggedized Case**

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model 2410
Options R
Option R01 0.5 ppm
Option R02 0.1 ppm

Specifications are subject to change.

Sweep Generators

Sweep generators are ideal for testing the frequency response of a device or system. Unlike point by point techniques, sweeping is thorough, and sweeping saves time in broadband testing. No information is lost when continuous frequency characterization of a device or system is taken between two frequency points.

Wavetek sweepers are stand alone units (no mainframes or plug-ins) with discrete swept frequency ranges, from 1 MHz to 2.5 GHz. The 1060 and 1080 series are economical laboratory quality broadband sweepers that are simple to use. Both units are available in 75 or 50Ω. The Model 1801C has excellent flatness and linearity, and is ideally suited for CATV applications. The 1801C is a 75Ω unit, but is also available in 50Ω. For applications above 1 GHz, the Models 2001 (I-1400 MHz), and 2002B (I-2500 MHz) are rugged and reliable performers that provide the most flexibility of use, with a variety of operating modes. The Model 2002B is also available with GPIB, IEEE-488 interface to program frequency and output level.

Flexible Sweepers
Wavetek sweepers offer different sweep modes for the various applications needed. Full sweep, start/stop, delta F (ΔF), and CW (continuous wave) modes are available depending on the unit. Full sweep is a sweep of the frequency range of the unit. Start/stop is sweeping from any user selected beginning and ending frequency. Delta F is a selected sweep width around a desired center frequency. A wide variety of sweep rates, from 10 ms to 100 seconds, can be triggered on command or repetitively, and speed of repetition can be selected.

RF Output and Leveling
Wavetek sweepers have the added dimension of external modulation capabilities to extend their usefulness in sweeping and signal generation for signal simulation. External AM and FM are both available.

Sweeper Applications
Sweepers have many applications because of their ability to maintain a given level of power over a wide range of frequencies. Sweepers are used extensively with swept scalar analyzers to characterize the amplitude and frequency responses of broadband devices, both active and passive. Return loss, and insertion loss measurements are applications of interest to manufactuers of splitters, directional couplers, attenuators, filters, coaxial cables, attennas, and other frequency dependent products. The Model 1801C, 1060, and 1080 series are ideal for these applications. For CATV applications the Model 1801C has features such as a wide sweep rate from 10 ms to 100 seconds. Also, the unit is 75Ω impedance standard, and has the capability to house up to eight single frequency or harmonic markers. For military and commercial radar testing the 2001 and 2002B are well suited for these applications.

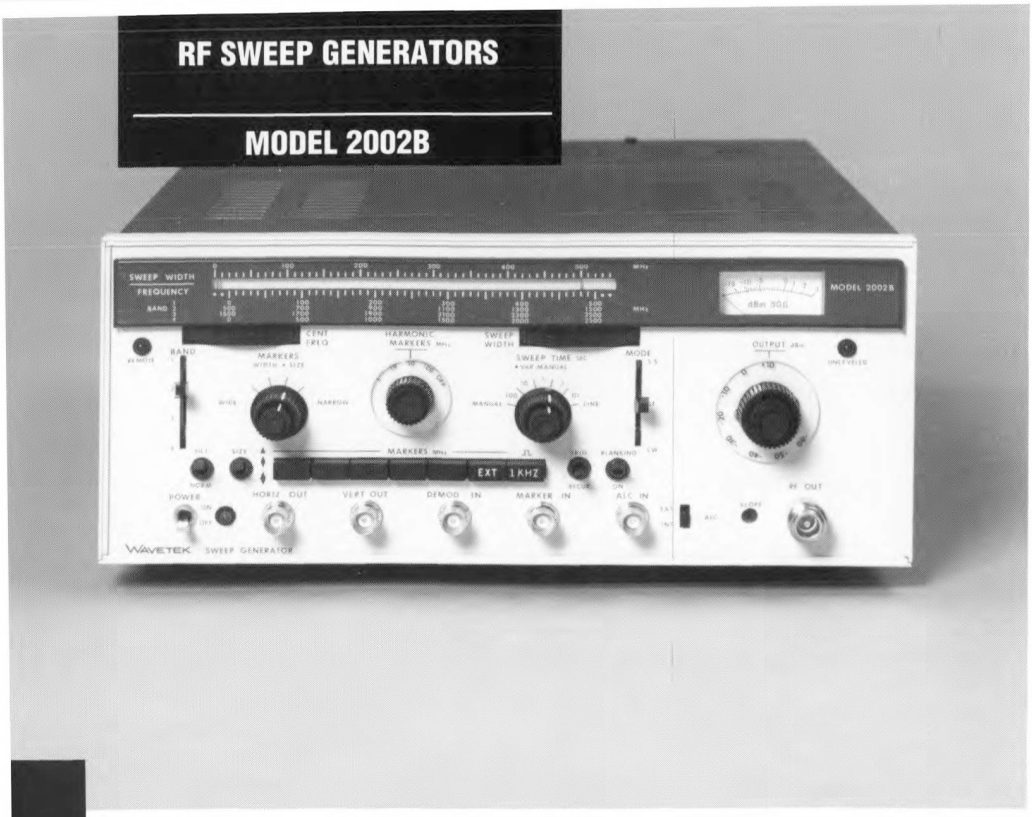
Options
All Wavetek Sweep Generators except the 1060 Series have as a standard feature three harmonic markers (see individual units for frequencies). In addition, single frequency and other harmonic markers are options for all Wavetek sweepers. An external marker input module is standard. A single frequency marker will put a birdy marker at the frequency needed. A harmonic marker will put birdy markers at multiples of the fundamental. Both are available for all Wavetek Sweepers.

Accessories
Rack mounts are available for all sweepers.

RF SWEEP GENERATOR SELECTION GUIDE

Top Frequency (Low Frequency is 1 MHz)	400 MHz	500 MHz	400 MHz	500 MHz	1000 MHz		1400 MHz	2500 MHz
MODEL	1062	1062-522	1067	1067-522	1080,1081	1801C	2001	2002B
Output Power (dBm)	+10 to -55		+57 to -7 (dBmV)		+13 to -70 (1080) +60 to -10 dBmV	+57 to -33 (dBmV)	+10 to -80	+13 to -77
Flatness (dB)	±0.25		±0.5		±0.25		±0.5	
Spurious Content Harmonic	>30 dBc above 10 MHz							
Frequency Bands	1 Band						3 Bands*	4 Bands*
Impedance	50 Ω		75 Ω (50 Ω 1080)			75 Ω **	50 Ω	
Sweep Time	Variable/Line Locked					Variable/Line Locked/Calibrated Manual		
Operating Modes	ΔF/CW				Full Sweep/ ΔF/CW	ΔF/CW	Start/Stop/ΔF/CW	
Modulation Capability	AM/FM				FM Only	AM/FM		
Remote Programming Analog Standard for Center Frequency, Sweep Width and Output Level	•	•		•	•	•	•	GPIB Optional *
Square Wave Generator								•
Marker System								
External CW	•	•	•	•	•	•	•	•
Harmonics Std.	Optional				1,10,100		1,10,50	1,10,50,100
Harmonics Optional	1,5,10,50,100				N/A	5,50	5,100	5
Single Frequency Range	1 to 400	1 to 500	1 to 400	1 to 500	N/A	1 to 1000	1 to 1300	1 to 1300
Optional Marker Space	4	4	4	4	N/A	4	3	5
Featured on Catalog Page	101	101	101	101	106	104	102	100

* See Specifications
** 50 Ω available



2500 MHz Sweeper

- **Start/Stop, ΔF and CW Modes**
- **Analog Programmable**
- **GPIB Programmable**

Model 2002B covers the 1 to 2500 MHz range in three bands. A fourth band covers the entire range.

Each of the four frequency bands may be used in start/stop, Δ F or CW mode. Frequency can be swept over any portion of a given band, in either direction, at rates up to 50 sweeps per second. Sweeps can be manual, triggered, or recurring.

Crystal-controlled harmonic markers are front-panel size and width controlled for optimum adjustment of the marker display. In addition to the standard harmonic markers, five optional marker modules may be installed. Each marker has its own front-panel switch.

Remote control is by an optional GPIB inter-face or a standard rear-panel programming connector.

RF FREQUENCY
Range
1 to 2500 MHz in 4 bands:
1 to 500 MHz (band 1);
500 to 1500 MHz (band 2);
1500 to 2500 MHz (band 3);
1 to 2500 MHz (band 4 stacked).

Dial Calibration Increments

Band 1	10 MHz
Band 2	20 MHz
Band 3	20 MHz
Band 4	50 MHz

CW/Center Frequency Accuracy at 25 C: ±1 dial calibration increment.
Sweep Width ΔF: 200 kHz to 500 MHz
Start/Stop: 200 kHz to full band.
Display Linearity: 1%
Drift: (1 hr warm-up at constant temp.)
1 to 1500 MHz: 100 kHz/5 min, 2 MHz/8 hr.
1500 to 2500 MHz: 200 kHz/5 min, 4 MHz/8 hr.
Blanking: Front panel controlled.

CALIBRATED RF OUTPUT
Impedance: 50Ω.
SWR: 1.5:1 10 dB attenuation min.
RF Output Range: +13 dBm to -77 dBm.
Attenuation: 10 dB steps with 10 dB vernier.
Step Attenuator: 70 dB.
Vernier: ±0.5 dB (top 11 dB of range).
Output Flatness: ±0.5 dB.
Slope Adjustment: Up to ±1 dB/GHz.
Modulation: 1 kHz square wave controlled by front panel switch. Ext AM and FM panel jack.
Output Connector: Type N.
External Leveling: A negative signal, between 0.2 and 2 V, will level the RF output.

SPECTRAL PURITY
Harmonics
1 to 2500 MHz: -39 dBc.
Nonharmonics
1 to 500 MHz: -35 dBc.
500 MHz: nondetectable.
Residual FM (CW Mode): 20 kHz peak to peak.

SWEEP CHARACTERISTICS
Sweep Modes: Repetitive, single, externally triggered, manual and line-locked sweep.
Sweep Time: Continuously variable from 10 ms to 100s, in 4 decade steps, plus vernier.
Horizontal Output: 0 to -10V. Impedance 10 kΩ .

MARKER SYSTEM
RF Markers: 1, 10, 50 and 100 MHz harmonic and external marker input are standard. A-1 single frequency markers are optional (maximum of 5 markers).
Marker Switches: Individual front-panel on/off switches.
Accuracy: 0.005%.
Amplitude: Dual sizes 10 mV to 4 Vp-p and ±50 μV to 25 mVp-p. Internal ratio adjust.
Width: =15 to 400 kHz. Adjusts in 4 steps.
Marker Tilt: Adjustible from vertical to approx. 90° .
External Marker: Ext CW signal ≥ 100 mV into 50Ω input.
Marker Rectifier Switch: For use with X-Y plotters.

REMOTE PROGRAMMING
GPIB: Options C-2 and C-3.
Analog: F and CW modes, band, level and sweep trigger. Also AM and FM inputs.

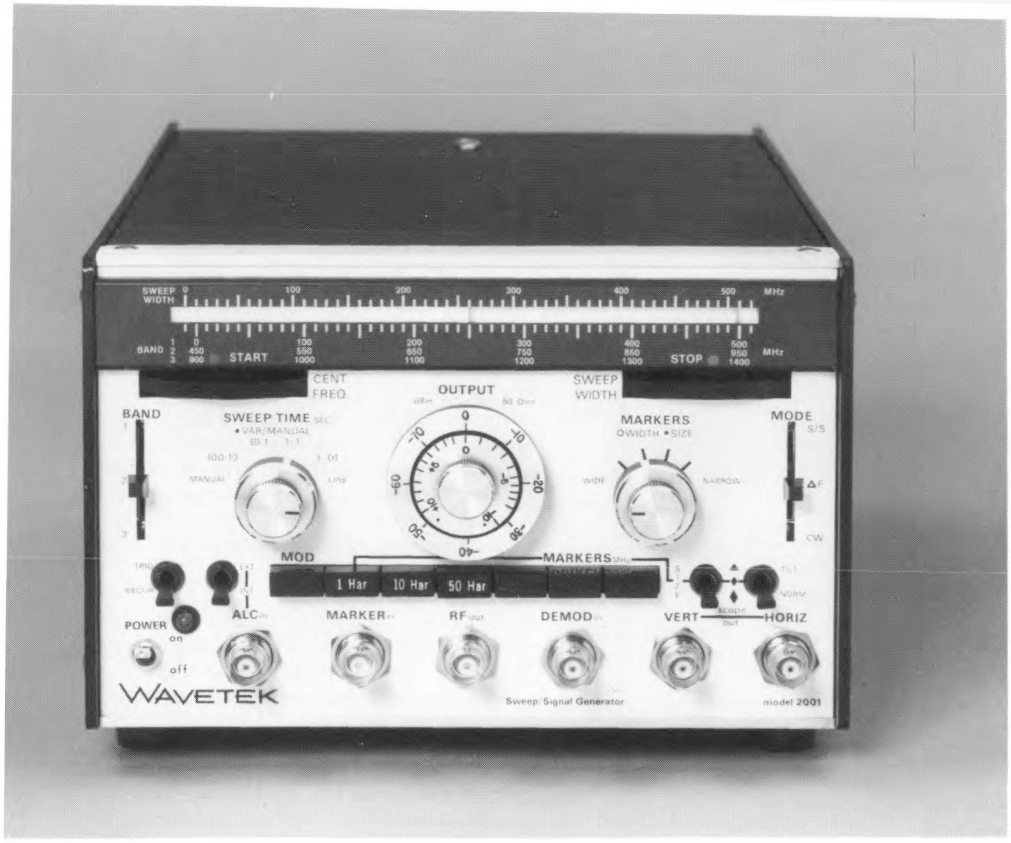
Frequency Range: DC To 10 kHz (3 dB bandwidth).
Sensitivity: 1 Vp-p per 10% AM.
Maximum Modulation %: 10 to 90% (Level dependent.)

GENERAL
Dimensions: 31.8 cm (12 1/2 in.) wide; 13.3 cm (5 1/4 in.) high; 48.3 cm (19 in.) deep.
Weight: 10.5 kg (23 lb) net; 12.7 kg (28 lb) shipping.
Power: 100, 120, 220, or 240 Vac ±10%; 45 to 400 Hz, 60 VA maximum.

OPTIONS
A-1: Single Frequency Marker. Specify frequency.
C-2: GPIB controls ΔF, S/S, CW modes, band and level.
C-3: GPIB controls 0 to 70 dB Attenuator.

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model 2002B
Options
Single Frequency Marker
GPIB Programming
Programmable Step Attenuator



1400 MHz Sweep/Signal Generator

• Start/Stop, ΔF and CW Modes

1 to 1400 MHz Frequency Range
Model 2001 Sweep/Signal Generator offers versatility and a wide frequency range of 1 to 1400 MHz in a rugged, solid state instrument. Provision for complete remote programming and external AM or FM modulation is standard.

Multiple Operational Modes
Operating modes are Start/Stop, ΔF, and 100% duty cycle CW. In the ΔF mode, sweep width is read directly on the calibrated slide rule type dial.

Marker System
The 2001 has a crystal controlled birdy bypass marker system and the standard unit includes three harmonic markers at 1, 10 and 50 MHz. Up to three additional plug-in marker modules (each with individual on/off switches) may be added to the marker system. The markers may be at single discrete frequencies or at harmonically related frequencies (comb type markers).

Markers can be specified with the instrument or ordered at a later date for field installation. Size and width controls enable optimum adjustment of the marker display. The markers may be tilted up to 90° for easy viewing when displayed with steep transition signals, or they may be rectified by a front panel switch for X-Y plotter applications. Model 2001 also converts a 100 mV external marker input signal to a birdy marker.

Model 2001 will interface with most network analyzers and attenuation test sets.

RF FREQUENCY
Range:
1 to 500 MHz (band 1).
450 to 950 MHz (band 2).
900 to 1400 MHz (band 3).
Dial Calibration: 10 MHz/div.
Accuracy: 10 MHz (band 1). 2% of selected frequency (bands 2 and 3).
Sweep Width: 200 kHz to 500 MHz. Calibration in 10 MHz/div.
Operating Modes: ΔF, CW, Start/Stop.
Display Linearity: 2%.
Spurious Signals: -30 dB (10 to 1400 MHz).

RF SWEEP GENERATORS

MODEL 2001

RF OUTPUT
Impedance: 50 Ω
Output Flatness: ±0.5 dB (at 10 dBm).
Accuracy
±0.5 dB to 500 MHz.
±1 dB to 1000 MHz.
±2 dB to 1400 MHz.

SWEEP CHARACTERISTICS
Sweep Modes: Recurring, single sweep, external trigger, manual and line lock.
Sweep Time: Continuously variable from less than 10 ms to greater than 100s.

MARKER SYSTEM
RF Markers: 1, 10 and 50 MHz harmonic markers are standard and rear panel external marker input is provided.
Accuracy: ±0.005%.
Width: Adjustable from approximately 15 to 400 kHz in 4 steps.
Amplitude: Adjustable from approximately 15 mV to 12V p-p and 100 mV to 50 mV p-p.
Marker Tilt: Adjustable from vertical to approximately 90° .
External Marker: BNC input accepts CW signal for conversion to birdy marker. Input level must be at least 100 mV into 50 W.
Recorder Processing: Front Panel switch removes negative portion of birdy markers for use with X-Y recorders.

REMOTE PROGRAMMING
Rear mounted jack provides necessary connections for remote control of center frequency, sweep width and 20 dB vernier output control. Additional capabilities include External FM, External AM and External Leveling

GENERAL
Dimensions: 20.9 cm (8 1/4 in.) wide; 14.3 cm (5 1/2 in.) high, 34.9 cm (13 3/4 in.) deep.
Weight: 9.1 kg (20 lb) net; 11.4 kg (25 lb) shipping.
Power: 115 or 230V ±10% (available for 100 or 200V at no extra cost); 50 to 400 Hz; approximately 20 watts.

OPTIONS
A-1: Single Frequency Marker 1 to 1400 MHz. **Specify frequency.**
A-2: Harmonic Type Marker. Comb type frequency markers at 5 or 100 MHz.

ACCESSORIES
K103: Rack Mount for mounting one unit
K104: Rack Mount for mounting two units
D152: Detector: (See page 232).

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model 2001
Options
Single Frequency Marker
Harmonic Type Marker

Sweep Signal Generator

• 1 to 1000 MHz Frequency Range
• Features for CATV Applications

Versatility
Solid State Model 1801C Sweep/Signal Generator provides features and options ideally suited for the manufacturer of TV and CATV equipment and for the installers and operators of CATV systems. Model 1801C's 1 to 1000MHz frequency range is standard.

Calibrated Output
The ultra-flat (0.25 dB, 1 to 1000 MHz) 75Ω output system is calibrated from +57 to -33dBmV. A three position front-panel level switch permits the output level to be increased or decreased by an identical fixed amount (internally adjustable to provide changes ranging from 0.05 to 0.5 dB). This feature aids in flatness measurements by providing an accurate, rapid calibration reference which is unaffected by the return loss of the test device or system. A DC block on the RF output prevents accidental equipment damage.

Sweep Rate Versatility
Model 1801C will sweep at line frequency or as slow as 1 sweep in 100 seconds. In addition, a special sweep rate position provides a variable 1 to 10 ms sweep that repeats every 1 to 10 seconds. This is ideal for simultaneous sweep testing of operating cable systems with minimum subscriber interference. Model 1801C may be used with any available sweep receiver.

SPECIFICATIONS

RF FREQUENCY
Range: 1 to 1000 MHz.
Dial Calibration: 20 MHz/div. with 20 MHz vernier.
Accuracy: 20 MHz.
Sweep Width: 200 kHz to 1000 MHz.
Display Linearity: 1%.
Spurious Signals: -30 dB above 10 MHz.
Residual FM: <10 kHz peak in CW mode.
Drift: (At constant temperature after hour warm-up) <100 kHz/5 minutes, 2 MHz for 8 hours.

RF OUTPUT
Maximum Output Amplitude: +57 dBmV
Impedance: 75Ω (50Ω available).
Output Flatness: ±0.25 dB, 1 to 1000 MHz.
Attenuation: Continuously adjustable from +57 to -33 dBmV.
Accuracy:
±0.5 dB to 500 MHz.
±1.0 dB to 1000 MHz.
Reference Attenuator: Internally adjustable from 0.5 dB above and below output level.
Slope Adjustment: To compensate for external cables, detectors, etc., up to ±1 dB/GHz of slope may be imposed on the RF output via the front panel slope control.
Output Connector: Type BNC

SWEEP CHARACTERISTICS
Sweep Modes: Recurring, single sweep, external trigger, manual and line lock.
Sweep Time: Continuously variable from 10 to 100 ms and 1 to 100s, plus a special variable 1 to 10 ms sweep time range with an associated variable 1 to 10s repetition rate for testing of operating CATV systems.

MARKER SYSTEM
RF Markers: 1, 10, and 100 MHz harmonic markers are standard. Provision for up to 3 additional crystal-controlled plug-in birdy bypass markers, plus rear-panel external marker input. Markers may be either discrete frequency (Option A-1) or harmonic type (Option A-2).
Accuracy: 0.005%.
Amplitude: Adjustable from approximately 1 mV to 1 Vpp.
Width: Adjustable from approximately 15 to 400 kHz in 4 steps.

REMOTE PROGRAMMING
Rear-mounted jack provides connections for remote control of center frequency, sweep width and 0 to 20 dB vernier level control. Additional capabilities include External FM, External AM, and External Leveling.

GENERAL
Dimensions: 20.9 cm (8 in.) wide; 14.3 cm (5 in.) high; 34.9 cm (13 in.) deep.
Weight: 9.1 kg (20 lb) net; 11.4 kg (25 lb) shipping.
Power: 115 or 230 V ±10% (available for 100 to 200V at no extra cost); 50 to 400 Hz, approximately 20 watts.

OPTIONS
A-1: Single Frequency Marker. 1 to 1000 MHz. Specify frequency.
A-2: Harmonic Type Marker. Comb type frequency markers at 5 or 50 MHz. Specify frequency.
50Ω Version: The 1801C is available with a 50Ω output attenuator. Output level is calibrated from +10 dBm to -80 dBm.

ACCESSORIES
K103: Rack Mount for Mounting One Unit (P/N 1019-00-0028).
K104: Rack Mount for Mounting Two Units (P/N 1019-00-0029). See page 209 for details.
D-151 Detector: (see page 207).

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model 1801C
Options
Single Frequency Marker
Harmonic Type Marker

1000 MHz Single Band Sweepers

- **Frequency Range 1 to 1000 MHz**
- **CW, ΔF and Full Sweep Modes**
- **Digital Readout**
- **1% Display Linearity**

Series 1080 compact and economical sweep generators feature simple operation, 1% display linearity, digital readout and three operating modes: CW, ΔF and full sweep. Models 1080 and 1081 have the same frequency range but different power output levels.

Frequency in CW mode is set by a ten-turn control and displayed with 1 MHz resolution on a 3 1/2 digit display. In ΔF mode, sweep width range (200 kHz to 1000 MHz max) is set by a 100 MHz/step selector and a 100 MHz vernier. In full sweep mode, the frequency control and display operate as a variable marker.

Model 1080 has an output power range of +13 to -70 dBm into 50Ω and is continuously adjustable with a 10 dB/step attenuator and an 11 dB vernier. Output level is displayed on a 3 1/2 digit readout with 0.1 dB resolution. An "auto-zero" circuit improves frequency accuracy. Model 1081 is a 75Ω version with a calibrated output of +60 to -10 dBmV.

FREQUENCY
Range: 1 to 1000 MHz
Readout: 3 1/2 digit, 1 MHz resolution
Accuracy: CW, Center Frequency of ΔF, and Variable Marker ±10 MHz. Can be improved to ±1 MHz at a specific frequency.
Sweep Width at 100 MHz Intervals: ±10 MHz.
Sweep Width
DF: 200 kHz to 1000 MHz.
Full Sweep: Same as range.
Display Linearity: 1% at maximum sweep width.
Operating Modes: CW, ΔF, and Full Sweep
Drift: <200 kHz for 10 min. (At a constant temperature after 1/2 hour warm up.)

RF OUTPUT
Impedance
Model 1080: 50Ω
Model 1081: 75Ω
Power Level Range
Model 1080: +13 to -70 dBm.
Model 1081: +60 to -10 dBmV.
Output Flatness: ±0.25 dB.
Attenuation: Adjustable in 10 dB steps with an 11dB vernier. Output level display is 3 1/2 digit with 0.1 dB resolution.
Accuracy
Step Attenuator: ±0.3 dB + 1% of attenuation.
Output Connector: Type BNC.

RF SWEEP GENERATORS
MODEL 1080

SPECTRAL PURITY
Harmonic Output
1 to 2 MHz: <-15 dBc;
2 to 10 MHz: <-25 dBc;
10 to 1000 MHz: <-30 dBc in 1 to 2000 MHz band.
Nonharmonics
1 to 400 MHz: <-50 dBc;
400 to 1000 MHz: ±-35 dBc.
Residual FM (CW Mode): <10 kHz peak.

SWEEP CHARACTERISTICS
Sweep Modes: Recurring and single sweep.
Sweep Time
Fast: 0.010 to 1s (typical).
Slow: 1 to 100s (typical).
Line: Approximately 1/2 of AC line period.
Horizontal Output: 0 to 10V, 1000Ω impedance.
Blanking: RF blanked during sweep retrace.

MARKER SYSTEM
RF Markers: Birdy bypass harmonic markers are front-panel switched giving: 100 MHz only; 100 MHz and 10 MHz; or 100 MHz, 10 MHz and 1 MHz.
Accuracy: ±0.005%.
Amplitude: Adjustable ~1 mV to 250 mVp-p.
Width: Adjustable ~10 to 500 kHz.
Variable Marker: (Full Sweep Mode Only.) Frequency control and display function as a variable marker. 2ms sweep ramp delay allows a bright spot marker on display scope. Accuracy is 0.1 MHz.
External Marker: BNC input accepts CW signal for conversion to a birdy marker. Input level must be 100 mV into 50 Ω.

REMOTE PROGRAMMING
Frequency: Control of center frequency, sweep width and external frequency modulation.
Level: Variable from -10 to +10dB in a 10dB range.
Trigger: TTL input, during high to low transition. Also, by contact closure to ground.

GENERAL
Dimensions: 28.6 cm(11 1/4 in.) wide; 13.3 cm (5 1/4 in.) high; 26.7 cm (10 1/2 in.) deep.
Weight: 4.9 kg (10.8 lb) net; 6.8 kg (15 lb) shipping.
Power: 90 to 110V; 105 to 125V; 190 to 220V; or 210 to 250V; 50 to 60 Hz; approximately 35 watts.

ACCESSORIES
K019: Rack Mount Kit for center mounting in a 19 in. rack, 6 31/32 in. height.

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model 1080

RF SWEEP GENERATORS

MODEL 1060

Economical 400 and 500 MHz Sweepers

- **1 to 400 MHz Range, Option to 500 MHz**
- **+10 to -55 dBm Calibrated Output**
- **Built-in RF Detector**
- **Complete Crystal Marker System**
- **Used in NMR Applications**

These small, compact sweepers will sweep any portion of their wide frequency range. Sweep can be triggered, and sweep rates are variable. RF output is controlled by turret and calibrated, continuously variable, PIN-diode attenuators. Source impedance is either 50 or 75 ohms, depending on model.

The marker system accepts up to four crystal controlled plug-in marker modules, allowing either fixed single frequency, and/or harmonic (comb) type markers. The marker amplitude and bandwidth can be adjusted by varying the front-panel controls.

RF FREQUENCY
Frequency Range
Models 1062, 1067: 1 to 400 MHz
Models 1067-522, 1062-522: 1 to 500 MHz
Dial Calibration: 50 MHz intervals vernier included.
Accuracy: 5% full scale.
Sweep Width: 0.2 to 400 MHz.
Display Linearity: 2%.
Operating Modes: Sweep and CW.
Drift: At a constant temperature after 1/2 hr. warmup, 100 kHz for 5 min; 2 MHz for 8 hr.

RF OUTPUT
Impedance
Model 1062: 50 Ω
Model 1067: 75 Ω
Power Level Range
Model 1062: +10 to -60 dBm.
Model 1067: +57 to -7 dBmV.
Output Flatness: ±0.25 dB (at 10 dBm).
Attenuation
Range: 65 dB total; 50 dB in 10 dB steps plus 0 to 15 dB PIN diode attenuator.
Accuracy
Step Attenuator: ±0.2 dB/10 dB.
Vernier Attenuator: ±1 dB.
Output Connector Type
Model 1062: BNC.
Model 1067: F.
Spectral Purity: Harmonic and nonharmonic, 30 dBc (10 to 400 MHz).
Residual FM: Less than 10 kHz peak.

SWEEP CHARACTERISTICS
Sweep Modes: Recurring, single sweep and trigger.
Sweep Rate: Variable from 0.5 Hz to 60 Hz.
Output: 10 Vp-p symmetrical about ground.
Blanking: RF output blanked during retrace; removed for CW operation.

MARKER SYSTEM
RF Markers: Provision for up to 4 crystal controlled plug-in birdy bypass marker modules (see Options A-1 and A-2). External marker is standard.
Marker Switches: Individual on/off switches; The external marker position is always on.
Accuracy: 0.005%.
Amplitude: Adjustable from ~ 2 mV to 2 Vp-p.
Width: Adjustable from ~ 100 to 400 kHz.
External Marker Signal: 0.1V into 50Ω rear panel BNC.

REMOTE PROGRAMMING
Control of center frequency, sweep width and 0 to 20 dB vernier level control.

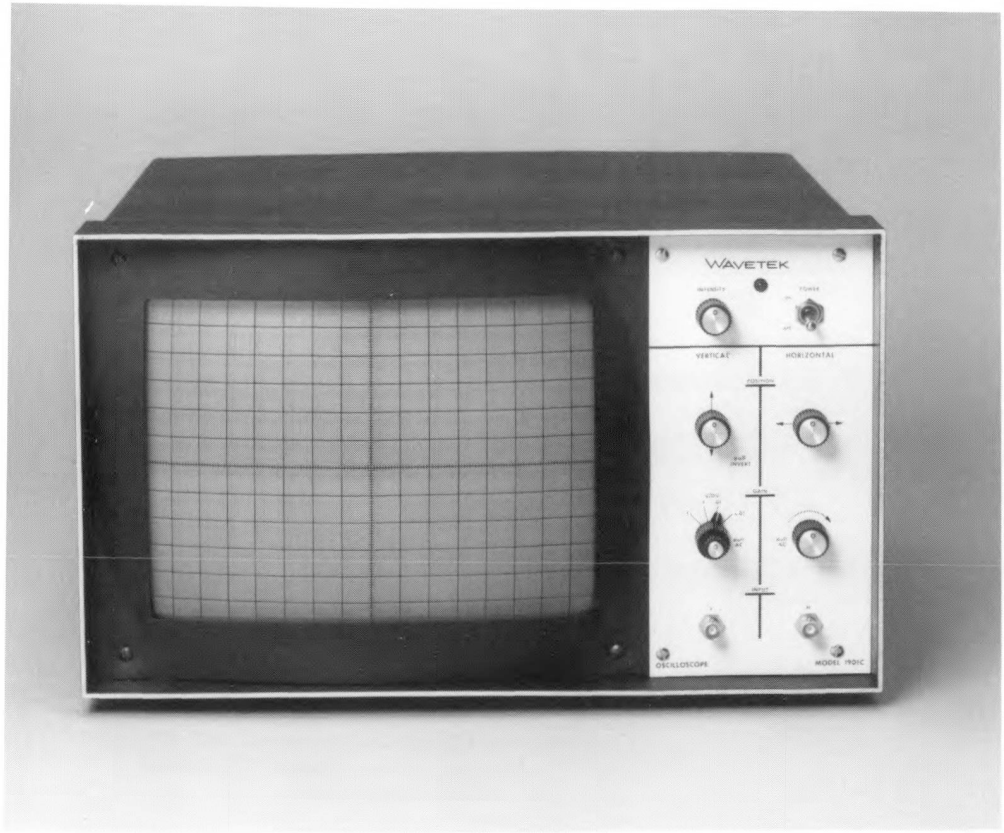
GENERAL
Dimensions: 28.6 cm (11 in.) wide; 10.2 cm (4 in.) high; 26.7 cm (10 1/2 in.) deep.
Weight: 3.7 kg (8 1/4 lb) net; 6.8 kg (12 1/2 lb) shipping
Power: 115 or 230V ±10%; 50 to 400 Hz; approximately 25 watts.

OPTIONS
A-1 Single Frequency Marker. 1 to 500 MHz. Specify frequency.
A-2 Harmonic Type Marker. Comb type frequency markers at 1, 5, 10, 50 or 100 MHz. Specify Frequency.
SP-522 Frequency Extension. 400-500 MHz available with 1062, 1067

ACCESSORIES
K015 Rack Mount Adapter. (P/N 1019-00-0119)
D151 Detector (50Ω)
D171 Detector (75Ω)

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model 1062
Model 1067
Options
Single Frequency Marker
Harmonic Type Marker
Model 1062-522
Model 1067-522



X-Y Display Oscilloscope

- **Large 12 Inch Diagonal CRT**
- **Ideal for Production Testing**
- **Excellent Sensitivity**
- **Economical**

Model 1901C is a low cost, electromagnetic, X-Y display scope ideal for use in displaying the sweep response of passive or active circuits. High performance and low cost make this scope an excellent choice for engineering laboratories, production facilities, educational institutions, and original equipment manufacturers of such devices as medical instrumentation and automotive test equipment.

Features

Model 1901C is a single trace, general purpose scope. It may be intensity modulated and used either on the bench or rack mounted for production use.

Model 1901C features a large 12 inch diagonal screen which produces a bright, stable, focused trace for ease of viewing. An automatic blanking circuit prevents phosphor damage by blanking the CRT when the horizontal input is removed. Medium persistance phospor (P1) is standard.

Model 1901C features Z-axis intensity modulation for grey scale operation.

Model 1901C also features a marker adder which accepts both birdy and pulse markers. Marker amplitude is constant regardless of vertical gain.

DISPLAY
CRT: 12 in (30 cm) diagonal
Phosphor: P1 (medium persistence, green)
Graticule: 1.5 cm/div., 12 cm vertical, 16 cm horizontal
Deflection: Magnetic
Acceleration Voltage: 9 kV nominal

VERTICAL
Sensitivity: 4-position step attenuator for 1, 10 100 mV and 1 V/div., continuously variable vernier between steps
Impedance: 374 k Ω
Bandwidth: DC to 15 kHz
Coupling: Switchable AC-DC (when AC coupled maximum DC voltage plus AC peak not to exceed 200 V)
Linearity: 5% (center 10 div.)

X-Y DISPLAY OSCILLOSCOPE
MODEL 1901C

Input Connector: BNC, front panel Drift: Typically 1/2 div. for 8 hr. (at constant temperature after 1/2 hr. warmup)
Polarity: Front-panel switch for inversion of vertical signal

HORIZONTAL
Sensitivity: Continuously adjustable from 0.1 V/div. to over 10 V/div.
Impedance: 320 k W
Bandwidth: DC to 1.5 kHz
Coupling: Switchable AC-DC (when AC coupled, maximum DC voltage plus AC peak no to exceed 200 V)
Linearity: 3%
Input Connector: BNC, front panel
Drift: Typically <1/2 div. for 8 hr. (at a constant temperature after 1/2 hr. warmup)
Protection Circuit: Prevents burnout of CRT by blanking beam when horizontal signal is approximately 4 div. (60 Hz rate). When operating at slower rate, or for servicing, rear-panel switch can disable the protection circuit.

INTENSITY MODULATION
Sensitivity: Adjustable from 1 to 10 V for full modulation.
Input Impedance: 20 kW in parallel with 10 pF
Bandwidth: Flat from DC to 1 MHz, 3 dB down at 3.5 MHz, 10 dB down at 10 MHz
Polarity: Positive going voltage intensifies trace. Internally changeable for positive blanking.
Input Connector: BNC at rear panel

MARKER ADDER
Input Signal: Pulse or birdy
Sensitivity (Max): Typically 0.5 V/div. (continuously adjustable with rear-panel control)
Polarity: Rear-panel switch provides polarity reversal
Input Impedance: Approximately 15Ω

GENERAL
Dimensions: 26.2 cm (10 5/16 in.) high; 41.9 cm (16 1/2 in.) wide; 36.2 cm (14 1/4 in.) deep
Weight: 11.8 kg (26 lb.) net; 15 kg (35 lb.) shipping
Power: 115 or 230 V ±10%; 50/60 Hz; approximately 75 watts

OPTIONS
LP: Longer persistence Phosphor (supplied with amber faceplate).

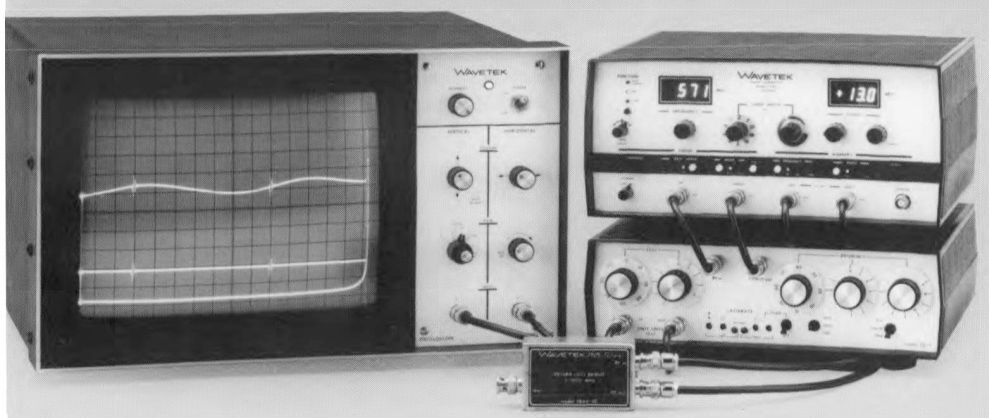
ACCESSORIES
K107: Rack Mount P/N 1019-00-0030

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model 1901C
Option LP

RF SCALAR ANALYZERS

MODELS 1076 & 1077



RF Scalar Analyzer Systems

• Sweeps 1 MHz to 1 GHz in a Single Band

Wavetek Scalar Analyzer System is a versatile, low-cost system especially well suited for production testing. A real-time, broadband swept system, it provides highly accurate measurement at any frequency from 1 MHz to 1 GHz. The system is available in either 50 or 75Ω impedance.

System Components
The system consists of a sweep frequency source, Model 1080 (1081 is 75Ω); a calibrated dual-channel switching RF return loss Bridge, Model FB40-50 (FB40-75); and a large-screen oscilloscope, Model 1901C to simultaneously display both test and reference channels.

Measurements to 1 GHz in a Single Band
The system sweeps from 1 MHz to 1 GHz in a single band. Harmonic markers of 100 MHz, 10 MHz, and 1 MHz help identify frequencies easily and accurately at any point in the sweep band. The size of the markers may be controlled to optimize readability and resolution.

Broadband Search Mode
When the passband of a device under test is not known, the full sweep mode may be used to locate the passband and the variable marker may then be moved to coincide with the center of the passband. A simple, push-button control changes the mode to ΔF around the center frequency.

System Level Correction
Inaccuracies found in test setups caused by high-frequency roll off of system components (such as adapters, cables, or "lossy" connectors) may be compensated for via the slope control on either the 1080 (1081) Sweep Generator or the Model 1077 (1076) RF Sweep Comparator. Absolute gain or loss measurements of the device under test are now possible with this step.

Absolute accuracy is determined by precision attenuators in each channel. Excellent trace coincidences of 0.3 dB allow very accurate relative measurements between the unknown and the reference or test channels. Use of a common internal detector, amplifier, and cable, virtually eliminates errors due to drift. A cable set to connect the device under test is matched to internal cables to minimize errors normally encountered when connecting the device under test.

MODEL 1077/1076
FREQUENCY
Range: 1 MHz to 1 GHz in 1 band
Sweep Width: 0.2 to 1000 MHz
Full Sweep: same as range
Display Linearity: 1% at max sweep width
Drift: Measured at constant temp after 1/2 hr warm-up. 200 kHz for 10 min.
Operating Modes: CW, F and Full Sweep

RF OUTPUT
Impedance: 50 or 75
Power Level Range
50:+13 to -70 dBm
75:+60 to -10 dBm
Output Flatness: ±0.25 dB

AMPLITUDE VS. FREQUENCY
Gain Measurement Range: 0 to 79.9 dB (resolution: 1 dB).
Loss Measurement Range: 0 to 60 dB (resolution: 0.1 dB).

Step (dB)	Accuracy	
	2 to 500 MHz	1 to 1000 MHz
0.1	±0.10	±0.20
1	±0.10	±0.25
10	±0.50	±1.00

Trace Coincidence
2 to 500 MHz: ±0.2.
1 to 1000 MHz: ±0.3.

FB40-50/FB40-75 Impedance
Model FB40-50: 50
Model FB40-75: 75
Open-Short Change: ±1.2 dB
Insertion Loss: 15 dB nominal
Directivity: 40 dB.
Connectors: BNC connectors are standard.

GENERAL
Dimensions
Model 1076/1077: 10.2 cm (4 in.) high; 28.6 cm (11 1/4 in.) wide; 26.7 cm (10 1/4 in.) deep.
Model FB40-50/FB40-75: 5 cm (2 in.) high; 11.5 cm (4 1/2 in.) wide; 3.2 cm (1 1/4 in.) deep.
Weight
Model 1076/1077: 3.0 kg (6.5 lb) net; (10 lb) shipping.
Model FB40-50/FB40-75: 0.35 gram (10 oz) net; 2.3 kg (5 lb) shipping.
Power: Supplied by associated sweep.

NOTE: For more information
Model 1080: page 106.
Model 1081: page 106.
Model 1901C: page 107.

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model 1076
Model 1077

Frequency Synthesizers

Wavetek produces a variety of high performance bench top and programmable frequency synthesizers with function, signal and sweep versatility.

As can be seen from the selection guide, synthesizers that cover a wide range of capabilities are available. Frequencies to 1 GHz are possible with the 5155A, while Model 650 has up to 10 digits of resolution and a maximum output level of 50 Vp-p. Available synthesized functions include sine, square, triangle, ramp and haverwaves that can be triggered, gated, frequency swept and burst in various combinations. Amplitude and phase modulation as well as variphase operation are available on Model 178. Models 178 and 650 have the added ability of linear or logarithmic operation, stored settings and markers.

Models 5100, 5120A, 5135A and 5155A
Frequency Synthesizers employ Direct Digital Synthesis for increments (digits) less than 100 kHz and Direct Analog Synthesis for increments 100 kHz and higher. This produces low switching transients, low phase noise and exceptional short term stability. In binary word format, true amplitude and phase continuity are maintained in switching between any two frequencies (i.e., no switching transient). Programming delay ranges from <20 µs down to near zero, depending on the model number and frequency increment. Thus, linear frequency sweeping or frequency hopping (including FSK signaling) are easily programmed. In addition, Model 5135A provides exceptionally fast phase-continuous switching. Model 5100 provides constant 0.001 Hz resolution. Direct synthesis makes these instruments unique in their ability to generate pure, stable signals and to change frequencies in microseconds. Applications include FSK and coherent radars, satellite tracking, NMR systems, secure communications and cellular radio.

Model 650
Model 650 has 29 sweep modes and a phase accuracy of 0.005° at frequencies below 1kHz. It comes standard with 2 channels, but can be expanded to four. As many as ten Model 650's can be cascaded to obtain up to 40 individually programmed channels of phase coherent, phase controlled signals with 5 millidegree resolution. Up to 25 complete instrument setups can be stored in battery backed-up RAM. Model 650 is suited for analog and digital design, FSK, phase meter calibration, phased arrays, avionics, robotics and communications.

Model 650 Internal Calibration
Model 650 has internal calibration facilities that render classical calibration procedures obsolete and effectively reduce the cost of ownership. There are only two adjustments for the main generator and reference/calibration circuits. Each output channel also has five adjustments, three of which are factory set and not expected to change. Complete calibration of a four channel Model 650 can be accomplished in minutes. Once calibration is complete, the instrument performs an autocal procedure. The autocal procedure requires no external measurements or additional instruments.

Model 650 Quick-Cal
A quick-cal procedure that provides optimum accuracy for the instrument setup under the prevailing ambient conditions is available.

Model 650-Self Diagnostics
Model 650 has an elaborate internal self-diagnostic test that systematically verifies proper operation of various functional blocks within the instrument. After isolating the problem, an operator may then replace the faulty plug-in board and repeat the test until satisfactory results are obtained. These internal self-diagnostic and calibration procedures further underline Wavetek's efforts to keep the cost of equipment ownership to a minimum.

Model 178
Model 178 contains two fully synthesized generators. The sweep generator can be used by itself as an independent generator or with the main generator as a sweep or trigger source. Sweep can be linear or true log, up or down, and in virtually any sweep time. Sweep can also be mixed with continuous, trigger, gate, burst and other modes. Pulses in continuous, single, burst, gated and complement are fully synthesized. One of ten preset markers can be selected, and up to 40 complete instrument setups may be stored for future use. Model 178 can be used in such applications as low frequency medical stimulations, mechanical stimulations, and low frequency pulse generation.

Remote Programming
Remote programming allows rapid frequency or amplitude changes in all models. Remote control also takes advantage of the high-speed and phase-continuous, spurious-free synthesizer switching of Models 5100, 5120A, 5135A and 5155A. For Model 5135A, the 0.1 Hz minimum switching increment that is available with front panel (local) control is improved to 0.001 Hz under remote control.

GPIB (IEEE-488) remote interface is standard on Models 178 and 650, optional on Models 5100, 5120A, 5135A and 5155A. Models 178 and 650 are MATE compatible for CIIL programming per USAF Standard 2806763.

SYNTHESIZER SELECTION GUIDE

Top Frequency	2 MHz	3 MHz	50 MHz	160 MHz		1000 MHz
MODEL	650	5100	178	5120A	5135A	5155A
Low Frequency	100 µHz	DC	100 µHz	100 kHz		1 MHz
Frequency Resolution	10 digits or 0.1 mHz	0.001 Hz	8 digits	0.1 Hz	0.1 Hz (Local) 0.001 Hz (Remote)	0.1 Hz
Switching Transient	≤500 ns	<625 ns	N/A	<20 µs	1 µs to 10 µs	1 µs to 300 µs
Phase Continuous Switching	Yes		N/A	Yes[1]		
Phase Control	Yes		Yes			
Output Level	50 Vp-p	1 Vp-p 10 Vp-p (2 MHz)	20 Vp-p	+3.1 to +13 dBm		
Frequency Response	±0.5% (<100 kHz) ±3% (≤2 MHz)	±0.25 dB (<500 kHz) ±0.5 dB (<3 MHz)	±1% (1µHz to 20 kHz) ±15% (to 50 MHz)	±0.5 dB		±0.5 dB (<500 MHz) ±1.0 dB (≥500 MHz)
Spectral Purity Spurious	-70 to -50 dBc	-70 dBc (<100 kHz) -60 dBc (<500 kHz) -50 dBc (<2 MHz)	-60 to -50 dBc	-70 dBc		-64 dBc (<500 MHz) -58 dBc (≥500 MHz)
Harmonics	-33 to -60 dBc	-40 to -55 dBc	-30 to -55 dBc	-35 dBc		-17 dBc (<10 MHz) -20 dBc (≥10 MHz)
SSB Phase Noise (Residual) 100 Hz 10 kHz 100 kHz				-100 dBc/Hz -120 dBc/Hz -125 dBc/Hz		-95 dBc/Hz (<500 MHz) -110 dBc/Hz -115 dBc/Hz
Integrated Phase Noise (30 kHz BW) (Excluding 1 Hz centered about fundamental frequency)		-50 dBc (<2 MHz)	-46 dBc	-70 dBc		
Internal Ref Standard	10 MHz	8 MHz	10 MHz	10 MHz (Option)		
External Ref Standard	10 MHz	1,8 MHz 5/10 MHz (Option)	10 MHz	1 to 5, 10 MHz (1 MHz Option)		5, 10 MHz
Trigger/Gate/Burst/						
Sweep Modes	Yes		Yes			
Multi-Channel	Yes					
Triangle/Ramp/Square	Yes		Yes			
Local Control	Yes		Yes			
Remote Control (TTL)		Yes				
GPIB Programmable	Yes	Option	Yes	Option		
Page	64	110	62	109	109	111

[1] Over a limited frequency range.

[2] Excluding 1 Hz centered about the fundamental frequency.

Programmable VHF Synthesizers

- **0.1 to 160 MHz Frequency Range**
- **0.001 Hz Constant Resolution**
- **High Speed, Spurious-Free Switching**
- **True Phase Continuity**
- **Direct Synthesis: No Phase-Lock Loops**

Models 5120A and 5135A are precision frequency sources whose outputs are coherent with, and reflect the stability and accuracy of, either a 1, 5 or 10 MHz reference standard.

FREQUENCY
Range
Local: 100,000 to 159,999,999.9 Hz.
Remote: 100,000 to 159,999,999.9 Hz (Model 5120A), 100,000 to 159,999,999.999 Hz (Model 5135A).
Resolution
Local: 0.1 Hz.
Remote: 0.1 Hz (Model 5120A). 0.001 Hz (Model 5135A).

REMOTE PROGRAMMING
Switching Time
Model 5120A: <20 µs.
Model 5135A: <1µs (digits <10 MHz), <5 µs (10 MHz digit).

Phase Continuity (Model 5135A): Phase continuous between frequencies for any combination of the 8 digits below 100 kHz increment.
Switching Spurious (Model 5135A): Spectral purity not degraded when switching below 100 kHz band, and using decades through 10 kHz only.

SPECTRAL PURITY
Phase Noise Spectral Density: Guaranteed SSB S/N ratio measured in 1Hz bandwidth.

Offset Frequency	Guaranteed S/N
10 Hz	-93 dB
100 Hz	-100 dB
1kHz	-110 dB
10 kHz	-120 dB
100 kHz	-125 dB

Non-Harmonic: 70 dB below fundamental, 100 kHz to 160 MHz.
Harmonic: 35 dB below fundamental at full output, 100 kHz to 160 MHz.

AMPLITUDE
Main Output
Level: Nominal level adjustable from +3 dBm to +13 dBm into 50Ω.
Flatness: ±0.5 dB, 0.1 MHz to 160 MHz at +13 dBm.
Control: Local or remote by external dc voltage.
Settling Time: 50 µs.
Auxiliary Reference Output: 10 MHz.

REFERENCE FREQUENCY STANDARDS
External Reference Only (Option 000)
Internal 10 MHz Crystal
High Stability (Option 001)
Aging Range: $\pm 4 \times 10^{-9}$/day.
Temperature Stability: $\pm 1 \times 10^{-8}$, 0° to 40°C.
TXCO (Option 002)
Aging Rate: $\pm 4 \times 10^{-6}$/year, 0° to 40°C.
Temperature Stability: $\pm 1 \times 10^{-6}$, 0° to 40°C.
External Input Capability
1MHz (Option 007): Receives 1MHz, 0.4 Vrms into 50Ω, nominal.
5 or 10 MHz (Standard): Receives 0.4 Vrms into 300Ω, nominal.

GENERAL
Environment: Operating 0° to +40°C, spec operation 25° ± 10°C after 20 minute warm-up.
Dimensions: 48.3 cm (19 in.) wide, 13.3 cm (5.25 in.) high, 48.3 cm (19 in.) deep.
Weight: 15 kg (33 lb) net, 18 kg (40 lb) ship.
Power: 115/230 Vac ±10%, 47-63 Hz, 75 VA.

OPTIONS
Option 000, 001 or 002 must be selected.
000: External Crystal Reference Only
001: High Stability Crystal Reference. (Proportional Oven Control).
002: TCXO. Temperature Compensated.
003: Rear Panel Output. In lieu of front.
006: IEEE 488-1978 Interface
007: 1MHz Ext Ref Input
008: Chassis Drawer Slides

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 5120A
Model 5135A
Option 000
Option 001
Option 002
Option 003
Option 006
Option 007
Option 008

For full specifications or demonstration, contact your nearest Wavetek representative (pageS 211 and 213).

Programmable Synthesizers

- **Frequency Range: DC to 2MHz**
- **Resolution: Constant 0.001 Hz**
- **Direct Digital Synthesis: No Range Multipliers Mixing or Phase Lock Loops**
- **Ultra-Fast Switching: 1.5 μs**
- **True Phase and Amplitude Continuity**

Model 5100 Programmable Frequency Synthesizer has excellent short term stability, and maintains amplitude and phase continuity when switching between any two frequencies.

Model 5100 may be programmed locally and remotely.

FREQUENCY
Range: DC to 2,000,000.000 Hz.
Resolution: Constant 0.001 Hz.
Control: Local, BCD remote or optional GPIB.

SWITCHING CHARACTERISTICS
Programming Delay: 1.5 μs per binary word with phase and amplitude continuity. 20 μs per BCD word with output reset to zero phase during delay. 20 μs minimum per 4 BCD and binary bytes with output reset to zero phase during programming.
Update Rate: 625 ns per binary word. 18 μs per BCD word and byte modes.
Zero Phase Reset: 800 ns to and from zero phase output asynchronously set to zero phase).

MAIN OUTPUTS (FRONT AND REAR BNC'S)
Fixed Output: 1Vp-p no load, 0.5 Vp-p into 50Ω.
Variable Output: 5Vp-p into 50Ω (max). 10 Vp-p into open circuit (max).
Auxiliary Output: 1 or 8MHz square wave reference at TTL levels.
Level Control
Model 5100 Only: 0 to 85 dB in 1dB steps plus 0 to 10 dB continuous control.
With Option 002: Remote program control (7 bits) of 85 dB in 1dB steps.

SPECTRAL PURITY
Spurious Components: 70 dB to 100 kHz; 60 dB to 500 kHz; 50 dB to 2MHz.
Harmonic Components (at 1 Vrms): 55 dB to 100 kHz; 50 dB to 500 kHz; 45 dB to 2MHz.
Phase Noise: 30 kHz band excluding 1Hz centered on carrier. 50 dB to 2MHz.
Attenuator Response to 60 dB: 0.5 dB to 500 kHz.

GENERAL
Environment: Operating 0° to +50°C. Storage -20° to +70°C.
Dimensions: 43.2 cm (17 in.) wide; 8.9 cm (3.5 in.) high; 33 cm (13 in.) deep.
Weight: 9.6 kg (21 lb) net; 11.4 kg (25 lb) shipping.
Power: 115/230 Vac 10%, 50 to 60 Hz, 65 watts.

OPTIONS
001: High Stability Crystal Reference
002: Remote Programmable Attenuator
020: Auxiliary TTL Output.
GPIB: Use Model 1488A-12.

ACCESSORIES
Rack Adapters
Programming Connector

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 5100
Option 001
Option 002
Option 020

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

FREQUENCY SYNTHESIZERS

MODEL 5155A

UHF Frequency Synthesizer

- **1 MHz to 1 GHz Frequency Range**
- **0.1 Hz Frequency Resolution**
- **As Low as 1μs Switching Speed**
- **Phase Continuous Switching**
- **Very Low Close-in Phase Noise**

Fast Switching
Model 5155A standard BCD interface allows fast (less than 1μs) phase-continuous frequency switching. Phase continuity is maintained for frequency changes less than 100 kHz.

Applications
Model 5155A offers the simplicity, stability, and resolution to maintain performance in frequency coded radars. Secure communication transmissions need fast, spurious-free switching to make detection virtually impossible. For cellular radio requirements, low, close-in phase noise, fast switching, and fine resolution makes this instrument well suited in both testing and cell site maintenance.

FREQUENCY
Range: 1 to 1000 MHz (999.999 999 9 MHz).
Resolution: 0.1 Hz.

MAIN OUTPUT
Level: +3.1 to +13.0 dBm into 50Ω (nominal).
Resolution: 0.1 dB.

SPECTRAL PURITY
Non-Harmonic (≥300 Hz Offset.):
<500 MHz: <-64 dBc.
≥500 MHz: <-58 dBc,
Harmonic (At +13 dBm):
Fc <10 MHz: <-17 dBc.
Fc ≥10 MHz: <-20 dBc.
Residual Phase Noise Spectral Density (dBc/Hz): Steady State.

Offset Frequency	Output Frequency <500 MHz	≥500 MHz
10 Hz	- 80	- 74
100 Hz	- 95	- 89
1 kHz	-105	- 99
10 kHz	-110	-104
100 kHz	-115	-109

REMOTE BCD PROGRAMMING
Logic: TTL, parallel BCD, negative-true logic with double buffering.
Switching Transient:
≤1 MHz Increment (digit): 1 μs.
≥10 MHz Increment: 100 μs.
Phase Continuity: Phase continuous for any frequency change using only the 6 increments (digits) below 100 kHz.
Amplitude Settling Time: (Destination Frequency <500 MHz.)
Δ ≤10 MHz: 50 μs.
Δ ≤100 MHz: 100 μs.
Δ >100 MHz: 200 μs.

REFERENCE FREQUENCY STANDARDS
Internal 10 MHz
None Supplied (Option 000): External reference must be supplied.
High Stability (Option 001)
Aging Rate: ±4 x 10^{-9}/day.
Temperature Stability: ±1 x 10^{-8}, 0° to +50°C.
TCXO (Option 002)
Aging Rate: ±4 x 10^{-6}/year.
Temperature Stability: ±1 x 10^{-6}, 0° to + 50°C.
External Reference Input: 5 or 10 MHz (standard). 0.32 Vrms into 50Ω (nominal).

GENERAL
Environment: Operating 0° to + 50°C, storage -20° to +70°C.
Dimensions: 48.2 cm (17 in.) wide; 13.3 cm (5.25 in.) high; 48.3 cm (19 in.) deep; includes rack ears.
Weight: 18 kg (40 lb) net; 21 kg (44 lb) shipping.
Power: 115/230 Vac ±10%, 47 to 63 Hz, 85 VA.

OPTIONS
One option (000, 001, or 002) must be selected.
000: External Reference Only
001: High Stability Crystal Reference
002: TCXO Reference
003: Rear Panel BNC Output
006: GPIB (IEEE-488 1978). In addition to BCD programming.
007: 1 MHz External Reference Input
008: Rack Slides

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 5155A
Option 000
Option 001
Option 002
Option 003
Option 006
Option 007
Option 008

For full specification or a demonstration, contact your nearest Wavetek representative (pages 211 and 213).

Microwave Test and Measurement Products

Index To Section: **Pg. No.**

The Wavetek line of RF/Microwave Test and Measurement products includes Scalar Analyzers, CW and Peak Power Meters, Signal Sources and Sweepers as well as two Microwave Signal Generators.

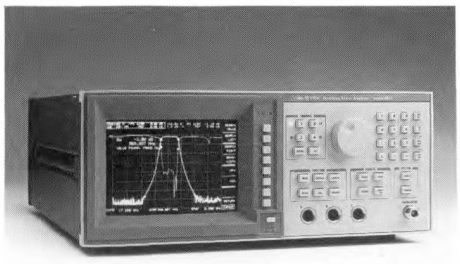
Many of the products provide industry leading performance for making precise measurements. Others provide significant savings for applications requiring cost effective products.

Wavetek's microwave products provide the high performance required by design engineers. In addition, every product is fully field supportable.

Scalar Analyzers

The 8003 is the latest addition to Wavetek's line of scalar analyzers. It offers the highest performance available in the market place.

The 8003 sets a new industry standard for dynamic range of 90 dB. This was achieved by taking advantage of Wavetek's unique power sweep calibration system to characterize the diode detectors used in the power sensors.



The power sweep calibrator also allows the analyzer to make precise power measurements over the full dynamic range. An excellent linearity of ±0.04 dB, built-in cal factor correction and NIST traceability removes the need to include a separate power meter for measurements like the 1 dB compression point on amplifiers.

Significant improvements have also been made in the integration of the sweeper into the system. Exchange of data takes place using a private GPIB link resulting in sophisticated control for complex scalar measurements. The sweeper is then transparent to the user. It is configured to track the analyzer settings, such as start and stop frequency, using just the appropriate controls on the analyzer.

A major step forward in ease-of-use was achieved by using a color display. This greatly simplifies the simultaneous display of multiple waveforms along with measurement data and status information.

A critical part of any scalar measurement system is the detectors. By using balanced diodes, Wavetek detectors have the unique advantage of reducing the effect of harmonics on measurement accuracy, blocking low level DC and providing high sensitivity. These advantages have been taken a step further by adding an EEPROM to the 80300 series of power sensors used with the 8003 scalar analyzer.

The EEPROM contains calibration factor data for the associated detector that can be read by the analyzer and used to correct the power readings for the frequency of operation. This adds to the ease-of-use and resulting accuracy of the measurements.

Wavetek also has a very comprehensive line of couplers and bridges for use with the scalar network analyzers. For accurate measurements, bridges have the advantage of better directivity than couplers. Accurate measurements using Wavetek's latest bridges have been taken a step further using the same power sweep calibration factor techniques previously described.

CW and Peak Power Meters

Wavetek is committed to providing customers with a series of power meters for the precise measurement of CW and peak power. This commitment started in 1967 with the first digital readout power meter, the 1009. Then, in 1969, the 1018 Peak Power Meter was introduced. This was the first direct reading peak power meter.

Today, the 8530 and 8531 CW Power Meters provide customers with accurate, fast reading-rate products. The 8530 is a general purpose analog power meter. Power levels are indicated on an anti-parallax mirror scale.

The 8531 is a digital power meter combining state-of-the-art accuracy with a modern feature set. Microprocessor control provides simple keyboard or GPIB operation, fast response and high accuracy.

Precision diode and thermocouple average responding power sensors for use with the 8530 and 8531 provide wide dynamic range from +20 dBm to -70 dBm and frequency coverage from 30 kHz to 26.5 GHz.

Users of RF/microwave systems where the carrier is either pulsed or digitally modulated need to accurately measure the power at various points on the waveform. Wavetek's 8500A Series Peak Power Meters measure pulsed signals in the frequency range from 30 MHz to 40 GHz with risetimes as fast as 15 ns.

The 8500A Series Peak Power Meters have established new standards, both in accurate measurements and the ability to do waveform analysis using a built in graphics display. Microprocessor con-

trol provides simple keyboard or GPIB operation, fast response and high accuracy.

Excellent peak power meter linearity is achieved by calibrating the power sensors using a built in power sweep calibration system. Now, peak power sensors can be interchanged and user recalibrated under microprocessor control in less than one minute.

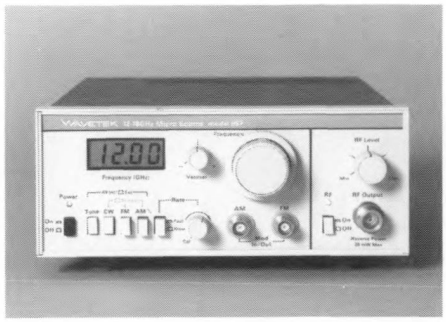
Wavetek's peak power sensors use balanced diodes for excellent sensitivity and reduction of even-order harmonic errors. Frequency range is 30 MHz to 40 GHz.

Power Sensor frequency response errors are corrected using built in PROMs which have been programmed with Cal Factor data. Single frequency correction can be selected from the front panel or over the GPIB. Swept frequency corrections are also possible using the V ∝ F feature on the power meter and an appropriate source.

Pulse Timing measurements can be made with the 8500A Series without the need for any additional test equipment. Using markers, precise measurements of risetime and pulse width can be quickly and accurately made.

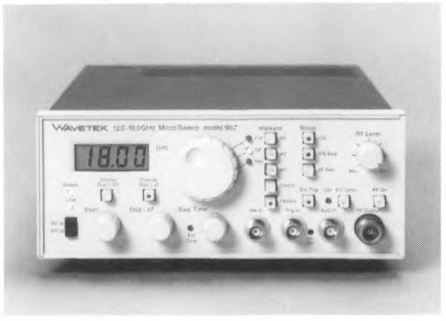
GPIB capability is standard in the 8500A Series and permits full control of the instrument. In addition, waveforms can be downloaded for storage or display on the controller CRT.

Signal Sources and Sweeps
Wavetek's Micro Sources, the 950 Series provide a low cost source of microwave signals covering the 1 to 18 GHz frequency range with four units.



Each Micro Source is small, light weight and easy-to-use. In addition to an excellent CW signal, the sources feature: internal sweep; AM and FM modulation capabilities; external power leveling capability and a wide range RF power level control.

The 960 Micro Sweep Series provides many of the most important bench top sweep generator capabilities at a significantly lower price.



Each Micro Sweep features start/stop and Δ F sweep, three independently settable markers, external modulation capabilities and provision for a leveled output.

Microwave Signal Generators
Two band oriented generators, the 904 and 907A, offer excellent modulation capabilities (AM, FM and Pulse) as well as a very accurate power level control capability. The 0 to -127 dBm output level control makes these generators very attractive for testing receiver sensitivity and gain response. Frequency range of the 904 is 3.7 to 7.6 GHz and for the 907A is from 7 to 12.4 GHz. The generators also feature 80 dB pulse on/off ratio, internal frequency sweep capability and optional GPIB capability. The Model 907A Microwave Signal Generator has been assigned a National Stock Number by the US Air Force.

1 to 18 GHz MicroSources

- **1 to 18 GHz From 4 Models**
- **CW, AM, FM and Internal Sweep**
- **+10 dBm Typical Output Power**
- **External Leveling Capability**
- **Compact, Portable and Exceptional Value**

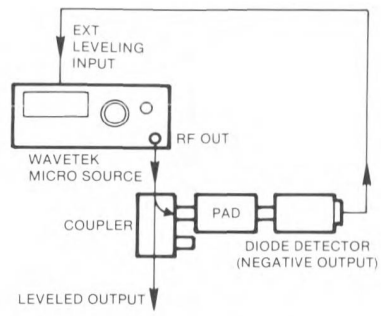
Versatile Performance
The Wavetek Model 950 Micro Sources are exceptional value in compact and modern packages. The four models cover the following frequency ranges:

Model	Range
952	1.0 to 4.0 GHz
954	3.7 to 7.6 GHz
955	7.5 to 12.4 GHz
957	12.0 to 18.0 GHz

Each Micro Source uses a YIG tuned oscillator to generate low noise, stable CW signals. Maximum output power is typically greater than +10 dBm, with over 25 dB of power control range. In addition to CW, each source provides internal AM, FM and frequency sweep. For greater versatility, both frequency and power level are externally controllable, and all units permit convenient external power leveling and phase locking.

Frequency Control
The output frequency of each Micro Source is controlled via a front panel 10-turn potentiometer and single-turn vernier, or by an external 0 to +10 V input to the rear panel connector. In addition, the full frequency range may be internally swept at adjustable rates between 0.1 and 50Hz, and the external tune capability permits full or partial band sweeps. During each of the above operations, the large, easy-to-read LCD display presents the output frequency with resolution of 10 MHz, and a total accuracy of better than +1%. While in the internal sweep mode, a 0 to +10V output proportional to frequency is provided at the rear panel Ext Tune/Sweep Out connector.

Power Level Control
Output power level is manually controlled over a 25 dB range by the front panel single turn knob, or externally controlled by a DC voltage applied to the AM input connector. External leveling is also permitted via input of a detected signal to the rear panel Ext Level connector.



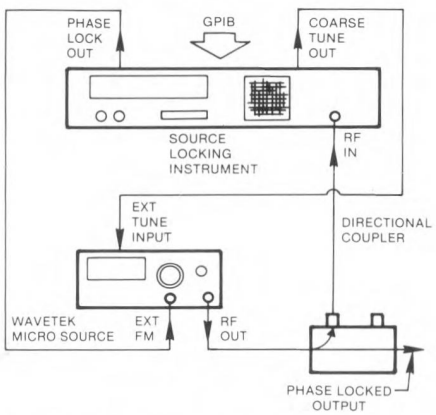
Externally Leveled Power

Also, a front panel RF On/Off switch can completely turn off the internal oscillator without removing power from the rest of the unit.

Internal Modulation
Each Micro Source internally generates both AM (square wave) and FM over a wide range of rates. In conjunction with the Fast/Slow pushbutton, the front

panel Rate knob adjusts modulation rates over the 10 to 500 Hz and 100 to 5000 Hz ranges.

External Modulation
External AM and FM are made possible through input to two front panel BNC connectors. In addition, each connector provides a 5V peak-peak output signal

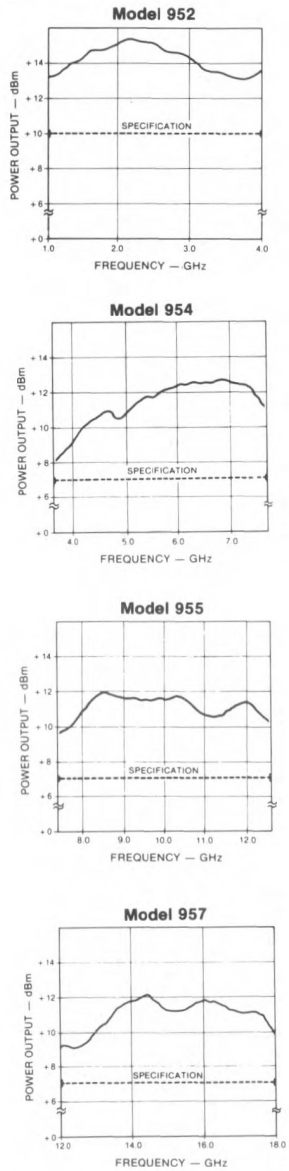


Phase Locked Operation Under GPIB Control of Frequency

for monitoring purposes during internal AM and FM. Each of these two external modulation inputs is DC coupled to allow power control via the AM input and external phase locking through the FM input. Phase locking does not require any adjustments or modifications to the Micro Source.

FREQUENCY
Range
952: 1.0-4.0 GHz.
954: 3.7-7.6 GHz.
955: 7.5-12.4 GHz.
957: 12.0-18.0 GHz.
Display Resolution: 10 MHz.
Accuracy: ±1.0% of display (Note 2).
Stability (Typical)
With Temperature: 0.007% per °C.
With 10% Line Voltage Change: 0.001%.
With Time
Short Term: 0.002% over 5 min. (Note 3).
Long Term: 0.009% over 1 hr. (Note 3).
With Load (Mid-band, 3:1 VSWR): 0.1%.
Vernier Tune Range (nominal): ±3 MHz, ±4 MHz, ±5 MHz, ±6 MHz respectively.
External Tune: 0 to 10V for full range: ±1.0% linearity relative to tuned frequency.
Internal Frequency Sweep: Full band, 0.1 to 50 Hz rate (0 to +10V output proportional to frequency. No markers.)

OUTPUT POWER
Maximum Level
Guaranteed
952: +10 dBm;
954, 955 and 957: +7 dBm
Typical: (See Typical Power Output curves.)
Control Range: 25 dB (30 dB typical).
Output Impedance: 50Ω nominal.
Reverse Power Protection: +13 dBm.
External Leveling
Flatness: ±0.1 dB excluding coupler/detector variations (Note 4).
RF Output Control Range: 7 dB nominal
Input Sensitivity: -50 dB/mV nominal
Input Impedance: 1 kΩ nominal.



Typical Output Power

SIGNAL PURITY
Residual FM, Peak (Note 5)
Guaranteed
952: 8 kHz;
954, 955 and 957: 15kHz.
Typical
952: 4 kHz;
954, 955 and 957: 6 kHz.
Spurious: -55 dBc.
Harmonics
Maximum (Note 6)
952, 954: -12 dBc;
955, 957: -20 dBc.
Typical
952, 954: -15 dBc;
955, 957: -30 dBc.

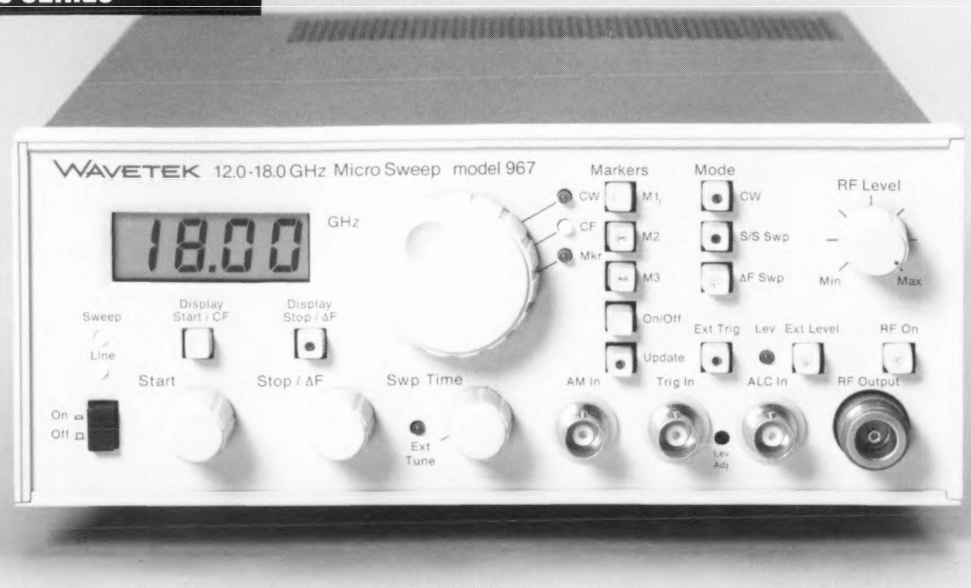
MODULATION
AM
Internal (Square Wave): 0 to 25 dB depth minimum, 30 dB typical, 10 Hz to 5 kHz adjustable rate.
External: 0 to 25 dB depth minimum, 30 dB typical, 0 to ±10V, 100 kHz typical 3 dB bandwidth, DC coupled.
Rise/Fall Time: 5μs maximum (10 to 90%).
Monitor Output: TTL compatible, 0 to +5V nominal (during internal modulation only).
FM
Internal (Sawtooth): ±5 MHz minimum, 10Hz to 5 kHz adjustable rate.
External: ±5 MHz minimum deviation for ±4V input, 50 kHz nominal 3 dB bandwidth, DC coupled.
Monitor Output: 5 Vp-p nominal (during internal modulation only).

GENERAL
Connectors
RF Output: Precision Type N.
AC Power: CEE 22 Type VI.
Other: BNC.
Temperature
Operating: 0° to +50°C.
Non-operating: -40° to +75°C.
Humidity: 0 to 95% non-condensing.
Dimensions: 21.6 cm (8.5 in.) wide, 9.8 cm (3.5 in.) high, 29.9 cm (11.75 in.) deep.
Weight: 5.4 kg (12 lb), approximately.
Power: 90-126 Vac or 198-252 Vac; 50-400 Hz (50-60 Hz for Model 954); 40 VA maximum.

Notes:
1. All specifications apply after 1 hr warmup and at+ 25° ±10°C unless otherwise stated.
2. Includes all source of error including tuning nonlinearity, temperature, voltage variation, mismatch, etc., with output power set at maximum level.
   Excludes display resolution.
3. After 1 hr warmup and 15 min following any frequency change, with environment held constant.
4. At maximum output (using HP 8472A negative polarity detector and 16 dB coupler).
5. 50 Hz to 15 KHz post-detection bandwidth.
6. (This note applies to Model 952 only.) For output power levels of -10 dBm the harmonic specification is -10 dBc.

FACTORY/FOB
Sunnyvale, CA

ORDER INFORMATION
Model 952
Model 954
Model 955
Model 957



1 to 18 GHz Micro Sweep Generator

- **Start/Stop and ΔF Sweep Plus CW**
- **3 Independent Markers**
- **+10 dBm Leveled Power**
- **Smaller Than a Sweeper Plug-in**
- **Very Cost Effective**

The 960s are a series of four microwave sweep generators.

Model	Range
962	1 to 4 GHz
964	3.7 to 8.4 GHz
965	7.0 to 12.4 GHz
967	12.0 to 18.0 GHz

They feature three operating modes (Start/Stop Sweep, ΔF Sweep and CW) plus External Tune/Sweep, and three independently settable markers. CW accuracy is ±1%, and the digital frequency display provides 10 MHz resolution.

Each Micro Sweep is smaller than a typical sweeper plug-in and weighs less than 12 pounds, yet is a fully functional sweep generator.

Every Micro Sweep employs a low noise YIG tuned oscillator to cover one or more full bands within the 1 to 18 GHz range. More than +12dBm of unleveled output power is available and may be controlled over greater than a 25 dB range. +10 dBm is available while using external leveling or the internal leveling option.

CW, Center Frequency, and Marker frequencies are easily set by the high resolution frequency control knob. Individual controls set the other parameters.

Markers may be set as CRT Z-axis intensity or RF pip markers, or both. Intensity marker and retrace blanking Z-axis output can be set for either a positive or negative CRT intensity control.

Sweep Functions

Start/Stop Sweep: Sweeps from the frequency set by the Start control to the frequency set by the Stop/ΔF control. Both frequencies are continuously adjustable over full range. Pressing the front panel S/S Swp pushbutton selects the Start/Stop sweep mode. Pushbuttons below LCD readout select the frequency displayed. Minimum practical sweep width is less than 1% of band. Downward sweep is permitted.

ΔF Sweep: Sweeps symmetrically upward, centered on the frequency set by the main tuning knob. Pressing front panel ΔF Swp pushbutton selects the ΔF sweep mode. Sweep width is set by using the Stop/ΔF control. Pushbuttons below the LCD readout select the frequency displayed. Width is adjustable from 100% to less than 1% of the band.

CW Operation: Single frequency RF output is controlled by the main tuning knob. Pressing front panel CW mode pushbutton selects the CW mode. An illuminated LED near the main tuning knob indicates when the knob is functioning as CW, Center Frequency, or Marker Frequency control.

Remote Control: Both frequency and RF level may be remotely controlled. Remote frequency control/sweep is controlled by a 0 to 10V analog signal at the Swp Out/Ext Tune In BNC connector located on the rear panel. To select this mode, turn Swp Time control to full counter clockwise detent position (Ext Tune position), thus illuminating Ext Tune LED and automatically switching control settings to CW mode. The front panel display indicates the tuned frequency. RF output level is remotely controlled by supplying a dc input to AM In BNC connector.

Frequency Markers

Three constant width markers, independently adjustable over the full frequency band of the instrument, are available for all sweep functions: Start/Stop, ΔF, CW and Remote. Intensity (CRT Z axis), amplitude (RF pip) or both marker methods are selected by a switch internal to the unit.

Intensity Marker: A rectangular pulse provides marker signal for Z-axis input to CRT display units. Polarity is factory set for negative, but may be changed to positive via an internal switch. (Retrace blanking signal will be of the opposite polarity.)

Amplitude (RF PIP) Marker: Generated by momentarily reducing the RF output. (Factory set position enables this type of marker. It can be disabled with an internal switch.)

Operation: Marker 1, Marker 2, and Marker 3 are set in any order by first pressing the pushbutton of the desired marker and displaying its frequency at the LCD readout. This activates the marker to accept other commands. The marker is then toggled on/off using the On/Off pushbutton. Marker frequency is changed by pressing the Update pushbutton and then adjusting the main tuning knob. The marker being displayed and operated on is identified by a flashing indicator.

Resolution: Each marker may be set to a digitized resolution of 0.1% of the instrument bandwidth. Display resolution is 10 MHz.

Accuracy: The frequency accuracy of the marker display is typically ±1.0%. (Add ±3 MHz for Model 962.)

Blanking

During retrace, a +5V, nominal, direct coupled rectangular pulse provides the Z-axis input to the CRT display. Polarity may be changed to negative by changing an internal switch. RF blanking is not provided.

Sweep Time

Continuously adjustable from 0.02 to 20 seconds, nominal, per sweep.

Sweep Trigger

Auto-Trigger: Sweep is automatically triggered on a continuous basis.

External Trigger: A single sweep is triggered by a signal at the front panel Trig In BNC. Pressing the Ext Trig pushbutton selects this mode as indicated by an illuminated Ext Trig pushbutton. The sweep is triggered by the falling edge (high to low) of a TTL signal or a switch contract closure to ground. (For longer sweep times, a double pressing of the pushbutton provides a convenient front panel single sweep.)

Sweep Output

During internal sweep, a 0 to +10V direct coupled modified sawtooth waveform is provided at the rear panel Swp Out/Ext Tune In BNC connector. The signal limits are 0V (beginning of the sweep) and +10V (end of the sweep) regardless of sweep width, rate, or direction. In CW mode, output is proportional to frequency, with linear 0 to +10V, nominal, for full instrument bandwidth.

FREQUENCY

Range

962: 1.0 to 4.0 GHz.
964: 3.7 to 8.4 GHz.
965: 7.0 to 12.4 GHz.
967: 12.0 to 18.0 GHz.

Accuracy (Of Absolute Frequency)[2]

CW: ±1% (0.5% typical).
Markers, Center Frequency: ±1%, typical.
Start, Stop, ΔF: ±2%, typical.

Stability (Typical)

With Temperature: 0.007%/°C, (0° to +50°C).
With 10% Line Voltage Change: 0.001%.
With Time
Short Term: 0.004% over 5 min.[3]
Long Term: 0.01% over 1 hr.[3]
With Load (Midband 3:1 VSWR): 0.1%.

OUTPUT CHARACTERISTICS

Maximum Output Power

Unleveled (Without Internal Leveling Option): +12dBm.
Unleveled (With Internal Leveling Option Installed): +11 dBm.
Leveled (Via Internal Leveling Option): +10 dBm.

RF Level Control

Unleveled Operation: 25 dB minimum, 30 dB typical.
Leveled Operation: 7 dB min, 10 dB typ.

RF Leveling

Internal Option: Flat ±1.0 dB
External Leveling: Flat ±0.1 dB max. excluding coupler/detector variation.[4]
Input Sensitivity: -50 dB/mV nominal. Front panel access for gain adjustment provided.
Input Impedance: 1 kΩ nominal.
Output Impedance: 50Ω nominal.

VSWR (With Internal Leveling Option)

962: <2.5.[5]
964, 965, 967: <1.5.

SPECTRAL PURITY

Residual FM Peak[6]

962: 8 kHz.
964: 15 kHz.
965: 20 kHz.
967: 25 kHz.

Spurious: -55 dBc.

Harmonics

962: -12 dBc max.[7]
964, 965, 967: -20 dBc max.

MODULATION

External AM

Depth: 0 to 25 dB min. (30 dB typical) for a 0 to -10V input.
Bandwidth: 100 kHz typical, 3 dB bandwidth, dc coupled.
Input Impedance: 10 kΩ nominal.

External FM

Deviation: ±5 MHz min. deviation for ±4V input.
Bandwidth: 50 kHz typical, 3 dB bandwidth, dc coupled.
Input Impedance: 10 kΩ nominal.

GENERAL

Connectors

RF Output: Precision type N.
AC Power: CEE22 Type VI.
All Others: BNC.

Temperaure

Operating: 0° to +50°C.
Nonoperating: -40° to +75°C (Rate of temperature change not to exceed 1°/min.)

Humidity: 0 to 95% noncondensing.

Dimensions: 21.6 cm (8.5 in.) wide, 9.8 cm (3.5 in.) high, 29.9 cm (11.75 in.) deep.

Weight: 5.4 kg (12 lb) nominal.

Power: 90 to 126 Vac or 198 to 252 Vac; 50 to 400 Hz; 40 VA.

OPTIONS

XXX-001: Internal Leveling

1 All specifications apply after 1 hr warm-up at +25°C ±10°C unless otherwise stated.
2 Includes all sources of error including tuning nonlinearity, temperature, voltage variation, mismatch, etc., with output power set at maximum level. Excludes display resolution. For 962 marker accuracy, add ±3 MHz.
3 After 1 hr warm-up and 15 min. following any frequency change, with environment held constant.
4 At maximum output (using HP 8472A negative polarity detector and 16 dB coupler).
5 (This note applies to Model 962 only.) Typical performance at maximum output level.
6 50 Hz to 15 kHz post-detection bandwidth.
7 (This note applies to Model 962 only.) For output power levels of <-10 dBm the harmonic specification is -10 dBc.

FACTORY/FOB
Sunnyvale, CA

ORDER INFORMATION

Model 962
Model 964
Model 965
Model 967
Option 962-001
Option 964-001
Option 965-001
Option 967-001

MICROWAVE SIGNAL GENERATORS

MODELS 904/907A

3.7 to 12.4 GHz Signal Generators

- **0 to -127 dBm Output Control**
- **All Solid State Construction**
- **80 dB Pulse On/Off Ratio**
- **Internal Frequency Sweep**
- **Optional GPIB Programming**

All Solid State Construction
Wavetek's Model 900 Series Microwave Signal Generators feature 100% solid state construction and all the capabilities of traditional signal generators. Remote analog control of frequency and output level, internal full-band sweep and optional GPIB control further enhance their usefulness for many applications.

High Performance
Efficient RF power level control is provided by a single control knob with digital display and automatic internal power leveling. Power level accuracy is enhanced by a modern design which includes digital power correction. The electronic output attenuator will never wear out, even after continuous power cycling under computer control. Excellent pulse modulation characteristics meet the needs of modern radar systems, while AM and FM provide versatility with a minimum of additional test equipment.

Optional GPIB Programming
The optional General Purpose Interface Bus (GPIB) programming is fully compatible with the IEEE Standard 488-1978. This option is ideal for high volume testing and applications which require remote control.

Versatility
A CW signal source with AM, FM, pulse modulation, and sweep capabilities. All parameters are independently adjustable. Pulse modulation, frequency modulation and sweep ramp signals from either the internal modulation generator or external input. Frequency and level can be externally controlled by analog voltages or optional GPIB. Auxiliary output and internal modulator signals are available at the front panel.

Modes

CW: Continuous RF output. Frequency and level adjustable.

FM: Internal or external signal frequency modulates the RF output. Rate and deviation adjustable.

Pulse: Internal or external signal pulse modulates the RF output. Pulse width adjustable or fixed 50% duty cycle; rate adjustable. External gate mode allows the external input to control pulse width and repetition rate.

Sweep: Internal or external controlled sweep (up to 15 Hz rate) of the entire RF frequency range.

MICROWAVE SIGNAL GENERATORS

MODELS 904/907A

SPECIFICATIONS

NOTE: Specifications for non-sweep modes only.

Frequency: Varied by a 10-turn potentiometer and vernier or by an external 0 to +5V. GPIB control optional.
Range:
904: 3.7 to 7.6 GHz.
907A: 7.0 to 12.4 GHz.
Readout: 3 digit LCD.
Resolution: 10 MHz.
Accuracy: ±1% of reading.
Stability: Typically <60 ppm/°C and 20 ppm (+5, -10% line variation).

Signal Purity
Residual FM: <5 kHz peak in a post-detection bandwidth of 100 Hz to 10 kHz.
Harmonics: <-25 dBc.
904: <-25 dBc.
907A: <-30 dBc.
Spurious: <-55 dBc.

Level: Varied by a 10-turn potentiometer or external 0 to +13.6V (-10 dB/V). Output can be unleveled or automatically leveled. Output can be switched on and off. GPIB control optional.
Range (Leveled): 0 to -127 dBm; 0.225V to 0.100 μV (into 50Ω).
Range (Unleveled): Typically >+3 to <-115dBm.
Readout: 3 1/2 digit LCD, in units of dBm, dBref, Vrms.
Display Resolution: 0.1 dB.

Amplitude Accuracy
904:

Accuracy	Range
±1 dB (typ ±0.5)	0 dBm
±2 dB	+1 to -100 dBm
±3 dB	-100 to -120 dBm

Leveled power to approximately -127 dBm.

907A:

Accuracy	Range
±1 dB (typ ±0.5)	0 dBm
±2 dB	+1 to -60 dBm
±3 dB	-60 to -120 dBm

Leveled power to approximately -127 dBm.

Level Flatness (>-10 dBm): ±1.0 dB
VSWR: <1.5 relative to 50Ω.
Connector: Female type N coax.
Auxiliary Output: Typically >-10 dBm CW.
Reverse Power Protection: +30 dBm (both RF outputs).

Frequency Sweep
Internal: Pushbutton gives full band sweep; rate adjustable.
Rate Range: 0.02 to 15 Hz.
External: Control with ramp input. 0 to +5V for full band sweep.
904 Sweep Range: 3.7 to 7.6 GHz.
904 Rate Range: Up to 15 Hz.
907A Sweep Range: 7 to 12.4 GHz.
907A Rate Range: Up to 15 Hz.
Frequency Control Monitor: Output voltage (0 to +10V nominal) proportional to RF frequency control signal. 600Ω source impedance.
Pen Lift (TTL): Selective polarity output pulse.

PULSE MODULATION
904
Transition Times: <20 ns for leading and trailing edges. (Typically 10 ns).
On-Off Ratio: >80 dB when main output is set at 0 dBm.
Width: 50 ns to 500 μs in 2 ranges; for greater widths, use external gated mode.
Delay Range: 100 ns to 1 ms in 2 ranges, relative to normal sync.
(Not applicable to gated pulse).

907A
Transition Times: <35 ns for leading and trailing edges. (Typically 15 ns).
On-Off Ratio: >80 dB when main output is set at 0 dBm.
Width: 200 ns to 100 μs in 2 ranges; for greater widths, use external gated mode.
Delay Range: 3 μs to 1 ms in 2 ranges, relative to normal sync. (Not applicable to gated pulse).

Internal Mode: Fixed square wave or variable width pulses; 10 Hz to 10 kHz in 3 ranges.
External Trigger Input: 1 Vp-p min, ±10V max trigger; slope and trigger point adjustable; 0 to 10 kHz with full leveling.
External Gate Mode: RF output occurs for the duration that pulse trigger input signal exceeds trigger level setting; 0 to 10 kHz with full leveling.

FM—FREQUENCY MODULATION
Internal Sawtooth Modulator: 10 Hz to 10kHz in 3 ranges; 0 to >5 MHz p-p deviation.
External Modulation: >1 MHz/V; ±2.5V max; >5 MHz p-p deviation; 10 kΩ nominal input impedance.
Bandwidth: >10 kHz (DC coupled).

AM—AMPLITUDE MODULATION
Bandwidth: >10 kHz (DC coupled).
Max Source Level: ±2V peak.
Sensitivity: 27 dB/V (nominal).
Input Impedance: 10 kΩ nominal.

MODULATOR OUTPUTS
FM: Signal from external or internal modulation generator. 600Ω source impedance.
Pulse: Positive TTL level pulse set by modulator pulse repetition rate, delay, and width controls.
Normal Sync: Positive TTL level pulse occurring at selected repetition rate.
Delayed Sync: Positive TTL level pulse synchronous with modulator pulse with selected delay.

GENERAL
Literature: Refer to Models 904/907A Summary Brochure -900-10 and Technical Information Brochure -900-20 for more complete performance characteristics and instrument descriptions.
Environment: Specifications apply for 25° ±10°C after 1 hour warm-up. Instrument operates from 0° to +50°C, to 10,000 ft and to 90% relative humidity, non-condensing.
Storage: -25° to +65°C. Designed and type tested to MIL-T-28800 class V.
Dimensions (Max): 43.2 cm (17 in.) wide; 13.3 cm (5 1/4 in.) high; 49.5 cm (19 1/2 in.) deep. Adapters supplied for rack mounting.
Weight: 19.5 kg (43 lb) net; 23.2 kg (51 lb) shipping.
Power: 100V, 120V, 220V, 240V (+5%, -10%); 48 to 66 Hz; <130 VA.

OPTIONS
001: GPIB Programming. General Purpose Interface Bus (GPIB) programming fully compatible with the IEEE Standard 488-1978. Allows programming of frequency, level, CW, output on/off and leveled/unleveled.

NOTE: Option requires factory installation. Option price applies to original purchase only. Contact factory for retrofit option price.

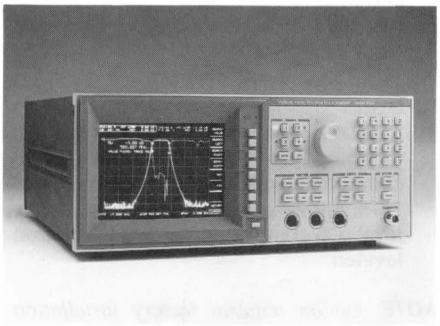
FACTORY/FOB
Sunnyvale, CA

ORDER INFORMATION
Model 904
Model 907A
Option 001

Scalar Network Measurements

A scalar network analyzer is one of the four fundamental system components required to characterize RF and microwave components. It is used to process and display the response of a device to either a swept or CW signal. The other three components of the system are: a swept signal source; detectors and signal separation devices such as bridges.

Since there are many different choices for each of these components depending on performance required and budget available, it is important to consider the key parameters that will impact the measurement. This has become particularly important with the very significant improvements in performance now available in all four components of the measurement system.



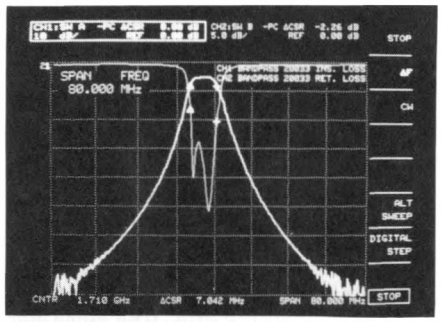
The Network Analyzer

For precision network analysis, the network analyzer must be able to do the following:

- Make accurate absolute and relative power readings.
- Measure over a wide dynamic range with excellent linearity.
- Take advantage of digital technology for enhanced accuracy and repeatability.

In addition, it should be easy and intuitive to use.

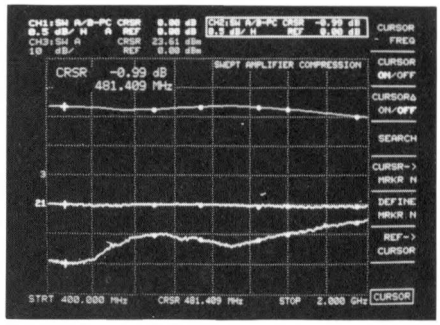
Wavetek's 8003 is the first network analyzer to incorporate a power sweep calibrator. The power sweep calibration system makes possible accurate power measurements over a wide 90 dB dynamic range by compensating for the non-linearity of the diodes in the detector. Now, power measurements can be made with power meter accuracy, traceable to the NIST, using a network analyzer. This is particularly important for component manufacturers where the need is to establish and measure power very accurately over a wide dynamic range. In many applications a separate power meter will no longer be required making a significant cost savings.



Path calibration is a technique used to establish a reference when making transmission, (gain/attenuation), measurements. Digital storage of the path calibration using a "through" for a given frequency span and then normalizing by subtracting the "through" response from the DUT response was the first major improvement made in reducing the measurement uncertainty.

This technique has been further refined by eliminating the need to do a path calibration whenever the frequency limits are changed within those used for the initial path calibration. Adaptive path calibration stores calibration data for the entire frequency range of the sweeper with sufficient resolution that further path calibration is unnecessary for any subsequently selected start/stop frequencies. A capability that improves accuracy and productivity.

With Wavetek's 8003 Scalar Analyzer, the user will no longer have to accept compromises in dynamic range and accuracy when using AC detection. This is particularly important when measuring low level signals in the presence of higher level broadband noise. DC detection is available for routine devices measurements as well as measurements affected by the AC Modulation such as amplifiers with automatic gain control.



Through technical improvements and cost reductions, a color display has now become a powerful tool for improving the instrument/user interface. In the 8003, full advantage is taken of each of the three basic qualities of color, (hue, saturation and lightness), depending on the information being displayed, to make the display very easy to read.

Other important human engineering considerations when selecting a network analyzer include an easy to learn menu driven user interface and well grouped front panel keys.

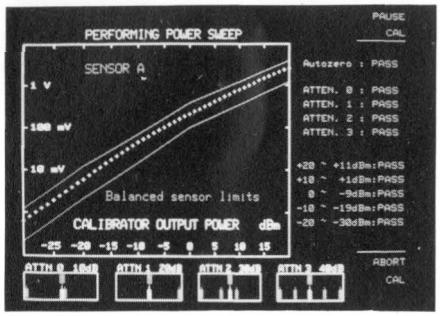
The Signal Source

The 8003 Scalar Analyzer has been designed to work with a wide range of sweepers. Depending on the sweeper used, it is possible to completely control it from the front panel of the analyzer using the "private" bus. This advanced system integration increases speed of operation.

Extensive "smarts" has been built into the 8003 to automatically establish parameters such as frequency and power range limits depending on the source configuration. The 8003 will also work with a wide variety of "operator integrated" sweepers. This requires setting up the sweeper independently, but has the advantage of providing compatibility with non-software supported sweepers.

Power Sensors

Major improvements have been made in power sensor performance to support the processing capabilities of the scalar analyzer. The scalar analyzer must compensate for the fact that all diodes are non-linear above power levels around -20 dBm. The power sweep system in the 8003 described earlier transfers the linearity of the thermistor in the analyzer to the diode power sensors over their entire 90 dB dynamic range.



Wavetek uses balanced diodes which have the advantage of reducing the measurement errors introduced by harmonics from the source. Balanced diodes also provide improved sensitivity and block low level DC voltages.

To compensate for the frequency response of the power sensors, a PROM in each sensor is used to provide CAL FACTOR data to the analyzer based on the measurement frequency.

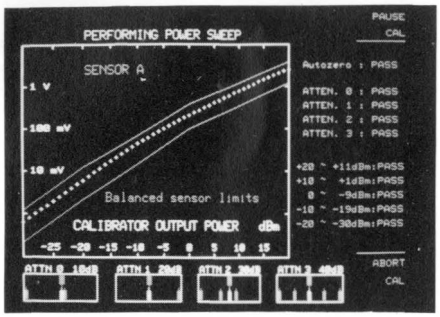
Three special purpose power sensors are available to enhance the accuracy of power measurements. To reduce mismatch uncertainties, use the ultra low VSWR power sensor.

When measuring amplifier parameters such as the 1 dB compression point in which the harmonic content will be substantial, Wavetek's square law power sensor will ensure that power measurements made using a diode power sensor will be in agreement with those made using thermocouple devices.

For measurements on amplifiers with up to 1 Watt output power, use the high level power sensor with its own built-in pad.

SUMMARY OF 8003 FEATURES

Frequency Range	10 MHz to 40 GHz
Power Range	+30 to -70 dBm
Dynamic Range	90 dB
Accuracy (Linearity)	±0.02 dB (±0.5%)
Number of Inputs	3 (A, B and C)
Display Channels	4
Power Sweep Calibrator	Yes
0 dBm Calibrator	Yes
DC Detection	Yes
AC Detection	Yes
Adaptive Path Calibration	Yes
Normalization	Yes
CW Power Meter Capability	Yes
Color Display	Yes
CRT Readout of Data	Yes
Cursor Readout	Yes
Integrated Markers	Yes
Limit Lines	Yes
Sweep Averaging	Yes
Stored Setups	Yes
Sweeper Integrated	Yes
Use with any Sweeper	Yes
IEEE Compatible	Yes
Bus Controllable Operation	Yes
Digital Plotter Compatible	Yes
X-Y Recorder Compatible	Yes
Balanced Diode Detectors	Yes
Application Specific Sensors	Yes



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Limit Lines	Yes
Sweep Averaging	Yes
Stored Setups	Yes
Sweeper Integrated	Yes
Use with any Sweeper	Yes
IEEE Compatible	Yes
Bus Controllable Operation	Yes
Digital Plotter Compatible	Yes
X-Y Recorder Compatible	Yes
Balanced Diode Detectors	Yes
Application Specific Sensors	Yes

Additional ease of use features include max-hold, min-hold and stored set-ups.

Total Sweeper Integration

The 8003 can be used with a wide variety of firmware supported sweepers over the private line GPIB with no operator intervention required. Sweeper control is from the front panel of the scalar analyzer.

Full Range of Power Sensors

Users can select from a family of power sensors depending on the frequency range and application. Power sensors are available with appropriate coax connectors to cover from 10MHz to 40 GHz. Ultra low VSWR sensors are available for highly accurate transmission and power measurements. For applications such as compression measurements on amplifiers where the harmonic content will be substantial, there are true RMS power sensors. High power sensors measure up to 1 watt.

Various Hardcopy Options

Produce color plots with multipen plotters or the HP printjet. Use laserjet, inkjet or dot matrix printers for black and white records.

SYSTEM SPECIFICATIONS

Frequency Range: 10 MHz to 40 GHz in coax using Wavetek's 80300 Series power sensors and 80500 Series bridges and an appropriate sweeper. Waveguide detectors extend the frequency coverage to 110 GHz.

Power Range: +30 dBm to -70 dBm (see power sensor specifications).

System Dynamic Range:

CW Measurements:	90 dB
Swept Measurements:	AC Mode 90 dB
	DC Mode 80 dB

Inputs: Three inputs, A, B and C accept detected outputs from Wavetek's power sensors and bridges.

DISPLAY

CRT: Full color display. Each channel can be assigned a different color. Graticule color is selectable (default green).

Display resolution: 608 x 430 points for each channel.

Channels: Four channels can be used to select and simultaneously display inputs from A, B, and C in single channel or ratio mode.

Display Modes

Graph/Readout: Graph mode displays swept frequency response on CRT. Readout mode displays power level at cursor frequency or CW power levels in digital format on CRT.

Graph Mode

Log

dBm: Single channel power measurement.

dB: Relative power measurement (ratio or relative to trace memory).

Readout Mode

Log:

dBm: Single channel measurement.

dB: Relative power measurement.

Lin:

nW, μW, mW and Watts: Single channel measurement.

%: Dual channel measurement.

% Rel: Dual channel measurement relative to a reference.

Autoscale: Automatically sets the scale factor, reference level and reference position to provide optimum display of active channel.

Averaging: 2, 4, 8, 16, 32, 64, 128, or 256 successive traces can be averaged to reduce effects of noise on measurement.

Smoothing: Provides a linear moving average of adjacent data points. The smoothing aperture can be set from 0.1% to 25% of the trace width.

Adaptive Path Calibration (Normalization): Traces are stored and normalized with the highest resolution, independent of display scale/division or offset.

Trace Memory: Ten traces can be stored and recalled. Trace differences can be displayed.

Settings Store/Recall: Allows up to nine full front panel setups, plus power down state to be stored and recalled from nonvolatile memory.

Limit Lines: Horizontal, sloped, and/or single point lines for each trace can be set as go/no-go data limits. Limit lines are stored in non-volatile memory. Complex limit lines can be entered through the front panel or via the GPIB interface.

CURSOR AND MARKERS

Cursor: The cursor can be positioned with the tuning knob or via the numeric keypad. The frequency and amplitude of test data at the cursor on all active channels is digitally displayed.

Cursor Delta: Displays differences in dB and frequency between the reference cursor and the main cursor.

Cursor Min/Max: Automatically moves the cursor to the minimum or maximum value of test data.

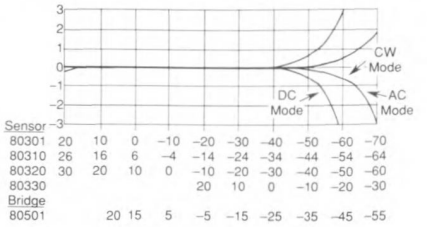
Cursor "x" dB: Automatically moves the cursor to the point on the trace equal to the value of "x" in dB or dBm.

Cursor "x" Bandwidth: Automatically displays cursors to the right and left of the cursor at the frequencies where the test data is equal to the value of "x" dB. The bandwidth between the cursors is displayed.

Markers: Displays up to 10 markers which are generated by the 8003. The cursor can be moved directly to any marker or moved sequentially through the markers.

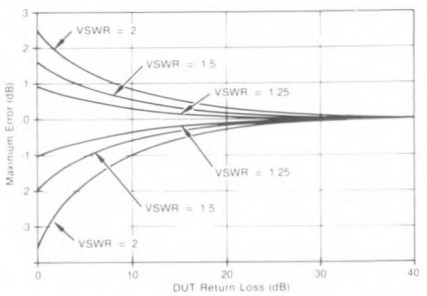
ACCURACY

Transmission Loss or Gain Measurement: Transmission loss or gain measurements are made relative to a 0 dB reference point established during calibration. Therefore, frequency response errors of the source, sensors, and signal splitting device are removed. The remaining elements of uncertainty are instrument linearity and noise uncertainty (see graph) and mismatch error.

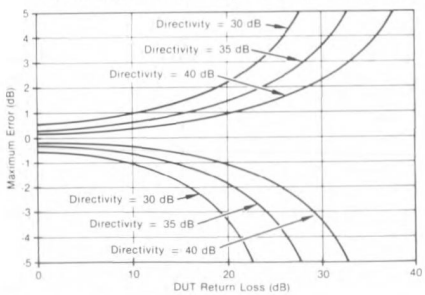


Linearity Plus Zero Set vs. Input Power

Reflection Measurement Accuracy: When measuring devices with high return loss (>10dB), reflection accuracy is typically dominated by the effective system directivity, instrument linearity errors, and noise uncertainty. With low return loss devices (<10 dB), reflection accuracy is typically dominated by source match, see following graphs. Calibration with an open and short effectively remove uncertainties due to frequency response of the source, sensors, and signal splitting device. Reflection Accuracy = Scalar Accuracy + Reflection Bridge Accuracy.



Reflection Uncertainty vs. Source Match



Reflection Uncertainty vs. Directivity

Absolute Power Measurement Accuracy: The absolute power measurement accuracy is determined by a number of factors including calibrator accuracy, noise, sensor calibration factor error, and the mismatch uncertainty between sensor and device under test.

Calibrator: Provides a 50 MHz calibration signal at 51 very accurately controlled levels from +20 to -30 dBm to dynamically linearize the sensors.

Frequency: 50 MHz nominal.

Connector: Type N(f) precision connector, 50Ω. (Adapters supplied for calibrating sensors with other connector types.)

MICROWAVE SCALAR ANALYZERS
MODEL 8003

Settability: The 1.00 mW level in the power sweep is factory set to ±0.7% traceable to the National Institute of Standards and Technology (formerly NBS).

Accuracy: ±1.2% worst case for one year, over temperature range 15° to 35°C.

VSWR: <1.05 (Return Loss >33 dB).

Instrument plus Power Sensor Linearity:

Standard Sensors:

CW Mode:

±0.02 dB (±0.5%) over any 20 dB range from +16 to -70 dBm
±0.02 dB + (+0 dB, -0.05 dB/dB) from +16 to +20 dBm
±0.04 dB (±1.0%) from +16 to -70 dBm

Swept Mode:

±0.03 dB (±0.7%) over any 20 dB range from +16 to -70 dBm
±0.03 dB + (+0 dB, -0.05 dB/dB) from +16 to +20 dBm
±0.06 dB (±1.4%) from +16 to -70 dBm

Low VSWR Sensors:

-64 to +20 dBm: Same as for Standard Sensors
+20 to +26 dBm: Same as for Standard Sensors, plus an additional ±0.13 dB (typically)

High Power Sensors:

-60 to +20 dBm: Same as for Standard Sensors
+20 to +30 dBm: Same as for Standard Sensors, plus an additional ±0.13 dB (typically)

True RMS Sensors:

CW Mode:

±0.02 dB (±0.5%) over any 20 dB range from +20 to -30 dBm
±0.04 dB (±1.0%) from +20 to -30 dBm

Swept Mode:

±0.03 dB (±0.7%) over any 20 dB range from +20 to -30 dBm
±0.06 dB (±1.4%) from +20 to -30 dBm

Temperature Coefficient of Linearity: <0.1%/°C temperature change after calibration.

Zeroing Accuracy
(CW Mode, Averaging Factor =32)

Zero Set: ±50 pW

Zero Drift: Typically <±200 pW in 1 hour at constant temperature after a 24 hour warmup.

(Swept Mode, Averaging Factor = 32)

Zero Set: ±50 pW (AC Detection)
±800 pW (DC Detection)

Zero Drift: typically 2 nW (DC Detection in 1 hour at constant temperature after a 24 hour warmup. Zero drift not applicable in AC detection.

Noise Uncertainty: Typically <50 picowatts, at constant temperature, measured over a 1 minute interval, two standard deviations)

GPIB

Interface: Operates according to IEEE-488 interface standard. A private line GPIB is used to connect the analyzer to firmware supported sweepers. Pass through commands allow control of the signal source using a controller other than the analyzer.

Programmable Functions: All front panel functions, except power on/off are programmable.

Interrupts: SRQ's are generated for the following conditions: Front panel key pressed, Operation complete, Illegal command, Instrument self test error, and Limit test failed.

REAR PANEL INPUTS/OUTPUTS

Sweep Voltage Requirements (Sweep In): (BNC connector). 0 to +10V nominal.

Blanking Input: (BNC connector). Used to blank the sweep oscillator band switching points on the 8003 display.

Input 1: (BNC connector). Used with some sweepers to provide synchronization.

AC Modulation Output: (BNC connector). Provides driver to modulation input on sweeper or external modulator for use in AC detection mode.

DAC Output: (BNC connector). Used to supply V prop. F signal to drive a microwave generator or tracking filter.

Current Compliance: 2 mA maximum.
Minimum Load: 5 KΩ.

Bias Output: (BNC connector). Programmable output voltage used to display family of curves.

Voltage Range: ±10V.
Current Compliance: Source or sink 150 mA maximum.

POWER SENSOR SELECTION GUIDE

Model No. (Application)	Frequency Range	Power Range	Maximum Power	Maximum VSWR	RF Connector	Dimensions		
						Length	Diameter	Weight
80301 (Standard)	10 MHz to 18 GHz	-70 to +20 dBm (100 pW to 100 mW)	+23 dBm (200 mW)	10 MHz - 2 GHz; 1.12 2 GHz - 12.4 GHz; 1.22 12.4 GHz - 18 GHz; 1.29	N(m) 50Ω	11.45 cm (4.5 in.)	3.2 cm (1.25 lb.)	0.18 kg (0.4 lb.)
80302 (Standard)	10 MHz to 18 GHz	-70 to +20 dBm (100 pW to 100 mW)	+23 dBm (200 mW)	10 MHz - 2 GHz; 1.12 2 GHz - 12.4 GHz; 1.22 12.4 GHz - 18 GHz; 1.29	APC-7 50Ω	11.45 cm (4.5 in)	3.2 cm (1.25 lb.)	0.18 kg (0.4 lb.)
80303 (Standard)	10 MHz to 26.5 GHz	-70 to +20 dBm (100 pW to 100 mW)	+23 dBm (200 mW)	10 MHz - 2 GHz; 1.12 2 GHz - 12.4 GHz; 1.22 12.4 GHz - 18 GHz; 1.29 18 GHz-26.5 GHz; 1.43	APC-3.5(m) 50Ω	11.45 cm (4.5 in.)	3.2 cm (1.25 in.)	0.18 kg (0.4 in.)
80304 (Standard)	10 MHz to 40 GHz	-70 to +20 dBm (100 pW to 100 mW)	+23 dBm (200 mW)	10 MHz - 2 GHz; 1.12 2 GHz - 12.4 GHz; 1.22 12.4 GHz - 18 GHz; 1.38 18 GHz - 26.5 GHz; 1.43 26.5 GHz - 40 GHz; 1.92	K(m) 50Ω	11.45 cm (4.5 in.)	3.2 cm (1.25 in.)	0.23 kg (0.5 lb.)
80310 80313 80314 (Low VSWR)	10 MHz to 18 GHz 10 MHz to 26.5 GHz 10 MHz to 40 GHz	-64 to +26 dBm (400 pW to 400 mW)	+29 dBm (800 mW)	10 MHz - 2 GHz; 1.13 2 GHz - 12 GHz; 1.16 12 GHz - 18 GHz; 1.23 18 GHz - 26.5 GHz; 1.29 26.5 GHz - 40 GHz; 1.50	K(m) K(m) K(m) 50Ω	12.7 cm (5.0 in.)	3.2 cm (1.25 in.)	0.23 kg (0.5 lb.)
80320 80323 80324 (High Power)	10 MHz to 18 GHz 10 MHz to 26.5 GHz 10 MHz to 40 GHz	-60 to +30 dBm (1 nW to 1 W)	+33 dBm (2 W)	10 MHz - 2 GHz; 1.11 2 GHz - 12 GHz; 1.12 12 GHz - 18 GHz; 1.18 18 GHz - 26.5 GHz; 1.22 26.5 GHz - 40 GHz; 1.36	K(m) K(m) K(m) 50 W	12.7 cm (5.0 in.)	3.2 cm (1.25 in.)	0.23 kg (0.5 lb.)
80330 80333 80334 (True RMS)	10 MHz to 18 GHz 10 MHz to 26.5 GHz 10 MHz to 40 GHz	-30 to +20 dBm (1 µW to 100 mW)	+33 dBm (2 W)	10 MHz-12 GHz; 1.12 12 GHz-18 GHz; 1.15 18 GHz-26.5 GHz; 1.8 26.5 GHz-40 GHz; 1.29	K(m) K(m) K(m) 50Ω	15.25 cm (6.0 in.)	3.2 cm (1.25 in.)	0.27 kg (0.6 lb.)

POWER SENSOR CAL FACTOR UNCERTAINTIES

Freq. (GHz)		Sum of Uncertainties (%)[1]					Probable Uncertainties (%)[2]				
Lower	Upper	80301 80302	80303 80304	80310 Series	80320 Series	80330 Series	80301 80302	80303 80304	80310 Series	80320 Series	80330 Series
0.1	1	1.61	3.06	2.98	2.96	2.95	1.04	1.64	1.58	1.58	1.58
1	2	1.95	3.51	3.58	3.57	3.55	1.20	1.73	1.73	1.73	1.73
2	4	2.44	4.42	4.33	4.29	4.27	1.33	1.93	1.91	1.91	1.90
4	6	2.67	4.74	4.67	4.63	4.60	1.41	2.03	2.02	2.01	2.01
6	8	2.86	4.94	4.87	4.82	4.80	1.52	2.08	2.07	2.06	2.06
8	12.4	3.59	6.04	5.95	5.90	5.87	1.92	2.55	2.54	2.53	2.53
12.4	18	4.09	6.86	6.76	6.69	6.64	2.11	2.83	2.80	2.79	2.78
18	26.5	—	9.27	9.43	9.28	9.21	—	3.63	3.68	3.62	3.59
26.5	40	—	15.19	14.20	13.86	13.66	—	6.06	5.54	5.39	5.30

[1]Includes uncertainty of reference standard and transfer uncertainty. Directly traceable to NIST.
[2]Square root of sum of the individual uncertainties squares (RSS).

DIRECTIONAL BRIDGE SELECTION GUIDE

Model No.	Frequency Range	Directivity (dB)	Input Connector	Test Point Connector	Test Port Match (SWR)
80501	0.01 to 18 GHz	38	N(f)	N(f)	0.01-8 GHz: <1.17 8-18 GHz: <1.27
80502	0.01 to 18 GHz	40	N(f)	APC-7	0.01-8 GHz: <1.13 8-18 GHz: <1.22
80503	0.01 to 26.5 GHz	35	WSMA(f)	WSMA(f)	0.01-8 GHz: <1.22 8-18 GHz: <1.22 18-26.5 GHz: <1.27
80504	0.01 to 40 GHz	30	K(f)	K(f)	0.01-8 GHz: <1.35 8-18 GHz: <1.35 18-26.5 GHz: <1.35

User GPIB: (GPIB connector). Used to connect 8003 to GPIB system controller.
Instrument GPIB: (GPIB connector). Used to connect 8003 to dedicated signal source, plotter or printer.
RS232 Port: Serial Communications Interface for driving the Laserjet printer.

SIGNAL SOURCES
System Integrated: The 8003 can be system integrated (total sweeper control using the 8003) with the following sweepers:
- HP8350A/B with an RF plug-in (HP83500 Series or HP86200 Series with HP11869A Adapter)
- HP8340A/B or HP8341A/B synthesized Sweeper
- Gigatronics 610 and 910 Series Synthesized Sweepers
- Wiltron 6600B Sweep Generators
- Wiltron 6700A Swept Frequency Synthesizers
- Marconi 6310 Series Programmable Sweep Generators

Operator Integrated: The 8003 is compatible with any signal source that meets the following requirements:
Horizontal Ramp: Provides a 0 to +10V nominal ramp signal.
Blanking Signal: Provides +5V during retrace and bandswitching.

Modulation
AC Detection Mode: A square wave is provided by the analyzer to modulate the signal source.
RF Off Level: <-80 dBm during retrace.

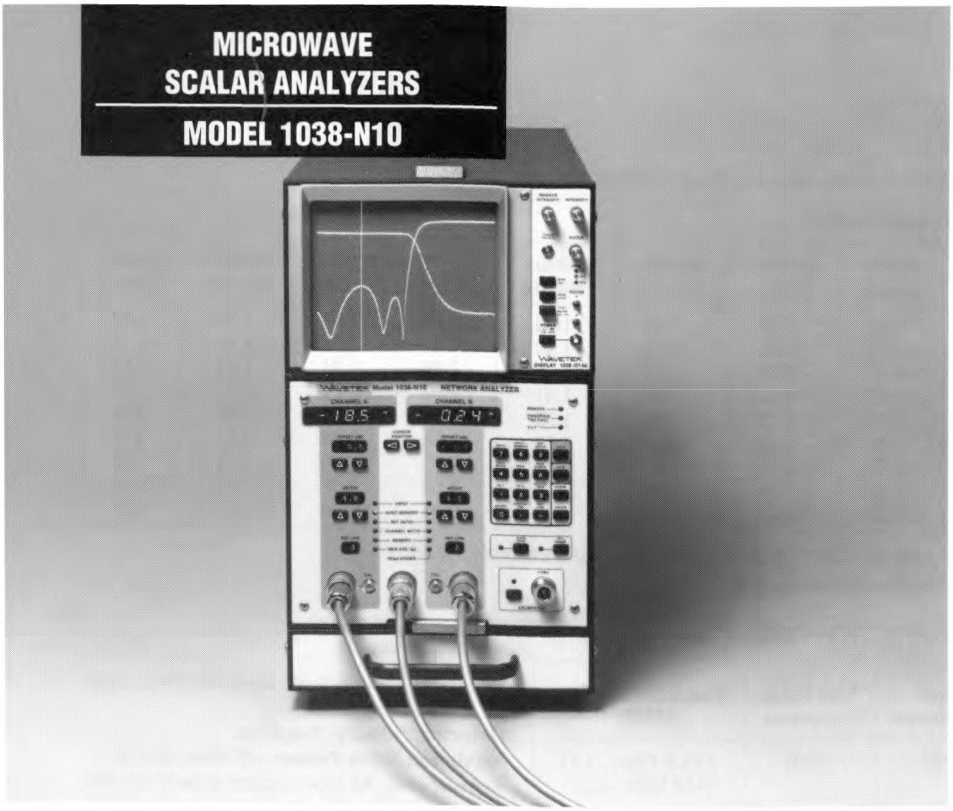
GENERAL
Temperature: Operating 0° to +50°C, storage -40° to +70°C.
Power Requirements: 100/120/220/240V ±10%, 48 to 440 Hz, 200 VA typical.
Dimensions: 45.1 cm (17.76 in.) wide, 17.8 cm (7 in.) high, 48.3 cm (19 in.) deep.
Weight: 16.6 kg (36.5 lb.) net.

POWER SENSORS
The 80300 Series of Power Sensors are designed specifically for use with the 8003. The same sensors are used for both swept measurements and CW measurements. Both AC and DC detection modes can be used with any of the power sensors. Each sensor includes an EEPROM which has been programmed with Calibration Factor data for that sensor.

DIRECTIONAL BRIDGES
The 80500 Series of Directional Bridges are designed specifically for use with the 8003 to measure the return loss of a test device. The bridges can be used in AC or DC detection mode. Each bridge includes an EEPROM which has been programmed with identification data for that bridge. Alternatively, an adapter is available to allow Wiltron Directional Bridges (SWR Autotesters) to be used with the 8003.
Bridge Frequency Response: Calibrated return loss measurements using the 8003 can be frequency compensated using the standard "Open/Short" supplied with the bridge.
Insertion Loss: 6.5 dB nominal from input port to test port.
Detector Polarity: Negative.
Maximum Input Power: +27 dBm (0.5 W).
Accessories: An Open/Short is included for establishing the 0 dB return loss reference during path calibration.

FACTORY/FOB
Sunnyvale, CA

ORDER INFORMATION
Model 8003
Option 01 Rack Mount
Option 02 RGB Interface
Standard Power Sensors
Model 80301
Model 80302
Model 80303
Model 80304
Low VSWR Power Sensors
Model 80310
Model 80313
Model 80314
High Power, (1W), Power Sensors
Model 80320
Model 80323
Model 80324
True RMS, (30 to 20 dBm input level), Power Sensors
Model 80330
Model 80333
Model 80334
Power Sensor Options
Option 19548-001
Option 19548-002
Option 19548-003
Option 19548-004
Option 19548-005
Directional Bridges
Model 80501
Model 80502
Model 80503
Model 80504
Accessories
8003 Service Manual
20757 Detector Adapter
20779 Bridge Adapter
20641 PC Board Extender Kit



Scalar Analyzer

- **76 dB Dynamic Range (+16 to -60 dBm)**
- **Frequency Range 100 kHz to >200 GHz**
- **Direct LED Power Readout**
- **Change Frequency Limits Without Recalibration**
- **Use With Any Late Model Sweeper**

Model 1038-N10 Network Analyzer System is completely microprocessor controlled and features direct digital readout of power data.

Ease of Operation
Exceptionally accurate simultaneous or individual transmission, reflection, and ratio measurements are made with the N10 system in just three easy steps:

1. Set up equipment and turn it on.
2. Calibrate both channels — seven keys total.
3. Insert test device, and read data directly from digital readouts.

System Configuration
- 1038-D14A Mainframe (Display)
- 1038-N10 Analyzer Module
- Two or three RF Diode Detectors

Versatile Mainframe
Model 1038-D14A Mainframe is standard with Wavetek's N10 microwave scalar measure-ment swept systems.

Detectors
The patented*, high performance, balanced detectors provide high sensitivity, block low level DC, reduce harmonic effects, and compensate for DC drift. Refer to RF Diode Detec-tor section for additional information.

Auto Zero Modes
Two Auto Zero modes to ensure drift free low-level operation no matter what kind of swept source is used. (Any late model sweeper can be used, and does not have to be bus controlled.) If the sweeper turns off the RF power completely during retrace, the Auto Zero is automatic, or it can be done manually for sweepers that do not turn off the RF.

V∝F Feature
The V∝F (1V/GHz) feature lets you zoom in on a frequency segment, and then return to the original frequency without losing the memory calibration.

Special Functions
Special functions are available that allow you to turn channels on or off, position the cursor, check the health of the unit, sound an audio alarm to signal error or end of test, and to go to a manually controlled sweep mode. These functions are available both through the front panel keypad and through the IEEE bus.

Specifications
The following is an abbreviated listing of the full specifications for the 1038-N10. Full specifications are available from your Wavetek representative.

Frequency: 100 kHz to 40 GHz, expandable to above 200 GHz with mm detectors and adapter cable.

Dynamic Range
- **Balanced Detectors:** 76 dB (+16 to -60 dBm).
- **Waveguide Detectors:** 70 dB (+10 to -60dBm).
- **Reference Channel:** 46 dB (+16 to -30 dBm).

Calibrator
- **Signal Level:** 0 dBm (1 mW) ±0.06 dB.
- **Frequency:** 50 MHz ±2%.
- **Harmonics:** <-50 dBc.
- **Source Impedance:** 50Ω.
- **Output VSWR:** <1.07:1.

Power: For 1038-D14A Mainframe and N10 Analyzer Module: 100, 120, 220, and 240 Vac ±10%; 50 to 440 Hz; 100 VA nominal.

OPTIONS
01: Rack Mount Configuration
02: Mainframe Fan Assembly
03: Horizontal Bench Configuration
05: Vertical Bench Configuration

ACCESSORIES
Contact your Wavetek representative.

*US Patent 4,360,865 – 1982

FACTORY/FOB
Sunnyvale, CA

ORDER INFORMATION
Model 1038-N10
(Complete System)
Option 01
Option 02
Option 03
Option 05

RF Diode Detectors

Detector Types
Two types of detectors are provided for use with the N10 system. These are the balanced coaxial models, and the balanced element waveguide detector. The coaxial detectors (1 MHz to 18.5GHz or 1 MHz to 26.5GHz, useful to 34 GHz) are available with Type N, APC7, and APC3.5 connectors and will handle up to 200 mW (+23 dBm) of continuous CW or peak power. The waveguide detector (26.5 GHz to 40 GHz) has a WR28 waveguide with a UG-599/U flange and will handle up to 100 mW (+20 dBm) of continuous CW or peak power.

Balanced Detectors
The balanced detectors use two diodes in a patented co-planar full wave circuit. This arrangement provides the following unique features:
- 76 dB dynamic range
- Reduces the effect of even harmonic errors, thereby increasing measurement accuracy
- Blocks low level dc offset voltages
- Very low thermal drift
- Frequency response of +0.5 dB to -1.0 dB up to 18.5 GHz and +0.5 dB to -1.5dB up to 26.5GHz
- Detector accuracy as shown in figure 1
- Return loss as shown in the matrix

Waveguide Detector
The waveguide detector's features are similar to the balanced diode detector's except for the following:
- Frequency response from 26.5 to 40 GHz is flat within ± 2.0 dB.
- Detector accuracy is shown in figure 2.
- Return loss shown in matrix.

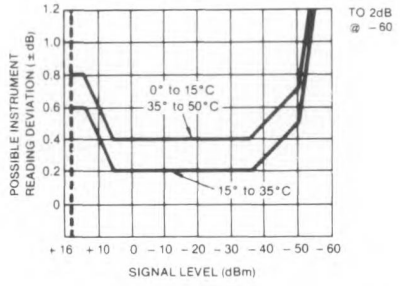


Figure 1. Models 1038-N10 System Coaxial Detector Accuracy from 1 MHz to 26.5GHz.

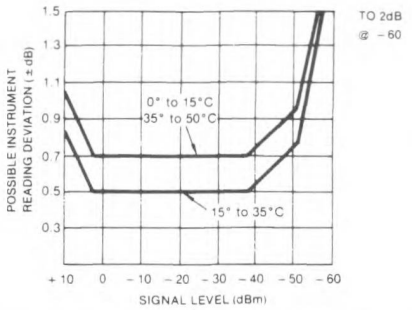


Figure 2. Models 1038-N10 and System Waveguide Detector Accuracy from 26.5 GHz to 40 GHz.

RETURN LOSS (dB)

Frequency	To 2 GHz	To 12.4 GHz	To 18.5 GHz	To 26.5 GHz	To 34 GHz	To 40 GHz
Balanced (any connector below 18.5 GHz APC 2.5 above 18.5 GHz	20	18	16	10	—	—
Waveguide	—	—	—	—	10	10

**Typical special order only.*

FACTORY/FOB
Sunnyvale, CA

ORDER INFORMATION
Contact Sales Representative

CW and Peak Power Measurements

CW Power Meters
There are two categories of CW Power Meter—Analog and Digital. Analog meters use a meter to indicate power levels; this inherently limits their accuracy compared with digital meters which use displays such as LCD's to display the amplitude of the detected signal.

Analog displays are generally used in lower cost instruments intended for general purpose applications, service requirements and so on. As such, they are less expensive than digital power meters.

Modern digital power meters make considerable use of microprocessor technology to improve accuracy and ease-of-use.

Accuracy depends on factors such as instrument/power sensor linearity, resolution versus reading speed, zeroing accuracy, noise averaging capabilities and power sensor VSWR.

Digital technology has been used to improve the linearity specification for thermocouple sensors. This reduces the uncertainty of the measurement at higher power levels without the need for any calculations by the user.

The 8531 digital power meter lets the operator select between fast power readings with limited resolution and slower power readings, but with greater resolution.

With digital power meters, the zeroing process can be executed automatically on each range. This eliminates zero carryover errors.

Digital averaging can be used at low power levels to reduce the effects of noise on the power meter reading.

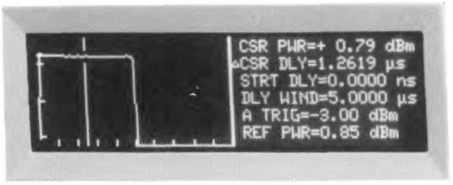
Power Sensors for CW Power Meters
The performance of the power sensors is critical to the overall performance of a power meter. Key specifications are: frequency range, dynamic range and VSWR.

Wavetek's sensors cover the range from 30 kHz to 26.5 GHz using various RF connectors. Each sensor is supplied with an individual chart specifying calibration factor data and its associated uncertainty. The uncertainty is the lowest in the industry and is a critical factor in minimizing the total power measurement uncertainty.

Each sensor has a dynamic range of 50 dB. By using a thermocouple sensor and a diode sensor, the power meter can display measurements over a 90 dB dynamic range.

Mismatch uncertainties are generally the biggest single uncertainty in a power measurement. Wavetek's power sensors have VSWR's equal to or better than any other comparable sensors to minimize the mismatch uncertainty.

Peak Power Meters
Peak power meters are used to accurately measure pulsed signals where the type of signal precludes using an averaging (CW) power meter and then making a correction, such as dividing by the duty cycle, to obtain the peak power in the signal.



Wavetek's peak power meters and associated power sensors provide the best accuracy available using a unique calibration system and balanced diode power sensors.

No duty cycle measurements or calculations are required since peak power meters make an instantaneous measurement of power at a user selected point on the pulse waveform.
Only diodes have a fast enough response to make instantaneous power measurements. Wavetek's power sweep calibration system is used to compensate for the nonlinearity of the diodes in the power sensor. The calibration process is initiated by the user from the front panel and is executed under microprocessor control in about one minute. This system provides the best linearity available (±3%) over the full dynamic range of the power meter (+20dBm to -20 dBm).

Ease-of-use is important when using modern peak power meters because of the wide range of measurement capabilities designed into the instrument. The 8500A can autoscale on a wide range of pulses, making it easy to measure the peak power and see the pulse waveform without the need for an external oscilloscope. The operator has full control of the exact point on the pulse profile for making a peak power measurement.

The same peak power meter can be used to make precise timing measurements on the pulse envelope. Markers make the traditional risetime and pulse width measurements very simple yet very accurate (0.01%).

Power Sensors for Peak Power Meters
Peak power meter sensors can be subdivided into two categories: slow risetime (750 ns) and fast risetime (15 ns). The risetime selected also determines the lower frequency limit for the sensors.

Wavetek's power sensors include a PROM in the assembly. The PROM is programmed with NIST traceable frequency response data. The power meter reads the Cal Factor data from the power sensor and displays frequency corrected power readings.

Another important consideration with diode power sensors is that they should be field repairable. All Wavetek's power sensors are field maintainable.

POWER METER SELECTION GUIDE

PEAK POWER METERS:

MODEL	8500A Series	1018B
Frequency Range	30 MHz to 40 GHz	100 MHz to 26.5 GHz
Power Range	+20 to -20 dBm	+10 to -20 dBm
Dynamic Range	40 dB	30 dB
Accuracy (Linearity)	±0.15 dB (±3%)	±0.2 dB (±5%)
Power Sweep Calibrator	Yes	No
Fixed Level Calibrator	No	Yes
Number of Inputs	8501A 1, 8502A 2	1
Display Pulse Profile	Yes	No
Markers (Timing/Amplitude)	Yes	No
No. of Readings/Second	100	500
CW Power Measurements	Yes	Yes
Stored Setups	Yes	No
PROM Cal Factor Correction	Yes	No
Operation over GPIB	Yes	Limited
Digital Plotter Compatible	Yes	N/A
Balanced Diode Power Sensors	Yes	Yes
High Speed/Low Speed Power Sensors	Yes	No

CW POWER METERS:

MODEL	8530	8531
Frequency Range	30 MHz to 26.5 GHz	30 MHz to 26.5 GHz
Power Range	+20 to -70 dBm	+20 to -70 dBm
Dynamic Range	50 dB	50 dB
Accuracy (Linearity)	±0.09 dB (±2%)	±0.02 dB (±0.5%)
Number of Inputs	1	1
Calibrator	Yes	Yes
Auto Cal	No	Yes
Auto Zero	No	Yes
Digital Readout	No	Yes
Analog Display	Yes	Yes
Cal Factor Correction	Yes	Yes
Linearity Correction	No	Yes
Duty Cycle Correction	No	Yes
Digital Averaging	No	Yes
Analog Averaging	Yes	No
Offsets	No	Yes
Storage Registers	No	Yes
Operation over GPIB	No	Yes
Use with Diode Sensors	Yes	Yes
Use with Thermocouple Sensors	Yes	Yes
Battery Operation	Yes	No

Microwave Peak Power Meter

- **High Instrumentation Accuracy ±3% (±0.13dB)**
- **30 MHz to 40 GHz Frequency Range**
- **Graph Mode for Plot of Pulse Profile**
- **Full GPIB Control**
- **Complete Family of Low VSWR Sensors**

The 8500A Series of Peak Power Meters is designed for making highly accurate power measurements on pulsed RF signals independent of pulse width or rep rate of the pulses. Single channel and dual channel versions are available. The pulse profile can be displayed on the electroluminscent screen along with the main measurement parameters. Pulses as narrow as 15ns can be displayed and measured.

A family of diode power sensors complements the power meter. To minimize mismatch errors, each of the sensors has a low VSWR. In addition, each sensor includes a built-in PROM which has been programmed with frequency response information for that particular power sensor. Both fast risetime (high speed) and slow risetime (low speed) sensors are available.

Rack mount (5 1/4 inches high) and bench top units are available. The power sensor inputs and calibrator output can be on the front or rear of the instrument.

Precise Amplitude Measurements
A unique power sweep calibration system is used to provide the ±3% linearity specification over the power range from +20 dBm to -20 dBm. With this system any power sensor can be used with any power meter without degradation in accuracy. The calibration system also serves as a test for the measurement system to prevent damaged diodes in the sensors generating erroneous power readings. Calibration of the sensors to the power meter can be done at any time by the user. The operation is microprocessor controlled and takes less than 45 seconds. This same calibration system transfers NIST traceability to the 8500A Series peak power meter and sensors.

Corrections to power readings over the full frequency range of the sensors is executed by reading Cal Factor information from a PROM built into the power sensor. The measurement frequency can be entered manually, or automatically via the GPIB, or by applying an external analog voltage corresponding the frequency of the signal.

Offsets can be entered into the 8500A Series Peak Power Meters to compensate for losses in directional couplers and attenuators used to sample the RF power. This allows the display of true power being delivered at the measurement point.

Precise Timing Measurements
In many applications, the 8500A Series peak power meter can be used to replace crystal detectors and oscilloscopes for timing measurements. Using built-in markers, the user can precisely measure the pulse width and risetime either manually or over the GPIB. The time base is crystal controlled providing high accuracy and reliability over a wide range of time base (delay) speeds.

A delay line has been incorporated to permit viewing the leading edge of the pulse without the need for an external trigger.

Measurement Convenience Using Stored Setups

Nine store/recall memories are available to store the complete operating state of the instrument. A tenth memory retains the power down status which is then available automatically as an option when next using the instrument.

Powerful GPIB Capability

Full GPIB control makes the 8500A Series ideal for systems applications. Many internal high level functions such as rise time and pulse width are available over the bus and return results instead of just data to the controller.

Hardcopy pulse profiles are easily made using a digital plotter connected to the GPIB interface. No other controller is required. The plot is fully annotated including time, data and part identification.

SPECIFICATIONS

Frequency Range: 30 MHz to 40 GHz depending on detectors (see PEAK POWER SENSOR specifications).

Power Range

Pulse: -20 dBm to +20 dBm.
CW: -40 dBm to +20 dBm.
(See sensor specifications.)

Accuracy: Uncertainty of microwave power measurements depends on several factors, the most important of which is the effective mismatch of both the power sensor and the RF source. Excluding mismatch effects, the measurement uncertainties of the instrument are:
Calibrator Power Uncertainty (at 0 dBm): ±1.5%.
Linearity After Automatic Calibration: ±3% (at stable temp.).
Temperature Coefficient of Linearity at Ambient ±5°C, CW and Peak, Typical:
>-10 dBm, negligible, 0° to +50°C.
<-10 dBm, ±0.5%/°C, +15° to +50°C.
±1%/°C, 0° to +15°C.
Instrument indicates if ±5°C calibration range is exceeded.

Uncertainty Due to Zeroing and Noise:
CW (Avg.500): <±10 nW, +15° to +50°C,
CW (Avg.500): <±20 nW, 0° to +15°C.
Peak (Avg.100): <±3.5 µW, +15° to +50°C,
Peak (Avg.100): <±5.0 µW, 0° to +15°C.
Single Pulse: <±15 µW, typical +15° to +50°C,
Single Pulse: <±30 µW, typical 0° to +15°C.

Time Base Range: 1.2 ns/div to 20 ms/div (12ns to 200 ms time window), using either the Data Entry Keyboard or the Control Knob.
Resolution: 0.1 ns.
Accuracy: 0.01% of time window, ±1 ns.

Trigger Delay Range: 0 to 200 ms using either the Data Entry Keyboard or the Control Knob.
Resolution: 0.1 ns.
Accuracy: 0.01% of delay, ±1 ns.

Triggering Modes
Internal: -10 dBm to +16 dBm.
External (BNC): TTL levels, Maximum PRF 1 MHz.

Markers: Up to 4 markers/channel plus a Reference Power Level cursor. Markers can be positioned at any point on the pulse waveform. Typically they would be positioned to make risetime and pulse width measurements. The markers and cursor can be positioned either at user selected delays or automatically at specified percentage of amplitude for pulse parameter measurements.

Graph Display Mode: Plots the outline of the detected pulse on the electroluminscent display. Also provides readout of amplitude and timing information.

Fast Measurement Mode: Available under GPIB control to provide fast data acquisition and output. For an averaging number = 1, typically between 70 and 120 measurements/second. Also can be used to provide fast data acquisition and throughput via rear panel analog output for using an 8500A with a suitable scalar network analyzer to make swept frequency response tests.

Calibrator
Frequency: 1 GHz ±5%.
Power Uncertainty at 1 mW: ±1.5%.
Return Loss at 1 mW: >25 dB.
Self Calibration Time: <1 minute.
Connector: Type N.

Output Channels
8501A: Single Channel.
8502A: Dual Channel.

Auxiliary Outputs/Inputs (BNC).
Monitor: Provides a voltage proportional to the detected RF envelope. Risetime is typically 20 ns, output impedance is nominally 50W.
Analog Output: Provides a voltage proportional to detected power. Scale Factor is 100mV/dB, ±0.5%, offset is <±10 mV.
Trigger Input: TTL.
RF Blanking: TTL open collector low during zeroing. Used to control power source.
Voltage Proportional to Freq (V/GHz): Allows direct entry of frequency from RF power sources equipped with a V µ F output.
GPIB Interface: In accordance with IEEE 488 1978.
GPIB Indicators: REM, TLK, LSN, SRQ, LLO.
Remote Operation: Complete setup and measurement capabilities accessible via GPIB (IEEE-488). Reporting of errors, malfunctions, operational status and self-test diagnostics available through serial poll capability.
Direct Plot Output: Outputs hardcopy pulse profile including time, date and part identification to a GPIB plotter.
GPIB Address: Selectable from front panel.
GPIB Interface Functions: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, TE0, LE0.

OPTIONS
01: Rack Mount.
03: Rear Panel Connections (Sensor(s) and Calibrator). Deletes front panel connections.
04: Internal MATE Interface. (Contact your Wavetek representative for information.)

GENERAL
Stored Setups: Saves settings at power down and nine additional stored setups in non-volatile memory.
Self-Test: Self-Test is optionally performed at any time. A diagnostic code indicates the cause and location of any errors.
Reset Control: (Rear Panel) Returns instrument to preset default condition.
Design and Construction: To the intent of MIL-T-28800C, Type III, Class 5, Style E, Color R.
Power Requirements: 100, 120, 220 or 240 Vac ±10%, 48 to 480 Hz. Approx. 100 VA.
Environmental Characteristics
Temperature:
Operating: 0° to +50°C (+32° to +122°F).
Non-operating: -40° to +65°C (-40° to +149°F).
Humidity: Operating (without precipitation):
95% ± 5% to +30°C.
75% ± 5% to +40°C.
45% ± 5% to +50°C.
Physical Characteristics
Dimensions: 42.57 cm (16.76 in.) wide, 14.83cm (5.84 in.) high with feet, 13.25 cm (5.22 in.) without feet, 35.56 cm (14 in.) deep.
Weight:
Model 8501A: 12 kg (26 lb.) net.
Model 8502A: 13 kg (28 lb.) net.

PEAK POWER SENSORS
For specifications on peak power sensors, see page 132.

FACTORY/FOB
Sunnyvale, CA

ORDER INFORMATION
Model 8501A
Model 8502A
Option 01
Option 03
Option 04
Option 05
Declassification ONLY

For order information on 8500A Sensors, see page 132

MICROWAVE POWER PEAK METERS

8500A SERIES

Power Sensors for the 8500A Series

- **Wide Frequency Range 30 MHz to 40 GHZ**
- **Low VSWR (<1.22 up to 12.4 GHz)**
- **Balanced Diodes Minimize Phase Errors**
- **Rield Replacement Diode Elements**

Peak Power Sensors
Power range of the sensors is from +20 dBm to -20 dBm (peak) and +20 dBm to -40 dBm (CW). The unique blanaced diode configuration minimizes errors due to phase changes on signals with even order harmonics present that can result from measuring power using single diode sensors in their peak detection range (>-20 dBm).

Low Frequency and Fast Reisetime Options
Three different sensors are available for use down to 30 MHz and up to 26.5 GHz depending on the connector selected. These sensors have a risetime of 750 nS.

For fast risetime pulses, four sensors are available with a risetime of 15 nS. Frequency range is 750 MHz to 40 GHz depending on connector.

Digital Cal Factor Correction
Wavetek's sensors contain a PROM which has been programmed with Calibration Factor data for that specific sensor. The user only has to enter the frequency of operation to the power meter to obtain a power reading corrected for the frequency of the sensor.

SPECIFICATIONS

Frequency Ranges
High Speed: (High Speed) Detectors can be used down to 500 MHz.)
750 MHz to 18.5 GHz - Type N
750 MHz to 26.5 HGz - Type K
750 MHz to 40 GHz - Type K
Low Speed:
30 MHz to 18.5 GHz - Type N
30 MHz to 26.5 GHz - Type K

Risetime
High Speed: <15 ns, typically 10 ns
Low Speed: <750 ns, typically 500 ns

Power Range
Measurements: -20 to +20 dBm (Pulse) - 40 to +20 dBm (CW)

Return Loss (SWR):

	Type N, APC-7	Type K
Below 2 GHz	>25 dB (1.12)	>25 dB (1.12)
2 to 12.4 GHz	>20 dB (1.22)	>20 dB (1.22)
12.4 to 18 GHz	>16 dB (1.37)	>16 dB (1.37)
18 to 26.5 GHz		>14 dB (1.50)
26.5 to 40 GHz		>10 dB (1.92)

Calibration Factor Uncertainty:

	Sum of Uncertainties (%)	Probable Uncertainty (%)
Below 10 GHz	2.6%	1.2%
10 to 18 GHz	6.4%	3.7%
18 to 26.5 GHz	10%	6.5%
26.5 to 40 GHz	20%	10%

ORDER INFORMATION
Model 16936
Model 16937
Model 17266
Model 17071
Model 16934
Model 16935
Model 17267

PROM Programmer for Series Detectors

- **Switch Selectable PROM Choices**
- **Fast Programming Time**
- **Menu Directions from 8500A**
- **Zero Insertion Force PROM Socket**

The PROM Programmer, for use with Wavetek 8500A Series Peak Power Meters and their associated detectors, provides a quick and convenient way to enter calibration factor data into the detector PROM. This can be done when re-calibrating the detectors, or when new diode element has been inserted in the field repairable sensor. A new PROM will be required in each case.

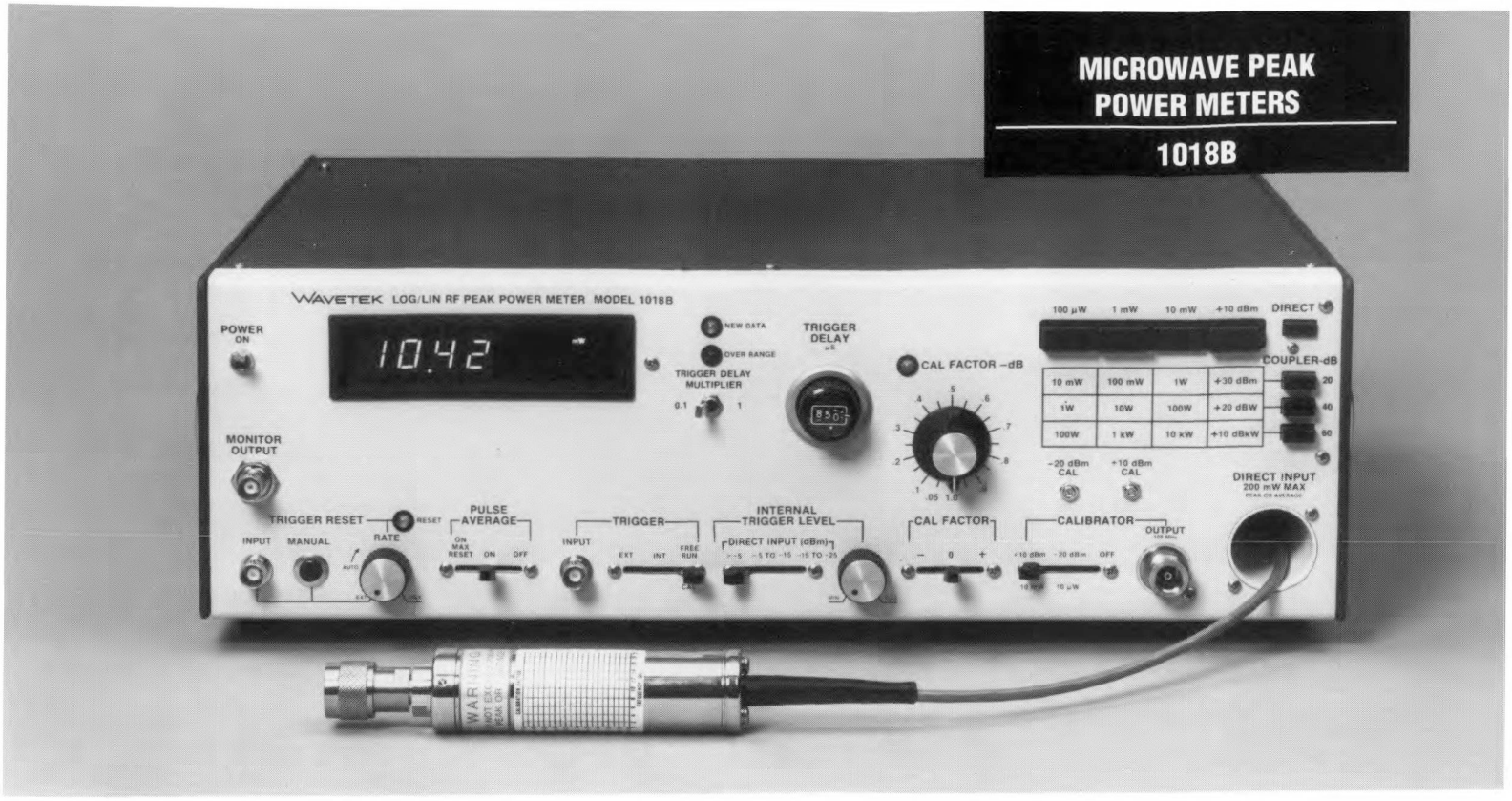
The programmer is easy to use; the display of detailed instructions for PROM programming is one of the menu choices on the Model 8500A.

SPECIFICATIONS

Types of PROMs Programmable:
In Switch Position 1: Motorola MCM7685 or Harris HM-7685.
In Switch Position 2: National Semiconductor Corp. DM875185.
In Switch Position 3: Signetics 82S185.
Programming Time: Less than 30 sec.
Power Requirements: 100, 120, 220 or 240 Vac rms ±10%. 50, 60 or 400 Hz ±5%.
Power Consumption: Approx. 10 VA.
Temperature:
Operating: 10° to 40°C (50° to 104°F).
Non-operating: -40° to 65°C (-40° to 149°F).
Dimensions: 8.3 cm (3.25 in.) high; 28.0 cm (11 in.) wide; 22.9 cm (9 in.) deep.
Weight: 2.3 kg (5 lb.)

FOB/FACTORY:
Sunnyvale, CA

ORDER INFORMATION
P/N 16976



Microwave Peak Power Meter

- **100 MHz to 26.5 GHz**
- **10 µW to 10 mW Peak**
- **Reads in mW or dBm**
- **Measures a Single Pulse**
- **Three Trigger Modes**

Model 1018B, a direct reading peak power meter, measures power on a single pulse, repeating pulses, or CW. Three trigger modes (Internal, External, and Free Run) plus an adjustable measurement gate, which can be placed at the desired point by use of trigger delay circuitry, add to its versatility.

The 1018B measures and digitizes its readings in only 1 ms and readings can be made at rates up to 500/s. Single pulses down to 200 ns can be sampled and displayed in either dBm, mW, or on the 1018B's three digit readout. Three fixed "Coupler-dB" ranges can be used with external couplers or attenuators to extend the measurement range for high power applications.

A GPIB option (05) can be specified, which will provide an isolated data output, as well as bus control for the trigger and trigger delay.

SPECIFICATIONS

Frequency Range: 100 MHz to 18 GHz (to 26.5 GHz with Option 07).

Power Range: 10 µW to 10 mW (-20 to +10 dBm).

Accuracy

Linear (µW, mW): ±5% of reading.
Logarithmic (dBm): ±0.3 dB.

Calibrator Output

High Level: +10 dBm ±0.06 dB.
Low Level: -20 dBm ±0.10 dB.
Impedance: 50Ω.
Return Loss: 31 dB.
Frequency: 105 MHz nominal.

Trigger Reset

Automatic: 0.3 Hz to 500 Hz.
External: +1.5V, ±10V max; width >0.5 µs; timing >1 µs prior to pulse which is to be measured; >1 kΩ input impedance.
Manual: Front panel pushbutton.

Environment

Operating: +15° to +45°C.
Storage: -40° to +65°C.

Power: 100, 120, 220, 240 Vac, ±10%, 50 to 400 Hz, 40 VA maximum.

OPTIONS

02: APC-7 Connector
04: Isolated Data Output
05: GPIB (includes Option 06)
06: Trigger Delay Divider
07: 26.5 GHz Measurement Range
Model 1031: Rack Adapter for Model 1018B

FACTORY/FOB

Sunnyvale, CA

ORDER INFORMATION

Model 1018B
Model 1018B/02
Model 1018B/07
Model 1031
Option 04
Option 05
Option 06

MICROWAVE CW POWER METERS

MODEL 8531

Digital Power Meter 30 kHz to 26.5 GHz

- **High Instrumentation Accuracy ±0.5% (±0.02 dB)**
- **Wide Dynamic Range +20 dBm to -70 dBm (100 mW to 100 pW)**
- **Full GPIB Control**
- **Fast Response Time**
- **Complete Family of Low VSWR Sensors**

The 8531 power meter is a general purpose digital power meter for accurate manual and automatic RF and microwave power measurements. It is a single channel instrument combining state-of-the-art accuracy with a modern feature set. Microprocessor control provides simple keyboard or GPIB operation, fast response and high accuracy.

The meter is complemented by the 85300 Series thermocouple and diode power sensors. To minimize mismatch errors, the sensors have low VSWR. In addition, each sensor is calibrated to characterize calibration and linearity factors for optimum accuracy. Frequency range of the sensors is from 30 kHz to 26.5 GHz.

Easy automatic operation in both measurement and calibration modes results from microprocessor control. Meter zeroing is carried out with a single key press or GPIB command. This digital circuit provides almost infinite hold and reduces zero carryover errors to less then ±0.03% of full scale.

The 8531 is 3 1/2 inches high in a half-rack width cabinet, thus minimizing the use of valuable rack space in ATE systems. A convenient tilt handle is provided for benchtop use.

Accuracy and Speed

Power measurement errors due to frequency response and power linearity can be corrected to reduce measurement uncertainties. Instrumentation error is specified at ±0.5% of full scale in the linear mode or ±0.02 dB in the logarithmic mode.

Calibration factors may be entered and stored in non-volatile memory to 0.01% resolution. All thermocouple sensors show a characteristic departure from linearity which is significant over the top 10 dB of their operating range. Rather than use a simple but less accurate shaping circuit to compensate for this error, the 8531 allows user entry of a calibrated linearity correction for the sensor in use. This reduces linearity error to <±0.5%.

The 8531 can take up to 40 readings per second over the bus. This is critical in ATE systems where the power meter is often the slowest instrument in the system.

To optimize response time, the power meter automatically selects the best resolution for the range in use. The measured power level is shown on the LCD display; the lower the power level, the lower the resolution so that the 1 dB resolution is shown without delay.

With the 8531, the user is in control of the trade off between measurement speed and display resolution. To increase resolution, the user can enter an averaging factor from 1 to 253. For example, on range 1, with an averaging factor of 20, a 0.1 dB resolution is given after 4 display updates (1 second) and a 0.01 dB resolution is given after 16 additional updates. Averaging can also be used to reduce the effects of noise on the measurement.

System Calibration

In either the manual or GPIB modes of operation, AUTO CAL switches on the power reference and normalizes the power meter so that calibration values for each range are stored in non-volatile memory. The 8531 will then provide auto-ranging over five decades.

The power meter can display the measured power in either logarithmic mode (dBm) or linear mode (nW, µW, mW, W). By entering a power level as a reference, relative power measurements can be made and displayed as dBr. In addition, offsets may be entered via the keyboard. This enables direct readout of high power levels corrected for external couplers or attenuators.

Measurement Convenience Using Stored Setups

Nine store/recall registers are available to store the complete operating state of the instrument. Further, the power meter can be uniquely programmed to retain all the current front panel settings, or default to a different set of conditions on power down. This allows the turn-on mode to be user selected.

MODEL CW POWER METERS

MODEL 8531

Full GPIB Capability

Full GPIB control makes the 8531 ideal for systems applications where talker/listener functions are required. GPIB program codes include 6 trigger modes. These set the trigger mode or start a measurement after a hold condition. The SRQ facilities provide response for End of measurement, Error, and End of GPIB operation. The 8531 power meter easily replaces older style power meters in existing GPIB systems. Only a few simple program changes are required.

Multi-Point Measurements

Simultaneous power measurements at a number of different points can be made by controlling multiple 8531 power meters on the GPIB. Using the fast trigger modes and the SRQ facilities, measurements are rapid, avoid the internal power meter channel switching delays and have high common mode rejection.

Analog Outputs

Two analog voltage outputs proportional to RF input power are provided on the rear panel. The Recorder Output, useful for wide dynamic range plots on an X-Y recorder, offers the full 50 dB dynamic range of the instrument in dB mode at 1V/decade for wide range power measurements. In the watt mode this output provides 0 to 5V linear voltage proportional to the RF input power. The fast Leveling Output provides a wider bandwidth signal with a 1V per range linear output for effective power leveling of sweepers or signal sources. The calibration and linearity correction data for the sensor are not included to give a fast response.

Self Test

The 8531 has a built in self test at switch on. Validity of the information in the non-volatile memory is automatically checked. Additionally, a single keyswitch operation can check the liquid crystal display alphanumerics and annunciators.

8531 POWER METER

METER

Frequency Range: 30 kHz to 26.5 GHz, depending on sensor used.

Power Range: +20 dBm to -70 dBm (100 mW to 100 pW), depending on sensor used.

Dynamic Range: 50 dB, in five 10 dB full scale ranges.

Display Resolution: User selectable from 1 dB to 0.001 dB.

ACCURACY

Power Reference

Power Output: 1 mW factory set to ±0.7%. Traceable to NIST.
Accuracy: ±1.2% worst case for one year.
Frequency: 50 MHz nominal.
Connector: Type N(f) precision connector, 50Ω.

Instrumentation Accuracy

Watts Mode: ±0.5%.
dB Mode: ±0.02 dB.
dB REL Mode: ±0.02 dB.

Zeroing Accuracy

Zero Set: ±1% of full scale on the most sensitive range.
Zero Carryover: ±0.03% of full scale when zeroed on the most sensitive range.
Zero Drift: Sensor dependent.
8531X Series Sensors: ±0.1%.
85320 Sensor: ±2%.
Values represent percent of full scale on most sensitive range. Decrease percentage by a factor of 10 for each higher range.

Noise Uncertainty: Less than 1% of full scale of most sensitive range, with an averaging factor greater than 19.

REMOTE OPERATION

GPIB Interface: Optional GPIB interface allows all front panel functions to be remotely programmed. Compatible with IEEE 488-78.

GPIB Measurement Speed: 40 readings per second. Six trigger modes offered including fast readings, settled readings, triggered and free running.

METER FUNCTIONS

Averaging: User selectable, averaging from 1 to 253 readings to smooth noisy measurements. Increased averaging automatically selects increased reading resolution down to 0.001 dB.

Duty Cycle: Allows direct display of peak pulse power for pulsed signals, calculated from measured average power. Meter accepts duty cycle values in the range of 0.001% to 100%.

Linearity Factor: Allows precise correction for slight departure from linearity found in top 10dB of dynamic range in any thermocouple or diode sensor.

dB REL and Offset: Allows both relative readings and offset readings. Power display can be offset by -99.9 to +99.9 dBm to account for external attenuation, coupling or gain.

Cal Factor: Allows direct entry of sensor Cal Factor (frequency response correction).

Auto Cal: Automatic, one pushbutton (or programmable) zeroing of sensor and meter.

Storage Registers: Allows storage and recall of 10 front panel settings of the instrument.

OUTPUTS

Fast Leveling: 0 to 1V linearly proportional to power on each range.

Accuracy: ±0.5% (excluding Cal Factor and Linearity Data). BNC connector.

Recorder Output: BNC connector.

dB Mode: 1V/decade, 7V maximum on Range 5 (highest power range).
Watts Mode: 0 to 5V linearly proportional to power over the full 50 dB dynamic range.

Blanking Output: Pulls low during power meter autozero. Can be used to shut off sweep generator RF during sensor zeroing. Open collector output. Maximum voltage 25V, maximum current 50 mA.

GENERAL

Temperature Range

Operational: 0° to +50°C.
Storage: -40° to 70°C.

Humidity: 95% relative at 30°C.

Line Voltage: 105V to 120V ±10%, 210V to 240V ±10%, 45 Hz to 440 Hz.

Power Consumption: 25 VA maximum.

Dimensions: 108 mm (4.3 in.) high including feet, 88 mm (3.5 in.) without feet; 256 mm (10.1 in.) wide including handle, 216 mm (8.5 in.) without handle; 359 mm (14.1 in.) deep.

Weight: 3.2 kg (7 lb) net.

OPTION

001: GPIB

POWER SENSORS

85309: 10 MHz to 18 GHz. -30 to +20 dBm, Type N

85310: 0.01 to 20 GHz. -30 to +20 dBm, Type N.

85311: 10 Mhz to 20 GHz. -30 to +20 dBm, Type APC-7

85312: 20 kHz to 4.2 GHz. -30 to +20 dBm, Type N.

85313: 0.01 to 26.5 GHz. -30 to +20 dBm, APC-3.5.

85319: 30 kHz to 3.0 GHz. -30 to +20 dBm, 75Ω Type N.

85320: 0.01 to 20 GHz. -70 to -20 dBm, Type N.

85323: 10 MHz to 26.5 GHz. -70 to -20 dBm, APC-3.5

FACTORY/FOB

Sunnyvale, CA

ORDER INFORMATION

Model 8531
Option 001
Model 85309
Model 85310
Model 85311
Model 85312
Model 85313
Model 85319
Model 85320
Model 85323

MICROWAVE CW POWER METERS

MODEL 8530

Analog Power Meter

- **Frequency Range 30 kHz to 26.5 GHz**
- **Dynamic Range +20 dBm to -70 dBm**
- **50 and 75 ohm Capability**
- **Easy Operation with Simple and Stable Calibration**
- **Portable with Optional Internal Battery**

SPECIFICATIONS

Frequency Range: 30 kHz to 26.5 GHz depending on sensor used.

Power Range: +20 dBm to -70 dBm (100 mW to 100 pW) depending on sensor used.

Dynamic Range: 50 dB, in ten 5 dB full scale ranges.

Response Time: Continuously variable between 30 ms and 15s using rear panel control.

Meter scale: Moving coil meter with linear scales of 0 to 3 and 0 to 10, and a logarithmic scale of 0 to -10 dB.

ACCURACY

Power Reference

Power Output: 1 mW factory set to ±0.7%. Traceable to NIST.

Accuracy: ±1.2% worst case for one year.

Frequency: 50 MHz nominal.

Connector: Type N(f) precision connector, 50Ω.

Instrumentation Accuracy: ±0.5% using the recorder output, ±2% using the front panel meter.

Zeroing Accuracy

Zero Carryover: ±0.02% of full scale when zeroed on the most sensitive range using the front panel Zero control.

Zero Drift: Sensor dependent.

8531X: ±0.1%.

85320: ±2%.

(Represents percent of full scale on most sensitive range. Decrease percentage by a factor of 3.16 for each higher range.)

Noise Uncertainty: Less than 3% of full scale of most sensitive range. (Typical, at constant temperature, peak change over a one minute interval).

METER FUNCTIONS

Calibration Factor: Front panel control is used to normalize the meter reading for sensor frequency response. Range is 70% to 100%, continuously variable.

Cal Adjust: Screwdriver adjustment of meter gain to calibrate sensor to meter using built-in 1 mW power reference.

OUTPUTS

Recorder Output: BNC connector. Provides an output proportional to the indicated power with 1 V corresponding to full scale. 1 kΩ output impedance.

BATTERY PACK

Nickel Cadmium battery, 12 V nominal, 4 ampere hour capacity. Operating time better than 8 hours after 14 hours continuous charge.

GENERAL

Temperature Range

Operational: 0° to +50°C.

Storage: -40° to +70°C.

Humidity: 95% relative at 35°C.

Altitude: Up to 2000 meters (pressurized at 27 kPa differential, i.e. 3.9 lbf/in.^{2}).

Line Voltage: 105 to 120 V ±10%, 210 to 240 V ±10%, 45 to 440 Hz.

Power Consumption: 25 VA maximum, 15 VA typical.

Dimensions: 108 mm (4.3 in.) high including feet, 88 mm (3.5 in.) without feet; 256 mm (10.1 in.) wide including handle, 216 mm (8.5 in.) without handle; 369 mm (14.5 in.) deep.

Weight: 3.2 kg (7 lb.).

OPTION

045: Rechargeable Battery Pack

POWER SENSORS

85309: 10 MHz to 18 GHz. -30 to +20 dBm, Type N

85310: 0.01 to 20 GHz. 30 to 20 dBm, Type N.

85311: 10 MHz to 20 GHz. -30 to +20 dBm, APC-7

85312: 30 kHz to 4.2 GHz. -30 to +20 dBm, Type N.

85313: 0.01 to 26.5 GHz. -30 to +20 dBm, APC-3.5

85319: 30 kHz to 3.0 GHz. -30 to +20 dBm, 75Ω, Type N.

85320: 0.01 to 20 GHz. -70 to -20 dBm, Type N.

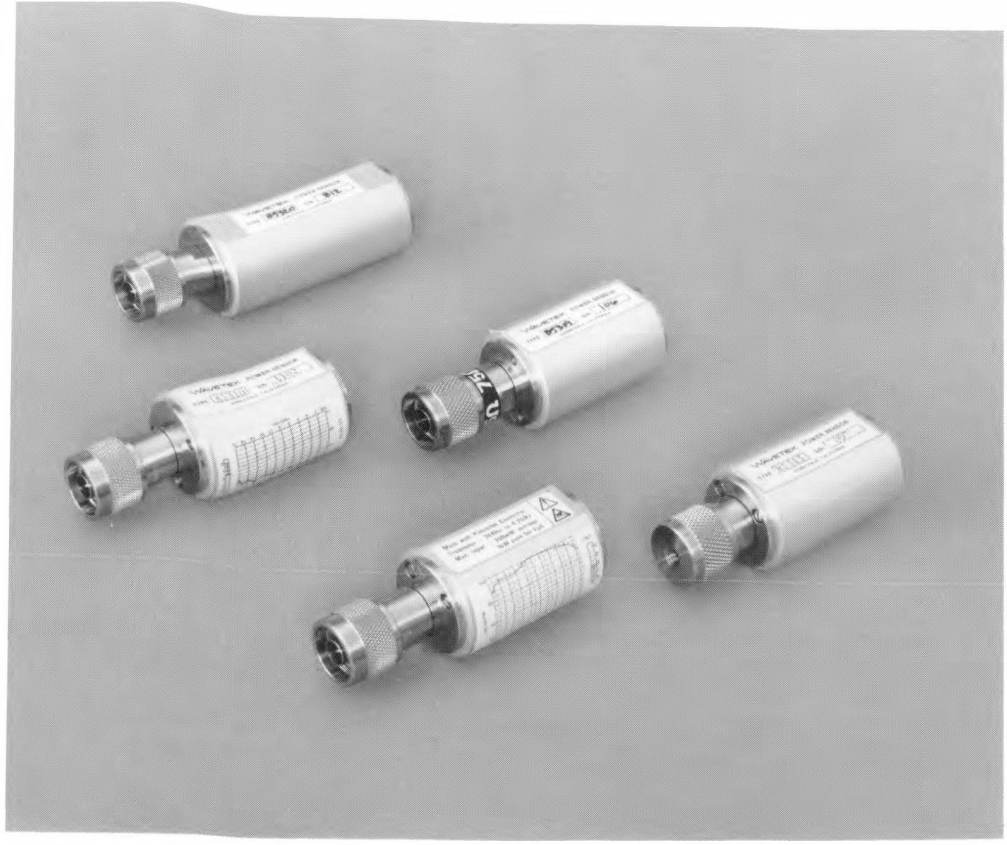
85323: 10 MHz to 26.5 GHz. -70 to -20 dBm, APC-3.5

FACTORY/FOB

Sunnyvale, CA

ORDER INFORMATION

Model 8530
Model 85309
Model 85310
Model 85311
Model 85312
Model 85313
Model 85319
Model 85320
Model 85323
Option 045



Power Sensors for 8530/31 Power Meters

- **Wide Frequency Coverage 30 kHz to 26.5 GHz**
- **Wide Dynamic Range +20 dBm to -70 dBm**

Power Sensors
The performance of the power sensors is critical to the overall performance of a power meter. Frequency coverage, dynamic range and accuracy are important sensor specifications. Wavetek's range of power sensors, designed for use with the 8530 and 8531, provide state-of-the-art performance in these key areas.

These low VSWR, precision calibrated sensors are fitted with precision connectors and have a multiway socket for cable connection to the power meter.

All of the sensors are small and lightweight making them very adaptable for use without requiring additional mechanical support.

Rugged mechanical construction makes them ideal for bench or field use. Minimum down-time is ensured by using a field replaceable RF sensing assembly.

Full Calibration Data
Using a specially designed test system to reduce uncertainties, each power sensor is measured for calibration factor. This data is shown on the sensor body. In addition, a unique linearity correction factor for each sensor is provided. This enables the user to account for power linearity variations between actual and measured power. This can be entered into the 8530 and 8531 via the front panel and into the 8531 over the GPIB.

Model Number	Frequency Range	Power Range	Maximum Power	Linearity Factor Accuracy	Maximum VSWR	RF Connector	Dimensions		
							Length	Diameter	Weight
85310	10 MHz to 20 GHz	−30 to +20 dBm (1 μW to 100 mW)	+24.8 dBm (300 mW)	±0.5% at 25°C	1.25; 10 MHz-30 MHz 1.10; 30 MHz-2 GHz 1.18; 2 GHz-16 GHz 1.28; 16 GHz-18 GHz 1.40, typical to 20 GHz	Type N(m) 50Ω	87 mm (3.4 in.)	33.5 mm (1.3 in.)	0.14 kg (0.30 lb.)
85312	30 kHz to 4.2 GHz	−30 to +20 dBm (1 μW to 100 mW)	+24.8 dBm (300 mW)	±0.5% at 25°C	1.60; 30 kHz-100 kHz 1.20; 100 kHz-300 kHz 1.10; 300 kHz-4.2 GHz	Type N(m) 50Ω	87 mm (3.4 in.)	33.5 mm (1.3 in.)	0.14 kg (0.30 lb.)
85313	10 MHz to 26.5 GHz	−30 to +20 dBm (1 μW to 100 mW)	+24.8 dBm (300 mW)	±0.5% at 25°C	1.40; 10 MHz-50 MHz 1.15; 50 MHz-100 MHz 1.10; 100 MHz-2 GHz 1.15; 2 GHz-12.4 GHz 1.20; 12.4 GHz-18 GHz 1.25; 18 GHz-26.5 GHz	APC-3.5(m) 50Ω	80 mm (3.2 in.)	33.5 mm (1.3 in.)	0.14 kg (0.30 lb.)
85319	30 kHz to 3 GHz	−30 to +20 dBm (1 μW to 100 mW)	+24.8 dBm (300 mW)	±0.5% at 25°C	1.40; 30 kHz-100 kHz 1.15; 100 kHz-300 kHz 1.10; 300 kHz-2 GHz 1.20; 2 GHz-3 GHz	Type N(m) 75Ω	88 mm (3.5 in.)	33.5 mm (1.3 in.)	0.14 kg (0.30 lb.)
85320	10 MHz to 20 GHz	−70 to −20 dBm (100 pW to 10 μW)	+23 dBm (200 mW)	±0.5% at 25°C	1.4 to 1.2; 10 MHz-40 MHz 1.20; 40 MHz-10 GHz 1.35; 10 GHz-18 GHz 1.40, typical to 20 GHz	Type N(m) 50Ω	104 mm (4.1 in.)	33.5 mm (1.3 in.)	0.18 kg (0.38 lb.)

WAVETEK POWER SENSOR SPECIFICATIONS

Datron – Innovation for Systems and Calibration

Datron Range and Autocal

The choice of Datron precision DMMs and Calibrators is extensive, with instruments to suit a broad range of different applications - from bench and system use in a production environment to the exacting measurements performed in Standards and Calibration Laboratories. Each instrument offered by Datron provides not only the excellent performance associated with a technological leader, but also the high quality of a well established international supplier.

One of the strongest themes which links all of the instruments is that of automated calibration, where innovation in its application can lead to both improved accuracies and ease of support. Techniques of automated calibration can be applied to instrumentation at different levels, but they all have the common objectives of reducing calibration downtime, and improving the reliability, repeatability, and accuracy of the process. In addition, because calibration may be carried out with the instrument on-site even in its A.T.E. rack if necessary - some of these benefits extend to the systems in which such instruments are used. These include reduced system downtime, lower spares and logistics costs, higher accuracy and increased confidence in the overall system measurement.

Datron is a pioneer in the field of automated calibration, and leads the market in three different but related areas: AUTOCAL, SELFCAL and PORTOCAL.

Autocal

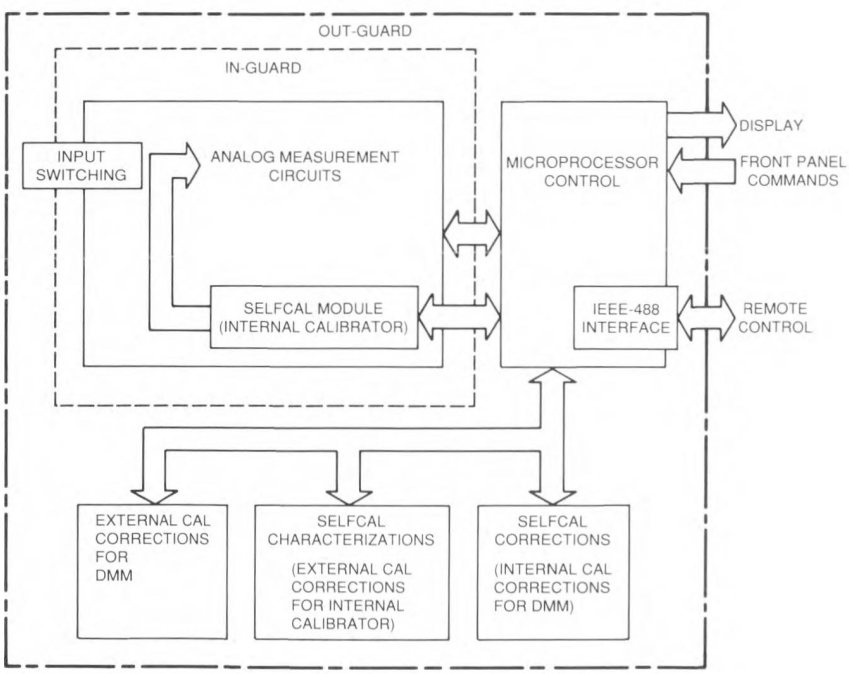
Before the development of Autocal, calibration of precision DMMs was undoubtedly one of the biggest headaches for the user. Calibration involved the removal of the DMM's covers, which in itself upset the thermal balance within the instrument, and then manually adjusting up to 30 or 40 trim-caps- each one tending to interact with the others. This meant that the whole calibration procedure was a long and complex process, requiring experienced and skilled personnel.

Taking advantage of a microprocessor's ability to make calculations and control analog circuitry, Datron was the first DMM manufacturer to develop complete, electronic covers-on calibration, Autocal. This technique has proved to be so successful that variations are employed by the vast majority of precision and systems DMMs available today.

Selfcal

As the pioneer of Autocal, Datron has taken advantage of its technological leadership in this area and has taken the concept one stage further - with Selfcal. Whereas Autocal is an electronic technique for calibrating equipment against external calibration standards, Selfcal - as embodied in Datron's model 1281 & 1271 DMMs - is a technique for calibration against traceable *internal* standards. Selfcal has all the benefits of Autocal plus one additional factor: the calibrator is actually inside the instrument - so you do not need an external source.

Embedded within the Selfcal DMMs normal measurement circuits is an accurate internal calibrator composed of highly stable zener diodes, reference resistors, and a precision transformer multiplier. During a Selfcal, the inherently stable turns ratio of the transformer multiplier is used to derive different levels of very high accuracy calibration signals from the DMM's zener references, which are then routed via an internal signal bus to all of the instrument's various functions. Over 150 different calibration measurements are used by the microprocessor to compute and store corrections for the effects of time and temperature drift in the DMM's circuits, significantly enhancing long term performance and temperature coefficient specifications. The result is a 2:1 improvement in temperature coefficient and a 35% improvement in performance over the identical instrument when used without Selfcal. This means the instrument is capable of maintaining its standards lab performance over longer periods before returning to the Calibration Laboratory. In addition, the ability to calibrate itself, even in an A.T.E. rack, gives the 1281 & 1271 the ability to perform very well in relatively hostile production environments.



The Models 1281 & 1271 contain separate calibration memories for the DMM and its internal calibrator. When the DMM calibrates itself against the internal calibrator, another set of calibration corrections are derived and stored.

Portocal
This is the name given to Datron's series of automated DMM calibration systems. The word is short for 'Portable Calibration', and is appropriate because these systems are compact and rugged enough to be wheeled around a factory installation to calibrate equipment on-site (e.g an Autocal DMM located in a A.T.E rack). All of Datron's Autocal and Selfcal instruments can be remotely controlled and calibrated via the IEEE-488 interface, which means that apart from being ideal for general systems applications, these instruments can also either form part of a computer controlled calibration system, or indeed be totally automatically calibrated by such a system. Datron provides comprehensive menu driven software to help users to develop automated calibration procedures for all kinds of DMMs. In addition, the system controller also manages the calibration data that is generated from using the system. This means that past results and comments can be retrieved very quickly, and presented in a high quality format - important facilities for the management of any calibration laboratory. Such systems, based on one of Datron's 4700 series of calibrators, can provide a very compact, accurate and yet cost-effective integrated solution for DMM calibration and data management.

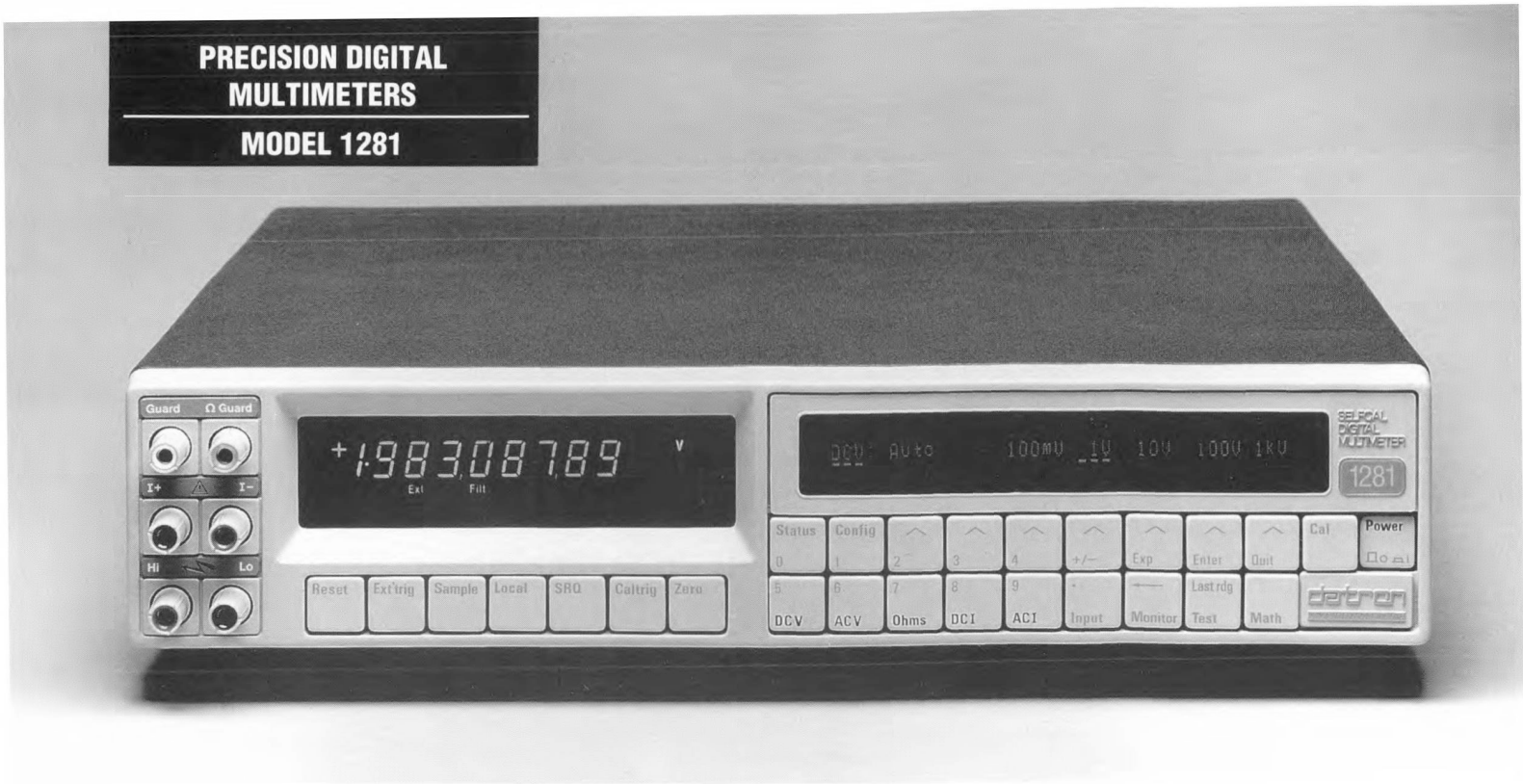
Innovation
As can be seen, being innovative with automated calibration techniques has allowed Datron to provide all kinds of measurement and support advantages for users of their instruments. Furthermore, these benefits are not just confined to the calibration laboratory, finding very real use in systems and other factory applications.

PRECISION DIGITAL MULTIMETERS

MODEL	RANGES	RESOLUTION (digits)	ACCURACY (1 Year, 23°C±5°C, ±(ppmR + ppm FS))	DIGITAL INTERFACE	OTHER FEATURES	PG	
1281	DCV: 100 mV to 1kV ACV: 100 mV to 1kV Ω: 10Ω to 1GΩ DCI: 100 µA to 1A ACI: 100 µA to 1A	DCV: 10 nV, 8 1/2 ACV: 100 nV, 6 1/2 Ω: 1 µΩ, 8 1/2 DCI: 100 pA, 6 1/2 ACI: 1 nA, 5 1/2	DCV: 3 + 0.1 ACV: 60 + 5 Ω: 6+ 0.3 DCI: 25 +2 ACI: 200 + 100	IEEE-488.2	Ratio/Rear Input Spot Frequency ACV Low Current Ohms Frequency SELFCAL/AUTOCAL Math/Limits/Max-Min Spec Readout	140	
1271	DCV: 100 mV to 1kV ACV: 100 mV to 1kV Ω: 10Ω to 10GΩ DCI: 100 µA to 1A ACI: 100 µA to 1A	DCV: 10 nV, 8 1/2 ACV: 100 nV, 6 1/2 Ω: 1 µΩ, 8 1/2 DCI: 100 pA, 6 1/2 ACI: 1 nA, 5 1/2	DCV: 7 + 0.25 ACV: 60 + 10 Ω: 10 + 0.5 DCI: 25 + 2 ACI:200 + 100	IEEE-488.2	Ratio/Rear Input Line-locking Ohms Guard Frequency SELFCAL/AUTOCAL Math/Limits/Max-Min Spec Readout	142	
1061A	DCV: 100 mV to 1kV ACV: 100 mV to 1kV Ω: 10Ω to 10 MΩ DCI: 100 µA to 1A ACI: 100 µA to 1A	DCV: 100 nV, 6 1/2 ACV: 10 nV, 6 1/2 Ω: 10 µΩ, 6 1/2 DCI: 1 nA, 5 1/2 ACI: 1 nA, 5 1/2	DCV: 30 + 4 ACV: 600 + 100 Ω: 45 + 4 DCI: 150 + 20 ACI: 0.3% + 0.05%	IEEE-488 BCD (1061 Only)	Ratio/Rear Input AUTOCAL Math/Limits/Max-Min dB/Spec Readout	144	
1062MT	DCV: 100 mV to 1kV ACV: 100 mV to 1kV Ω: 10Ω to 10 MΩ DCI: 100 µA to 1A ACI: 100 µA to 1A	DCV: 100 nV, 6 1/2 ACV: 1 µV, 5 1/2 Ω: 10 µΩ, 6 1/2 DCI: 1 nA, 5 1/2 ACI: 1 nA, 5 1/2	DCV: 30 + 4 ACV: 600 + 100 Ω: 45 + 4 DCI: 150 + 20 ACI: 0.3% + 0.05%	MATE IEEE-488	Rear Input AUTOCAL Math/Limits/Max-Min Spec Readout	144	
1062MT-5	DCV: 100 mV to 1kV ACV: 100 mV to 1kV Ω: 10Ω to 10 MΩ	DCV: 100 nV, 6 1/2 ACV: 1 µV, 5 1/2 Ω: 10 µΩ, 6 1/2	DCV: 60 + 4 ACV: 1000 + 250 Ω: 60 + 4	MATE IEEE-488	Rear Input AUTOCAL Math/Limits/Max-Min Spec Readout	144	
1362 VXIbus Card DMM	DCV:100 mV to 300V ACV:100 mV to 300V Ω:100Ω to 10 MΩ DCI: 1A ACI: 1A	DCV: 100 nV, 6 1/2 ACV: 100 nV,6 1/2 Ω: 100 µΩ, 6 1/2 DCI: 1 µA, 6 1/2 ACI: 1 µA, 6 1/2	DCV: 30 + 2 ACV: 400 + 100 Ω: 40 + 3 DCI: 300 + 10 ACI: 0.3% + 0.03%	VXI Compatible IEEE-488.2 or MATE(CIIL) command syntax	C size,single slot Ratio 1000 readings/sec CMRR >130 dB	10	

PRECISION DIGITAL MULTIMETERS

MODEL 1281



Selfcal Digital Multimeter

- **The World's Finest 8 1/2 Digit DMM**
- **1 Year DCV Specifications to ±3.1 ppm**
- **1 Year ACV Specifications to ±65 ppm**
- **Selfcal Internal Calibration**
- **Simultaneous Display of Frequency and True RMS ACV**

State of the Art Accuracy
A glance at the specifications opposite will confirm that the 8 1/2 digit 1281 Selfcal Digital Multimeter is, without exception, the finest DMM in the world. Designed with Standards and Calibration laboratories in mind, the 1281 provides the ultimate in electrical measurement, outperforming all rivals in accuracy, functional capability, and ease of use.

Selfcal
The impressive specifications of the 1281, achieved through a blend of innovation, experience and new component technology, are further enhanced by "Selfcal"— Datron's unique method of accurate internal calibration.

Embedded within the 1281's normal measurement circuits is an accurate, compact internal calibrator, based on an inherently stable precision transformer multiplier. This is used to derive different levels of very high accuracy calibration signals from the 1281's zener references, which are then routed to the various measurement circuits in order to calibrate them. Over 150 calibration measurements are used by the microprocessor to compute and store corrections for the effects of time and temperature drift in the 1281's circuits, significantly enhancing its long term performance and temperature coefficient specifications.

Applications
Long term accuracy and wide functional capability make the 1281 an obvious choice as a laboratory standard for the smaller calibration facility, while its short term stability and ease of calibration without removal of covers also makes it ideal for the short term transfer work appropriate to a Standards environment. In addition to its stability, the 1281's rugged construction and extensive selftesting capability (which can be carried out to very high precision due to the 1281's internal calibrator) are characteristics that lend it to audit applications, where laboratories can compare measurements knowing that the transfer instrument can check itself to a high degree of accuracy after transportation, and is highly stable over the period the measurements are taken.

Calibration Systems
Apart from enhancing accuracies, the 1281's ability to internally calibrate itself gives it a low effective temperature coefficient, which when combined with comprehensive control over the IEEE-488 interface makes the instrument an ideal component either for a mobile calibration system, or for integration within a high accuracy A.T.E. The low temperature coefficient means that the 1281 can deliver highly accurate measurements outside a controlled calibration environment.

Versatile
In addition to its basic measurement capability, the 1281 incorporates many features to enhance the usefulness of its fundamental performance. These include frequency measurements which can be displayed simultaneously with the true RMS value of the signal, low-current resistance modes which will

interest users of resistance thermometers, comprehensive autoranging ratio (including difference and deviation measurements), rolling and block averaging, linear math computations, dBs and automatic readout of measurement uncertainty.

DC Voltage

Ranges: 100 mV to 1000V in decades.
FS: 2 x Full Range. 100% Overrange. (Except 1kV range).
Resolution: 10 nV, 8 1/2 digits.
Accuracy: 1 Year, 23°C ± 5°C, ±(ppmR + ppmFS):

100 mV Range:	6 + 0.5
1V Range:	3 + 0.2
10V Range:	3 + 0.1
100V Range:	6 + 0.2
1000V Range:	6 + 0.2

CMRR: (1kΩ unbalance) >140 dB at DC, >(80 dB NMRR) at 1 Hz-60 Hz.
NMRR: 60 dB at 50/60 Hz ±0.09% (Filter out), 110 dB at 50/60 Hz (Filter in).
Input Impedance: >10,000 MΩ from 100 mV to 10V ranges, 10 MΩ ±0.1% on 100V and 1000V ranges.
Input Protection: Withstands 1kV RMS on any range.
Input Current: <50 pA.
Settling Time: (To 10ppm step size) <50 ms (Filter out), <1s (Filter in).
Read Rate: 1/6s at 8 1/2 digits, 150/s at 4 1/2 digits.

True RMS AC Voltage

Ranges: 100 mV to 1000V in decades.
FS: 2 x Full Range. 100% Overrange. (Except 1kV range).
Resolution: 100 nV, 6 1/2 digits.
Accuracy: 1 Year, 23°C ± 5°C, Signal >1%FS, ±(ppmR + ppmFS):

100 mV Range:	
40 Hz-10 kHz	100+20
10-30 kHz	300+40
30-100 kHz	700+100
1V to 100V Ranges:	
40-100 Hz	80+10
100 Hz-2 kHz	60+10
2-10 kHz	80+10
10-30 kHz	200+20
30-100 kHz	500+100
100-300 kHz	0.3%+0.1%
300 kHz-1 MHz	1%+1%
1000V Range:	
40 Hz-10 kHz	80+10
10-30 kHz	200+20
30-100 kHz	500+100

Lf Accuracy: (DC coupled. Add to main accuracy specs).

DC	±(50 ppmR+20 ppmFS+20 µV)
1 Hz-10 Hz	±(20 ppmR+50 ppmFS)
10 -40 Hz	±(20 ppmR)

CMRR: (1kΩ unbalance) >90dB at DC-60Hz.
Input Impedance: >1MΩ & 150 pF.
Input Protection: Withstands 1kV RMS on any range.
Crest factor: 5:1 at Full Range.
Max Volt-Hertz: 1 kV x 30 kHz
Settling Time: (To 100 ppm step size) <500ms (100Hz), <1.25s (40 Hz), <5s (10 Hz), <50s (1 Hz).
Read Rate: 1/s at 6 1/2 digits.

Spot Frequency AC Voltage:

Accuracy: 1 Year, 23°C ± 5°C, Signal >1%FS, ±(ppmR + ppmFS); Valid within ±10% of calibrated RMS value and Spot Frequency).

100 mV Range:	
40 Hz-10 kHz	100+10
10-30 kHz	150+25
30-100 kHz	500+100
1V to 100V Ranges:	
40 Hz-10 kHz	60+5
10-30 kHz	150+15
30-100 kHz	400+50
100-300 kHz	0.2%+0.05%
300 kHz-1 MHz	0.5%+0.3%
1000V Range:	
40 Hz-10 kHz	60+5
10-30 kHz	150+15
30-100 kHz	400+50

Resistance

Ranges: 10Ω to 1GΩ in decades.
FS: 2 x Full Range, 100% Overrange.
Resolution: 1 µΩ, 8 1/2 digits (Except 100 MΩ and 1 GΩ ranges).
Accuracy: 1 Year, 23°C ± 5°C, ±(ppmR + ppmFS):

10Ω Range:	12+1
100Ω to 10 kΩ Range:	8+0.3
100 kΩ Range:	6+0.2
1 MΩ Range:	10+0.7
10 MΩ Range:	20+4
100 MΩ Range:	200+45
1 GΩ Range:	0.2%+450

Open Circuit Voltage: <20V.
Lead Resistance: Up to 100Ω.

Current Through Unknown:	
10Ω and 100Ω	10 mA
1 kΩ	1 mA
10 kΩ and 10 0kΩ	100 µA
1 MΩ	10 µA
10 MΩ	1 µA
100 MΩ	100 nA
1 GΩ	10 nA

Input Protection: Withstands 250V RMS on any range.
Settling Time: Up to 100 kΩ generally the same as DCV.
Read Rate: 1/6s at 8 1/2 digits, 150/s at 4 1/2 digits

Low Current Resistance

Accuracy: 1 Year, 23°C ± 5°C, ±(ppmR + ppmFS):

10Ω to 1 kΩ Ranges:	12+1
10 kΩ Range:	15+1
100 kΩ Range:	70+3
1 MΩ Range:	400+10

Open Circuit Voltage: <0.2V.

Current Through Unknown:	
10Ω	10 mA
100Ω	1 mA
1 kΩ	100 µA
10 kΩ	10 µA
100 kΩ	1 µΩ
1 MΩ	100 nA

DC Current

Ranges: 100 µA to 1A in decades.
FS: 2 x Full Range. 100% Overrange.
Resolution: 100 pA, 6 1/2 digits.
Accuracy: 1 Year, 23°C ± 5°C, ±(ppmR + ppmFS):

100 µA to 10 mA Ranges:	25+2
100 mA Range:	50+5
1A Range:	150+10

AC Current

Ranges: 100 µA to 1A in decades.
FS: 2 x Full Range. 100% Overrange.
Resolution: 1 nA, 5 1/2 digits.
Accuracy: 1 Year, 23°C ± 5°C, ±(%R + %FS):

100 µA to 100 mA Range:	
40 Hz-5 kHz	200+100
1A Range:	
10 Hz-1 kHz	500+200
1-5 kHz	0.15%+0.04%

Frequency

Resolution: 4 1/2 or 6 1/2 digits.
Accuracy: (1 Year, 13°C to 33°C).
±10 ppmR + 2 digits (6 1/2 digits, 10 Hz - 1 MHz).
±2 digits (4 1/2 digits, 200 Hz - 1 MHz).
Sample Interval:
Fast Gate, 50 ms (4 1/2 digits).
Normal Gate, 1s (6 1/2 digits)

Ratio Accuracy

±(net signal accuracy + net reference accuracy).

GENERAL

Calibration: Selfcal internal calibration. Autocal external calibration from front panel or via IEEE-488 interface.
Remote Programming: IEEE-488.2
Environmental:
Operating temp: 0°C to +50°C.
Storage temp: -40°C to +70°C.
Dimensions: 88 mm (3.5 in.) high, 427 mm (16.8 in.) wide, 487 mm (19.2 in.) deep.
Weight: 13.5 kg (30 lb).
Power: 100-130 Vac or 200-260 Vac, 47 Hz-63 Hz, 37VA.

OPTIONS

10: True RMS AC Converter
20: 2-Wire and 4-Wire Resistance Converter
30: Current Converter. (Only available with Option 20)
70: Isolated Analog Output
80: 115V 60 Hz Line Operation
81: 115V 50 Hz Line Operation
90: Rack Mounting Kit

ACCESSORIES

1501: DMM Lead Kit

FACTORY/FOB

Indianapolis, IN & Norwich, England

ORDER INFORMATION

Model 1281
(Includes DCV, Ratio, Rear Inputs, IEEE-488.2, 1 Year Warranty)
Option 10
Option 20
Option 30
Option 70
Option 80
Option 81
Option 90
Accessory 1501

PRECISION DIGITAL MULTIMETERS

MODEL 1271

Selfcal Digital Multimeter

- **A DMM for the System Specialist**
- **Functional Capability & High Accuracy**
- **1000/sec, 5 1/2 Digit Readings**
- **IEEE 488.2 Compatible**
- **Outstanding Diagnostics**

The Datron 1271 is a Premium Digital Multimeter designed for the system specialist. It has a performance optimized for military and aerospace test applications and is a significant addition to the Datron Selfcal range of DMMs.

Premium Systems Performance
With DCV and IEEE-488 bus control fitted as standard, the model 1271 also offers individual Ohms, Ratio, DCI & ACI options and two versions of ACV to produce unrivalled combinations of performance and price.

High accuracy is provided across all functions, and with scale lengths from 5 1/2 to 8 1/2 digits and resolutions to 1 part in 200 million, a useful range of readrates is achieved.

With systems use firmly in mind, the 1271 incorporates a variety of dedicated facilities. Maths processing, reading storage and limit testing are available on all functions. Included with Ohms are active guarding, low source currents and true ohms modes, maintaining accuracy in difficult measurement applications.

Selfcal & Autocal
The high accuracy claims of the 1271 are supported by two independent calibration techniques, AUTOCAL and SELFCAL, both offering guaranteed traceability to provide the highest possible calibration confidence. Autocal provides for complete direct calibration against external certified standards. Selfcal, which relies only on internal standards, can be initiated at any time, and in a 10 minute sequence re-calibrates all functions and ranges.

Noise Rejection
Line related EMI can degrade the performance of any DMM's functions, and to combat this, the critical timing waveforms of the 1271 digitizer precisely sychronize with the frequency of the incoming power line. The effect of this line-locking is to present a deep and narrow 60 dB continuously tracking rejection notch at line frequency. In cases of excessive wideband noise, on DCV & Ohms where unstable readings could occur, a selectable 2 pole active filter can be introduced to provide a further 40 dB above line frequency.

Continuous Operation
The 1271 has been designed to withstand the rigors of continuous operation in military type environments.
With a tough exterior and rigid modular construction, the 1271 meets the environmental, reliability and maintainability requirements of MIL-T28800C (Type III, Class 5, Style E).

No exhaust fans or cooling inlets are used, and with the terminals retracted the enclosure is sealed and ideally suited for mobile activity. High level protection is fitted to all inputs, enabling 1kV RMS to be applied continuously on the most sensitive voltage ranges.

Exceptional Self - Test
The DMM is often the instrument most fundamental to the integrity of overall system performance. Of paramount importance therefore is the facility to conduct regular, fast and effective self-checks. In the 1271, full use has been

made of the SELFCAL source to provide early warning of potential problems by using a selectable two level diagnostic routine. First level checks monitor key circuit operation in a high speed, one minute sequence. The full test mode includes more that 250 checks at critical points in the 1271, and using the full accuracy of the SELFCAL calibrator, precise, accuracy checks are made on every function and range. As a final check, noise tests are conducted at all zero and cardinal points, and at any stage error codes are output to pinpoint failures or areas of weakness.

SPECIFICATIONS

DC Voltage

Ranges: 100 mV to 1000V in decades.
FS: 2 x Full Range. 100% Overrange. (Except 1kV range).
Resolution: 10 nV, 8 1/2 digits.
Accuracy: 1 Year, 23°C ± 5°C, ±(ppmR + ppmFS):

100 mV Range:	10 + 1
1V Range:	8 + 0.5
10V Range:	7 + 0.25
100V Range:	8 + 0.5
1000V Range:	10 + 1

CMRR: (1kΩ unbalance) >140 dB at DC, >(80 dBNMRR) at 1 Hz-60 Hz.
NMRR: 60 dB at line frequency (Filter out), add 40 dB at 50/60 Hz + 12dB/octave (Filter in).
Input Impedance: >10,000 MΩ from 100 mV to 10V ranges, 10 MΩ ±0.1% on 100V and 1000V ranges.
Input Protection: Withstands 1kV RMS on any range.
Input Current: <50 pA.
Settling Time: (To 10 ppm step size) <500 µs (Filter out), <500 ms (Filter in).
Read Rate: 3/s at 7 1/2 digits, 1000/s at 5 1/2 digits.

True RMS AC Voltage (High Speed)

Ranges: 100 mV to 1000V in decades.
FS: 2 x Full Range. 100% Overrange. (Except 1kV range).
Resolution: 100 nV, 6 1/2 digits.
Accuracy: 1 Year, 23°C ± 5°C, Signal >1%FS, ±(ppmR + ppmFS):

100 mV & 1000V Ranges:

40 Hz-2 kHz	250+70
2-20 kHz	400+120
20-100 kHz	0.16%+0.022%

1V to 100V Ranges:

40-20 kHz	200+50
20-100 kHz	0.1%+0.02%
100-300 kHz	1%+1%
300-1 MHz	2%+2%

Settling Time: (To 100 ppm step size) <30 ms (1 kHz), <100 ms (360 Hz).
Read Rate: 20/s at 6 1/2 digits.

True RMS AC Voltage (High Accuracy)

Ranges: 100 mV to 1000V in decades.
FS: 2 x Full Range. 100% Overrange. (Except 1kV range).
Resolution: 100 nV, 6 digits.
Accuracy: 1 Year, 23°C ± 5°C, Signal >1%FS, ±(ppmR + ppmFS):

100 mV Range:

40 Hz-10 kHz	100+20
10-30 kHz	300+40
30-100 kHz	700+100

1V to 100V Ranges:

40-100 Hz	80+10
100 Hz-2 kHz	60+10
2-10 kHz	80+10
10-30 kHz	200+20
30-100 kHz	500+100
100-300 kHz	0.3%+0.1%
300 kHz-1 MHz	1%+1%

1000V Range:

40 Hz-10 kHz	80+10
10-30 kHz	200+20
30-100 kHz	500+100

Settling Time: (To 100 ppm step size) <500 ms (100Hz), <1s (40 Hz), <5s (10 Hz), <50s (1Hz).
Read Rate: 1/s at 6 1/2 digits.
Lf Accuracy: (DC coupled. Add to main accuracy specs).

DC	±(50 ppmR+20 ppmFS+20 µV)
1 Hz-10 Hz	±(20 ppmR+50 ppmFS)
10-40 Hz	±(20 ppmR)

CMRR: (1kΩ unbalance) >90dB at DC-60Hz.
Input Impedance: >1 MΩ shunted by 150 pF.
Input Protection: Withstands 1kV RMS on any range.
Crest factor: 5:1 at Full Range.
Max Volt-Hertz: 1 kV x 30 kV.

Resistance

Ranges: 10Ω to 1GΩ in decades.
FS: 2 x Full Range, 100% Overrange.
Resolution: 1 µΩ, 8 1/2 digits (Except 100 MΩ and 1 GΩ ranges).
Accuracy: 1 Year, 23°C ± 5°C, ±(ppmR + ppmFS):

10Ω Range:	18+2
100Ω to 100 kΩ Range:	10+0.5
1 MΩ Range:	15+1
10 MΩ Range:	30+5
100 MΩ Range:	400+50
1 GΩ Range:	0.3%+500

Open Circuit Voltage: <20V.
Lead Resistance: Up to 100Ω.
Current Through Unknown:

10Ω and 100Ω	10 mA
1 kΩ	1 mA
10 kΩ and 100 kΩ	100 µA
1 MΩ	10 µA
10 MΩ	1 µA
100 MΩ	100 nA
1 GΩ	10 nA

Input Protection: Withstands 250V RMS on any range.
Settling Time: Up to 100 kΩ generally the same as DCV.
Read Rate: 3/s at 7 1/2 digits, 1000/s at 5 1/2 digits

DC Current

Ranges: 100 µA to 1A in decades.
FS: 2 x Full Range. 100% Overrange.
Resolution: 100 pA, 6 1/2 digits.
Accuracy: 1 Year, 23°C ± 5°C, ±(ppmR + ppmFS):

100 µA to 10 mA Ranges:	50+2
100 mA Range:	100+5
1A Range:	150+10

AC Current

Ranges: 100 µA to 1A in decades.
FS: 2 x Full Range. 100% Overrange.
Resolution: 1 nA, 5 1/2 digits.
Accuracy: 1 Year, 23°C ± 5°C, ±(%R + %FS):

100 µA to 100 mA Range:

40 Hz-5 kHz	200+100

1A Range:

10 Hz-1 kHz	500+200
1-5 kHz	0.15%+0.04%

Frequency

Resolution: 4 1/2 or 6 1/2 digits.
Accuracy: (1 Year, 13°C to 33°C).
±10 ppmR+2 digits (6 1/2 digits, 10 Hz - 1 MHz).
±2 digits (4 1/2 digits, 200 Hz - 1 MHz).
Sample Interval:
Fast Gate 50 ms (4 1/2 digits).
Normal Gate 1s (6 1/2 digits)

Ratio Accuracy

±(net signal accuracy + net reference accuracy).

GENERAL

Calibration: Selfcal internal calibration. Autocal external calibration from front panel or via IEEE-488 interface.
Remote Programming: IEEE-488.2
Environmental:
Operating temp: 0°C to +50°C.
Storage temp: -40°C to +70°C.
Dimensions: 88 mm (3.5 in.) high, 427 mm (16.8 in.) wide, 487 mm (19.2 in.) deep.
Weight: 13.5 kg (30 lb).
Power: 100-130 Vac or 200-260 Vac, 47 Hz-63 Hz, 37VA.

OPTIONS

10: True RMS High Speed AC Converter
12: True RMS High Accuracy AC Converter
20: 2-Wire and 4-Wire Resistance Converter
30: Current Converter. (Only available with Option 20)
40: Comprehensive Ratio
70: Isolated Analog Output
80: 115V 60Hz Line Operation
81: 115V 50Hz Line Operation
90: Rack Mounting Kit
Model 1271MT:
as 1271 mainframe with MATE (CIIL) Interface & including options 12,20,30,40, & 70

ACCESSORIES

1501: DMM Lead Kit

FACTORY/FOB

Indianapolis, IN & Norwich, England

ORDER INFORMATION

Model 1271
8 1/2 Digit SELFCAL Digital Multimeter (Includes DCV, Rear Input, IEEE-488.2, 1 Year Warranty)
Option 10
Option 12
Option 20
Option 30
Option 40
Option 70
Option 80
Option 81
Option 90
Model 1271MT
Accessory 1501

PRECISION DIGITAL MULTIMETERS

MODELS 1061A & 1062MT

Autocal Digital Multimeters

- **6 1/2 Digit Resolution**
- **90 Day DCV Specifications to ±28 ppm**
- **High Accuracy ACV Option**
- **IEEE-488 and MATE Models**
- **200 Readings/sec**

The 1061A/1062 series are accurate 6 1/2 digit DMMs optimized for systems applications, which also satisfy a wide range of bench and professional requirements.

Instrument Configurations
Maximum flexibility is assured by offering the 1061A as a DC voltmeter to which options may be added, giving it multifunction capability specific to the user's requirements. Optional functions include true rms ACV (normal or high accuracy versions), Resistance, Current, Ratio, and IEEE-488. The model 1062 is a fixed configuration version, featuring DCV, true rms ACV, Resistance, selectable rear inputs, and IEEE-488.

To fulfill MATE requirements, the 1062MT model offers DCV, true rms ACV, Resistance, selectable rear inputs and IEEE-488 as standard, and an optional Current converter furnishes DCI and ACI measurement capability. It provides the same specifications as the 1061A/1062, but for less stringent applications, a lower specified model, the 1062MT-5 is available.

Systems Capability
These DMMs when configured with an IEEE-488 interface are capable of meeting the most demanding systems applica-tions. With complete control available from the bus, and featuring a wide selection of SRQ and trigger modes, they can readily adapt to a wide variety of systems configurations. For the more exacting ATE applications, these DMMs provide an impressive selection of specialist features, including Ohms Guard for in-circuit resistance measurements, and excellent common mode and series mode rejection characteristics ensure that they maintain a high degree of measurement integrity under the most adverse conditions.

For users wishing to interface the 1061A into parallel BCD systems, a BCD Digital Interface can be fitted to a 5 1/2 digit version of the instrument known as the 1061. Full range and function programming is provided together with control of the DMM's triggering, while readings are output as BCD data together with full instrument status. With this interface fitted, the 1061 can achieve 30 readings per second with 5 1/2 digits resolution or up to 100 readings per second in 4 1/2 digit Superfast mode. In applications requiring more than one instrument on a common data bus, the BCD interface can be tri-stated to disconnect it from the system.

MATE Compatibility
The 1062MT is specifically designed for Modular Automated Test Equipment applications (MATE). Under the United States Air Force MATE System Control Interface Standard, this DMM is classed as a Sensor Module, type DMM, with a single measurement channel. The Control Interface Intermediate Language, CIIL, is used as the normal programming language, although native IEEE-488 bus commands may be used when required. The 1062-MT5 is a similar but less accurate version, please contact your Sales Office for specifications of this model.

High Reliability
In systems use, the high reliability and fast AUTOCAL features eliminate expensive downtime for repair and recalibration. In addition, an extensive diagnostic

self-check routine can be run on command to test measurement circuits, displays and the non-volatile calibration memory.

Computation
These DMMs are supplied with math functions which include offset and scaling, Max, Min, and Max-Min stores for capturing the largest excursions of a signal over a period of time, Hi and Lo limits for testing signals to predetermined limits, and dB conversion covering a dynamic range of ±200 dB to a resolution of 0.0001 dB.

DC Voltage
Ranges: 100 mV to 1000V in decades.
FS: 2 x Full Range. 100% Overrange. (Except 1 kV range).
Resolution: 100 nV, 6 1/2 digits.
Accuracy: 90 Days, 23°C ± 5°C, ±(ppmR + ppmFS):

100 mV Range:	30 + 8.
1V & 10V Ranges:	20 + 4.
100V Range:	30 + 4.
1000V Range:	30 + 4.

CMRR: (1kΩ unbalance) 140 dB at DC, >(80 dB + NMRR) at 1Hz - 60 Hz.
NMRR: 66 dB at 50/60 Hz (Filter out), 100 dB at 50/60 Hz (Filter in).
Input Impedance: >10,000 MΩ from 100 mV to 10V ranges, 10 MΩ ±0.1% on 100V and 1000V ranges.
Input Protection: Withstands 1kV RMS on any range.
Input Current: <50 pA.
Settling Time: (To 10 ppm step size) <5 ms (Filter out), <350 ms (Filter in).
Read Rate: 1.5/s at 6 1/2 digits, 200/s in Super-fast mode, 4 digits.
True RMS AC Voltage.
Ranges: 100 mV to 1000V in decades.
FS: 2 x Full Range. 100% Overrange. (Except 1kV range).
Resolution: 1 µV, 5 1/2 digits.
Accuracy: 90 Days, 23°C ± 5° C, Signal >0.25%FS, ±(%R + %FS):
100 mV and 1000V Ranges

45 Hz - 5 kHz:	0.08 + 0.02.
5 kHz - 100 kHz:	0.2 + 0.05.

1V to 100V Ranges

45 Hz - 5 kHz:	0.04 + 0.01.
5 kHz - 100 kHz:	0.1 + 0.025.

CMRR: (1kΩ unbalance) >90 dB at DC -60 Hz.
Input Impedance: >1 MΩ & 150 pF.
Input Protection: Withstands 1kV RMS on any range.
Crest factor: 7:1 at Full Range.
Max Volt-Hertz: 1 kV x 20 kHz.
Settling Time: (To 0.1% step size) <500 ms (Filter in), <150 ms (Filter out).
Read Rate: 3/s.

High Performance True RMS ACV
Resolution: 100 nV, 6 1/2 digits.
Accuracy: 90 Days, 23°C ± 5°C, Signal >1%FS, ±(%R + %FS):
100 mV and 1000V Ranges

45 Hz - 2 kHz:	0.04 + 0.007.
2 kHz - 30 kHz:	0.08 + 0.015.
30 kHz - 100 kHz:	0.2 + 0.022.

Add 0.01% per 100V above 500V.
1V to 100V Ranges

45 Hz - 2 kHz:	0.025 + 0.005.
2 kHz - 30 kHz:	0.05 + 0.01.
30 kHz - 100 kHz:	0.1 + 0.02.

Ranges, FS, CMRR, Input Impedance, Input Protection, Max Volt/Hertz:
All as Option 10.
Crest Factor: 5:1 at Full Range.
Settling Time: (To 0.1% step size) <200 ms (Filter out), <1.25 ms (Filter in).

Resistance
Ranges: 10Ω to 10 MΩ in decades.
FS: 2 x Full Range, 100% Overrange.
Resolution: 10 µΩ, 6 1/2 digits.
Accuracy: 90 Days, 23°C ± 5° C, ±(ppmR + ppmFS):

10Ω Range:	40 + 8.
100Ω to 10 kΩ Range:	30 + 4.
100 kΩ Range:	40 + 4.
1 MΩ Range:	100 + 4.
10 MΩ Range:	300 + 4.

Open Circuit Voltage: <10V.
4-wire Lead Resistance: Up to 100Ω.
Current Through Unknown:

10Ω	10 mA
100Ω	10 mA
1 kΩ	1 mA
10 kΩ	100 µA
100 kΩ	10 µA
1 µΩ	1 µA
10 MΩ	100 nA

Input Protection: Withstands 250V RMS on any range.
Settling Time: Up to 10 kΩ generally the same as DCV.
Read Rate: As DCV.

DC Current
Ranges: 100 µA to 1A in decades.
FS: 2 x Full Range. 100% Overrange.
Resolution: 1 nA, 5 1/2 digits.
Accuracy: 90 Days, 23°C ± 5°C, ±(ppmR + ppmFS):
100 µA to 100 mA Ranges: 100 + 20.
1A Range: 200 + 20.
Shunt Resistance:

100 µA	1kΩ
1 mA	100Ω
10 mA	10Ω
100 mA	1Ω
1A	100 mΩ

Settling Time: (To 10 ppm of step size) <5 ms (Filter out), <350 ms (Filter in).
Read Rate: as DCV.

AC Current
Ranges: 100 µA to 1A in decades.
FS: 2 x Full Range. 100% Overrange.
Resolution: 1nA, 5 1/2 digits.
Accuracy: 90 Days, 23°C ± 5°C, ±(%R + %FS):
100µA to 1A Ranges:
45 Hz - 5 kHz 0.2 + 0.05
Shunt Resistance: as DCI.
Settling Time: (To 0.1% of step size) <150 ms (Filter out), <500 ms (Filter in).
Read Rate: As ACV.
Ratio Accuracy:
±(net signal accuracy + net reference accuracy).

GENERAL
Calibration: Autocal from front panel or via the IEEE-488 interface.
Remote Programming:
IEEE-488, MATE on MT models.
BCD (1061 Only)
Environmental:
Operating Temp: 0°C to +50°C.
Storage Temp: -40°C to +70°C.
Dimensions: 88 mm (3.5 in.) high, 455 mm (17.9 in.) wide, 420 mm (16.5 in.) deep.
Weight: 10 kg (22 lb.).
Power: 105-127 Vac or 205-255 Vac, 50 Hz, 60 Hz, or 400 Hz. 20 Watts approx.

CONFIGURATIONS
Model 1061A: 6 1/2 Digit AUTOCAL Digital Multimeter (includes DCV, 5 Year Warranty).
Model 1061: 5 1/2 Digit AUTOCAL Digital Multimeter (includes DCV, 5 Year Warranty).
Model 1062: (U.S. only) 6 1/2 Digit AUTOCAL Digital Multimeter (includes DCV, ACV, Resistance, rear input, IEEE-488, 1 Year Warranty).
Model 1062/12: (U.S. only) 6 1/2 Digit AUTOCAL Digital Multimeter (includes DCV, High Performance ACV, Resistance, rear input, IEEE-488, 1 Year Warranty).
Model 1062-MT: as 1062 with MATE interface.
Model 1062-MT5: contact Sales Office.

OPTIONS
10: True RMS AC Converter
12: High Performance True RMS AC Converter
20: 2-wire and 4-wire Resistance Converter
30: Current Converter (Not available with Option 12)
40: Comprehensive Ratio and Rear Input
41: Selectable Rear Input (Included with Option 40)
50: IEEE-488 (1978) Standard Digital Interface
51: BCD Digital Interface (1061 only. Not available with Option 50)
52: Remote Trigger (Included in Option 50)
70: Analog Output
80: 115V 60 Hz Line Operation
81: 115V 50 Hz Line Operation
82: 115V 400 Hz Line Operation
90: Rack Mounting Kit

ACCESSORIES
1501: DMM Lead Kit

FACTORY/FOB
Indianapolis, IN & Norwich, England

ORDER INFORMATION
Model 1061A
Model 1061
Model 1062
Model 1062/12
Model 1062MT
Option 10
Option 12
Option 20
Option 30
Option 40
Option 41
Option 50
Option 51
Option 52
Option 70
Option 80
Option 81
Option 82
Option 90
Accessory 1501

Calibrators

The Datron Instruments Autocal family of calibrators and automated calibration systems leads the world in innovative calibration technology, providing an unparalleled choice of functional capability and performance. Together with Datron's calibration software, controllers, accessories and support products, the Autocal range offers a selection of high quality instruments and systems with a variety of different specifications and costs. From this range, the optimum solution can be found to most digital multimeter (DMM) calibration requirements, together with high accuracy system source and DC to Low Frequency Standards applications. Datron calibrator performances vary from the Standards Laboratory accuracy of a multifunction calibrator capable of calibrating today's highly accurate 7 1/2 and 8 1/2 digit DMMs, to one similar in appearance and functionality, but with a performance and price which is ideally suited to handheld and 3 1/2 and 4 1/2 digit DMM calibration requirements. Functionally, the number of options within the complete calibrator range is virtually limitless, varying from dedicated DCV-only or ACV-only units, suitable for standards laboratory or systems use, to calibrators which are fully multifunction: single instruments with the flexibility of functions and the breadth of range in both amplitude and frequency to fulfill the ever more stringent demands of the modern calibration facility. Practical and straightforward to use on the bench, all Datron Autocal calibrators are fully programmable via the IEEE-488 interface, making them excellent sources for automated calibration systems. In addition, the wide temperature tolerance of these instruments extends their usefulness to many A.T.E. or systems applications outside the calibration laboratory, for example, on the production floor or in the factory test bay. Datron Calibration Software is available to enhance these features, offering a range of fully integrated, menu driven, automated multimeter calibration systems either for use in the traditional calibration environments, or for more demanding mobile calibration roles. A superb range of complementary DC Standards equipment provides users with levels of accuracy, traceability and reliability which meet the most demanding calibration requirements.

BENCHTOP CALIBRATION SYSTEMS

Software	Calibrator	Controller	Printer	Analog Leads	IEEE Leads	Pg.	
4101B	4708, 4700, 4705	IBM-XT, HP Vectra (4103A) or Compaq (4103B)	4104	PLK-2	2	155	
4101B	4708, 4700, 4705 with 4600 amplifier	IBM-XT, HP Vectra (4103A) or Compaq (4103B)	4104	PLK-2 440151 440154	2	155	

Note: Printer includes printer interface cable

CALIBRATION SUPPORT PRODUCTS

Model No.	Description	pg.	
4901 Calibration Bridge and Lead Compensator	Calibrates each section of the divider to the very highest precision, using ratio techniques approved by National Standards authorities.	157	
4902S Reference Divider	True 4 wire, 5 terminal resistive divider capable of providing 10:1 and 100:1 ratio accuracies, with a 100V or 1000V input, to within 0.2 ppm.	157	
4904 Standard Cell Buffer	Low noise, low drift unity gain amplifier, with four wire remote sensing to drive Kelvin-Varley type dividers, featuring full protection for the Standard Cell.	157	
4910 DC Voltage Reference Standard	Four independent 10V output 'cells' in one unit, each adjustable to <0.1 ppm resolution. Four wire sensed buffer, and adjustable outputs at the 1.018V and 1V levels.	156	
4911 DC Voltage Reference Standard	As for 4910 but excluding the four wire buffer and 1.018, 1V outputs.	156	

PROGRAMMABLE CALIBRATORS SELECTION GUIDE

Model No.	Basic Functions	Optional Functions	Display Resolution	Ranges	Basic Accuracy 90 day, ±1°C ±(ppmR + ppmFS)	Frequency Span	Comments	Pg.	
4708	Fully configurable: IEEE-488	DCV, ACV, DCI, ACI and Ω	7 1/2 6 1/2	DCV: 100 µV-1 kV ACV: 1 mV-1 kV DCI: 100 µA-1A ACI: 100 µA-1A Ω: 10Ω-100 MΩ	1 + 0.15 30 + 5 20 + 5 70 + 30 3	10 Hz-1 MHz 10 Hz-5 kHz	For calibration of up to 8 1/2 digit DMMs 4101B compatible 4600 compatible	140	
4700	DCV & ACV to 200V, IEEE-488	1kV ranges DCI, ACI and Ω	7 1/2 6 1/2	DCV: 100 µV-1 kV ACV: 1 mV-1 kV DCI: 100 µA-1A ACI: 100 µA-1A Ω: 10Ω-100 MΩ	4 + 0.5 120 + 20 40 + 7 220 + 80 6	10 Hz-1 MHz 10 Hz-5 kHz	For calibration of up to 6 1/2 DMMs digit 4101B compatible 4600 compatible	142	
4705	DCV, ACV, DCI, ACI, Ω, IEEE-488	None	6 1/2 5 1/2	DCV: 100 µV-1 kV ACV: 1 mV-1 kV DCI: 100 µA-1A ACI: 100 µA-1A Ω: 10Ω-100 MΩ	15 + 1 250 + 50 50 + 15 220 + 80 6	10 Hz-100 kHz 10 Hz-5 kHz	For calibration of up 5 1/2 digit DMMs 4101B compatible 4600 compatible	144	
4600	DCI, ACI	None	-	DCI: 0-11A ACI: 90 mA-11A	50 + 25 200 + 55	10 Hz-20 kHz	Transconductance amp for high currents	146	

MODEL 4708

Multifunction Standard

- **DCV, ACV, DCI, ACI and Ω Functions**
- **True 1kV AC Performance from a Single Unit**
- **Configurable to Meet Individual Requirements**
- **IEEE-488, Autocal, 4101B and 4600 Compatible**
- **Calibrates DMMs of up to 8 1/2 Digit Scale Length**

The model 4708 Autocal Multifunction Standard offers the very best in programmable multifunction performance. Capable of calibrating—BY ITSELF—the latest generation of high performance systems and standards DMMs, it represents the most practical and cost-effective solution to today's high accuracy calibration requirements.

DC Voltage
With outputs available from 10 nV to 1100V, and 90 day, ±1°C specifications to 1 ppm, the DC Voltage function offers performance unrivalled by any other instrument. This performance extends to high linearity and low noise, essential when calibrating 7 1/2 and 8 1/2 digit DMMs, while the fast settling times inherent in the signal generation techniques employed make the instrument ideal for automated applications.

AC Voltage
The AC Voltage function also offers unmatched performance and functional capability, offering 90 day, ±1°C specifications to 30 ppm with 65 mA of current drive available on the 1000V range. In practice this means that the high voltage-high frequency test requirements of today's DMMs may be met by one single, compact unit, the 4708 driving up to 750V at 100 kHz.

A 'Spot' frequency calibration feature can be used to eliminate the flatness component of the accuracy specification, providing enhanced accuracy at up to five user selected frequency points per range, for both ACV and ACI functions.

The internal AC-DC transfer is accomplished by a fully electronic technique, which offers faster settling times than traditional thermal techniques. These settling times are also independent of signal level, a most desirable feature in automated applications.

Resistance and Current
Fully floating, high accuracy DC and AC currents are generated using a voltage to current converter which incorporates specially developed low loss shunts and is driven from either the DCV or ACV sections of the calibrator. For applications that require higher currents, such as the calibration of handheld multimeters, the model 4600 Transconductance Amplifier extends the current function to 11A. Resistance outputs are derived from eight fixed value, hermetically sealed standard resistors, each being 4-wire or 2-wire connected to the output terminals, using ultra high isolation relay switches.

Flexibility and Ease of Use
The IEEE-488 interface is fitted as standard, enabling the 4708 to form the heart of a compact and highly accurate calibration or test system, while its rugged construction and insensitivity to temperature variations make it ideal for

applications outside of the traditional calibration environment. It is compatible with the Datron 4101B Multimeter Calibration software package, a combination which forms an automated calibration system capable of calibrating anything from simple handheld multimeters up to the most sophisticated Standards DMMs.

Calibration

The Model 4708 employs Autocal, the electronic adjustment technique whereby all calibration adjustments are made through the use of digital corrections stored in non-volatile memory. The instrument is calibrated by applying the standard and following a simple sequence of front panel keystrokes or IEEE-488 bus commands. Moreover, the signal generation circuit configuration employed during calibration is the same as that used during normal operation, ensuring fast, traceable, repeatable calibration.

SPECIFICATIONS

DC Voltage (Option 10)

Ranges: 100 µV to 1000V in decades.
Full scale: 2 x range except 1000V range, where max output is 1100V.
Resolution: 1 digit in 19,999,999 or 10 nV, whichever is greater.
Accuracy: 90 days, 23°C ±1°C: ±(ppm Output + ppmFS)

100 µV to 100 mV Ranges: 3 + 0.4 µV

1V Range:	2 + 0.4
10V Range:	1 + 0.15
100V Range:	2 + 0.25
1000V Range:	3 + 0.25

Sensing: Selectable remote/local sensing on 1V to 1000V ranges.
Guarding: Selectable remote/local guarding.
Settling Time: <1 s to 10 ppm of step size.
Output Impedance/Max Output Current:
100 µV to 100 mV Ranges: 100Ω.
1V to 1000V Ranges: 25 mA max.

AC Voltage (Option 20)

Ranges: 1 mV to 1000V in decades.
Full Scale: 2 x range except 1000V range, where max output is 1100V.
Resolution: 1 digit in 1,999,999 or 100 nV, whichever is greater.
Frequency: Ranges: 100 Hz to 1 MHz in decade steps. Resolution: 1% of range. Accuracy: <±100 ppm.
Sensing: Selectable remote/local sensing on 1V to 1000V ranges.
Guarding: Selectable remote/local guarding.
Maximum Capacitive load: 1000 pF on 1V to 100V ranges, 300 pF on 1000V range.
Wideband Accuracy: 90 days, 23°C ± 1°C: ±(ppm Output + ppmFS)

1 mV to 100 mV Ranges

110 + 20 + 5 µV:	(10 - 31 Hz)
60 + 20 + 5 µV:	(32 - 330 Hz)
50 + 20 + 5 µV:	(300 Hz - 10 kHz)
60 + 20 + 5 µV:	(10k - 33 kHz)
250 + 20 + 5 µV:	(30k - 100 kHz)
750 + 50 + 10 µV:	(100k - 330 kHz)
1550 + 500 + 20 µV:	(300k - 1 MHz)

1V and 10V Ranges

80 + 15:	(10 - 31 Hz)
40 + 10:	(32 - 330 Hz)
30 + 5:	(300 Hz - 33 kHz)
60 + 10:	(30k - 100 kHz)
180 + 50:	(100k - 330 kHz)
1100 + 200:	(300k - 1 MHz)

100V Range

90 + 15:	(10 - 31 Hz)
50 + 10:	(32 - 330 Hz)
40 + 5:	(300 Hz - 10 kHz)
50 + 10:	(10k - 33k Hz)
90 + 15:	(30k - 100 kHz)
280 + 50:	(100k - 200 kHz)

1000V Range

130 + 10:	(45 - 330 Hz)
90 + 10:	(300Hz - 10 kHz)
130 + 10:	(10k - 33 kHz)
750 + 20:	(750V max, 30k - 100 kHz)

Settling Times: To 100 ppm of step size: <10s (10-32 Hz), <3 s (33-330 Hz), <1 s (>330 Hz).

DC Current (Option 30)

Ranges: 100 µA to 1A in decades.
Full scale: 2 x range.
Resolution: 1 digit in 1,999,999 or 100 pA, whichever is greater.
Accuracy: 90 days, 23°C ± 1°C: ±(ppm Output + ppmFS)

100 µA Range:	50 + 10
1 mA Range:	20 + 5
10 mA Range:	20 + 5
100 mA Range:	20 + 5
1A Range:	50 + 10

10A Range (Requires Model 4600): 50 + 25
Guarding: Selectable remote/local guarding.

AC Current (Option 30)

Ranges: 100 mA to 1A in decades.
Full Scale: 2 x range.
Resolution: 1 digit in 1,999,999 or 100 pA, whichever is greater.
Accuracy: 90 days, 23°C ± 1°C: ±(ppm Output + ppmFS).

100 µA Range

120 + 30:	(10 Hz - 1 kHz)
250 + 40:	(1 k - 5 kHz)

1 mA Range

70 + 30:	(10 Hz - 1 kHz)
120 + 30:	(1k - 5 kHz)

10 mA Range

70 + 30:	(10 Hz - 1 kHz)
120 + 30:	(1k - 5 kHz)

100 mA Range

70 + 30:	(10 Hz - 1 kHz)
120 + 30:	(1k - 5 kHz)

1A Range

250 + 30:	(10 Hz - 1 kHz)
400 + 40:	(1k - 5 kHz)

10A Range (Requires Model 4600):

280 + 70:	(10 Hz - 1 kHz)
730 + 75:	(1k - 5 kHz)

Guarding: Selectable remote/local guarding.

Resistance (Option 30)

Ranges: 10Ω to 100 MΩ in decades. (Ranges are nominal, actual calibrated values are displayed).
Connections: Selectable 2 or 4-wire, remote/local guard.
Display Resolution: 1 digit in 19,999,999.
Accuracy: 90 days, 23°C ± 1°C: ±(ppm Output):

10Ω:	10
100Ω, 1 kΩ, 10 kΩ, 100 kΩ:	3
1 MΩ:	10
10 MΩ:	25
100 MΩ:	30

GENERAL

Calibration: Autocal from front panel or via the IEEE-488 interface.
Environmental:
Operating Temp: 0°C to +50°C.
Storage Temp: -40°C to +70°C.
Dimensions: 178 mm (7 in.) high; 455 mm (17.9 in.) wide; 563 mm (22.2 in.) deep.
Weight: 36 kg (80 lb.) net.
Power: 100/120/220/240 Vac ±10%, 50 Hz or 60 Hz. Consumption 370 VA standby, 660 VA full power.

OPTIONS

10: DCV Ranges.
20: ACV Ranges.
30: DCI, ACI and Resistance Ranges (requires Option 10, or 20, or both).
42: Alternative Rear Output.
80: 115V 60Hz line operation.
81: 115V 50Hz line operation.
90: Rack Mounting Ki'

FACTORY/FOB

Indianapolis, IN & Norwich, England

ORDER INFORMATION

Model 4708
Option 10
Option 20
Option 30
Option 42
Option 80
Option 81
Option 90

Multifunction Calibrator

- **DCV, ACV, DCI, ACI and Ω Functions**
- **True 1kV AC Performance from a Single Unit**
- **Configurable to Meet Individual Requirements**
- **IEEE-488, Autocal, 4101B and 4600 Compatible**
- **Calibrates DMMs of up to 6 1/2 Digit Scale Length**

Over 90% of the typical calibration facility DMM workload consists of a range of instruments varying in performance and capabilities from simple handheld multimeters to the latest generation of mid-performance 5 1/2 and 6 1/2 digit systems DMMs. For these instruments, the model 4700 offers the most cost-effective calibration solution available, providing the necessary performance at an economic price.

DC and AC Voltage

The standard instrument will source DC voltages from 10 nV to 200V with 90 day, ±1°C specifications to 4 ppm, which provides a sufficient margin of accuracy over the latest generation of mid-performance half and full rack systems DMMs. With AC voltages from 90 mV to 200V to within 120 ppm, the 4700 is capable of calibrating all but the most accurate AC-measuring meters. The output capability of both functions may be extended to 1100V by the high voltage option. This is resident within the calibrator which is then capable of sourcing, from a single, compact unit, the high voltage-high frequency test points required by today's systems DMMs.

Resistance and Current

Fully floating, high accuracy DC and AC currents are generated using a voltage to current converter which incorporates specially developed low loss shunts and is driven from either the DCV or ACV sections of the calibrator. For applications that require higher currents, such as the calibration of handheld multimeters, the model 4600 Transconductance Amplifier extends the current functions to 11A. Resistance outputs are derived from eight fixed value, hermetically sealed standard resistors, each being 4-wire or 2-wire connected to the output terminals, using ultra high isolation relay switches.

Flexibility and Ease of Use

A major design objective of the 4700 was to make it simple and straightforward to operate. Rapid rolling up/down keys are used for fast and easy setting of amplitude and frequency. The selected output is displayed on a high brightness display, while the patented spec. readout feature eliminates the need to make complex and tedious calculations of the accuracy of the applied signal. Deviation controls—Error and Offset—enable the output of the calibrator to be varied from that indicated on the main output display, useful for checking the linearity and calibration of measuring instruments.

The 4700 is not limited to applications inside the calibration laboratory. Its rugged construction and insensitivity to temperature variations (specifications are available for 23°C ± 10°C operation) mean that the instrument is equally suited to applications outside of the traditional calibration environment. As an accurate test source or stimulus, the 4700 provides a highly cost effective solution to meet the growing requirements in A.T.E.s for improved test accuracy and confidence. For example, the basic 4700—without any options—can

be installed as an integral source within an ATE rack to provide accurate, stable, programmable DC and AC voltages up to 200V.

In addition, the instrument is compatible with the Datron 4101B Multimeter Calibration software package. Together, the 4700 (optionally configured with the model 4600) and 4101B can form the basis of a compact, rugged and highly versatile automated calibration system capable of calibrating any multimeter from simple handhelds up to 5 1/2 and 6 1/2 digit systems DMMs.

SPECIFICATIONS

DC Voltage

Ranges: 100 µV to 1000V in decades.
Full scale: 2 x range except 1000V range, where max output is 1100V.
Resolution: 1 digit in 19,999,999 or 10 nV, whichever is greater.
Accuracy: 90 days, 23°C ±1°C: ±(ppm Output + ppmFS)

100 µV to 100 mV Ranges:	6 + 0.8 µV
1V Range:	6 + 0.8
10V Range:	4 + 0.5
100V Range:	6 + 1.0
1000V Range (Option 10):	6 + 0.5

Sensing: Selectable remote/local sensing on 1V to 1000V ranges.
Guarding: Selectable remote/local guarding.
Settling Time: <1s to 10 ppm of step size.
Output Impedance/Max output current: 100 µV to 100 mV ranges: 100Ω.
1V to 1000V range: 25 mA max.

AC Voltage

Ranges: 1 mV to 1000V in decades.
Full scale: 2 x range except 1000V range, where max output is 1100V.
Resolution: 1 digit in 1,999,999 or 100 nV, whichever is greater.
Frequency: Ranges: 100 Hz to 1 MHz in decade steps. Resolution: 1% of range. Accuracy: <±100 ppm.
Sensing: Selectable remote/local sensing on 1V to 1000V ranges.
Guarding: Selectable remote/local guarding.
Maximum Capacitive Load: 1000 pF on 1V to 100V ranges, 300 pF on 1000V range.
Accuracy: 90 days, 23°C ± 1°C: ±(ppm Output + ppmFS)
1 mV to 100 mV Ranges

10 to 31 Hz:	250 + 60 + 10 µV
32 Hz to 33 kHz:	200 + 40 + 10 µV
30k to 100 kHz:	600 + 60 + 10 µV
100k to 330 kHz:	0.2% + 0.02% + 20 µV
300k to 1 MHz:	0.6% + 0.2% + 30 µV

1V and 10V Ranges

10 to 31 Hz:	200 + 40
32 Hz to 33 kHz:	120 + 20
30k to 100 kHz:	200 + 30
100k to 330 kHz:	600 + 200
300k to 1 MHz:	0.4% + 0.1%

100V Range

10 to 31 Hz:	200 + 40
32 Hz to 33 kHz:	120 + 20
30k to 100 kHz:	250 + 40

1000V Range (Option 10)

45 to 330 Hz:	200 + 50
300 Hz to 10 kHz:	150 + 50
10k to 33 kHz:	250 + 50

Settling times: To 100ppm of step size.

10 to 32 Hz:	<10s
33 to 330 Hz:	<3s
>330 Hz:	<1s

DC Current (Option 20)
Ranges: 100 µA to 1A in decades.
Full scale: 2 x range.
Resolution: 1 digit in 1,999,999 or 100pA, whichever is greater.
Accuracy: 90 days, 23°C ±1°C: ±(ppm Output + ppmFS)

100 µA Range:	50 + 10
1 mA Range:	40 + 7
10 mA Range:	40 + 7
100 mA Range:	40 + 7
1A Range:	100 + 15
10A Range: (Requires Model 4600):	60 + 25

Guarding: Selectable remote/local guarding.

AC Current (Option 20)
Ranges: 100 µA to 1A in decades.
Full scale: 2 x range.
Resolution: 1 digit in 1,999,999 or 100 pA, whichever is greater.
Accuracy: 90 days, 23°C ± 1°C: ±(ppm Output + ppmFS)

100 µA Range

10 Hz to 1 kHz:	400 + 80
1k to 5 kHz:	550 + 100

1 mA Range

10 Hz to 1 kHz:	220 + 80
1k to 5 kHz:	350 + 80

10 mA Range

10 Hz to 1 kHz:	220 + 80
1k to 5 kHz:	350 + 80

100 mA Range

10 Hz to 1 kHz:	220 + 80
1k to 5 kHz:	350 + 80

1A Range

10 Hz to 1 kHz:	400 + 80
1k to 5 kHz:	550 + 100

10A Range: (Requires Model 4600):

10 Hz to 1 kHz:	400 + 95
1k to 5 kHz:	820 + 90

Guarding: Selectable remote/local guarding.

Resistance (Option 20)
Ranges: 10Ω to 100 MΩ in decades (Ranges are nominal, actual calibrated values are displayed).
Connections: Selectable 2 or 4-wire, remote/local guard.
Display resolution: 1 digit in 19,999,999.
Accuracy: 90 days, 23°C ± 1°C: ±(ppm Output):

10Ω:	20
100Ω, 1 kΩ, 10 kΩ, 100 kΩ:	6
1MΩ:	20
10MΩ:	50
100MΩ:	100

GENERAL
Calibration: Autocal from front panel or via the IEEE-488 interface.
Environmental
Operating Temp: 0° to +50°C.
Storage Temp: -40°C to +70°C.
Dimensions: 178 mm (7 in.) high, 455 mm (17.9 in.) wide, 563 mm (22.2 in.) deep.
Weight: 36 kg (80 lb).
Power: 100/120/220/240 Vac ±10%, 50 Hz or 60 Hz. Consumption 370 VA standby, 660 VA full power.

OPTIONS
10: 1000V Ranges for DCV and ACV
20: DCI, ACI and Ω
42: Alternative Rear Output
80: 115V 60Hz line operation.
81: 115V 50Hz line operation.
90: Rack Mounting Kit

FACTORY/FOB
Indianapolis, IN & Norwich, England

ORDER INFORMATION
Model 4700
Option 10
Option 20
Option 42
Option 80
Option 81
Option 90

MODEL 4705

Multifunction Calibrator

- **DCV, ACV, DCI, ACI and Ω Functions as Standard**
- **ACV Output from 10 Hz to 100 kHz**
- **True 1kV AC Performance from a Single Unit**
- **IEEE-488, Autocal, 4101B and 4600 Compatible**
- **Calibrates DMMs of up to 5 1/2 Digit Scale Length**

The model 4705 is a low cost, fully multifunction, programmable calibrator which has all functions fitted as standard. It is designed to calibrate DMMs of up to 5 1/2 digit scale length without the addition of external performance enhancement techniques, such as the use of a standards DMM to monitor the output.

An IEEE-488 interface is fitted as standard, so the unit can readily be integrated into a cost effective automated calibration system. Furthermore, its rugged construction makes it ideal for applications outside of the calibration laboratory, while its insensitivity to temperature variations ensures that a minimal loss of accuracy is experienced when the unit is installed in an A.T.E. rack.

DC and AC Voltage
The 4705 is capable of sourcing continuously variable DC voltages from 100 nV to 1100V with 90 day, ±1°C specifications to 15 ppm, and so has a comfortable margin of calibration accuracy over those 5 1/2 digit DMMs and below that constitute 80% of the typical calibration laboratory DMM workload. The outputs are truly bipolar, which removes the need for an operator to change test lead connections when a change of polarity is required.

AC voltages are available from 90 mV to 1100V, at frequencies continuously variable between 10 Hz and 100 kHz, with 90 day, ±1°C specifications to 250 ppm. The solid state 1000V range drive circuitry is integral to the unit, and is able to drive a capacitive load of 300 pF. This means that all of the high voltage-high frequency test points required by today's 4 1/2 to 5 1/2 digit bench and lower performance systems instruments may be sourced by a single, compact unit.

Resistance and Current
The 4705 will source continuously variable DC and AC currents to 2A, with 90 day, ±1°C specifications to 50 ppm and 220 ppm respectively. For applications that require higher currents, such as calibration of handheld multimeters, the model 4600 Transconductance Amplifier extends the current function to 11A. The resistance function makes resistances between 10Ω and 100 MΩ available, in both 2 and 4-wire configurations, with 90 day, ±1°C specifications to 6ppm.

Flexibility and Ease of Use
A major design objective of the 4705 was to make it simple and straightforward to operate. Rapid rolling up/down keys are used for fast and easy setting of amplitude and frequency. The selected output is displayed on a high brightness display, while the patented spec. readout feature eliminates the need to make complex and tedious calculations of the accuracy of the applied signal. Deviation controls—Error and Offset—enable the output of the calibrator to be varied from that indicated on the main output display, useful for checking the linearity and calibration of measuring instruments.

MODEL 4705

In addition, the instrument is compatible with the Datron 4101B Multimeter Calibration soft-ware package. Together, the 4705 (optionally configured with the model 4600) and 4101B can form the basis of a compact, rugged, cost-effective and highly versatile automated calibration system capable of calibrating any multimeter from simple handhelds up to 5 1/2 digit systems DMMs.

SPECIFICATIONS

DC Voltage

Ranges: 100 µV to 1000V in decades.
Full scale: 2 x range except 1000V range, where max output is 1100V.
Resolution: 1 digit in 1,999,999 or 100 nV, whichever is greater.
Accuracy: 90 day, 23°C ± 1°C: ±(ppm Output + ppmFS)

100 mV to 100 mV Ranges:	15 + 1 µV
1V Range:	15 + 1
10V Range:	15 + 1
100V Range:	15 + 1
1000V Range:	15 + 1

Sensing: Selectable remote/local sensing on 1V to 1000V ranges.
Guarding: Selectable remote/local guarding.
Settling Time: <1s to 10 ppm of step size.
Output Impedance/Max output current:
100 mV to 100 mV ranges: 100Ω .
1V to 1000V ranges: 25 mA max.

AC Voltage

Ranges: 1 mV to 1000V in decades.
Full scale: 2 x range except 1000V range, where max output is 1100V.
Resolution: 1 digit in 199,999 or 1 µV, whichever is greater.
Frequency: Ranges: 100 Hz to 1 MHz in decade steps. Resolution: 1% of range. Accuracy: <±100 ppm.
Sensing: Selectable remote/local sensing on 1V to 1000V ranges.
Guarding: Selectable remote/local guarding.
Maximum Capacitive load: 1000 VpF on 1V to 100V ranges, 300 VpF on 1000V range.
Accuracy: 90 day, 23°C ± 1°C: ±(ppm Output + ppmFS)

1 mV to 100 mV Ranges:

300 + 60 + 10 µV	(10 - 31 Hz)
250 + 60 + 10 µV	(32 Hz - 33 kHz)
800 + 80 + 10 µV	(30k - 100 kHz)

1V, 10V, 100V Ranges:

300 + 60	(10 - 31 Hz)
250 + 50	(32 Hz - 33 kHz)
300 + 80	(30k - 100 kHz)

1000V Range:

300 + 60	(45 - 330 Hz)
250 + 50	(300 - 10 kHz)
300 + 80	(10k - 33 kHz)

Settling times: to 100 ppm of step size: <10s (10-32 Hz), <3s (33-330 Hz), <1s (>330 Hz).

DC Current

Ranges: 100 mA to 1A in decades.
Full scale: 2 x range.
Resolution: 1 digit in 199,999 or 1 nA, whichever is greater.
Accuracy: 90 days, 23°C ± 1°C: ±(ppm Output + ppmFS)

100 µA, 1 mA, 10 mA and 100 mA Ranges:	50 + 15
1A Range:	115 + 20
10A Range (Requires Model 4600):	65 + 25

Guarding: Selectable remote/local guarding.

AC Current

Ranges: 100 µA to 1A in decades.
Full scale: 2 x range.
Resolution: 1 digit in 199,999 or 1 nA, whichever is greater.
Accuracy: 90 days, 23°C ± 1°C: ±(ppm Output + ppmFS)

100 µA Range:

400 + 80	(10 Hz - 1 kHz)
550 + 100	(1k - 5 kHz)

1 mA, 10 mA and 100 mA Ranges:

220 + 80	(10 Hz - 1 kHz)
350 + 80	(1k - 5 kHz)

1A Range:

400 + 80	(10 Hz - 1 kHz)
550 + 100	(1k - 5 kHz)

10A Range: (Requires Model 4600)

500 + 115	(10Hz - 1 kHz)
950 + 120	(1k -5 kHz)

Guarding: Selectable remote/local guarding.

Resistance

Ranges: 10Ω to 100 MΩ in decades (Ranges are nominal, actual calibrated values are displayed).
Connections: Selectable 2 or 4-wire, remote/local guard.
Display resolution: 1 digit in 1,999,999.
Accuracy: 90 days, 23°C ± 1°C: ±ppm Output:

10Ω	30
100Ω, 1 kΩ, 10 kΩ & 100 kΩ	6
1MΩ	25
10MΩ	100
100MΩ	125

GENERAL

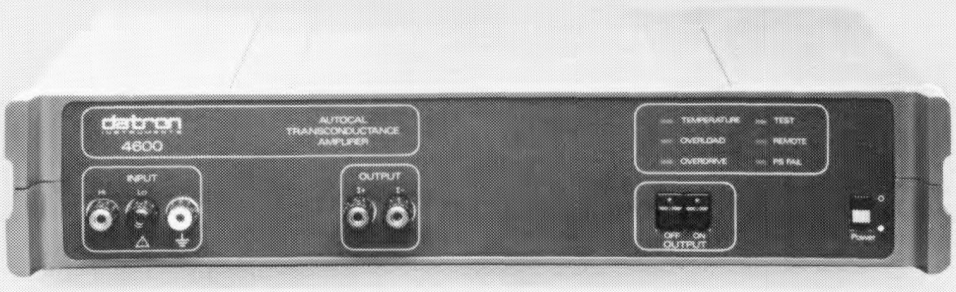
Calibration: Autocal from front panel or via the IEEE-488 interface
Environmental:
Operating temp: 0°C to +50°C.
Storage temp: -40°C to +70°C.
Dimensions: 178 mm (7 in.) high; 455 mm (17.9 in.) wide; 563 mm (22.2 in.) deep.
Weight: 36 kg (80 lb).
Power: 100/120/220/240 Vac ±10%, 50 Hz or 60 Hz. Consumption 370 VA standby, 660 VA full power.

OPTIONS

42: Alternative Rear Output
80: 115V 60 Hz Line Operation
81: 115V 50 Hz Line Operation
90: Rack Mounting Kit

FACTORY/FOB
Indianapolis, IN & Norwich, England

ORDER INFORMATION
Model 4705
Option 42
Option 80
Option 81
Option 90



Transconductance Amplifier

- **Extends Calibrator Currents to 11A DC & AC rms**
- **Slave Mode Programmable from 4708, 4700 &4705**
- **Solo Mode Operation for General Application**
- **AC Performance from 10 Hz to 20 kHz**

A significant proportion of lower performance bench and handheld DMMs are capable of measuring currents of 10A or more. In the interests of traceability and operator safety, these instruments require calibration at these higher current levels. The model 4600 Transconductance Amplifier provides a rugged, compact solution, capable of extending the current sourcing capabilities of Datron Calibrators to 11A DC or rms AC, and may also be used with other suitable voltage sources. When used with a compatible model 4708, 4700 or 4705, it provides a fully integrated solution, being transparently controlled by the calibrator.

Solo Mode
Working on the principle of converting a voltage input to a current output, the 4600 has a transfer characteristic of 1 Amp per Volt for both DC and AC, and may be coupled to any appropriate voltage source. With 90 day, ±1°C specifications of the order of 100 ppm for DC currents and 300ppm for AC, a sufficient margin of calibration accuracy is assured over the performance of bench and handheld DMMs.

Slave Mode
When used with a compatible model 4708, 4700 or 4705, two cables connect the Transconductance Amplifier to the Calibrator. The first is fully shielded and carries the analog voltage from the rear panel of the Calibrator to the 4600's rear panel, while a digital cable carries control signals between them. The 10A range of the Calibrator is automatically enabled when the 4600 is present, and the user is then able to program the required current output from the Calibrator's front panel, or remotely via its IEEE-488 interface.

Calibration
For use in the solo mode, where the Calibrator has no control over the amplifier, there are a series of easily accessible trimpots to allow periodic recalibration of the 4600's circuitry. The slave mode, however, eliminates the need for any mechanical adjustments during the recalibration process, as it utilizes the Autocal technique resident within Datron Calibrators.

SPECIFICATIONS

DC CURRENT

Accuracy Relative to Voltage Source:
90 days, 23°C ± 1°C:
±(50 ppm Output + 500 µA).
Temperature Coefficient (23°C ± 10°C):
7 ppm/°C.
Compliance: >2V.

AC CURRENT

Accuracy Relative to Voltage Source:
90 days, 23°C ± 1°C:
10 Hz - 1 kHz: ±(200 ppm Output + 1.1 mA)
1 kHz - 5 kHz: ±(700 ppm Output + 1.4 mA)
5 kHz - 10 kHz: ±(1400 ppm Output + 6 mA)
10 kHz - 20 kHz: ±(0.54% Output + 33 mA)
Temperature Coefficient (23°C ± 10°C)**:**
< 5 kHz: 10 ppm/°C; >5 kHz: 50 ppm/°C
Total Harmonic Distortion:
0.1% (10 Hz-1 kHz); 0.5% (1k-5 kHz);
1.0% (5k-10 kHz); 1.5% (10k-20 kHz).
Compliance: >2Vrms.
Scale Length: 9% to 110% of range.

GENERAL

Compatibility: Slave Mode compatible with all 4700 series calibrators equipped with firmware of issue 5.0 and above.
Input Impedance: 300 kΩ & 100 pF.
Isolation: 100V pk, I- to Chassis.
Output Protection: Fully protected against open circuit outputs.
Input Protection: 1.1kV DC or rms AC (10 sec), 240V DC or rms AC (continuous).
Calibration: Trimpots (Solo mode), Autocal from front panel or IEEE-488 interface of host calibrator (Slave mode).
Environmental:
Operating temperature: 0°C to +50°C.
Storage temperature: -40°C to +70°C.
Dimensions: 89 mm (3.5 in.) high; 455 mm (17.9 in.) wide; 420 mm (16.5 in.) deep.
Weight: 10 kg (22 lb).
Power: 100/120/220/240 VAC ± 10%, 50 or 60 Hz. Consumption 200W.

OPTIONS & ACCESSORIES

80: 115V 60 Hz Line Operation.
81: 115V 50 Hz Line Operation.
90: Rack Mounting Kit.
440151: Slave Mode Lead Kit.
440154: Current Output Lead Kit.

FACTORY/FOB
Indianapolis, IN & Norwich, England

ORDER INFORMATION
Model 4600
Options 80, 81
Option 90
Accessory 440151
Accessory 440154

Multimeter Calibration Systems

- **Calibrates Any Type of DMM or Analog Meter**
- **Comprehensive Menu Driven Structure**
- **Runs on IBM PC-XT, HP Vectra, Compaq Portable**
- **Extensive Inventory Management Capabilities**
- **Compatible With All Datron Calibrators**

The 4100 PORTOCAL series of multimeter calibration systems offers a selection of high quality systems configured with Datron calibrators, calibration software and accessories. All 4100 systems are supplied with 4101B Portocal Multimeter Calibration Software, a powerful and flexible package which is totally menu driven, and compatible with all Datron calibrators, IBM PC-XT, HP Vectra, and Compaq Portable II controllers.

4101B Software

The Portocal software is a self-contained package resident in its own subdirectory on the hard disk, allowing the controller to be used for tasks other than calibration. It is designed to maximize the effectiveness of the Datron Autocal range of calibrator hardware, and to guide the user in developing and controlling the calibration process, while providing, through the use of passwords, protection against unauthorized modification of any of the calibration procedures or historical data stored on the system.

Its use is not confined to IEEE-488 controllable DMMs. In fact all types of DMMs may be calibrated, from instruments that incorporate some method of electronic calibration such as Autocal, to instruments that are controllable over the IEEE-488 interface but are manually calibrated, to completely manually controlled and calibrated instruments.

Easy to Use

Ease of use is a prime feature of Portocal which, being menu driven, does not require the user to be familiar with instrument controllers or their languages.

Model 4101B Software

Program Size: 1.8 MBytes approx.
Max Number of Calibration Procedures: 999.
Typical Procedure File Size: 10 kBytes.
Max Number of Certificate Designs: 20.
Typical Certificate File Size: 8 kBytes.
Capacity of Instrument Inventory: 32,000.
Typical Instrument File Size: 120 Bytes.
Disk Operating System: PC-DOS 3.0 or later, MS-DOS 3.1 or later.

CONTROLLER CONFIGURATIONS

These are the controller configurations that will support the 4101B software package:
IBM PC-XT
Parallel Printer Adaptor
CGA Color Card
Color Monitor
Keyboard
IBM PC-DOS (3.0 or later)
IBM Basic
Ziatech ZT1488A & zSBX20 Interface Cards (Datron Part 440127-1)

Model 4103A:
HP Vectra ES Model 26 (D1226A)
14 In. Enhanced Monitor (D1182B)
MSDOS 3.3 PAM (45951 DU)
GW Basic (HP45952A)
Ziatech ZT1488A and zSBX20 Interface Cards (Datron Part 440127-1)

Model 4103B
Compaq Portable II Model 3
MS-DOS (3.1 or later).
Basic Interpreter
Ziatech ZT1488A and zSBX20 Interface Cards (Datron Part 440127-1)

Model 4104
Epson Printers: FX80 and FX800 series.

Model 4112 CALIBRATION CART
Includes all power distribution and cabling.

OPTIONS & ACCESSORIES

440127-1: Ziatech ZT1488A and zSBX20 Interfaces
PLK-2: Analog Benchtop Lead Kit. For 4700 Series Configurations.
440154: 11A Current Lead Kit. For use in systems containing model 4600.
400277-0.5: 0.5m IEEE Cable
400277-1: 1m IEEE Cable
400277-2: 2m IEEE Cable

FACTORY/FOB
Indianapolis, IN & Norwich, England

ORDER INFORMATION
Model 4101B
Model 4103A
Model 4103B
Model 4104
Model 4112
Accessory 440127-1
Accessory PLK-2
Accessory 400277-0.5
Accessory 400277-1
Accessory 400277-2
Accessory 440154

MODELS 4910 & 4911

DCV References

- **The First Real Alternatives to the Weston Cell**
- **Four Truly Independent 10 Volt Output "Cells"**
- **Hardware Averaging yields 1ppm/year Stability**
- **Overall <0.05ppm/°C for 0° to 40°C Operation**
- **4910 offers Divided Outputs, Buffered Output**
- **7 Day, Protected Battery Backup Transit Mode**

The models 4910 and 4911 are the ultimate in Electronic DC Voltage Reference Standards, establishing a performance benchmark for the assessment of other devices. Offering the traditional benefits of electronic references - ruggedness and ease of use - they are the first solid state devices available featuring sufficient stability to replace the Weston Cell as a company prime DC Voltage Reference Standard.

Versatile Architecture
Both the 4910 and 4911 offer four truly independent 10V output "cells", each possessing its own power supplies and control circuits, allowing direct intercomparison between the output terminals in order to detect and evaluate drift in any cell. Each cell's total independence means that errors arising from circuit elements are uncorrelated and therefore detectable. The output of each cell is adjustable with <0.1 ppm resolution, so that they may be calibrated to nominal to allow intercomparisons with a very high level of accuracy.

The four 10V cells may be selectively averaged in hardware giving a significant benefit in long term stability and short term noise when compared with the output of just one cell. The 10V average output provides the ideal low noise reference against which individual cells may be compared, and in the 4910, is permanently connected to the input of a four wire sensed buffer capable of sourcing 15 mA for driving an accurate voltage into a load without compensations. Cells included within the average group are identified by a front panel LED indicator.

Each cell's independence also allows higher voltages to be obtained by "stacking" cells, to provide up to 40V from one unit.

Model 4910 also offers adjustable outputs at the 1V and 1.018V levels.

Transit Mode
4910/11 feature fully monitored and protected battery backup systems, which can maintain integrity for 7 days. Charging circuitry is integral. Auxiliary inputs allows the use of 10 - 40VDC power.

SPECIFICATIONS

Stability, ppm (±1°C)

	30 days	90 days	1 year
10V Average	0.3	0.8	1.0
10V Cell	0.3	1.0	1.5
4-wire buffer*	0.3	1.0	1.5
1.018V*, 1V*	0.6	1.5	2.0

Temperature Coefficient (0°C - 50°C)

10V Average & Cell	0.05 ppm/°C
4-wire buffer*	0.06 ppm/°C
1.018V*	0.10 ppm/°C
1V*	0.12 ppm/°C

Noise, 0.01Hz - 2Hz

10V Average	0.02 ppm RMS
10V Cell	0.04 ppm RMS
4-wire buffer*	0.03 ppm RMS
1.018V*, 1V*	0.10 ppm RMS

Output Resistance/Protection

4-wire buffer*	<100 μΩ
4-wire buffer* will drive to 15 mA	
Other outputs	100Ω

Outputs withstand indefinite shorts, transients to 1100V (to 25 mA).

Setting Resolution

10V Cell	<±0.1 ppm
1.018V*, 1V*	<±0.2 ppm

GENERAL

Environmental
Operating temperature: 0°C to +40°C
Storage temperature: -40°C to +50°C

Dimensions
177 mm (7") high 214 mm (8.5") wide, 591 mm (23.3") depth

Weight: 20Kg (44 lbs)

Power
Line: 100V, 120V, 220V, 240V ±10%, 47-63 Hz, consumption <40VA.
Low voltage input: 10V - 40 Vdc.
Battery Backup, Transit Mode, 7 days at 25°C, to 4 days at 0°C, ambient.

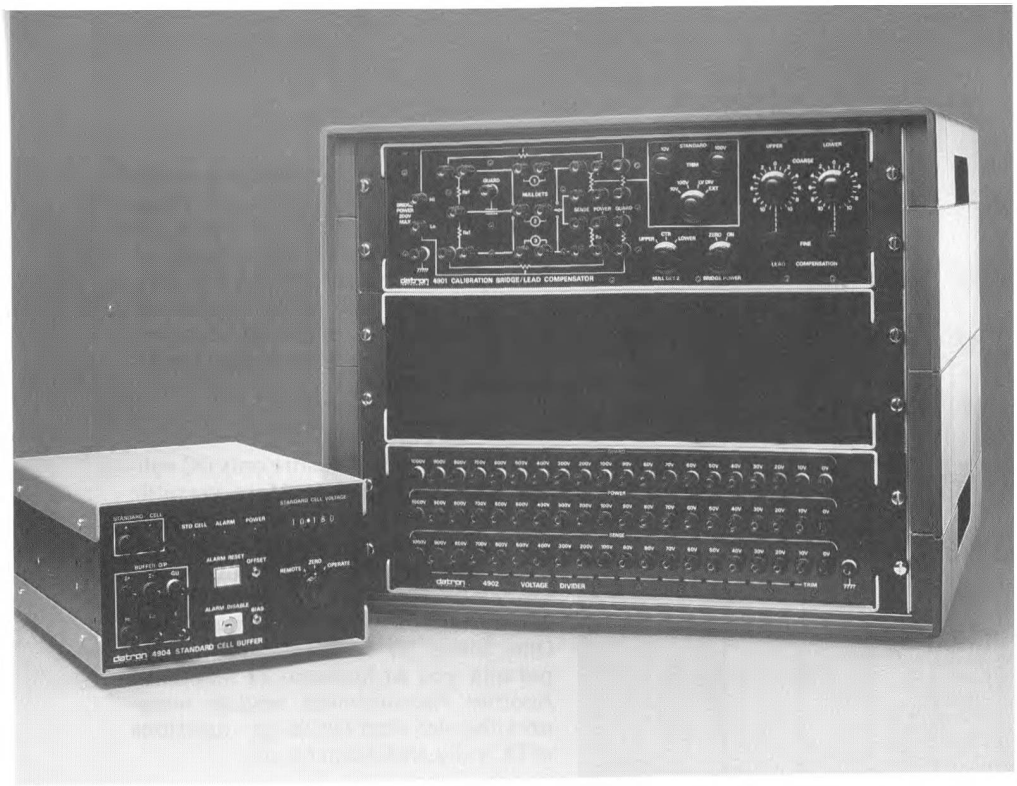
*(*Not applicable to 4911)*

OPTIONS

- **10: Calibration and hot shipment**
- **20: Drift rate characterization (must be ordered with Option 10)**
- **30: 1.018V set to requested level (must be ordered with Opt. 10)**
- **40: Ruggedized Transit Case**
- **50: Soft Carrying Case**
- **90: Rack Mount Kit**

FACTORY / FOB
Indianapolis, IN &
Norwich, England

ORDER INFORMATION
Model 4910
Model 4911
Option 10
Option 20
Option 30
Option 40
Option 50
Option 90



DC Standards

- **4901 Bridge and Lead Compensator**
- **4902S Reference Divider**
- **4904 Standard Cell Buffer**

4902S Reference Divider and 4901 Calibration Bridge
The design and construction of the 4902S Divider and its companion Calibration Bridge (4901) significantly reduces or eliminates the sources of error in traditional divider designs, and is fully capable of providing 10:1 and 100:1 ratio accuracies, with a 100V or 1000V input, to within 0.2 ppm.

The 4902S is a true 4 wire, 5 terminal resistive divider. Each tapping is fully guarded by a companion guard chain, eliminating leakage errors. The guard shield for each tapping is accessible to the user on the front panel, so that effective guard connections can be made to the source of the measured signal. Each resistor element has a maximum of 10V applied to it, so that voltage coefficients and self / mutual heating effects are negligible, ensuring rapid settling times.

The 4901 Calibration Bridge and Lead Compensator is used to calibrate each section of divider to the very highest precision, using ratio techniques approved by National Standards authorities. Calibration of the individual elements of the 4902S at the voltage used during normal operation takes self heating, power and voltage coefficients into account, enabling the unit's 0.2 ppm ratio accuracy.

SPECIFICATIONS (4902S)
Ratio Accuracy: 24 hours, ±1°C, assuming calibration with model 4901 Calibration Bridge: 0.2 ppm (1000:10 and 100:10).
Temperature Coefficient: <0.5 ppm/C.

GENERAL
Environmental: As 4904.
Dimensions: 132 mm (5.25 in.) high; 433 mm (17 in.) wide; 327 mm (12.9 in.) deep.
Weight: 5 kg (11 lb).

SPECIFICATIONS (4901)
Environmental: As 4904.
Dimensions & Weight: As 4902S.

4904 Standard Cell Buffer
This device allows the user to take the accuracy of his sensitive Weston Standard Cells out of the standards laboratory, even onto the production floor, while providing protection against accidental damage by inexperienced operators. It is a low noise, low drift, unity gain amplifier with a 4-wire remote sense output stage so that it may drive Kelvin-Varley type dividers. During operation, it performs a comprehensive sequence of self tests to ensure that all of the internal circuitry is functioning correctly. On detection of an error condition, it immediately disconnects the Standard Cell, and audible and visual alarms signal the user.

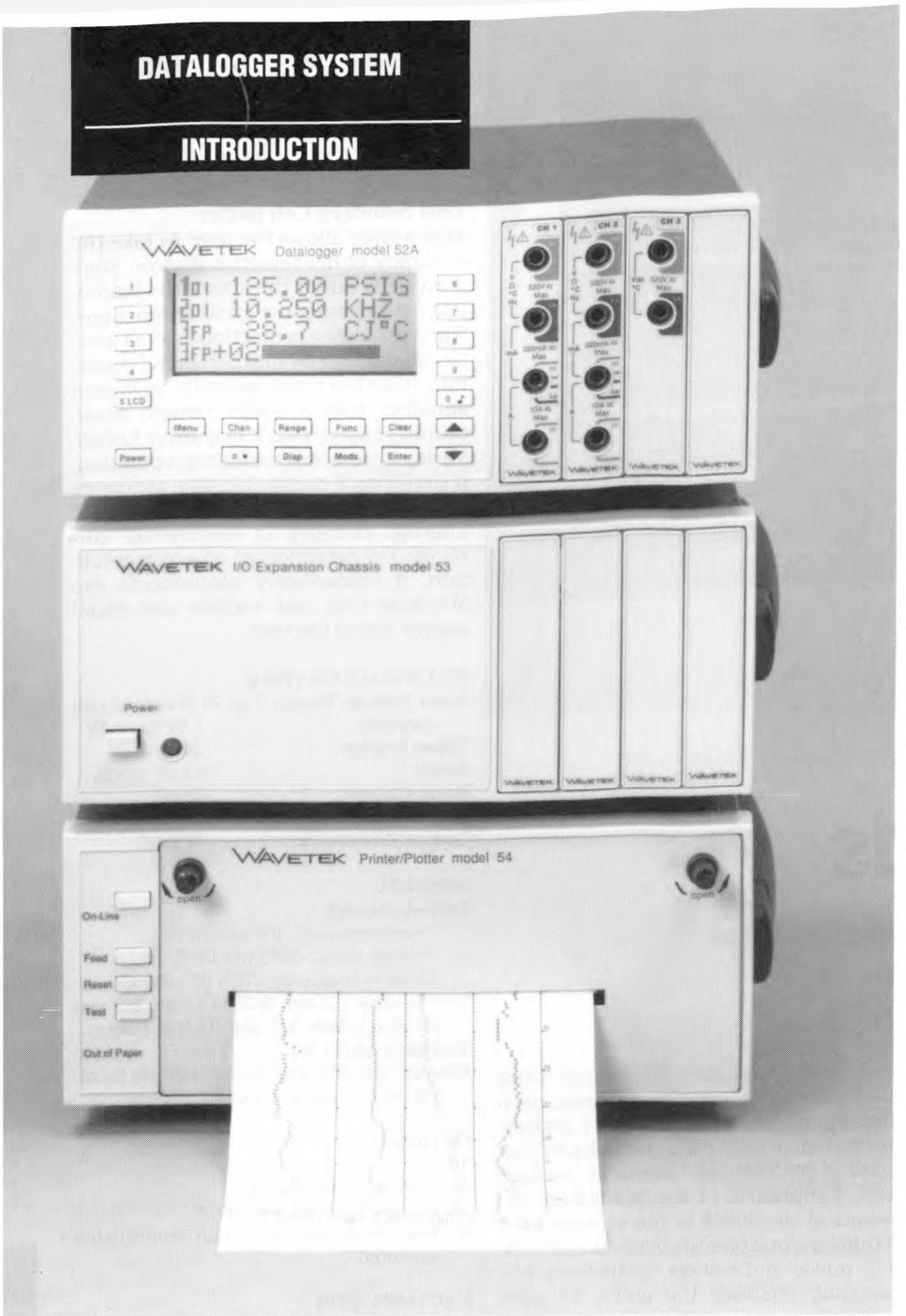
SPECIFICATIONS (4904)
Input Voltage Range: 1 to 10 Standard Cell outputs: 1.0V to 10.2V.
Offset Voltage: <0.1 µV.
Noise: 0.3 µV pk-pk.
Input Current: <5 pA.
Output Current: 15 mA.
Output Resistance: <0.1 mΩ.

GENERAL
Environmental:
Operating temp: 0°C to +30°C.
Storage temp: -40°C to +70°C.
Relative Humidity: <75% (0°- +30°C).
Dimensions: 132 mm (5.25 in.) high; 222 mm (8.75 in.) wide; 327 mm (12.9 in.) deep.
Weight: 5 kg (11 lb).
Power: 100/120/220/240 Vac ±10%, 50 Hz or 60 Hz. Consumption 8VA.

OPTIONS
10:
20: System Cabinet (6U)
30: System Lead Kit for 4902S
90: Rack Mounting Kit. Specify model being mounted.

FACTORY/FOB
Indianapolis, IN & Norwich, England

ORDER INFORMATION
Model 4901
Model 4902S
Model 4904
Option 20
Option 30
Option 90



Datalogger System

Dataloggers
A datalogger is an instrument or system capable of making one or more measurements over a period of time and storing the results for later recall and analysis. Some dataloggers include built-in clocks to turn themselves on and off at preselected times. Alarms are often included in order to indicate out-of-the ordinary conditions and to provide conditional programming. Dataloggers should be capable of operating as a self-contained unit, as opposed to data acquisition systems which require connections to computers or controllers. Wavetek's Series 50 Datalogger System meets all these requirements.

Versatile Configurations
Dataloggers with a wide variety of options and accessories permit you to buy only what is needed for the system, this results in considerable cost savings. The Series 50 Datalogger System consists of over 13 items that can be mixed and matched to meet your system requirements.

Multiple A/Ds
Modern multifunction dataloggers utilize an A/D converter to convert measured values into digital data which can be processed, stored, and displayed. Multiple A/Ds permit several measurement channels with simultaneous display of values. The Series 50 offers two different types of A/D converters (measurement modules).

Numerous Functions
Most dataloggers measure only DC voltage and temperature. More versatile dataloggers will measure AC voltages, current, resistance, frequency, period, event counting, pulse width, time interval and power. This type of datalogger gives you more measurement flexibility. One Series 50 measurement module permits you to measure 24 functions. Another measurement module measures the standard datalogger functions of DC volts and temperature.

Broad Ranges
To complement the numerous functions, a datalogger must have broad measurement ranges. Autoranging is a very desirable feature. Each function of the Series 50 measurement modules covers a wide variety of ranges. Most functions include autoranging.

Expanded Inputs
Multiplexers expand a datalogger's input capacity. Multiplexers for dataloggers come with a variety of ranges and channels. The Series 50 offers three different multiplexers; two multiplexers are part of a Model 53 Expansion Chassis and a third multiplexer is a stand-alone module. The Series 50 allows you to combine multiplexers to measure up to 260 inputs.

Time Control
Datalogger internal real-time clocks allow measurement programs to start and stop automatically at real or delta times and at preset intervals. The Series 50 allows you to do this and more.

Mathematical Operations
The ability to perform an internal mathematical operation on a channel or between channels without the use of an external computer can be a real asset. For example, this feature allows current and voltage readings to be multiplied together. The result can be displayed or stored. Another application would be to scale the output of a pressure transducer using a user-defined equation to display and store the actual physical parameter, such as psi. The Series 50 permits you to create up to 99 mathematical operations which can be used for interchannel calculations or to modify a single channel's reading.

INTRODUCTION

Data Storage
A datalogger's memory must be large enough to store all the data. Some dataloggers allow for internal memory expansion. The Series 50 can store up to 12,000 readings. Using combinations of the two memory expansion boards, you can increase the systems memory capacity to 1 megabyte, which stores up to 100,000 readings.

Data Displayed
Some form of local data display other than a printer is often useful. The Series 50 contains a dot-matrix LCD which permits four lines of alphanumeric or bargraph data to be displayed simultaneously.

Alarm Functions
Dataloggers should have an adequate number of individually programmable alarms, each with its own set of alarm thresholds and responses. The Series 50 permits you to program up to 99 alarm setups. Each alarm has its own set of conditions, setpoints, and responses.

Control of Events
Dataloggers with digital and analog output allow control of events based on measurements. For example, this type of datalogger could monitor the temperature in an oven. When the oven temperature exceeds a preset temperature limit, the datalogger digital output shuts off the oven. Series 50 digital I/O cards provide you with eight digital lines for event control, plus an analog output voltage, which can be used as a tracking output.

Portable
Many applications for dataloggers require operation in the field. The Series 50 can operate from low DC or AC voltages, or an optional internal battery which allows you to take your datalogger system into the field.

Interfaces
It is often necessary to operate a datalogger with a computer in order that data be down loaded on-line or from memory to the computer. RS-232C and IEEE-488 are typical interfaces. An interface also allows an external printer to be used with the datalogger. The Series 50 Model 52A Datalogger contains a built-in RS-232C interface, plus you can add another RS-232C or an IEEE-488 interface.

Series 50 Datalogger System
The Series 50 Datalogger System constitutes a complete datalogging system of up to 260 channels. The series can include:

Model 52A Mainframe,
Option 50-1 Full Function Measurement Module,
Option 50-2 DC Volts and Temperature Measurement Module,
Option 50-11 Rechargeable Battery,
Option 50-12A-128K and -256K Expansion RAM,
Option 50-13A IEEE-488 GPIB Interface,
Option 50-14 Digital I/O/Analog Output,
Accessory 50-31 Digital I/O/Analog Output Breakout Module,
Option 50-15 Second RS-232C Serial Port,
Accessory 50-20 8/16 Channel High Voltage Multiplexer,
Model 53 I/O Expansion Chassis,
Option 53-1 32/64 Channel Multiplexer,
Option 53-2 16/32 Channel Multiplexer.

All these models, options, and accessories can be configured in several different ways to form a Series 50 Datalogger System. The following table illustrates four typical system configurations. All Series 50 Datalogger Systems must include the Model 52A Mainframe. The numbers in the configuration table tell you the quantity of that option or accessory that is installed for the example configuration. Also, the table tells you where to find more information on the item.

Typical Configurations A, B, C, and D

Components	A	B	C	D	Featured on Page
Model 52A Mainframe	1	1	1	1	160
Option 50-1 Module, Full Function	4		1	1	161
Option 50-2 Module, DC/Temp		4			161
Option 50-11 Rechargeable Battery	1	1	1	1	163
Option 50-12A-256 RAM	2	2	1		163
Option 50-13A GPIB	1				163
Option 50-14 Digital I/O & Analog Out	1				163
Option 50-20 Multiplexer	16	1	4	1	163
Option 53-2: 16/32 Channel Mux (300V Max)	1	1	1		163
Option 53-1: 32/64 Channel Mux (3.2V Max)		8			164
Model 54 Printer/Plotter	1	1	1		164
No. of Channels (Differential)	260	260	33	9	
No. of Stored Readings	512K	512K	256K	128K	

Datalogger

- **More Measurement Functions and Wider Dynamic Range**
- **Up to a Megabyte of RAM**
- **Four Isolated A/D Converters**
- **Ultimate in Portability**
- **Powerful Programming**

Model 52A Datalogger combines the features of up to four digital multimeters with full-featured datalogging/data acquisition capability. Each measurement channel contains a fully isolated dual slope analog-to-digital converter. Each input is expandable with multiplexers to provide up to 260 channels, any four of which can be displayed at one time. Data on the high resolution liquid-crystal display can be shown in alphanumeric and bar graph form. All standard multimeter functions such as resistance and DC and true rms AC voltage and current are included, in addition to special measurement functions such as temperature, frequency, period, pulse width, time interval, volt-amperes, dB, continuity, and diode checking. Built-in math functions compute and display delta, delta %, minimum, maximum, or average values. Complex functions between channels may be calculated with user-defined math. Unique Closed-Box "Flex-Cal" automatic calibration allows calibration at any value.

Standard datalogging capability allows all measured data to be stored in internal RAM memory. Optional memory expansion to over 1 Megabyte permits storage of over 100,000 measurements. Stored data can be sent to any computer via the standard RS-232 C interface. An IEEE-488 interface is also available. Nested menus, channel list programming and a real time clock facilitate selection of functions, ranges, start and stop conditions, scan intervals, delays, alarms, etc. A digital I/O option which is combined with an analog output feature is also available for closed-loop and tracking applications.

All this measurement and data logging capability is contained in a very small portable package. The Model 52A can be operated from a vehicle battery or any other low-voltage AC or DC source. An internal rechargeable battery option provides even more versatility.

Datalogging Functions
The Model 52A can gather data continuously or at user defined scan intervals. Data is logged into memory or sent out the Comm port (either RS-232 C or IEEE-488). All setups are menu driven and no programming language is required.

Channel Lists
A group of channels are organized into "Channel Lists" that predefine channel function, range, and any modifiers such as deltas, alarms, averaging, etc. Each channel list is assigned up to an eight character name for later recalling. Channels can be entered individually or as groups. Channel lists are used in the program mode to define what data is logged.

Programs
Programs are defined as frameworks for datalogging. A program consists of a user defined program name, a start condition, a scan interval, a stop condition, an end condition and one or more channel lists.

Monitor Modes

The monitor mode defines what the Datalogger does in between scans. There are three monitor modes available:

- Display the time until the next scan.
- Power-down between scans to con serve battery life.
- Run a monitor channel list.

Printer Formatting

Model 52A can format print to provide alphanumeric, bargraph, strip-chart or XY plotting. The 52A provides control of readings/line (1 to 99) and lines/page (1 to 255 or continuous). One or two columns of data per line can be printed on the Model 54 Printer/Plotter. Four columns of data per line can be printed on an 80-column printer. Each data field is 20 characters wide. Headers and footers can be programmed. Control characters can be included in headers and footers.

Plotting

Model 52A combined with Model 54 Printer/Plotter can plot up to 16 channels simultaneously in 1, 2 or 4 "plot windows" to provide strip chart recorder capability. Each channel can have a unique plot symbol and independent plot scale values. Time stamping of plots is easily added and full annunciation of channel function, scaling and plot symbols is provided at the beginning of each plot. XY plots can be generated with stored data from up to 16 channel pairs, each of which can have up to 65,535 data points plotted.

Measurement Module

Up to four Measurement Modules can be installed in the Datalogger. Each module provides one set of front-panel input connectors and one pair of rear-panel multiplex input connectors. Auto-ranging is standard.

Two Measurement Module versions are available:

50-1: All specifications and functions listed below apply.

50-2: A lower-cost module limited to DC volts and temperature functions.

Accuracy specifications are for 1 year with an operating temperature of 18°C to 28°C (64°F to 82°F) and a relative humidity of 80% or less.

DC VOLTS

Resolution and Accuracy:

Range	Resolution For Digits Displayed 2.5	3.5	4.5	Accuracy ±(% of Rdg +% of Rng)	Input Impedance
30mV	0.1mV	10µV	1µV	0.04 + 0.02	>1000MΩ
300mV 3V	1mV 10mV	100µV 1mV	10µV 100µV	0.04 + 0.005	10MΩ±1% ||<50 pF
30V 300V	100mV 1V	10mV 100mV	1mV 10mV		

Resolution vs Data Rate and Noise Rejection (1kΩ Unbalance):

Display Mode	50-60 Hz NMR	60 Hz ECMR	50 Hz ECMR	Data Rate
4.5 digits	70 dB	150 dB	145 dB	5/sec
3.5 digits	50 dB	130 dB	125 dB	12/sec
2.5 digits	50 dB	130 dB	125 dB	12/sec

Max Input Voltage: ±450 Vdc or peak AC continuous. Inputs protected against 6 kV transients <10 µs wide. Max voltage to chassis ground: ±500 V peak.

AC VOLTS (RMS AC AND RMS AC+DC)

Accuracy (AC Coupled):

Range	Max Res	Accuracy ±(% of Rdg + % of Rng) For Frequency Ranges (Hz) 20-45	45-10K	10K-30K	30K-100K	100K-.3M	.3M-1M
30mV	1µV	1+.2	.5+.2	1+.2	3+.2	5+.5 Typ.	*
300mV 3V 30V 300V	10µV 100µV 1mV 10mV	1+.04	.5+.04	1+.07	2+.1	3+.2	5+.5 Typ.

* Not specified

Resolution

Range	Max Res
30 mV	1mV
300 mV	100 mV
30V	1mV
300V	10 mV

AC+DC Accuracy: Add 2% of range to the AC coupled specifications.

Input Impedance: 1 MΩ shunted by less than 50 pF.

Crest Factor: Up to 3 for rated specifications.

CMRR: >60 dB at 50 or 60 Hz (1kΩ Unbalance).

Maximum Input Voltage: Same as DC Volts except 20s max on the 3V, 300 mV, and 30 mV ranges. Volt-Hertz product $\leq 10^7$.

dB MEASUREMENTS

Relative dB, dBm, and dBW measurements are calculated in software. Assumes external reference load and a two-wire bridging mode.

Selectable Reference Impedance:

dBm: 50, 75, 90, 93, 115, 125, 135, 150, 250, 300, 500Ω, 600Ω (default), 600Ωrn, 800, 900Ω, 900Ωrn, 1000Ω (dBV), 1200Ω.

dBw: 2, 4, 8, 16Ω.

TEMPERATURE

Thermocouple linearizations are provided by software for types J, K, E, T, B, S, R. Linearizations for "385" and "392" 100Ω platinum RTD's are included.

COLD JUNCTION TEMPERATURE

Readable at +2° to +70° ±1.0°C with 0.01° resolution. Can be used to determine ambient temperature with no TC attached.

OHMS

Measurements are made two-terminal from the front inputs or four-terminal using the front panel inputs to source and the rear panel inputs to sense.

Resolution and Accuracy:

Range	Resolution For Digits Displayed 2.5	3.5	4.5	Accuracy ± (% Rdg + % of Rng)	FS Vout	I OUT
30Ω	0.1Ω	10mΩ	1mΩ	0.08 +0.02	30mV	1mA
300Ω	1Ω	100mΩ	10mΩ		2V	1mA
3kΩ	10Ω	1Ω	100mΩ		3V	1mA
30kΩ	100Ω	10Ω	1Ω	0.07 +0.005	2V	100µA
300kΩ	1kΩ	100Ω	10Ω		3V	10µA
3MΩ	10kΩ	1kΩ	100Ω	0.1 ±0.01	3V	1µA
30MΩ	100kΩ	10kΩ	1kΩ	0.15 +0.02	3V	0.1µA

Open Circuit Voltage: <10V at 1 mA or less.

Overload Protection: 280 Vrms or ±400V peak continuous.

HIGH MEGOHMS

The 52A can measure resistances up to 3200 MΩ by calculating parallel resistance.

Ranges: 300 MΩ, 3000 MΩ.

DIODE TEST

Measures forward biased junction voltage with any of five reference currents.

Range: 0 to 3.2V.

CONTINUITY

Range: All Ohms ranges, 3200 count resolution.

Threshold: 3Ω in the 30Ω range. 10% of range in all other ranges.

Indication: Internal tone generator, 1 kHz. Ohms on display.

Response Time: 50 ms, stretched to 300 ms.

All other **Continuity** specifications are the same as **Ohms** specifications.

DC CURRENT

Separate inputs for low current (up to 320 mA) and high current (up to 10A) measurements. Not available on the MPLX/rear panel input.

Resolution and Accuracy:

Range	Resolution For Digits Displayed 2.5	3.5	4.5	Accuracy ± (% Rdg + % of Rng)	MAX V Burden
30mV	100µA	10µA	1µA	0.07 + 0.02	40mV
300mA	1mA	100µA	10µA	0.07 + 0.005	400mV
3A	10mA	1mA	100µA	0.01 + 0.02	150mV
10A	100mA	10mA	1mA	0.1 + 0.005	500mV

Overload Protection: 300 mA fuse (3AG) fuse protects the low current input. The 10A input is unfused. Up to 30 A can be measured for a maximum of 20s before any damage is sustained.

AC CURRENT

True RMS, Shunt DC Coupled

AC Current specifications are the same as DC Current specifications except:

Range	Accuracy ±(% of Reading +% of Range) 20-45	45-1K	1K-10K	10K-30K	MAX V Burden
30mA	1 +0.3	0.5 +0.2	1 +0.3	5 +0.3	40mV
3A	1 +0.2	0.5 +0.3	1 +0.3	5 +0.3	150mV
300mA 10A	1 +0.04	0.5 +0.04	1 +0.04	5 +0.1	400mV 500mV

AC + DC Current: Add 1% of range to above specifications.

FREQUENCY

Frequency is measured by a period average counting method. Resolution is 6 digits per 1.3 sec (7 digits max). Typical frequency response to 8 MHz (4 MHz guaranteed).

Accuracy and Resolution:

Maximum Range	Accuracy	Resolution
10 Hz	0.0025%	0.000001 Hz
100 Hz		0.00001 Hz
1 kHz		0.0001 Hz
10 kHz		0.001 Hz
100 kHz		0.01 Hz
1 MHz		0.1 Hz to 300k
4 MHz		1 Hz to 1M

EVENTS (TOTALIZE)

Count Rate: 0 to 800 kHz.

Capacity: 0 to 9,999,999 counts.

Triggering: Positive or negative edge, selectable.

All other **Events** specifications same as the **Frequency** specifications.

PERIOD

Resolution and Accuracy:

Range	Resolution	Maximum Reading	Units	Accuracy
100 µs	10 ps	100.00000	µs	±100 ps
1000 µs	100 ps	1000.0000	µs	±100 ps
10 ms	1 ns	10.000000	ms	±1 ns
100 ms	10 ns	100.00000	ms	±10 ns
1000 ms	100 ns	1000.0000	ms	±100 ns

All other **Period** specifications same as the **Frequency** specifications.

PULSE WIDTH, TIME INTERVAL

Time intervals are measured from the negative edge of the optional rear panel counter inputs to either the positive or negative edge of the front panel input or multiplexed input. All other specifications are the same as the Period modes.

Resolution and Accuracy:

Range	Resolution	Maximum Reading	Units	Accuracy
100 ms	1 µs	100.000	ms	±2 µs
1000 ms	1 µs	1000.000	ms	±2 µs
10 s	1 µs	10.000000	s	±2 µs
100 s	10 µs	100.00000	s	±10 µs
360 s	100 µs	360.0000	s	±100 µs

Triggering: Positive or negative edge, selectable.

All other **Pulse Width**, **Time Interval** specifications same as the **Frequency** specifications.

LOGIC

Provides an easy check of logic levels and activity.

Indication: "1", "0".

Trigger Levels:

Logic Family	DC Threshold +Trig	-Trig
TTL	+2V	+0.8V
CMOS 5	+3.5V	+1.5V
CMOS 12	+8V	+4V

AC VOLT-AMPERES, DC WATTS

The 52A measures volt-amperes AC or watts DC by taking alternate readings of current and voltage and multiplying them together.

Range and Resolution:

Current Range	V Range 32V	320V	Resolution 9999999	999999	99999	Max VA
320 mA	X	—	1µW	10µW	100µW	10
320 mA	—	X	10µW	100µW	1mW	100
3.2 A	X	—	10µW	100µW	1mW	100
3.2 A	—	X	100µW	1mW	10mW	1k
10 A	X	—	100µW	1mW	10mW	320
10 A	—	X	1mW	10mW	100mW	3.2k

Accuracy: Equal to the accuracy of the volts input plus the accuracy of the current input.

Overload: Equal to the ratings of the respective volts and current ranges.

FUNCTION MODIFIERS

Delay: User programmable delays can be inserted in front of any function.

Range: 0 to 655.35 sec in 0.01 sec interval.

Track: The Track function produces voltage output proportional to the channel reading.

Alarms: Up to 99 alarms are user programmable. Each alarm can have up to two setpoints allowing window comparisons or out of limits alarms. Combined with a Digital I/O option the alarms can be used in control applications.

Alarm Modes: The alarm response is triggered when X≥T1, and X≤T1, X≥T1 or X≤T2 (out of limits), T1≤X≤T2 (X is channel data and T1 and T2 are user entered thresholds). Response can be latched on, or only respond to a threshold transition. Hysteresis (dead-zone) can be added to any threshold.

Alarm Responses: An alarm response can be any or all of the following:

1. Tone (up to 9 sounds).
2. Store and/or transmit reading, alarm number, and time.
3. Store and/or transmit all current scan data with time.
4. Output a digital word in any desired pattern.
5 Output an analog voltage.
6. Display, store, or transmit a user en tered message.

In addition to the above alarm responses, the user can cause a channel list or program to be started as a result of an alarm.

DISPLAY MODIFIERS

Delta: Either the current reading or a numeric entry offsets the displayed data.

Delta %: Similar to the Delta modifier except the reading is expressed in Delta %.

Min/Max: Stores and displays the minimum or maximum reading and updates the memory and display.

Average: From 1 to 65535 readings can be averaged.

Resolution: Display resolution is selectable to all functions except Events.

Bargraph: A segmented bargraph representation of the measurement shows the channel number and polarity, but range and function is not displayed. There are two bargraph types available: the Full range bargraph, and the high resolution bargraph.

Scale/Math Channel 0: All channels can be scaled by a user constant or by another channel's data allowing interactive display of complex measurements. Up to 99 formulas can be entered. Typical applications include scaling transducers, efficiency measurements, and ratio calculations.

Math Functions: +, -, x, =, √, ( ).

Labels: Up to four characters can be defined per Math channel, allowing custom labels.

GENERAL

RS-232 C Serial Port

Connector: DB-25 (female) on rear panel with DCE or DTE configuration user selectable by internal header.

Mode: Full duplex with CTS/RTS or XON/XOFF handshaking.

Data Format: 8 bits, no parity, one stop bit.

Data Rate: 300, 1,200, 9,600 and 76,800 baud, user selected by rear panel switch.

Display: 32 by 84 dot matrix liquid crystal graphics display. Full annunciation of channel, range, mode, and function is available on all displayed channels.

Isolation: Chassis common is fully isolated from earth ground but is common to RS-232 C or IEEE-488 ground. A banana jack connected to chassis common is provided to ground the chassis if so desired.

Input Low to Chassis Common: ±500 V peak max.

Channel Low to Any Other Channel Low: ±500 V peak max.

Chassis Common to Earth Ground: ±500V peak max. (AC transformer connected; no earth connections through I/O, RS-232 C, or IEEE-488).

Data Memory: Up to 12,000 readings can be stored in an unexpanded 52A. Memory can be expanded up to 1 megabyte allowing a maximum of approximately 100,000 stored readings.

Environmental

Operating and Storage Temperatures:

	Without Battery	With Battery
Operating	0° to +50°C	0° to +40°C
Storage	-20° to +70°C	-15° to +40°C

Temperature Coefficient: For operating temperatures <+18°C or >+28°C multiply the applicable accuracy specification times 0.1 per °C.

Humidity: ≤70% RH to +50°C, ≤80% RH to +35°C, except on the 3 MΩ, 30 MΩ, 300 MΩ, and 3000 MΩ ranges: ≤70% RH to +35°C.

Power

50-120 Line Transformer: 90 to 132 Vac, 50/60 Hz ≤16 VA.

50-220 Line Transformer: 180 to 260 Vac, 50/60 Hz ≤16 VA.

External Power: Any DC source from ±12 to 24V or any isolated AC source from 9 to 18V can be used to power the 52A. Current drain ranges from 10 µA at standby to 0.5A running an IEEE-488 option. Maximum drain without IEEE-488 is 400 mA at 12 Vdc with all four channels running any of the AC functions. Typical drain is approximately 100 mA.

When the internal battery option is installed, the power will automatically switch to the battery option if the line input fails or falls below 7.5V (6 Vac).

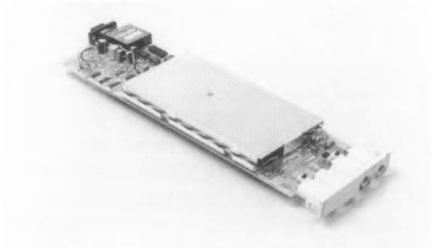
Dimensions: 21.5 cm (8.5 in.) wide w/o handle, 22.6 cm (8.9 in.) with handle; 8.8 cm (3.5 in.) high w/o feet, 10.8 cm (4 in.) with feet; 30.7 cm (12.1 in.) deep.

Weight

Net: 3.3 kg (7.25 lb) plus 0.45 kg (1 lb) Wall Transformer. Option 50-11 Battery adds 1.47 kg (3.25 lb).

Shipping: 4.4 kg (9.7 lb). Option 50-11 Battery adds 1.47 kg (3.25 lb).

OPTIONS FOR MODEL 52A



50-1: Measurement Module: Full function.

50-2: Measurement Module: DC volts and temperature.

50-11A: Rechargeable Battery: Rechargeable battery and charging circuitry.

Battery Type: 12V, 2.9 AH sealed lead acid (provided).

Charging Time:

From Deep Discharge to Full Charge: 12 hr.

From 1/2 Discharge to Full Charge: 4 hr.

Approximate Continuous Operating Time: Up to 50 hr depending on channel and function configuration.

50-12A-X: Ram Expansion Board: Expands data and program memory. In direct data storage, each 128K of expansion memory adds approximately 12,000 data points. Model 52A can hold up to 4 RAM boards (excluding other option boards) each of which can hold up to 256 kbytes. The RAM is backed up by an on board lithium battery.

50-12A-128: 128K RAM Expansion Board.

50-12A-256: 256K RAM Expansion Board.

50-13A IEEE-488 GPIB Interface Board: GPIB Option follows IEEE-488 1978 conventions. Full talk and listen capability.

Port Interface: Isolated from A/D channel cards, common to chassis ground, double buffered.

Address: 0 to 15, internal switch selected on initial power up, software selectable via front panel.

Subsets: SH1, AH1, T6, TEO, L4, SR1, RL1, PPO, DC1, CO, E1.

Power Interface: Will not run from the internal battery option. For external battery operation without GPIB (to preserve battery life), a switch is provided to turn off the GPIB board.

50-14: Digital I/O + Analog Out Board: Provides 8 bits of digital read, 8 bits of digital write, and an 8 bit digital to analog converter for monitor and control applications. This option board is fully isolated from the four A/D channels and is common to chassis ground. Mating connector included.

Digital Output Section: Open drain outputs can be used to switch up to 50 Vdc at 250 mA.

Digital Input Section: The digital read inputs are parallel polled under program control at up to a 20 ms rate. All eight inputs can be used as triggers to read contract closures and can be read independently or masked and read in any combination. The inputs are lightly pulled up (normally high) for reading contact closures to ground.

Analog Output Section: The analog output provides a controllable DC voltage for proportional control, driving chart recorders, and anything else requiring a linear output voltage.

Range: 0 to 2.55V in 256 steps.

50-15: Second RS-232 C Serial Port: A second, fully implemented serial port; it is an alternate to Option 50-13, either of which may be added to expansion slot 8 in Model 52A.

Connector: DB-25 (female) on rear panel with DCE or DTE configuration user selectable by internal header.

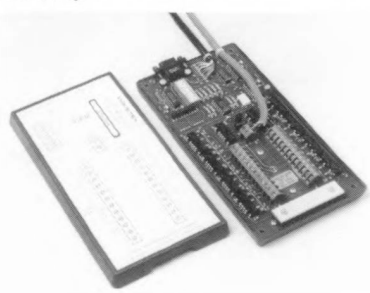
Mode: Full duplex with CTS, XON/XOFF and modem handshaking.

Data Format: 7 or 8 bits, even or odd mark/space parity checking, one stop bit.

Data Rate: 300, 600, 1200, 2400, 4800, 9600, 19,200 and 76,800 baud, user selectable by menu.

Break Character: Programmable break character provides 52A program interruption.

50-20: 8/16 Channel HI-V Multiplexer with Thermocouple Compensation: Multiplexes input signals to the Model 52A thereby expanding the total channel count. One option 50-20 will expand an A/D channel to 16 inputs single ended or 8 channels differential (internally selectable).



Maximum Input V: ±190Vdc or peak AC between any two input terminals. Transient protected to 6 kV peak <10 µs.

Maximum Current: ±180 mA peak single ended. ±140 mA peak differential.

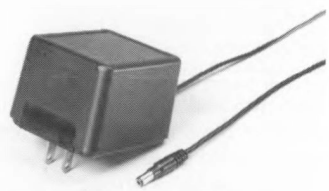
Thermal EMF: ≤400 nV single ended, ≤800 nV differential.

Closed Channel Resistance: From 0° to +50°C, ≤60Ω single ended. ≤120Ω differential.

Open Channel Leakage Current: 0.5 nA.

Functions: All functions are supported except current and VA. (Each channel can be fitted with a shunt for current measurements, including 4 to 20 mA loops.) Ohms requires the addition of a parallel 50-20 multiplexer to switch the test current (4 terminal). Degrade AC specifications by 1.00% and limit bandwidth to 100 kHz.

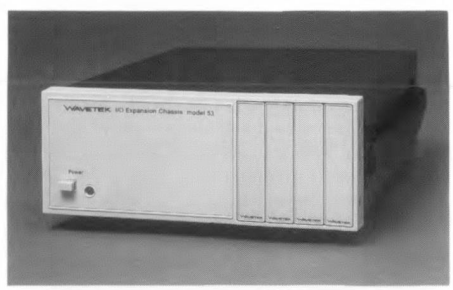
50-XXX: Line Transformer.



50-120: Line Transformer. 90 to 132 Vac, 50/60 Hz ≤16 VA.

50-220: Line Transformer. 180 to 260 Vac, 50/60 Hz ≤16 VA.

I/O EXPANSION CHASSIS & MULTIPLEXERS



The Model 53 with multiplexer options expands the capacity of the Model 52A Datalogger to as many as 260 channels. Temperatures can be logged with thermocouples, with TC types mixed in any order. Each MX module provides cold junction temperature compensation for accurate measurements. All Datalogger functions can be multiplexed, including DC and AC volts, ohms, frequency and current (with external shunts).

Model 53 has five slots to house options. Multiplexer options provide up to 64 channels of multiplexed input to each of up to four Model 52A measurement channels. For in-system use, the Model 53 can be mounted side by side with the Model 52A in 5.25 inches of rack space.

Options 53-1 and 53-2: 32/64 and 16/32 Channel Multiplexers. Options 53-1 and 53-2 Multiplexers multiplex input signals to the Model 52A Datalogger and thereby increase the number of measurement channels.

Measurement Module	Available Channels	
	53-1	53-2
Single-Ended	64	32
Differential	32	16
Four-Terminal	16	8

The 53-1 and 53-2 Multiplexers provide low thermal emf, low channel-to-channel leakage and infinite switch life. They utilize solid state relays which give relay performance without the limitations. Each channel can be user configured with a shunt (for current-to-voltage conversion), divider or filter for additional flexibility. All closures are break before make.

An isothermal block with temperature sensor is integral to each multiplexer option to allow software compensation of thermocouples. Thermocouple types can be mixed in any order.

The 53-1 uses CMOS technology. Optical MOSFET technology is used in the 53-2 to permit switching up to 300 volts.

MULTIPLEXERS

Max Input Volts

53-1: ±3.2 Vdc or 4.8V peak AC on any input terminal relative to circuit ground.
53-2: ±300 V peak AC of DC between terminal and ground.

Max Switch Current

53-1: ±200 µA peak.
53-2: ±180 mA peak single ended, ±140 mA peak differential.

Thermal EMF

53-1: ≤1.5 µV single ended, ≤3 µV differential.
53-2: ≤800 mA peak single ended, ≤1.6 µV differential.

Closed Channel Resistance

53-1: From 0° to +50°C; ≤1.1 kΩ single ended, ≤2.2 kΩ differential or four-terminal.
53-2: From 0° to +50°C; ≤60Ω single ended, ≤120 Ω differential.

Open Channel Leakage Current

53-1: 100 pA at +18° to +28°C, ≤5 µA at 0° to +50°C.
53-2: 0.5 nA x (V_{in}-V_{off1}) + 0.5 nA x (V_{in}-V_{off2}) + 0.5 nA at (V_{in}-V_{off3}). Where V_{off} represents the amplitude of unselected channels in each group of four inputs, and V_{in} represents the amplitude of the selected channels.

Switching Rate

53-1: 1000 channels/sec max. Measurement module limits switching rate to 15 readings/sec.
53-2: 500 channels/sec max. Measurement module limits switching rate to 15 readings/sec.

Functions: All Model 52A functions are supported except current (can be added by the use of an external shunt). Ohms requires operation in the four-terminal mode with half the mux being used to switch the excitation current. Ohms ranges are limited to greater than 3 kΩ.
53-1: AC specifications are degraded by 2% and bandwidth limited to 5 kHz.
53-2: AC specifications are degraded by 0.1% and bandwidth limited to 100 kHz.

Current Source (53-2 Only): A precision 1 mA current source is available for ohms measurements or transducer excitation. Can be switched in the 4 terminal mode for 8 channels of ohms measurements. The Model 52A math function can be used to scale the readings to ohms using the formula

$$\frac{\text{Voltage Reading}}{0.001} = \text{Ohms}$$

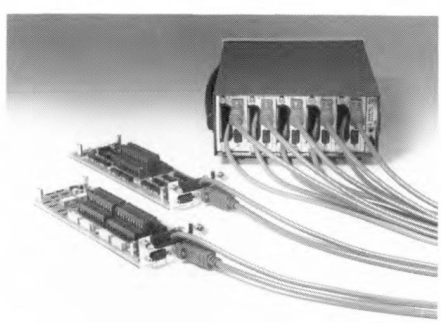
Current Source Compliance (53-2 Only): +3.2 Vdc.

Buffer (53-1 Only): Should the distance between Model 53 and Model 52A exceed 25 feet, a unity gain buffer may be connected. This buffer is suitable for TC, Vdc, and ohms sense measurements only. Vac below 100 Hz can be buffered with some accuracy degradation.

Buffer Accuracy (53-1 Only): The buffer will contribute up to 15 µV of error with less than 2 µV of drift. However, if this is significant to the application, the "CAL 0" can be performed with the buffer in circuit to eliminate the initial error.

Cables: A three foot (0.9 meter) analog and digital cable set is included to connect an Option 53-1 or 53-2 to the host model. See **Accessories** (page 165) for other cables.

OPTIONS FOR MODEL 53



53-1: 32/64 Channel Multiplexers
53-2: 16/32 Channel Multiplexers
50-120: Line Transformer. 90 to 132 Vac, 50/60 Hz, ≤16 VA.
50-220: Line Transformer. 180 to 260 Vac, 50/60 Hz, ≤16 VA.

PRINTER/PLOTTER

Up to 16 channels of stripchart output, as well as alphanumerics and X-Y plotting can be produced by the Model 54 Printer. The Model 54 is normally driven by the Model 52A Datalogger. However, the printer can be used as a high-speed, 42-column, self-contained thermal printer with a variety of systems from other manufacturers.

Stripchart printing can be done on up to four sets of labeled axes with continuous output. If straight X-Y plotting of data is desired, any data that has been stored by the 52A can be printed as an X-Y plot upon command. These features provide major advantages over numeric or alphanumeric printing. Trends can be identified. Out-of-tolerance conditions become obvious. Data can be scaled as desired to expand areas of interest for easy viewing.

In addition to stripchart and X-Y graphics, the Model 54 also offers barchart generation.

Printing at 5.8 lines/second, the Model 54 is fast enough for most data logging applications. Containing a 7168 byte FIFO buffer, the printer offers the ability to print either in TEXT or LIST mode. TEXT prints each line below the previous line and LIST prints each line above the previous line.

Four different print fonts can be displayed on the Model 54. Automatic shuttling allows viewing of the last line printed without missing readings. Up to 10,000 lines can be printed on each roll of 4.4 inch wide paper.

Front panel controls and indicators are provided for on/off line, paper feed, end of paper, and test mode. It can be stacked with the Models 52A and 53 to make a very compact package when space is limited. Model 54 can also be rack mounted.

Print

Printhead: Fixed Thermal Dot Row.
Print Rate: 5.8 lines/sec, typical.
Print Time: 0.17 sec./line, typical.
Line Density: 8.0 lines/inch, typical.

Line Width

No. of Columns: 42
No. of Dots: 256
Print Width: 3.5 in. (89.6 mm)

Paper Roll

Width: 4.4 in. (112 mm)
Length: 92 ft. (28 m)
Diameter: 2 in. (50.8 mm), max.
Data Capacity: 8800 lines/roll (92 ft. roll).

Characters

Height (all fonts): 0.097 in. (2.4 mm), nominal.

Fonts, Matrices, Char/Line

Fonts	Matrix	Char/Line
Normal	5 x 7	42
Expaned	10 x 7	21
Condensed	4 x 7	51
Condensed/ Expanded	8 x 7	25

RS-232 C Interface

Baud Rate: 110 to 9600 Baud.

Word Length: 10 bits including parity (1 start, 8 data, 1 or 2 stop or 1 start, 7 data, 2 stop).

Handshake Mode: Xon/Xoff (Tx Data).

Tx Data: Odd/Even Parity.

Environmental

Operating Temperature: 0° to +50°C.

Operating Humidity: 20 to 90% (non-condensing).

Dimensions: 8.9 cm (3.5 in.) high, 21.6 cm (8.5 in.) wide, 30.7 cm (12.1 in.) deep.

Weight: 3.6 kg (8 lb) net, 4.8 kg (10.5 lb) shipping.

Power:

115 Vac ±10% (Internally switch selectable), 50/60 Hz.

Power Consumption:

Idle: 20W, nominal.
Printing: 45W, nominal.
Printing Black: 120W.

ACCESSORIES FOR MODELS 52A, 53, & 54

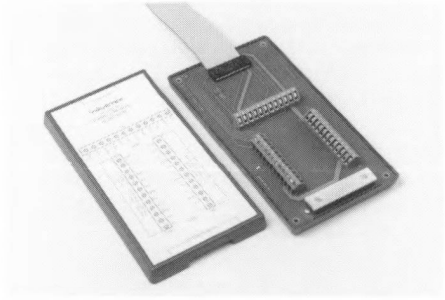
50-30: Test Lead Set

A deluxe test lead set consisting of a safety designed pair of test leads 48 in. long with banana plugs on one end and needle tips on the other. The tip shafts are threaded to accept the following included screw-on parts; alligator clips, spring hook adapters, spade lugs and tip covers. (Each 52A is shipped with this accessory.)

50-31: Soft Carrying Case

The carrying case for the Model 52A, 53 or 54 for field or portable applications has space for manual, test leads, multiplexers and more. Comes with shoulder strap and handles.

50-32: Digital I/O and Analog Output Breakout Module



Convenient terminal strip connections for Digital I/O channels.

50-33: Three-Foot Multiplexer Module Interconnecting Cable Set

A 3 ft. (0.9 meter) analog signal cable and digital control cable set to connect an Option 53-1 or 53-2 to the host Model. (Same as cable set furnished with Option 53-1 or 53-2.)

50-34: Ten-Inch Multiplexer Module Jumper Cable

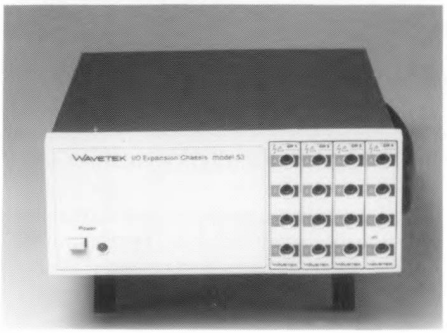
A 10 in. (0.25 meter) digital control jumper cable used to distribute control signals when multiplexer modules are daisy chained together.

50-35: Twenty-five Foot Multiplexer Module Interconnecting Cable Set

50-36: Two-Instrument Coupling Kit

Two strips couple a Series 50 instrument with any other Series 50 instrument. Two kits couple 52A, 53, and 54 together.

50-40: Jack Panel Kit



Installed in the Model 53 front panel to provide 16 safety-type banana jacks which terminate in 24 in. stripped and tinned, insulated wires. These wires may be attached to the screw terminals of any multiplexer module to provide front panel access.

3000-00-0181: Printer Paper

10 roles of paper for Model 54.

Style 18: Rack Adapter

Style 19: Dual Rack Adapter

Dual Rack Style 19 allows a Model 52A to be mounted side by side with a Model 53 or Model 54 in a standard 19 inch rack. It is 5.25 inches high.

FACTORY/FOB
San Diego, CA

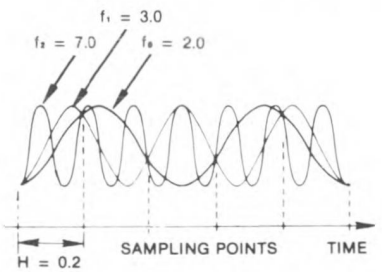
ORDER INFORMATION
Model 52A
Model 53
Model 54
Option 50-1
Option 50-2
Option 50-11A
Option 50-12A-128
Option 50-12A-256
Option 50-13A
Option 50-14
Option 50-15
Option 50-20
Option 50-120
Option 50-220
Option 53-1
Option 53-2
Accessory 50-30
Accessory 50-31
Accessory 50-32
Accessory 50-33
Accessory 50-34
Accessory 50-35
Accessory 50-36
Accessory 50-40
Accessory 3000-00-0181
Style 18
Style 19

For full specification or a demonstration, contact you local Wavetek representative (pages 211 and 213).

Signal Processing Filters

General
The subject of signal filtering is remarkable in that, while it appears to be simple in concept and easily understood qualitatively, its application to signal processing systems requires a sophisticated appreciation of many complex disciplines. For a more complete discussion of the fundamental ideas and concepts of filters as they pertain to signal-processing systems, please refer to our publication, *The Application of Filters to Analog & Digital Signal Processing.*

Aliasing
With the increasing use of *digital* signal processing, active *analog* filters have become more and more important. Because actual signals are never simple ideal sine waves, new frequency components called "aliases" will be generated.



Many different signals may, when sampled, yield the same set of data. These are called "aliases" of each other.

A continuous analog signal is converted into a finite number of digital values by an analog-to-digital converter. Problems occur when any higher frequency components such as random noise or spurious signals are present. At a given sampling rate, two frequencies will be defined by the same exact digital points when their sum or difference equals the sampling frequency (or multiples of the sampling frequency).

For example, at a sampling frequency (f_s) of 5kHz, a signal (f_o) at 2kHz will yield the same set of sample points as a 3kHz signal ($f_s - f_o$), a 7kHz signal ($f_s - f_o$), an 8kHz signal ($2f_s - f_o$), and so on.

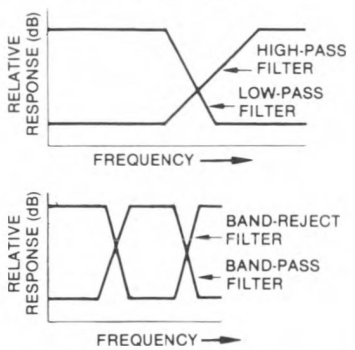
Signal Filtering
A filter is a circuit that has a deliberately non-uniform transfer function (ratio of output spectrum to input spectrum) with respect to frequency. Most filters are designed to pass signals in some frequency band and attenuate or reject signals in other frequency bands.

Filter Types
Lowpass filters pass signals from DC to the cutoff frequency and attenuate all higher frequency signals.

Highpass filters attenuate signals from DC to the cutoff frequency and pass all higher frequency signals (but only up to some limiting frequency).

Bandpass filters pass signals between two cutoff frequencies which may be far apart (wide bandpass) or very close (narrow bandpass).

Band-reject filters attenuate signals between two cutoff frequencies and pass signals at other frequencies.



Typical Idealized Filter Transfer Functions

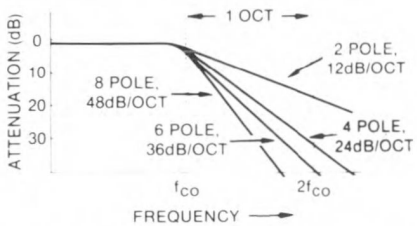
Filter Characteristics
All active Wavetek filters are capable of wide ranges of cutoff frequency and gain. They have excellent dynamic range (80 dB), high adjustment resolution (3 digits), excellent stability and linearity, and significantly higher performance than passive filters, particularly at low frequencies. Passive filters, while exhibiting low noise and requiring no power supply, can be bulky at low frequencies, difficult to make adjustable over wide frequency ranges, and are generally more temperature dependent. In addition, they are sensitive to impedance matching and exhibit insertion loss (i.e., no gain can be provided).

Wavetek manufactures active filters with three different responses:

Butterworth filters (Models 432, 442, 452, 716 and 852) provide nearly flat passband response and a moderately sharp cutoff characteristic. The rolloff characteristic between the passband and the stopband follows a constant rate of 6 dB/octave per filter pole. The phase response (delay) is somewhat non-uniform. Maximum attenuation is maintained throughout the stopband.

Bessel filters (Model 816) are optimized for linear phase response in the passband at the expense of sharpness of cutoff frequency and passband flatness. The rolloff characteristic is similar to the Butterworth filter but approaches the constant slope region more gradually. Bessel filters are often used in time domain applications where constant delay is required or where overshoot is undesirable in response to a step or transient.

Elliptic filters (Models 716, 752A and 753A) trade off ripple in the passband for an extremely fast rolloff characteristic providing a narrow transition region between the passband and stopband. This is very useful when the desired signal is close in frequency to an unwanted signal. Phase response is quite non-uniform and there is some degree of variation in the stopband attenuation.

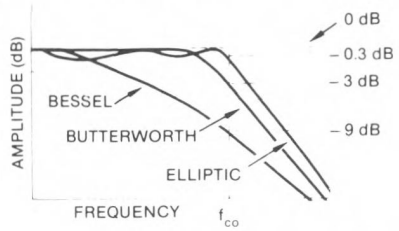


Effect of Number of Poles on Rolloff Rate for Butterworth Filter.

Cutoff Frequency
Cutoff frequency marks the beginning of the transition region (the end of the passband). For Butterworth filters, the cutoff frequency is defined as the frequency at which the transfer function shows 3 dB of attenuation with respect to the input signal. For linear phase fil-

INTRODUCTION

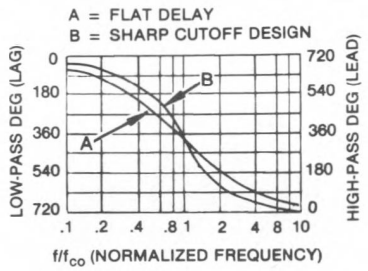
ters such as the Bessel filter, the cutoff frequency setting determines the *delay* to be maintained throughout most of the passband. In this case, the cutoff frequency is where 45° of phase shift per pole occurs. For elliptic filters, which have significant passband ripple, the cutoff frequency is defined as the frequency at which the attenuation increases and continues to increase beyond the ripple amplitude.



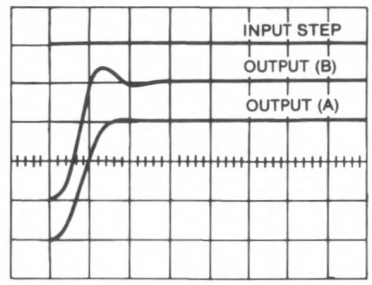
Amplitude Response Curves for Three Filter Characteristics.

Phase-Shift (Delay)

All filters exhibit frequency-dependent delay or phase shift between frequencies in the input and output signals. A given delay time corresponds to a specific phase shift at a particular frequency. For constant delay of all frequencies in the passband, the corresponding phase shift must be exactly proportional to frequency (linear phase response). Nonlinear responses will distort the input signal when that signal is composed of more than one frequency (i.e., ringing in a square wave).



Typical Phase Characteristics for Eight Pole Filters.



Typical Transient Response for Filter Designs A and B above.

FILTER SELECTION GUIDE

	Two-Channel						Multi-Channel	
Model	432	442	452	852	752A	753A	716	816
Frequency Range								
Lower (Hz)	1	10	0.1		1			0.1,1,10
Upper (kHz)	110	1100	111		99			1.5,15,150
Resolution (digits)	2		3		2			1
Rolloff Rate, per Channel (dB/Octave)	24			48	115			48
Filter Responses								
Butterworth	Yes						Yes	
Bessel								Yes
Elliptic					Yes			
Filter Function								
Lowpass	Yes							
Highpass	Yes					Yes		
Bandpass	Yes					Yes		
Band-Reject	Yes					Yes		
Notch	Yes					Yes		
Prefilter Gain (dB)	0, +20				0 to +40 in 10 dB steps			
Postfilter Gain (dB)							0, +10, +20	
No. of Channels	2						16	
Broadband Noise (μVrms)	250	500	100	200	10			710
Max. Attenuation (dB)	80		90		80			
Remote Programming					TTL & GPIB Opt		GPIB Opt	TTL (GPIB Opt)
Catalog Page	169	169	168	168	170	170	171	172

Dual HI/LO Variable Analog Filters

- **0.01 Hz to 111 kHz Range**
- **3 Digits Resolution**
- **Butterworth and Flat Delay Responses**

Filters
Models 452 and 852 are in Wavetek's complete line of quality two-channel and multi-channel filters. Also see the selection guide (page 167) for the filter best suited to your application.

Design
Models 452 and 852 Dual HI/LO Filters each consist of two identical filter channels. Each filter offers high pass and low pass functions, 0 dB and 20 dB gain, Butterworth/Flat Delay responses and 3-digit resolution for cutoff frequency selection.

Versatility
Channels may be interconnected for bandpass (or doubled rolloff) or band reject functions.

The Models 452 and 852 each cover the cutoff frequency range of 0.1 Hz to 111 kHz. Rolloff of the Model 452 is 24 dB/octave/channel, while the Model 852 is 48dB/octave/channel.

FUNCTIONS
Low Pass, High Pass, Band Pass, Band Reject, and (452 only) Notch.

Frequency Range and Resolution:

Multiplier	Frequency (Hz)	Resolution (Hz)
x10	0.1 to 111	0.1
x100	1 to 1.11k	1
x1k	10 to 11.1k	10
x10k	100 to 111k	100

Note: Specifications apply for cutoff frequency dial settings from 0.10 to 10.1010 for any multiplier setting.

Attenuation Rate per Channel
452: 24 dB/octave.
852: 48 dB/octave.

FLAT AMPLITUDE (BUTTERWORTH) RESPONSE
Passband Gain (452)
Low Pass: 0 dB/20 dB, 0.25 dB.
High Pass: 0 dB/20 dB, 0.25 dB. (±1 dB in x10k Multiplier position); –3 dB at approx. 2 MHz.
Passband Gain (852)
Low Pass: 0 dB/20 dB, 0.5 dB.
High Pass: 0 dB/20 dB, 0.5 dB (±1dB in x10k Multiplier position): –3dB at approx. 1 MHz.
Attenuation at Cutoff: 3 dB.
Maximum Stopband Attenuation: 80 dB min on x10K and x1K ranges for $f_{in} \leq 400$ kHz. 70 dB min on x100 and x10 ranges for $f_{in} \leq 300$ kHz.
Phase Match Between Channels (Typical)
452/452-001: 1° or 1%, whichever is greater.
852/852-001: 2° or 2%, whichever is greater.

FLAT DELAY RESPONSE
Low Pass Delay (Typical)
452: $1/(2f_c)$ seconds.
852: $1/f_c$ seconds.
Attenuation Cutoff
452: Approx 9 dB.
852: Approx 17 dB.

OUTPUT CHARACTERISTICS
Circuits: Single-ended. Short-circuit protected. May be DC isolated from power ground by rear panel switch.
Impedance: 50Ω.
Full-Scale Signal: ±10V (7.1 Vrms), DC to 300 kHz, decreasing to 4V (2.8 Vrms) at 1 MHz (RL ≥5kΩ), 15 mA max. current.

GENERAL
Environment:
Operating 0° to +50°C.
Storage –20° to +70°C.
Dimensions: 43.2 cm (17 in.) wide; 8.9 cm (3 in.) high; 33 cm (13 in.) deep.
Weight
Model 452: 4.5 kg (10 lb) net, 6.4 kg (14 lb) shipping.
Model 852: 5.5 kg (12 lb) net, 6.8 kg (15 lb) shipping.
Power: 115/230V ±10%, 50 to 500 Hz, 5 watts.

OPTIONS
002: 600Ω Output Impedance
Style 11: Rack-Mount Kit. Field installable.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 452
Model 852
Option 002
Style 11

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213)

Dual HI/LO Variable Analog Filters

- **1 Hz to 1.1 MHz Range**
- **2 Digits Resolution**
- **Butterworth and Flat Delay Responses**
- **24 dB/Octave/Channel Rolloff**

Filters
These are two models in Wavetek's complete line of quality two-channel and multi-channel filters. Also see the selection guide (page 167) for the filter best suited to your application.

Versatility
Individual channels may be readily interconnected for series or parallel operation, resulting in bandpass (or double rolloff) and band reject (including notch) functions.

Each filter channel provides switch selectable Flat Amplitude (Butterworth) response for frequency domain applications and Flat Delay response for transient-free time domain applications.

Range
Model 432 covers the cutoff frequency range of 1 Hz to 110 kHz; Model 442 covers 10 Hz to 1.1 MHz. Rolloffs are 24 dB/octave/channel.

Functions
Low pass, high pass, band pass, band reject, notch.

Frequency Range and Resolution: 2 digit resolution as follows:

Multiplier	Frequency (Hz)	Resolution (Hz)
x1(432)	1 to 110	1
x10	10 to 1.1k	10
x100	100 to 11k	100
x1k	1k to 110k	1k
x10k(442)	10k to 1.1M	10k

Attenuation Rate (Rolloff) per Channel: 24 dB/octave.

RESPONSE
Flat Amplitude (Butterworth)
Passband Gain, Low Pass: 0 dB/20 dB, ±0.5 dB.
Passband Gain, High Pass: 0 dB/20 dB, ±0.5 dB.
(±1 dB in highest multiplier position); approximately 3 dB down at f ≥2x maximum fc.

SIGNAL PROCESSING FILTERS
MODELS 432/442

Attenuation at Cutoff: 3 dB.
Max Stopband Attenuation:
Model 432: 80 dB min on x1K and x100 ranges for fin ≤400 kHz. 70 dB min on x10 and x1 ranges for fin ≤300 kHz.
Model 442: 80 dB min on x10K and x1K ranges for fin ≤1 MHz. 70 dB min on x100 and x10 ranges for fin ≤300 kHz.
Flat Delay
Low Pass Delay (Typical): 1/(2fc) sec.
Attenuation at Cutoff: Approx. 9 dB.

INPUT CHARACTERISTICS
Circuit: Single-ended, diode-protected.
Impedance
Model 432: 1 MΩ in parallel with 50 pF.
Model 442: 100 kΩ in parallel with 50 pF.
Full-Scale Signal at 0 dB Gain
Model 432: ±7V (5 Vrms) DC to 100 kHz. ±0.7V (0.5 Vrms) at 20 dB gain.
Model 442: ±7V (5 Vrms) DC to 1 MHz. ±0.7V (0.5 Vrms) at 20 dB gain.
Absolute Maximum Input: ±100V.
Maximum DC Component
High Pass: ±100V, 0 dB gain. ±10V, 20 dB gain.

OUTPUT CHARACTERISTICS
Circuit: Single-ended, short-circuit protected; may be DC isolated from power ground by rear panel switch.
Impedance: 50Ω.
Full-Scale Signal
Model 432: ±7V (5 Vrms) DC to 100 kHz, decreasing at higher frequencies (R_L≥5 kΩ). ±15 mA maximum current.
Model 442: ±7V (5 Vrms) DC to 1 MHz, decreasing at higher frequencies (R_L ≥5kΩ). ±15 mA maximum current.
Drift vs Temperature: 1 mV/°C.

GENERAL
Environment: Operating 0° to +50°C. Storage -20° to +70°C.
Dimensions: 43.2 cm (17 in.) wide; 8.9 cm (3.5 in.) high; 33 cm (13 in.) deep.
Weight: 4.5 kg (10 lb) net; 6.5 kg (14 lb) shipping.
Power: 115/230 Vac ±10%, 50 to 500 Hz, 5 watts.

OPTIONS
002: 600Ω Impedance. Model 432 only.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 432
Model 442
Option 002

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

SIGNAL PROCESSING FILTERS

MODELS 752A/753A

Programmable Brickwall® Filters

- **Frequency Range: 1 Hz to 100 kHz**
- **Rolloff: 115 dB/Octave**
- **Resolution: 2 Digits**
- **Overload Detectors**
- **Optional: GPIB Interface**

Models 752A and 753A are wide-range tunable, programmable Brickwall® filters with near ideal passband and stopband characteristics. Each network or channel employs a patented 7th order elliptic (Cauer) filter with very high attenuation slopes of 115dB/octave.

Local/Remote Programming
Programming of high and low filter cutoff frequencies, prefilter gain, and postfilter gain is by front panel controls and optionally, by digital programming through IEEE-488 1978 (GPIB) bus interface.

FUNCTIONS
Model 752A: Dual indepenent low pass channels.
Model 753A: Independent high pass and low pass channels.

CUTOFF FREQUENCY (f_c)
Range
1 Hz to 99 kHz with front panel control and GPIB.
Accuracy
Low Pass: –0, +3.0%.
High Pass: +0, –3.0%.
Stability: ±200 ppm/°C.
Gain (Prefilter): 0 to +40 dB (±0.25 dB) in 10 dB steps.

INPUT CHARACTERISTICS
Coupling
Low Pass channel: DC, AC with 0.3 Hz nominal cutoff.
High Pass channel: DC input, AC thruput.
Impedance: 1 MΩ, 50 pF, nominal.
Full-Scale Signal: ±10V at 0 dB gain; ±100V absolute max.

OUTPUT CHARACTERISTICS
Impedance: 50Ω nominal.
Full-Scale Signal: ±10V, into 5 kΩ.
Noise (1 MHz BW): Better than 80 dB below full scale referred to output at any prefilter gain. <10 μV referred to input at 40 dB prefilter gain.
Harmonic Components: >80 dB below full-scale for 1 kHz input frequency.
Spurious Components: >80 dB below full-scale (includes line related spurious).
Intermodulation Products: >70 dB below full-scale for 90 kHz and 70 kHz input frequencies.
DC Offset: <±50 mV, adjustable to 0 Vdc.

FILTER CHARACTERISTICS
Type: 7-pole, 6-zero elliptic (Cauer).
Rolloff: 115 dB/octave.
Passband Ripple
Low Pass Channel: 0.8 dB, p-p max.
High Pass Channel: 0.8 dB, max; 1.4 dB, p-p max, for f_c >40 kHz, –3 dB at approx. 400 kHz.
Stopband Attenuation
Low Pass channel:
>0.8 dB (DC to f_c).
>40 ±4 dB at 1.34 f_c.
>60 ±4 dB at 1.53 f_c.
>76 dB at 1.7 f_c.
High Pass channel:
>0.8 dB at f_c.
>40 ±4 dB at 0.75 f_c.
>60 ±4 dB at 0.65 f_c.
>76 dB at 0.6 f_c.
Maximum Stopband Attenuation
Low Pass Channel: 90 dB typ; 80 dB min. for f >2 fc.
High Pass Channel: 90 dB typ; 80 dB min for f <0.5 fc.
Amplitude Match: (Model 752A only.) ±0.25 dB, DC to 0.8 fc, ±0.4 dB, 0.8 fc to fc.
Phase Match: (Model 752A only.) ±3° max, DC to 0.8 f_c; ±4° max, 0.8 f_c to f.

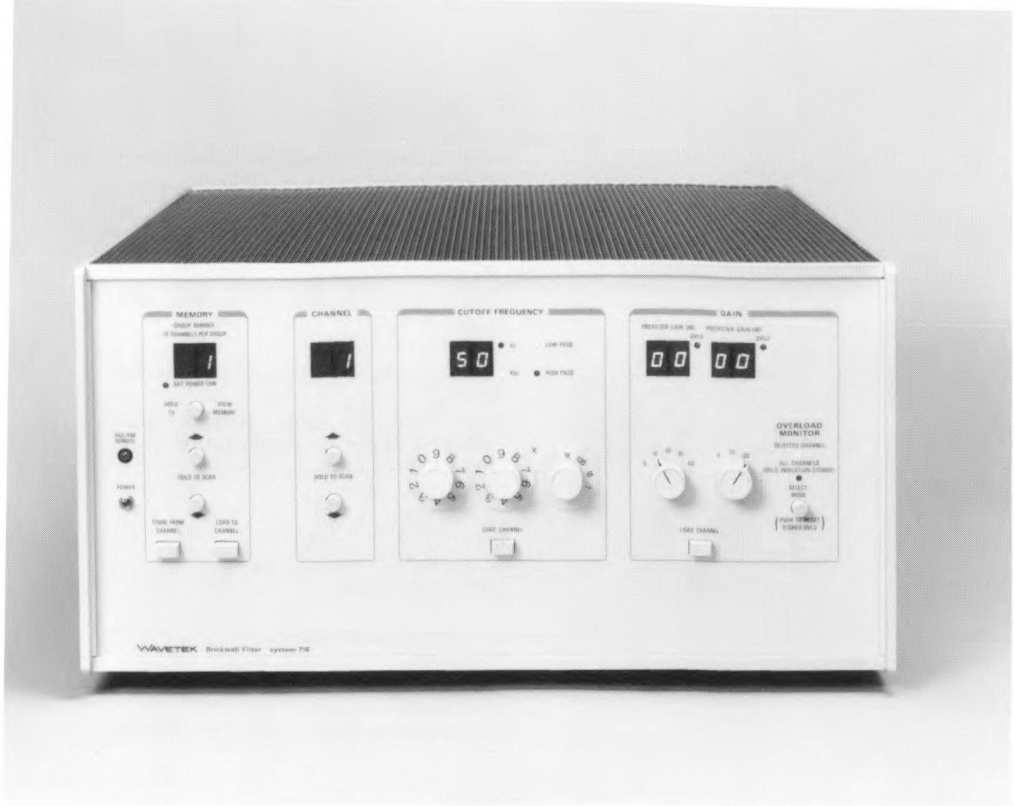
GENERAL
Environment
Operating Temperature: 0° to +40°C.
Storage Temperature: –20° to +70°C.
Dimensions: 43.2 cm (17 in.) wide, 8.9 cm (3.5 in.) high, 33 cm (13 in.) deep.
Weight: 8.2 kg (18 lb) net, 10.5 kg (23 lb) shipping.
Power: 115/230V ±10%, 50 to 60 Hz, 25 watts.

OPTIONS
002: IEEE-488 1978 Bus Interface (GPIB).
IEEE functions: AH1, L1, DT1.

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 752A
Model 753A
Option 002

For a full data sheet or a demonstration contact your local Wavetek representative (pages 211 and 213).



Multi-Channel Brickwall® Filter

- **1 Hz to 100 kHz Frequency Range**
- **115 dB/Octave Rolloff**
- **Pre- and Post-Filter Gain**

System 716, a multichannel programmable filter system, provides near-ideal passband and stopband characteristics in both high pass and low pass filter configurations. Control is local or remote via GPIB. Leading features include: self-diagnostics, storage of up to 16 groups of complete system setups and overload detection.

Configuration

System 716 consists of mainframe and up to 16 independent-channel filter cards.

FILTER CARD OPTIONS 001 AND 002

Functions: Low pass (001) or high pass (002); rolloffs of 115 dB/octave.

Cutoff Frequency

Local Control Range: 1 Hz to 99 kHz.
Remote Control Range: 1 Hz to 100 kHz.

Programming and Resolution:

Multiplier	Frequency	Resolution
x1	1 to 99 Hz	1 Hz
x10	100 to 990 Hz	10 Hz
x100	1k to 9.9 kHz	100 Hz
x1k	10k to 99 kHz	1 kHz

Accuracy

High Pass: +0%, –3.5% max.
Low Pass: –0%, +3.5% max.

Stability: ±200 ppm/°C.

Gain

Pre-Filter Gain: 0, +10, +20, +30, +40 dB (±0.25 dB). One 5-position switch.
Post-Filter Gain: 0, +10, +20 dB (±0.25 dB). One 3-position switch.

Input Characteristics

Impedance: 1 MΩ, 50 pF, nominal.
Full-Scale Signal: ±10V at 0 dB gain; divide by gain for other than 0 dB gain settings.
Absolute Maximum Input: ±100V.
Equivalent Input Noise (at max pre-gain): –150 dBv/√Hz above 50 Hz.

Filter Characteristics

Passband Ripple: 0.8 dB, p-p max (low pass and high pass), 1.4 dB, p-p max for high pass with f_c > 40 kHz.
Stopband Attenuation: 80 dB min for f > 2f_c (low pass), f < 0.5f_c (high pass).
f_x/f_c Ratio: 1.7 low pass; 0.6 high pass.
Amplifier Rolloff: –3 dB at approx. 400 kHz.

Output Characteristics

Impedance: 50Ω, nominal.
Full-Scale Signal: 10V into >5 kΩ.
Harmonic Components (1 kHz Input Frequency): 80 dB below full-scale.
Intermodulation Products (Input frequencies of 70 kHz and 90 kHz): 70 dB below full-scale.
DC Offset: Adjustable to 0V ±50 mV.
Drift (at 0 dB gain): ±50 mV, +15° to +40°C.
Crosstalk Between Channels (Input Source 50Ω or less):
Ref to Output: 85 dB below full scale.
Ref to Input: 110 dB below full scale.
Line Related or Spurious Components (Input Source 50Ω or less): 80 dB below full-scale.

Phase Match Between Channels

Low Pass: ±3° max DC to 0.8 f_c; ±4° max 0.8 f_c to f_c.
High Pass: ±3° max 1.3 f_c to 130 kHz; ±4° max f_c to 1.3 f_c.

Amplitude Match Between Channels

Low Pass: ±0.3 dB max DC to 0.8 f_c; ±0.5 dB max 0.8 f_c to f_c.
High Pass: ±0.3 dB max, 1.3 fc to 130 kHz; ±0.5 dB max, f_c to 1.3 f_c.

MODEL 716-11 MAINFRAME

Memory: 16 selectable groups; each group has storage for 16 channel settings.
Battery Back-Up For Memory: Trickle charged, when unit is powered; 1000 hours nominal back-up and an LED low battery indicator.
Display: 7-segment displays for: Group Number, Channel Number, Pre-Filter Gain, Post-Filter Gain, Cutoff Frequency
Channel Characteristic: LED for high pass or low pass.
Overload Indicators: Two LED's, one for filter input and one for filter output. Two overload modes can be selected: one mode monitors input and output of selected channels; the other mode monitors all channels and indicates which one is overloading.
Remote Programming/Sensing: IEEE-488 1978 (GPIB) digital interface meets the following standards: SH1, AH1, T6, TE0, L3, LE0, SR1, AL2, PP1, DC0, DT0, C0, E1.
Self-Test Diagnostics: Check at power-up; failure mode displayed.
Input/Output Connectors: Rear BNC's.

GENERAL

Environment: 0° to +40°C operation.
Dimensions
43.2 cm (17 in.) wide; 22.2 cm (8 in.) high; 53.4cm (21 in.) deep.
Weight
Mainframe: 15.4 kg (34 lb) net; 26.8 kg (59 lb) shipping.
Filter Card: 0.5 kg (1.2 lb) net; 1 kg (2.2 lb) shipping.
Power
115/230 Vac ±10%, 48 to 400 Hz, 150 watts (less than 7 watts/channel).

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 716-11
Option 001
Option 002

For full specification or a demonstration contact your local Waveteck representative (pages 211 and 213).

SIGNAL PROCESSING FILTERS

MODEL 816

Programmable Multi-Channel Analog Filter

- **0.1 Hz to 150 kHz Range**
- **Up to 16 Independent Channels In 5 in. Panel**
- **48 dB/Octave Rolloff**
- **Butterworth and Bessel Response**

System 816 is a versatile, fully programmable, multichannel filter system capable of processing up to 16 independent analog signal channels. Two 48 dB/octave responses are available: an 8 pole Butterworth and an 8 pole Bessel. The Butterworth lowpass configuration may be altered to highpass; combining two channels gives bandpass and band-reject filters.

16 Channel Capability

System 816 consists of mainframe and plug-in filter cards. The mainframe provides local, on-card, and remote programming, readout, power and connections for up to 16 independent channels. One filter card is required for each channel.

FUNCTIONS

Butterworth: Lowpass and highpass that may be combined for bandpass and band-reject filters.

Bessel: Lowpass only.
Rolloff: 48 dB/octave/channel.
Cutoff Frequency
Accuracy: ±2% (±3% on highest multiplier).
Resolution: 15 different values (1 to 15) for each of 4 multiplier ranges.
Range Options: (see Table 1).
Filter Card Compatibility: Mixing in a common mainframe of Butterworth and Bessel cards having different frequency ranges is permissible.
Filter Bypass: Obtained by selecting no multiplier range and a units value of 15. The filter operates as a DC amplifier with unity gain. Either lowpass Butterworth or Bessel cards may be used in this mode.

Gain: 0 dB ±0.25 dB.
Input Characteristics
Circuit: Single-ended; DC isolated from power ground.
Impedance: 1MΩ shunted by 50 pF.
Full Scale Signal: ±10 Vp-p.
Absolute Max Input: ±100V.
Output Characteristics
Circuit: Single-ended, DC isolated from power ground.
Impedance: 50Ω.
Full Scale Signal: ±10V, ±20 mA into 50Ω (typical).
Noise and AC Line Related Spurs (100 kHz Detector Bandwidth): 80 dB below full-scale (input shorted).
Distortion: <0.1%.
DC Offset: 0 ±10 mV.
Drift: 0.5 mV/°C (typical).
Phase Match between Channels: ±2° or ±2%, whichever is greater.

PROGRAMMING/SENSING

Standard: Front panel toggle switches, on-card programming and 17 remote TTL compatible lines.
Programming Delay: <3 ms for any function.

GENERAL

Accessories Supplied: Three mating connectors and operating manual.
Environment: Operating 0° to +50°C. Storage –20° to +70°C.
Dimensions (Mainframe): 48.3 cm (19 in.) wide; 13.3 cm (5.25 in.) high; 48.3 cm (19 in.) deep.
Weight
Mainframe: 10.9 kg (24 lb) net; 14.6 kg (32 lb) shipping.
Filter Card: 0.5 kg (1 lb) net; 1 kg (2 lb) shipping.
Power: 115/230V ±10%, 50 to 60 Hz, 200 watts, max. (less than 13 watts per channel).

Table 1. Cutoff Frequency Range Options

Mainframe	Option Filter Cards		Multiplier	Overall Frequency Range
	Butterworth (LP, HP)	Bessel (LP only)		
816-11	001	005	x10, x100, x1K, x10K	10 Hz to 150 kHz
816-12	002		x1, x10, x100, x1K	1 Hz to 15 kHz
816-13		007	x0.1, x1, x10, x100	0.1 Hz to 1.5 kHz

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 816-11
Model 816-12 or -13
Option 001
Option 002
Option 005
Option 007

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

Signal Switching Systems

The signal switching system has always been the heart of an ATE station. Without the switch, the programmable test equipment is useless. Until Wavetek introduced the Model 600 Programmable Signal Switcher, only large, expensive matrixes were available. Not only did they usually consume excess power, their ability to switch a variety of signal types left something to be desired. The small ATE designer and the bench top R&D engineer were forced to jury-rig something on their own.

The series 600 Signal Switching System gives you all the components you need for a wide variety of requirements. Just by inserting different modules, as many as three, into the Model 601 mainframe, you can switch signals with frequencies from DC to 26 GHz, handle microvolt signals and several hundred watt power lines. You can even do matrix switching, all in the same system. With the addition of the four-slot expansion chassis, your system can contain up to seven modules-that's over 130 channels.

The system is completely modular. The series 600 has been designed around the real-world needs of testing. One of the most important needs is front panel rack space. The Model 601 mainframe and Model 602 expansion chassis are each just eight inches deep. This allows you to mount them in either the front or rear of a standard rack. If you will be operating the system over the GPIB, and won't need a control panel, you can use the front part of the rack for other instruments. On the other hand, if manual control is needed, the Model 603 control panel can be mounted on the face of the rack or directly onto the mainframe to create a bench top instrument.

In addition to GPIB programmability, the mainframe provides a backup memory for up to 50 frequently used test setups, plus switch delay and trigger capabilities. On the GPIB bus, the stored settings can be recalled and executed with a single command. Manually, they can be stepped through by applying a trigger signal to the trigger input. The trigger output generates a signal that can be used to inform the operator when the last relay action has been completed. This feature is also useful in an automatic station. The output trigger says it's time to make a measurement.

As mentioned above, the versatile Series 600 Switching System can be easily and quickly configured for either ATE operation or bench top use.

Uses for Series 600 include microwave switching, board and component testing, power cycling, R&D, signal processing, data decoding, acceptance testing, test point monitoring, vibration analysis and machine condition monitoring. The complete modularity of Series 600 allows it to be used for a multitude of applications.

SIGNAL SWITCHING SYSTEM SELECTION GUIDE

Model	Function	Max Frequency	No. of Switches	Contact Type/Rating	Page	
Model 600 Signal Switching System (Accepts Modules)						
601	Main Chassis		Accepts 3 plug-in switch modules		175	
602	Expansion Chassis (with 1 ft cable)		Accepts 4 plug-in switch modules		175	
603	Control Panel				175	
Plug-in Modules for 601 and 602 Chassis						
610	A-Band RF Switching	200 MHz	10	200V, 0.5A, 10W	176	
611	B-Band RF Switching	500 MHz	10	100V, 2A, 60W	176	
612	Matrix/RF Switching	250 MHz	16 (4 x 4)	100V, 2A, 60W	176	
613	General Purpose I/O (Output on 50-pin sub-min. "D" Connector; also 2 lines each have 50Ω BNC Output)	N/A	16 Channels	16 TTL Drivers (+20/-10 mA per line) and 16 Relay Drivers with 40V/200 mA drive capability	176	
614	High Power Switching	N/A	5	250 VAC, 5A, Max 500 VA	177	
615	Low Level Switching	≤1 MHz	10	100V, 200 mA, Max 5W, <0.2Ω, <1 μV	177	
616	J-Band Microwave Switching	18 GHz	2	70V, 1.4A (N.S.)	177	
617	Attenuation (0 to 85 dB,1 dB steps, 2 sections)	250 MHz	2 Sections	100V, 2A, 5W Continuous Power	178	
618	D-Band RF Switching	1.5 GHz	10	100V, 2A, 60W	178	
619	Breadboard/ Customer defined	Customer defined	16 Channels	1 LS TTL per each of 16 lines	178	
620	K-Band Microwave Switching	26.5 GHz	4	Max 250 W at 100 MHz; derates to 15 W at 26.5 GHz	179	
622	20 Channel Module	50 MHz	Configure into 4 x 5, 2 x 10, 1 x 20	200 Vdc, 250 Vac, 2A, 60W	179	

SIGNAL SWITCHING SYSTEM

MODELS 601 THRU 622

Signal Switching System

- **Small Size, Low Cost, High Performance**
- **Wide Variety of Switch Modules**
- **GPIB and Stored Settings Standard**

The 600 Signal Switching System fills a wide variety of requirements. By inserting different modules into the three-slot 601 mainframe, you can switch at rates from DC to 26 GHz, handle microvolt signals, several-hundred watt power lines, and even matrix switching. Add the four-slot expansion chassis, and your system can contain over 100 channels.

MODEL 601 CHASSIS

Switch Module Slots: Three.

Programming: Control of Model 601 and switch modules is via the GPIB or Model 603 control panel. Parameters are: Module Number, Switch Number, Open/Close, Delay Mode, Delay Time, Group Make Before Break, Group Break Before Make, Group Immediate, Trigger Slope, Execute and Reset.

Delay Mode: Actuation modes are: open and close immediately; delay on open; delay on close; delay on both.

Stored Settings: A stored setting holds the configuration of every switch in the system. Fifty settings can be stored, recalled, or deleted via the GPIB or control panel, incremented via an external trigger or GPIB, and are non-volatile (backed by battery for 6 months minimum).

GPIB Programming: IEEE-488 1978 compatible, non-isolated, double buffered.

Address: 0 to 30; externally switch selectable.

Subsets: SH1, AH1, T6, TE0, L4, SR1, RL1, PP0, DC1, C0, E2.

Interface Timing: All parameters <25 ms.

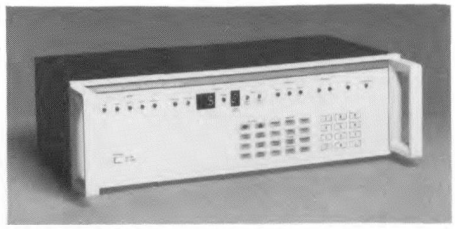
External Trigger Input: Switch closure or TTL change increments stored setting by one. 50 kΩ input impedance. Slope is programmable.

Trigger Output: TTL level change occurs at the completion of the longest switch delay. 500Ω source impedance.

MODEL 602 EXPANSION CHASSIS

Switch Module Slots: Four.

MODEL 603 CONTROL PANEL



Programming and Stored Settings
See Model 601, Chassis.

Displays

Module: Number.
Switch: Number, delay, delay increment open/closed, delay open/closed.
Stored Settings: Store, recall, delete.
Trigger: On rising edge, on falling edge, off.
Execute: Error, execute required.
GPIB: Address, talk, listen, remote, SRQ.

Controls

Switch: Module, number, delay, mode, open, close.
Stored Settings: Store, recall, delete.
Group: Make first, break first, immediate.
Trigger: Input.
GPIB: Address, SRQ, local.
Tone: On/Off.
Power: On, standby.
Misc: 0-9 keypad, clear entry, reset, execute.

GENERAL

Environment

Temperature Range: 0° to +50°C.
Warm-up Time: 0 hours.
Altitude: Up to 10,000 ft for operation. Sea level to 40,000 ft for storage.
Relative Humidity: 90% at +20°C and at sea level (non-condensing).

Dimensions

Model 601 and 602

Width: 43.2 cm (17 in.).
Height: 13.3 cm (5.25 in.).
Depth: 20.3 cm (8 in.).

Model 603

Width: 43.8 cm (17.25 in.).
Height: 13.3 cm (5.25 in.).
Depth: 4.4 cm (1.75 in.) excluding handles.

Weight

Model 601: 5.2 kg (11.5 lb) net; 6.8 kg (15 lb) shipping.
Model 602: 3.8 kg (8.5 lb) net; 5.9 kg (13 lb) shipping.
Model 603: 1.6 kg (3.5 lb) net; 3.2 kg (7 lb) shipping.

Mounting: Chassis can mount at front or rear of a standard 19 inch rack or be placed on a shelf or bench. Optional control panel can be remote or attached to Model 601.

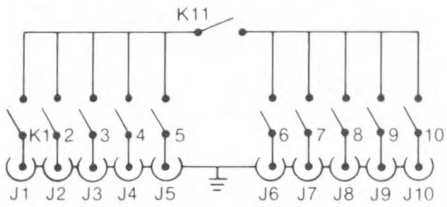
Power Required: 90 to 108, 108 to 130, 198 to 238, or 216 to 259 Vac; 48 to 66 Hz; 1 phase; less than 40W.

SIGNAL SWITCHING SYSTEM

MODELS 601 THRU 622

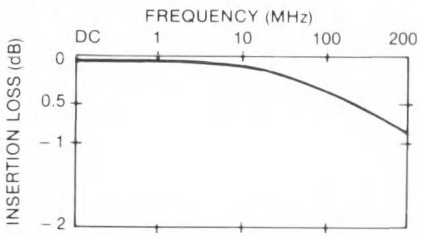
Power Distribution: The following power is available for modules:
Model 601: 10W at 12V, 1.5W at 5V.
Model 602: 12W at 12V, 1.5W at 5V.
The total number of switches turned on must not exceed this power. (See individual module specifications.)

MODEL 610 200 MHZ, 10-CHANNEL MODULE



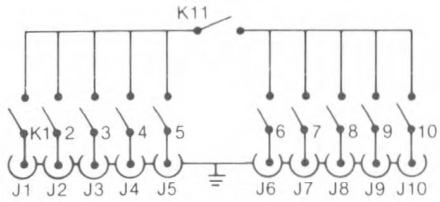
Model 610, a 200 MHz RF module, gives maximum flexibility with two sets of five relays in a modified star. Any I/O connector can be connected to any other or to multiple I/O connectors; all can be disconnected as well. The two groups of five relays can be connected together via another relay.

Insertion Loss: ≤0.5 dB at 100 MHz.
Bandwidth: ≥200 MHz at -3 dB.
Cross Talk: Any channel to any channel; all switches open:
10 MHz: ≤-75 dB
100 MHz: ≤-55 dB
200 MHz: ≤-50 dB
Isolation: One signal path, input to output; one switch open:
10 MHz: ≤-55 dB
100 MHz: ≤-40 dB
200 MHz: ≤-35 dB
Rise Time: ≤2.0 ns.
Max V/A/W: 200V, 0.5A, 10W.
Contact Resistance: ≤0.15Ω/switch.
Typical Insertion Loss:



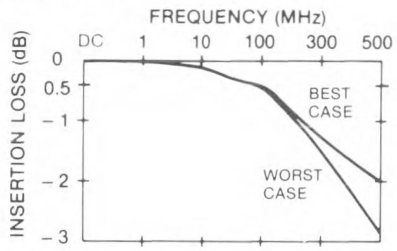
VSWR (Typical):
≤1.1:1 at 25 MHz,
≤1.2:1 at 95 MHz.
Switching Time: ≤2 ms.
I/O Connections: 10 BNC, female.
Power Consumption:
1.0 W max at 12V
0.1 W per switch.

MODEL 611 500 MHZ, 10-CHANNEL MODULE



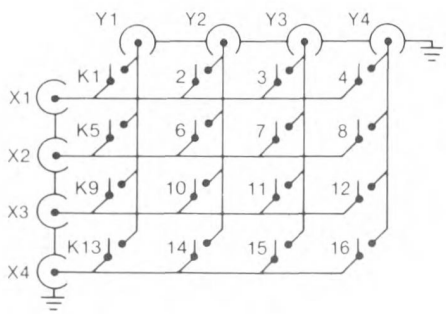
Model 611, a 500 MHz RF module, gives maximum connection flexibility by providing two sets of five relays in a modified star configuration.

Insertion Loss: ≤0.5 dB at 100 MHz.
Bandwidth: ≥500 MHz at -3 dB.
Rise Time: ≤1.0 ns.
Cross Talk: Any channel to any channel; all switches open:
10 MHz: ≤-100 dB
100 MHz: ≤-90 dB
500 MHz: ≤-60 dB
Isolation: One signal path, input to output; one switch open:
10 MHz: ≤-70 dB
100 MHz: ≤-60 dB
500 MHz: ≤-50 dB
Max V/A/W: 100V, 2A, 60W.
Contact Resistance: ≤0.10Ω/switch.
Typical Insertion Loss:



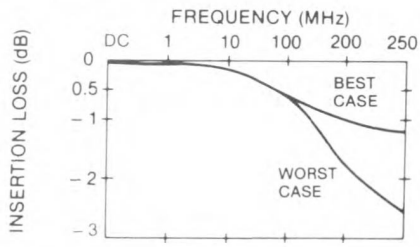
VSWR (Typical):
≤1.1:1 at 25 MHz,
≤1.2:1 at 95 MHz.
Switching Time: ≤10 ms.
I/O Connections: 10 BNC, female.
Power Consumption:
3.3 W max at 12V
0.3 W per switch.

MODEL 612 250 MHZ MATRIX MODULE



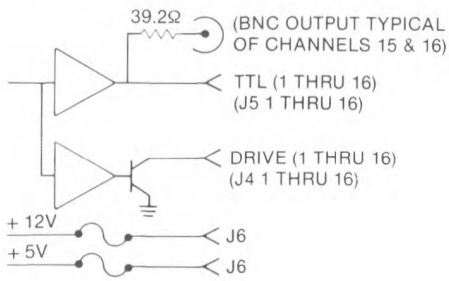
Model 612, a 250 MHz RF module, gives the ultimate in switching flexibility. The module is a 4 x 4 matrix allowing any port to be connected to any other port independently or all together and at the same time.

Insertion Loss: ≤0.75 dB at 100 MHz.
Bandwidth: ≥250 MHz at -3 dB.
Rise Time: ≤2.0 ns.
Cross Talk: Any channel to any channel; all switches open:
10 MHz: ≤-75 dB
100 MHz: ≤-70 dB
250 MHz: ≤-60 dB
Isolation: One signal path, input to output; one switch open:
10 MHz: ≤-70 dB
100 MHz: ≤-60 dB
250 MHz: ≤-50 dB
Max V/A/W: 100V, 2A, 60W.
Contact Resistance: ≤0.15Ω/switch.
Typical Insertion Loss:



VSWR (Typical):
≤1.1:1 at 10 MHz,
≤1.35:1 at 50 MHz.
Switching Time: ≤10 ms.
I/O Connections: 8 BNC, female.
Power Consumption:
4.5W max at 12V;
0.3W per switch.

MODEL 613 GENERAL PURPOSE, 16-CHANNEL DRIVER MODULE

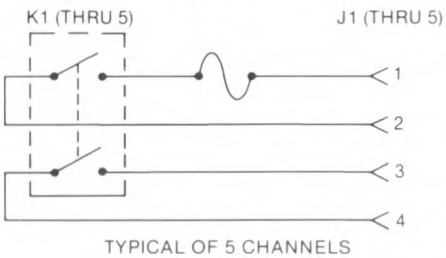


Model 613, a general purpose driver module, can drive external devices such as your own microwave switches. It provides 16 channels of both TTL level

drive and parallel +12V, 300 mA open collector drive. To conveniently trigger external devices, two channels have additional BNC outputs. Separately fused +12V and +5V supplies are available.

I/O Connections: 50-pin subminiature "D" connector and 48-screw terminals.
TTL Output: +20/-10 mA maximum per channel.
Max Collector Voltage: +40 Vdc.
Max Collector Current: 200 mA.
+5V Supply: 100 mA maximum load.
+12V Supply: 300 mA maximum load.
Output Power Available:
3.6W max at 12V;
1.0W max at 5V.

MODEL 614 HIGH POWER MODULE

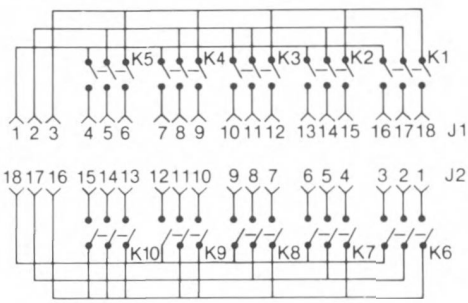


TYPICAL OF 5 CHANNELS

Model 614 switches high voltages and currents such as line voltages and power supplies. One side of the double pole relays is fused with the fuse holders conveniently located on the outside of the module. Also, two insulating covers shield top and bottom of module to protect the user from external high voltage.

Contact Rating:
5A at 30 Vdc,
3A at 125 Vac,
2A at 250 Vac.
Contact Resistance: ≤0.07Ω per contact.
Switching Time: ≤20 ms.
I/O Connections: 20 screw terminals.
Standard Fuse: 5A, fast blow.
Power Consumption:
1.8W max at 12V;
0.36W per switch.

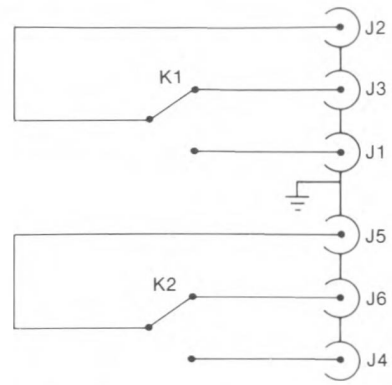
MODEL 615 LOW LEVEL 10-CHANNEL MODULE



Model 615, a low level, 10 channel module, switches very low level dc signals with relays that contribute no significant amount of thermal emf. There are two sets of five relays. Each relay is three-pole, single-throw for switching high, low and guard.

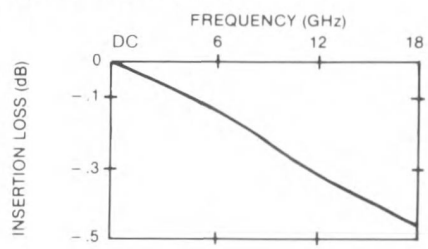
Signal Level: 100V, 200 mA, 5W.
Contact Resistance: <0.2Ω per contact.
Insulation Resistance: $>10^{12}\Omega$, <5 pF.
Contact Potential: <1μV after 20 min warm-up (output to copper leads).
Switching Time: ≤2 ms.
I/O Connections: 36 screw terminals.
Power Consumption:
0.8W max at 12V;
0.08W per switch.

MODEL 616 DC TO 18 GHZ MICROWAVE MODULE



Model 616, a dc to 18 GHz microwave switch module, provides the ultimate in RF switching quality. This module provides two channels of SPDT switching with 18 GHz bandwidth.

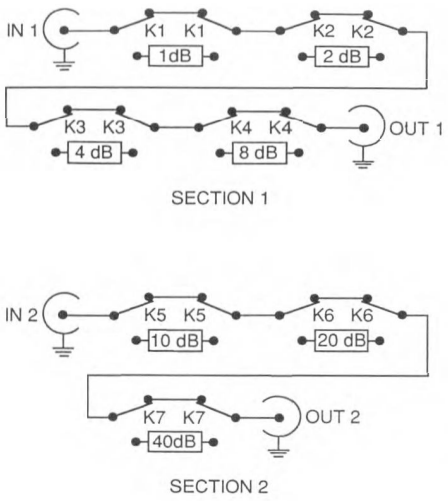
Insertion Loss: ≤0.5 dB at 18 GHz.
Isolation: ≥60 dB at 18 GHz.
VSWR: ≤1.50:1 at 18 GHz.
Switching Time: ≤30 ms.
Switch Power: 100W at 100 MHz decreasing to 7.5W at 18 GHz.
Switch Rating: 70V, 1.4A no switching.
I/O Connections: 6 SMA female connectors.
Power Consumption:
4.5W max at 12V;
2.25W per switch.
Typical Insertion Loss:



SIGNAL SWITCHING SYSTEM

MODELS 601 THRU 622

MODEL 617 250 MHZ ATTENUATOR MODULE



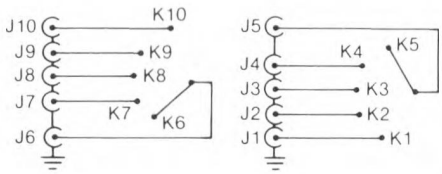
Model 617, a 250 MHz 5W attenuator, gives maximum flexibility by using two sections to provide up to 85 dB of attenuation in 1 dB steps. Section 1 contains four cells in 1, 2, 4, and 8 dB steps for a total attenuation of 15 dB. Section 2 contains three cells in 10, 20, and 40 dB steps for a total attenuation of 70 dB.

Rise Time: ≤1 ns.
Max V/A/W: 100V, 2A, 5W.
Contact Resistance: ≤0.5Ω input-output.
VSWR:
≤1.16 at 100 MHz;
≤1.4 at 250 MHz.
Switching Time: ≤10 ms.
Configuration: Two sections.
Accuracy (±dB): See table 1.
Attenuation:
Section 1: 1, 2, 4, and 8 dB.
Section 2: 10, 20, and 40 dB.
Impedance: 50Ω.
I/O Connections: 4 BNC, female.
Power Consumption:
2.3W max at 12V;
0.3W per switch.

Table 1. Accuracy

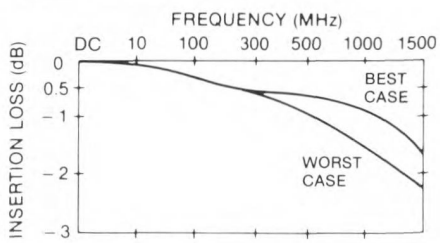
Frequency (MHz)	Attenuation Range (dB)				
	0-15	16-30	31-50	51-60	61-85
DC-1	0.5	0.5	1	1	2
1-10	0.5	1	1.5	2	3
10-100	1	1.5	2	3	—
100-250	2	2.5	3	—	—

MODEL 618 1.5 GHZ, DUAL 1 of 4 MODULE

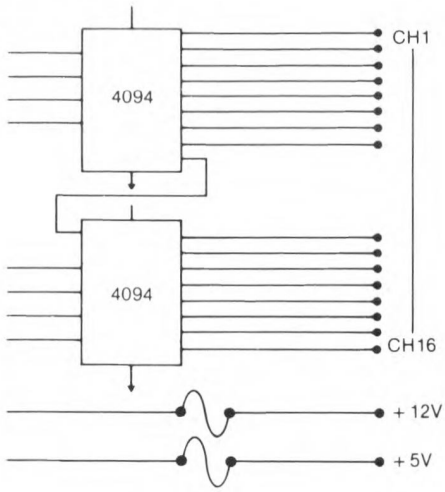


Model 618 offers outstanding 1.5 GHz RF performance at a very attractive cost per channel. The module has two sets of 1 of 4 channels. Switch actuation mode is always break before make.

Insertion Loss: ≤0.5 dB at 100 MHz.
Bandwidth: ≥1.5 GHz at -3 dB.
Rise Time: ≤0.5 ns.
Cross Talk: Any channel to any channel; all switches open:
10 MHz: ≤-100 dB
100 MHz: ≤-95 dB
1.5 GHz: ≤-40 dB
Isolation: One signal path, input to output; one switch open:
10 MHz: ≤-100 dB
100 MHz: ≤-90 dB
1.5 GHz: ≤-40 dB
VSWR (Typical): ≤1.1:1 at 200 MHz, ≤1.25:1 at 500 MHz.
Max V/A/W: 100V, 2A, 60W.
Contact Resistance: ≤0.25Ω/switch.
Switching Time: ≤10 ms.
I/O Connections: 10 BNC, female.
Power Consumption:
3.3W max at 12V;
0.3W per switch.
Typical Insertion Loss:



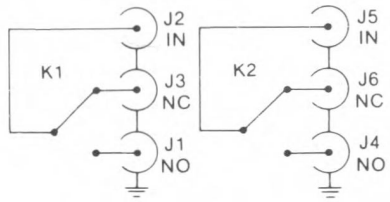
MODEL 619 UNIVERSAL BREADBOARD MODULE



Model 619, a breadboard module with all driver circuitry, breadboard space, and I/O terminals, allows you to build a custom switching module. The 7 by 2.7 inch breadboard space with 0.1 inch universal hole pattern, provides an area for mounting many standard relays, IC's and other components. You can program this "custom" module by addressing the 16 logic lines, just as you would any switch on other modules. A "close" command causes the channel output to go high and an "open" command results in a low output.

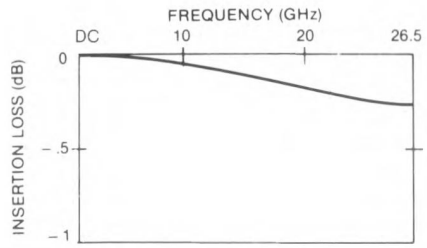
I/O Connections: Two terminal blocks with 12 screw connections each.
Driver Outputs: 16 channel low power (one LS TTL load per channel).
Supply Voltage: 300 mA max. at +12V; 100 mA max at +5V.
Breadboard Space: 7 by 2.7 in.
Hole Pattern: 0.1 in. matrix (66 by 29 holes).
Hole Size: 0.046 in.
Maximum Allowable Component Height:
Above board surface: 0.7 in.
Below board surface: 0.15 in.
Maximum Allowable External Supply: 42V, 1A, 5W.

MODEL 620 DC TO 26.5 GHZ MICROWAVE SWITCH MODULE



Model 620, a DC to 26.5 GHz microwave switch module, provides the maximum bandwidth available in a standard programmable plug-in. This module provides two channels of single-pole, double-throw, break-before-make switching with excellent power rating and 26.5 GHz bandwidth.

Insertion Loss: ≤1 dB at 26.5 GHz.
Isolation: ≤-40 dB at 26.5 GHz;
≤-50 dB at 20 GHz;
≤-70 dB at 12.4 GHz.
Typical Insertion Loss:

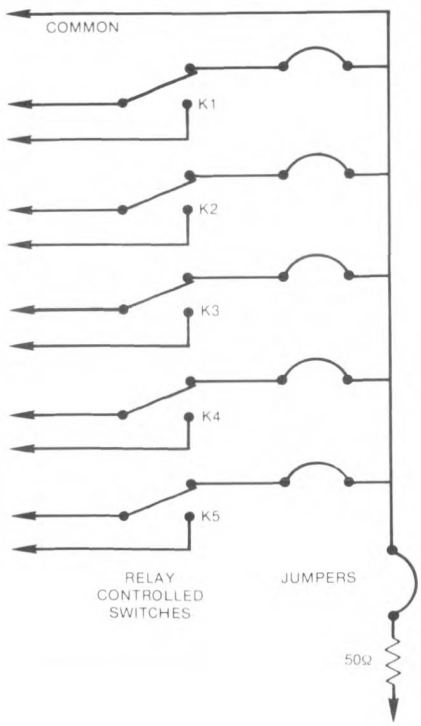


Impedance: 50Ω.
VSWR: ≤1.65:1 at 26.5 GHz.
Switching Time: ≤15 ms.
Switching Power: 250W at 100 MHz derated to 15W at 26.5 GHz.
I/O Connections: 6 SMA female connectors.
Power Consumption: 6W max at 12V; 3W per switch.

MODEL 622 50 MHZ, 20-CHANNEL MODULE

Model 622, a 50 MHz general purpose switching module offers switching flexibility for a multitude of applications. The module can be configured as a 4x5, a 2x10 or a 1x20 matrix either terminated or unterminated. The relays can switch up to 60 VA with a maximum voltage rating of 250V and maximum current rating of 2A. The quick connect/disconnect type terminal block makes installation and wiring very easy for this high density module. Although module bandwidth is typically 150 MHz, isolation and crosstalk due to small relays and connector type limit the practical use of the module to frequencies below 50 MHz.

Switch Diagram
(Typical of 1 of 4 Groups.)



Insertion Loss: ≥0.1 dB at 50 MHz.
Bandwidth: ≥100 MHz at -3 dB.
Crosstalk/Isolation: -48 dB at 100 kHz.
-35 dB at 5 MHz.
-17 dB at 50 MHz.
Max V/A/W: 200 Vdc, 250 Vac, 2A, 60W.
Contact Resistance: ≤0.1Ω/sw.
Switching Time: ≤5 ms.
I/O Connections: 4 each 12 pin quick connect/disconnect type.
Power Consumption: 0.2 Watt/sw 4.0 Watt max per module.

Notes:
- *Jumpers can be removed or installed as desired.*
- *Commons of groups can be interconnected as required.*
- *50Ω resistor is installed as a standard but can be removed or replaced by a different value as applications require.*

FACTORY/FOB
San Diego, CA

ORDER INFORMATION
Model 601
Model 602
Model 603
Model 610
Model 611
Model 612
Model 613
Model 614
Model 615
Model 616
Model 617
Model 618
Model 619
Model 620
Model 622

For full specifications or a demonstration, contact your local Wavetek representative (pages 211 and 213).

Broadband Overview

Today's cable TV system operators, as in years past, have a fundamental task of transporting distortion-free video signals to their subscribers. These efforts generally include: the collection of video services, the combining of these services into an orderly channel plan, and the distribution of these signals throughout the area of coverage. To date, the most cost effective medium for transportation of these services has been 75 Ω coaxial cable, along with line amplifiers and distribution passives. This equipment, when properly designed and maintained, will provide excellent picture quality over an extremely long life span.

To maintain a broadband system, one should consider four primary categories of test equipment:

- Signal Level Meters
- Sweep Frequency Systems
- Spectrum Analyzers
- Leakage Monitoring Equipment

Each category fulfills a separate, but dependent testing requirement in the operation of a well maintained broadband system.

Signal Level Meters
Signal Level Meter, as the name implies, are used to verify signal strength throughout the cable network. These instruments are generally light-weight and small, and are capable of with standing the rugged field environment demanded by system topology. Many come with other testing features, such as carrier-to-noise and hum modulation, which allow further evaluation of broadband performance.

Signal level meters are usually designed with a specific application in mind. Some have accuracies and features suited best for amplifier alignments and trouble shooting, whereas others were intended for simple measurements at the installer level. Wavetek manufactures many models and is prepared to assist the cable operator in selecting the best unit for the application.

Sweep Frequency Systems
Sweep Frequency Systems are used to determine a cable system's overall frequency response. This is an important test, as amplitude variations over frequency can cause degraded picture quality. The sweep system will alert the operator of response problems, standing waves, loose fitting and other discontinuities.

Wavetek has specialized instruments for system sweep, along with many years of technical support experience. Our equipment has been designed with precision and ease of use in mind, using field proven production practices. Whether high level, low level or no level, Wavetek has the sweep to suit the application.

Spectrum Analyzers
Any technician who has used an oscilloscope understands the value of visual inspection of complex waveforms. This value can also be realized in the frequency domain by using a device called a spectrum analyzer. Spectrum analyzers display amplitudes as a vertical deflection and frequency as a horizontal deflection on a CRT. This yields to the technicians, a visual reconstruction of the RF spectrum. Visual tests range from simple amplitude relationships to noise buildup, non-linear distortion testing, and ingress.

Wavetek produces a line of analyzers specifically designed for the cable environment. These microprocessor controlled units, called system analyzers, make daily testing and distortion analysis easy and precise, even for the inexperienced operator

Leakage Monitoring Equipment
Mechanical failures, such as loose fittings or defective equipment housings, can cause cable signals to "leak" into free space. As this leakage has the potential to interfere with other forms of radio wave communications, it must be kept under close surveillance by the cable operator.

Wavetek produces equipment specifically designed to monitor and measure the amount of cable leakage. This equipment, when incorporated into a well defined preventive plan, can help the operator find and repair system leaks which might otherwise go unnoticed.

Throughout this section we refer to Lexan. Lexan is a registered trademark of the General Electric Corporation.

Installer Meter

- **Signal Level Measurement to 550 MHz**
- **LCD Display of Measured Signal Level**
- **Auto-ranging & Over/Under Indicators**
- **Three Frequencies, Auto-off with Reset**
- **User Programmable Frequencies**

Utilizing advanced phaselock technology, the MicroSAM is a very compact digital signal level meter. Primarily intended for use by Cable TV installers, the MicroSAM is a versatile meter that is valuable in a wide range of Broadband applications. Due to it's versatility, accuracy, and size the MicroSAM can also be used by system personnel to verify various system levels and perform limited trouble shooting.

Frequency Mobility
The MicroSAM provides individual pushbutton selections for "Low", "Mid", and "High" frequencies or channels. With three measured frequencies instead of two, an installation can be more accurately performed. Each button is user configurable by dipswitch and has a wide tuning range up to 550 MHz (refer to product specifications). The dipswitches are located under an easy access front panel.

Precision Measurements
The MicroSAM measures and displays signal level on a high contrast LCD display. An Auto-ranging attenuator provides a wide 40 dB input range for the unit. At the simple push of a button, level is precisely displayed.

Mechanically Solid
The MicroSAM meter is constructed using the most modern design and assembly practices. The case is constructed of durable ABS plastic which withstands abuse over temperature and time. The front panel is constructed of LEXAN® with sealed membrane pushbutton switches. Resistance against moisture is therefore achieved. Each unit comes with a protective case and detachable shoulder strap. Clear windows in the protective case allow use of the MicroSAM without removal.

Simple To Use
After programming the MicroSAM to the desired frequencies/channels, a user simply connects the unit to the cable. Pressing a button will display the measured level for 5 seconds. The unit will then automatically shut off. If a second button is selected before the 5 second time-out, the unit will tune to the new frequency and display the level. If a signal is out of the MicroSAM's operating range, an "Under" or "Over" range LED will illuminate. The LCD display also provides a low battery indication which provides ample warning of limited battery life. A slide off panel allows replacement of batteries in a few seconds.

SPECIFICATIONS
Channel Programming, any Button
NCTA Standard & HRC)
Channels

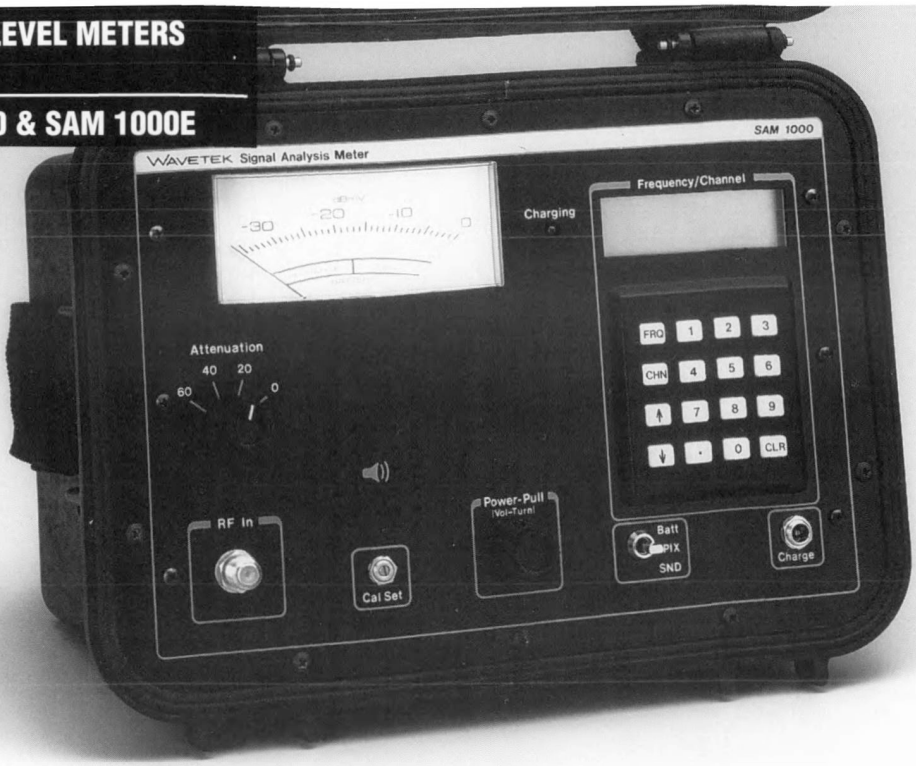
2-6	(54.00-85.25 MHz)
10-13, 23, 24	(192.00-223.25 MHz)
29-34	(252.00-283.25 MHz)
52-57	(390.00-421.25 MHz)
72-77	(510.00-541.25 MHz)

Frequency Accuracy
+.02%
Level Measurement Range
-22 dBmV to +22 dBmV
Level Accuracy
±1.5 dB, 15°Cto30°C
±2.0 dB, 0°C to 50°C
Relative to reading @ 1 5°C to 30°C
Input Impedance
75 Ohms
Return Loss
> 14 dB
Spurious/Intermod
≥20 dBc, 77 channels @
+20 dBmV
IF Bandwith
280 kHz ±50 kHz
Display
31/2 Digit LCD display, over/under range indicator LEDs
Display Resolution
0.1 dB

GENERAL
Batteries
(2) 9 Volt Alkaline
Case
Impact resistant ABS plastic
Dimensions
17.53 cm (6.9 in) high; 8.64 cm (3.4 in) wide; 3.81 cm (1.5 in) deep.
Weight
.499 kg (18 oz.)
Accessory
Protective case with detachable shoulder strap – included.

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model MicroSAM



Signal Level Meter

- **Synthesized Tuning to 557 MHz**
- **Measures Horizontal Sync Suppression Scrambled Channels Accurately**
- **Weatherproof**
- **Reliable Four Position Electronic Attenuator**
- **Switch Selectable Video/Audio Tuning**

Easy To Use
The SAM 1000 incorporates digital control to make its operation extremely simple. Tuning is as simple as entering the digits of the desired channel or frequency and then pressing the channel or frequency key. The exact channel or frequency to which the meter is tuned is displayed on the wide temperature range LCD display. Phaselocked loop circuitry ensures that the tuning is accurate and stable. The level is given on an easy to read analog meter, and is accurate even on horizontal sync suppressed channels.

Reliable
The SAM 1000 contains an electronic attenuator, which has proven to be more reliable (can withstand many more operations) than the mechanical attenuators used on other SLMs. The Lexan® case has been proven reliable in years of field use.

Weatherproof
The SAM 1000 has been thoroughly tested through temperature and humidity ranges. The LCD display (usually sensitive in extreme weather conditions) was given special attention in these tests to ensure that it works well in harsh environments. This meter performs well from -10 to +130° F, and to 95% humidity.

Fits Your Application
The SAM 1000 tunes from 50 to 557 MHz in a user selectable format: Standard, HRC, IRC, or Jerrold. The frequency range can be extended with a 4.5 to 50 MHz subband option. A SAM 1000 with a UHF option can tune from 4.5 to 890 MHz (options installable only at factory). The SAM 1000E allows user selectable formats for popular European plans (PAL-B/G, PAL-A, BLG-AP, GmbH-2).

SAM 1000 & SAM 1000E

SPECIFICATIONS (SAM1000)

Frequency Range
Standard 50—557.875 MHz
Sub-band Option—4.5-557.875 MHz
Sub/UHF Option—4.5-890 MHz

Format
User selectable (dip switch), Standard, HRC, IRC, Jerrold

Tuning Accuracy
±20kHz (4.5-557.875) @ 25°C.
±35 kHz all temperature ranges.
±50 kHz (557-890 MHz).

Level Measurement Range
-35 to +60 dB

Accuracy
±0.75 dB, at 70°F; ±2.0 dB, 0 to 120°F; (50-550 MHz)

Tuning
6 MHz (channel mode)
125 kHz (frequency mode)

IF Bandwidth
280 ±50 kHz at 3 dB point

Selectivity
Sufficient to distinguish 2 FM signals of equal amplitude 600 kHz apart. Sufficient to measure audio carrier in presence of upper channel video carrier 40 dB greater in amplitude.

SPECIFICATIONS (SAM1000E)

Frequency Range
Standard 47 - 557.875 MHz
Low Option 4.5 - 557.875 MHz
Low/High Option 4.5 - 890 MHz

Format
User selectable (dip switch), PAL-B/G, PAL-A, BLG-AP, GmbH-2.

Tuning Accuracy
±20kHz (4.5-557.875) @ 25°C.
±35 kHz all temperature ranges.
±50 kHz (557-890 MHz).

Level Measurement Range
±25 dBµV to +120 dBµV
Accuracy
±0.75 dB, at 21°C; +2.0 dB, -18°to+55°C; (47-557.875MHz)

Tuning
6, 7, 8 MHz based on channel plan
125 kHz (frequency mode)
IF Bandwidth
280 kHz ±50 kHz at 3 dB point

Selectivity
Sufficient to distinguish 2 FM signals of equal amplitude 600 kHz apart. Sufficient to measure audio carrier in presence of upper channel video carrier 40 dB greater in amplitude.

GENERAL

Case
Impact resistant Lexan® plastic, water resistant.

Battery Life
≥8 hrs. normal operation, intermittent on/off operation (50% Cycle). Rechargeable NiCads, wall mount transformer/ battery charger included, 120 VAC or 220 VAC.

Dimensions
22.2 cm (8 3/4 in) wide; 16.5 cm (6 1/2 in) high; 16.5 cm (6 1/2 in) deep.

Weight
3.4 kg (7 1/2 lb)

Options
- Low Frequency (4.5 - 557.875 MHz Coverage)
- Low/High Frequency (4.5 - 890 MHz Coverage)
- SAM 1000 Canvas Bag/ Accessory Kit
- Sky-2: Lid Mount Strand Hooks
- Level readout in dBmV (SAM 1000E)

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model SAM 1000
Model SAM 1000E
Options
Sub-band
Sub/UHF
SAM 1000 Canvas Bag/ Accessory Kit
Sky-2: Lid Mount Strand Hooks

Signal Level Meter

- **Keyboard Controlled Synthesized Frequency or Channel Tuning for Quickness and Accuracy**
- **Tuning and Measurement Result Information Clearly Displayed on LCD, with Analog Meter for Peaking**
- **Auto-Ranging or Manual Attenuator for Quick Accurate Measurements**
- **Automated Test Functions Permit Efficient, Time-Saving Amplifier Alignment**

The SAM 2000 is unique, in that its LCD readout provides not only tuned frequency or channel information, but measurement results as well. A traditional analog meter is provided for signal peaking. Like the SAM 1000, the SAM 2000 makes extensive application of advanced technology to make this meter easy to use, accurate and reliable. Automated measurement functions make the SAM 2000 exceptionally easy to use. A video minus audio function key permits quick, direct measurements of the video/audio carrier level relationship. A special tilt function simultaneously provides a tilt reading (for slope adjustment) on the left side of the LCD display, and a Hi pilot level (for gain adjustment) on the right side of the LCD display. Carrier-to-noise measurements are indicated directly on the LCD display, making calculations unnecessary.

The SAM 2000 makes innovative use of non-volatile memory for storage of calibration information, as well as user specific tuning information. Hi and Low pilot frequencies are keyboard configured to enable quick, one key tuning to these critical and commonly measured frequencies. Up to seven favorite channels are configurable, permitting quick, two key tuning. System channel plans (Standard, HRC, IRC, or Jerrold) are also easily selected via keyboard entry.

A built-in calibrator on the SAM 2000, provides measurement accuracy security. The calibrator is very easy to use. The meter is calibrated by simply connecting the test lead cable from the calibrator output to the RF input, and then implementing the calibration function (a two key operation). This process permits elimination of measurement errors caused by the use of a long test lead cable.

The application of new technology in the SAM 2000 design makes this meter very reliable. Weatherproofing was a major consideration in the SAM 2000 design, and this new SAM is essentially waterproof. An advanced programmable attenuator provides automatic meter ranging, or attenuation may be manually controlled by an electrical switch. Extensive use of reliable surface mount technology makes the SAM 2000 very dependable. The newly improved case is made of durable Lexan®, and contains integral (collapsable) strand hooks.

SIGNAL LEVEL METER

SAM 2000 & SAM 2000E

SPECIFICATIONS (SAM 2000)

Frequency Range
Standard 50—557.875 MHz
Sub-band Option—4.5-557.875 MHz
Sub/UHF Option—4.5-890 MHz

Format
NCTA Standard, HRC, IRC, or Jerrold channel plan keyboard selectable.

Tuning Increment
6 MHz (channel mode).
125 kHz (frequency mode).

Accuracy
±20 kHz (4.5-550 MHz) at 25°C. ±35 kHz all operating temperatures. ±50 kHz (550-890 MHz).

IF Bandwidth
280 ±50 kHz at 3 dB point.

Selectivity
Sufficient to distinguish 2 FM signals of equal amplitude 600 kHz apart. Sufficient to measure audio carrier in presence of upper channel video carrier 40 dB greater in amplitude.

AMPLITUDE MEASUREMENT

Range
-35 to 60 dBmV.

Accuracy
±0.75 dB level accuracy vs. frequency (flatness). ±0.75 dB level accuracy vs. level (meter linearity). ±1.5 dB total (±1.0 typical).

SPECIFICATIONS (SAM 2000E)

Frequency Range
Standard 47 - 557.85 MHz
Sub-band Option 4.5 - 557.85 MHz
Sub/UHF Option 4.5 - 890 MHz

Format
Popular European standards including PAL-B/G, PAL-A, Belgium, GmbH plan keyboard selectable. dBuV or dBmV level readout keyboard programmable.

Tuning Increment
6, 7, or 8 (based on channel format)
125 kHz (frequency mode)

Accuracy
±20 kHz (4.5 - 557.85 MHz) at25°C
±35 kHz all operating temperatures
±50 kHz (550 - 890 MHz)

IF Bandwidth
280 kHz ±50 kHz at 3 dB point

Selectivity
Sufficient to distinguish 2 FM signals of equal amplitude 600 kHz apart. Sufficient to measure audio carrier in presence of upper channel video carrier 40 dB greater in amplitude.

AMPLITUDE MEASUREMENT

Range
-35 to 60 dBmV/+25 to +120dBuV dBuV or dBmV level readout keyboard programmable.

Accuracy
±0.75 dB level accuracy vs. frequency (flatness) ±0.75 dB level accuracy vs. level (meter linearity) ±1.5 dB total (±1.0 typical).

GENERAL

Enviromental

Operating Temperature Range
-20 to 50°C (-4 to 122°F)

Humidity
95% ±5% water resistant

Case
Impact resistant Lexan®, water resistance.

Battery Life
≥8 hrs. normal operation, intermittent on/off operation, rechargeable NiCads, wall mount transformer/ battery charger included, 120 VAC or 220 VAC.

Dimensions
22.2 cm (8-3/4 in) wide; 16.5 cm (6-1/2 in) high; 16.5 cm (6-1/2 in) deep.

Weight
3.4 kg (7-1/2 lb)

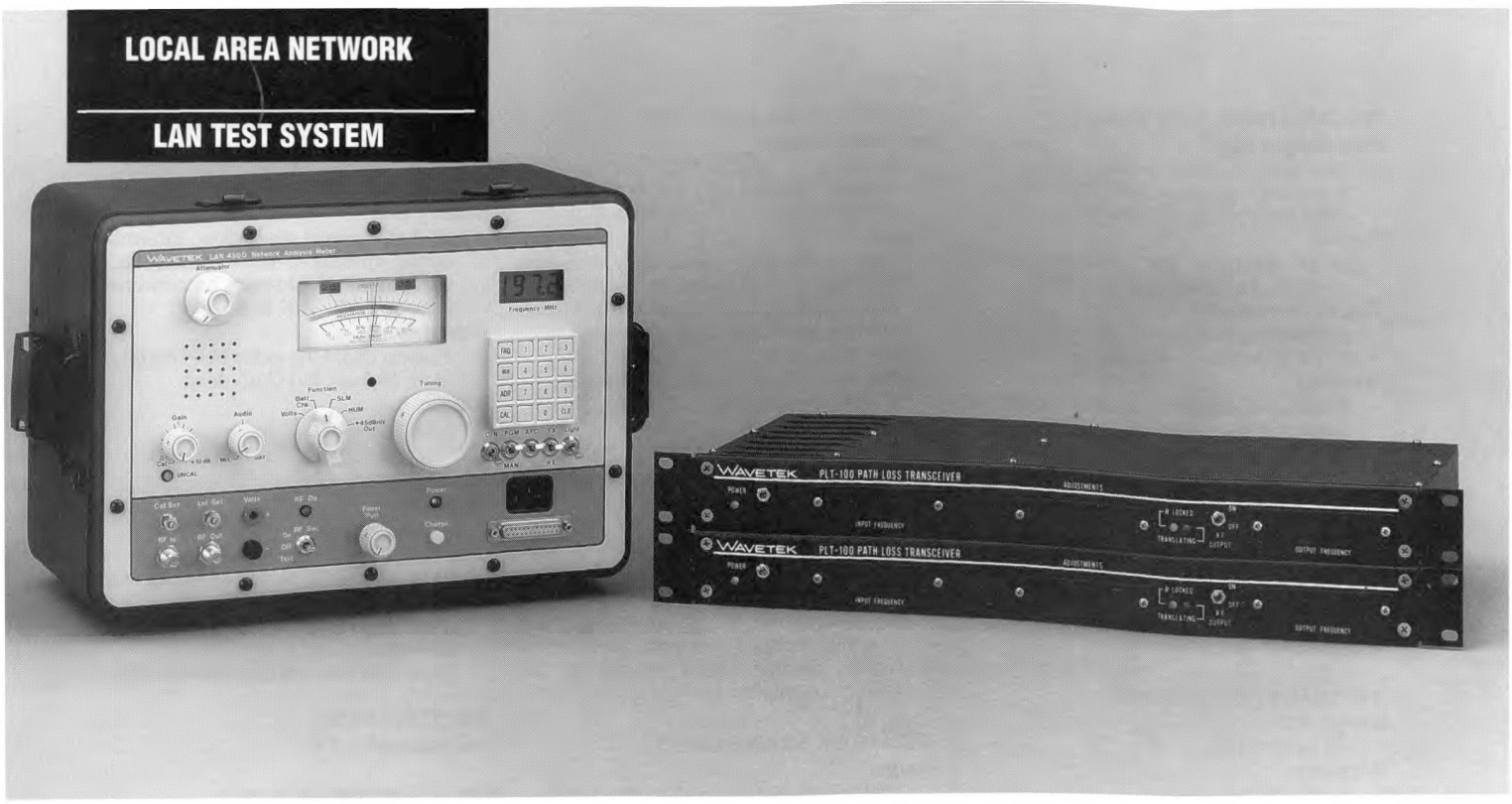
ACCESSORIES

Standard
Battery charger

Options
SAM 2000-SUB - Tunes from 4.5 to 557.875 MHz.
SAM 2000-UHF - Tunes from 4.5 to 890 MHz.
SAM 2000 BAG with Accessories Kit.

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model SAM 2000/2000E
Options
Sub-band
Sub/UHF
Protective Canvas Bag/ Accessory Kit



Bidirectional Interactive Test System

- **Quick Reaction Test System**
- **One Man Bidirectional Testing Capability**
- **Maintenance Testing and Certification System**
- **Frequency Agility and Narrow Bandwidth**

The BITS 4000 Bidirectional Interactive Test System consists of a full featured signal level meter with a built-in synthesized signal generator (LAN 450D) and two or more Path Loss Transceivers (PLT 100) .

LAN 450D Network Analysis Meter
The LAN 450D incorporates signal level measurement and signal generation in one versatile test instrument. Easy measurements of RF data carrier levels, carrier-to-noise, and hum modulation permit quick verification of proper system operation. A built-in signal generator allows measurement of "round trip" signal attenuation, or loop loss, from any point in the system.

The rugged, portable LAN 450Ds transmit and receive frequencies are independently tuned anywhere from 5 to 450 MHz, and are held in nonvolatile memory.

PLT 100 Path Loss Transceiver
The PLT 100 is a highly stable, yet frequency agile, test signal generator and translator. The test signal is active for testing system outbound path loss, carrier-to-noise ratio, and hum modulation. When a signal is applied to the input at the tuned input frequency, the output test signal is switched off, and the input signal is "translated" or converted to the frequency of the outbound test signal with a fixed calibrated gain. Since the gain of the transceiver is known and the outbound path loss has been measured, the inbound path loss can be found.

BITS 4000 — The System
As a test system integrated into the broadband LAN, the BITS 4000 permits quick, easy, one man testing of outbound and inbound path loss, carrier-to-noise ratio, and hum modulation.

Applications:
- Amplifier Alignment (Bidirectional)
- Tap Level Verification (Bidirectional)
- Translation Gain Measurements
- Pin-pointing System Outage Sources
- Certification and Routine Maintenance

LAN TEST SYSTEM

SPECIFICATIONS (LAN 450D)
FREQUENCY
Frequency (Receive)
5-450 MHz.
Frequency (Transmit)
5-450 MHz.
Amplitude (Receive)
-40 to +60 dBmV.
Amplitude (Transmit)
+45 dBmV ±5 dB. Continuously adjustable, and addressable (on-off).
Hum
0.5% to 5%.
Voltage
5-100V.
Relative Loss Measurement
0-55 dB.
Operating Temperature Range
0° to 104°F (-20° to +40°C).

MEASUREMENT ACCURACY
Amplitude (Receive)
±0.5 dB at 75°F; ±1.0 dB over temperature range.
IF Bandwidth
280 kHz at -3 dB; 600 kHz at -40 dB.
Selectivity
Sufficient to distinguish between two signals of equal amplitude 400 kHz apart.
Amplitude (Transmit)
±0.5 dB (5-450 MHz) temperature.
Residual FM
<20 kHz.
Transmit Frequency Setability
±125 kHz.
Harmonics and Spurious Signals
35 dBc.

GENERAL
AC Power Requirements (Charging Only)
110 V ±10% (220 V ±10% optional); 50 to 60 Hz.
Internal Battery
12 V nominal; rechargeable; battery life typically 4 hours continuous with intermittent transmitter operation.
Dimensions
25.4 cm (10 in.) high; 36.2 cm (14.25 in.) wide; 24.1 cm (9.5 in.) deep.
Weight
8.6 kg (19 lb.)

SPECIFICATIONS (PLT 100)
FREQUENCY
Frequency Range (Transmit)
50-400 MHz.
Frequency Range (Receive)
5-300 MHz.
Accuracy (Transmit and Receive)
±10 kHz.
Increment (Transmit and Receive)
125 kHz.
Level Range (Transmit)
+45 to + 60 dBmV.
Level Range Stability (Transmit)
±0.5 dB.
Level Range (Receive)
-10 to +20 dBmV, adjustable.

MEASUREMENT ACCURACY
Receive IF Bandwidth
300 kHz at -3 dB.
750 kHz at -40 dB.
Translation Gain
≤35 dB to ≥55 dB.
Translation Gain Stability
±0.5 dB.
Noise Figure
14 dB at maximum gain.
Harmonics and Spurious
<-60 dBc.
Residual AM
<0.25%
Output Test Point
-20 dB.
Delay Adjust
1-30 seconds, adjustable.

GENERAL
AC Power
110 V ±10%.
Optional AC Power
220 V ±10%.
Dimensions
18.3 cm (19in.) wide; 4.4 cm (1.75in.) high; 20.3 cm (8 in.) deep.
Weight
2.27 kg (5 lb.)
Operating Temperature Range
10°-40°C.

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model BITS 4000 System (LAN 450 & (2) PLT 1000)
Model LAN 450D
Model PLT-100

MODEL 1882A

Sweepless Sweep System Analyzer

- **1GHz Frequency Response Analysis without Interference**
- **Store Multiple Displays for Printout via RS232**
- **Normalized Test Accuracy**
- **Automated Spectrum Analysis Tests**

An All-In-One Analyzer
The 1882A provides an easy, accurate measurement of critical system parameters of signal level, carrier-to-noise, cross-modulation, and 2nd/3rd order composite distortion. Its leakage detection function provides a means of patrolling for leaks between amplifier test stations. In addition to all of the spectrum analysis test functions, the 1882A provides a non-interfering, normalized system frequency response test capability, to 1 GHz.

Why Normalized Testing?
Normalization is used when tests are to be completed in the presence of uncontrolled variables. This technique inherently cancels these variables, leaving only the purest test results. When normalization is used as a processing technique for sweeping, the technician will realize improvements in accuracy and repeatability.

How Does Normalization Work In The 1882A?
The 1882A operates on a very fundamental concept: If like amplifiers in a series cascade have identical output characteristics, the cascade complies with the unity gain concept. Any variation in characteristic outputs may be defined as frequency response deviations.

The 1882A uses normalization to validate compliance with the unity gain concept. Let's review the 1882A normalization procedure from both ideal and "real world" aspects.

From an ideal standpoint, amplitude measurements are taken of audio or video carriers (or both) and stored as a reference envelope. After taking the reference, the technician moves to the next amplifier in the cascade. The measurements are repeated using the same frequency plan and storing a test envelope. The microprocessor then subtracts the reference envelope from the test envelope and displays a difference curve relative to the two traces.

If the technician adjusts the amplifier in such a way that the entire curve falls on the 0 dB line, the amplifier is flat, since the test and reference information is identical. The 1882A can also be used with an active sweep generator (model 1801C or, 1855B, or model 5000) for situations where a frequency band has no active carriers.

SYSTEM SWEEP

MODEL 1882A

SPECIFICATIONS (1882A)
FREQUENCY
Range
4 to 1000 MHz.
Marker Accuracy
±100 kHz.
SPAN
Range
0 to 1000 MHz; user may select among pre-set spans of 0, 5, 10, 50, 120, 200, 250, 330, 450, 600, and 1000 MHz.
Accuracy
±10% (typical); ±20% (guaranteed).
Pre-Programmed Channels
Converter channels 2 through 60; UHF 14 through 83; (channel 1 is IF).

AMPLITUDE MEASUREMENT
Range
-40 to > +60 dBmV (60 or 12 dB displayed on CRT, depending on scale selected). -60 to >+40 dBmV with preamp.
Resolution
0.1dB.
Accuracy (System Analyzer)
±1.5 dB typical (Note: Absolute amplitude measurements should not be made through preamp.)

CARRIER-TO-NOISE MEASUREMENT
Range
50 dB (Note: A +20 dBmV signal level is required for this measurement and the RF processor may be used: requires a span of 5 MHz or less).
Resolution
I db.
Accuracy
±(2 dB + log linearity).

HUM MODULATION
Range
1.0 to 5.0%.
Resolution
0.1%.
Accuracy
±0.3%.

CROSS-MODULATION MEASUREMENT
Range
43 to 62 dB (with proper preselection).
Resolution
1 dB.
Accuracy
±2 dB.

FM DEVIATON MEASUREMENT
10 to 200 kHz.
Resolution
1 kHz.
Accuracy
+5% of full scale.

2ND/3RD ORDER INTERMODULATION MEASUREMENT
Range
70 dB to 200 MHz; 64 dB to 450 MHz; (proper pre-selection required).
Resolution
I dB.
Accuracy
±(3dB + log linearity).

DISPLAY
5 inch (diagonal) CRT; electromagnetic; refreshed raster scan; 6 x 10 division graticule displayed coincident with data.

PREAMP
Gain
20 ± 1.5 dB.
Frequency Response
4 to 1000 MHz.
Impedence
75Ω.

SWEEPLESS SWEEP® MODE
Sweep Accuracy
±0.5 dB (dependent on reference stability).
Sweep Rate
n channels (40 ms/channel) + 400 ms.
Span
600 MHz maximum in sweepless mode.
Test Resolution Bandwidth
280 kHz.
Display Resolution
2 or 10 dB per division.
Display Dynamic Range (Sweepless)
±30 dB in 10 dB/division mode; ±6 dB in 2 dB/division mode.
Channel Plans
2 plans.
Reference Storage
8 references.
Display Storage for Printing
8 displays.
Optional Continuous Sweep Rate
24 MHz/ms.

SPECIFICATIONS (1882E)
1882E designed specifically for European applications. Channel plans for sweep mode are entered individually to allow operation on a wide variety of frequency allocation formats.

OPTIONS
RFP: Optional Lid Package
(Preamp and Filters)
P-1: Portable Printer
Battery Operated

GENERAL
Temperature
0° to 50°C (32° to 120°F).
Power
Rechargeable 12V sealed lead acid battery. Battery life is approximately 2 1/2 hours. In the leakae monitor mode, with the CRT display switched off, battery life is approximately 4 hours.
Dimensions
23.5 cm (9 1/4 in.) high; 37.5 cm (13 7/8 in.) wide; 54.0 cm (21 1/4 in.) deep (including cover).
Weight
75 kg (34 lb).

FACTORY/FOB
Indianapolis, In

ORDER INFORMATION
Models 1882A or 1882E
RFP Lid Package
(Please specify 3 frequencies for the filter package.)
P-1 Portable Printer

Cable System Sweep

1855B - 450 MHz & 5000 - 600 MHz Transmitters

- **Microprocessor Controlled Precision**
- **Easy Keyboard Control of Sweep Parameters**
- **Sweep can be Remotely Activated with Model RC-IA**

1865B - 450 MHz & 6000 - 600 MHz Receivers

- **Cursor Identification of Frequency and Level**
- **Alpha-Numeric Readouts for Unambiguous Results**
- **Max-Min and Delta Keys Provide Quick Peak-To-Valley Measurement**
- **Multiple Storage and Normalization Option Available**

General Description

The 1855B/1865B Sweep Recovery system consists of a microprocessor controlled transmitter and receiver. The headend installed 1855B transmitter sends out a sweep of specified level, width and rate at a specified repetition interval. The transmitter has a flexible control arrangement, so the sweep parameters can be set to keep subscriber interference at a minimum. The portable, battery operated 1865B receiver is taken out in the field to test the swept response at any test point in the system. The Recovery System provides an easy-to-use technique to maintain or audit your cable system. It can cut service calls by indicating changes in the trunk which affect the swept response even though the pilots may be at the proper level. System sweeping will aid in locating problems as they develop, so they may be corrected before the entire system is down.

Model 1855B

The Model 1855B is a microprocessor controlled, bench or rack mounted sweep transmitter. The front panel keyboard and the easy to-read LED readouts verify entry and control settings. Once the parameters have been entered, the unit requires no additional attention unless a change in one of the parameters is desired. A microprocessor in the Model 1855B stores and automatically transmits the entered data on a phase modulated 50 MHz pilot carrier operating 20 dB below the sweep output level.

Other pilot carrier frequencies are available; 43 and 52 MHz for European use, and the standard optional pilot frequencies (5, 155, 165, 175, 225, 243, and 270 MHz). Optional pilots can be tailored specifically for any system configuration (5 to 270 MHz). The sweep system can be set with up to two optional pilots; for instance 5 and 155 MHz (the standard pilot is necessary in all systems).

Model 1855B uses a frequency counter to accurately set the Start/Stop sweep frequencies. Up/Down keys provide convenient automatic tuning in 100 kHz intervals from 1 to 450 Mhz. Remote selection of the Operate or Standby mode is possible through external contact closure via a rear panel connector.

Model 1865B

The Model 1865B Sweep Analyzer is a portable, battery-operated unit in a high impact plastic case. It features microprocessor technology, digital storage, refreshed display, alphanumeric readout, a unique moveable cursor/measurement system and a battery-saver circuit. The Model 1 865B receives the transmitted signal from the Model 1855B, decodes the phase-modulated pilot carrier, and instantly and automatically presets itself for the sweep duration, sweep repetition rate, and Start/Stop sweep frequencies that were entered into the Model 1855B at the headend.

The 1865B receiver has two memories, A and B. The A memory is the memory most often used, in which the current test trace is stored until a new update is received and processed. The B memory is for trace storage for later comparison. B memory can be loaded by reading a card reader card or by storing to B from an ME-3 "stacker" memory. When a comparison of the A and B memories is desired, the receiver display can be set up to alternate at a 20 Hz rate between A and B traces.

The "average" function of the B memory allows periodic, non-repetitive disturbances of the A memory response curve, to be averaged out by the B memory.

Cursor Measurement System

The Model 1865B has a unique cursor system which allows easy, precise measurement of the frequency and amplitude at any point on the displayed response curve. When in the frequency mode, either of the two cursors, M1 and M2, can be moved horizontally (independently) across the face of the CRT. The amplitude and frequency at the point where each cursor intersects the displayed response is automatically indicated on the CRT in alphanumeric characters.

The Delta key provides direct alphanumeric readout of the difference in frequencies of Ml and M2, and also the difference in level at those frequencies. The LEVEL/FREQUENCY key rotates M1 and/or M2 90° so that the cursors will appear as horizontal lines across the CRT. Either or both cursors can be moved vertically to any position on the CRT.

ME-3

The Memory Expansion option (ME-3) extends the capability of the 1865B receiver. It has three different modes of operation; the stacker, the normalizer, and the averager.

The stacker provides for the storage of up to 7 different reference traces, a kind of reference library. A headend reference can be stored in nonvolatile memory to be compared directly to a system test point, either by the A/B comparison method or by using the normalizer.

The normalizer aids in comparison analysis by subtracting a stored reference trace and displaying a 2 dB per division representation of the result.

When the system test point is aligned as well as possible the normalizer display will indicate a straight line response across the center line of the display, indicates no difference between the system test point and the reference that was stored at the first amp.

5000/6000

A high level sweep system designed for use on systems with channel/frequency capacity to 600 MHz. The ME-3 memory expansion feature is standard on the model 6000 sweep receiver.

SPECIFICATIONS (MODEL 1855B)

Frequency Range
1 to 450 MHz in 100 kHz steps maximum sweep width, 400 MHz anywhere in frequency range.

Operating Modes
CATV Sweep, Continuous Sweep, or CW.

Frequency Control Keyboard
Sweep Fl to F2 or CW.

Frequency Accuracy Sweep or CW
1% of Swept band, ±25 kHz.

Spurious Signals
1 to 450 MHz, 30 dBc.

RF Output Amplitude
Adjustable from +60 to +50 dBmV in 0.1 dB increments.

RD Output Impedance
75Ω.

RF Output Flatness
±0.25 dB over entire frequency range.

Tilt Control
6 dB.

Sweep Speed
1 ms to 15 ms in 1 ms intervals.

Repetition Rate
1 second to 25.5 seconds in 0.1 second intervals.

GENERAL

Dimensions
20 5 cm (12 in.) wide; 14 cm (5 1/2 in.) high; 34.9 cm (13 3/4 in.) deep.

Weight
9.9 kg (22 lb.)

Power
115 or 230 Vac ±10%; 50 to 60 Hz; approximately 40 VA.

OPTIONS

B-3
Tunable notches, blank sweep from selected portions of the spectrum. Center frequency for each notch is tunable throughout instrument sweep range, and span for each notch can be adjusted to any width up to the maximum frequency span of the instrument. Ideal for use with 1882A in combo sweep mode to eliminate continuous sweep from active video or other services susceptible to sweep interference.

DP-STD-1855B
Additional pilot (dual pilot option) to allow sweep of two way, institutional, and LAN cable systems. Standard frequencies: 5, 155, 165, 175, 225, 243, and 270 MHz.

DP-SP-1855B
Dual pilot at special (nonstandard) frequency (5 to 270 MHz).

TP-STD-1855B
Two additional pilots (triple pilot option) for sweeping different two way configurations. Standard frequencies: 5, 155, 165, 175, 225, 243, and 270 MHz.

TP-SP-1855B
Triple pilots with special frequency (5 to 270 MHz).

K-108
Rack mount kit for 1855B.

RC-IA
Remote Control Sweep.

SPECIFICATIONS (MODEL 1865B)

Frequency Range
5 to 450 MHz.

Sensitivity
-10 to +60 dBmV.

Impedance
75Ω.

SYSTEM SWEEP

1855B/1865B

Display
5 in. diagonal, electromagnetic. Type: Raster Scan, refreshed. Graticule, 8 div. x 10 div., developed by the microprocessor coincident with data.

Frequency Accuracy
±25 kHz over a single channel.
1% of swept band, ±0.1 MHz.

Level
Accuracy: ±0.5 dB.
Resolution: ±0.01 dB.

GENERAL

Weight
13.8 kg (30.5 lb).

Power
Battery, rechargeable sealed lead-acid, operating life approxitmately $^1/_2$ hours.

OPTIONS

DP-STD-1865B
Additional pilot (dual pilot option) to allow sweep of two way, institutional, and LAN cable systems. Standard frequencies: 5, 155, 165, 175, 225, 243, and 270 MHz.

DP-SP-1865B
Dual pilot at special (nonstandard) frequency (5 to 270 MHz)

TP-STD-1865B
Two additional pilots (triple pilot option) for sweeping different two way configurations. Standard frequencies: 5, 155, 165, 175, 225, 243, and 270 MHz.

TP-SP-1865B
Triple pilots with special frequency (5 to 270 MHz).

ME-3
Memory expansion option for 1865B. Stacker allows nonvolatile storage of 7 different reference traces. Normalizer provides 2 dB/division display of difference between stored reference and test point response. Advanced averager.

BC-3A
Heavy duty battery charger and power supply for 1865B.

BU-1
For holding 1865B or system analyzer while suspended in a bucket truck.

C-1
Polaroid camera for display pictures (1865B, 1880, or 1881)

RC-1
Addressable remote controller for 1855B. Activates 1855B sweep on reception of DTMF tone (from two way radio transmission).

MTT-1
Microphone tone transmitter. Two way radio microphone with built-in DTMF keypad for tone transmission (for use with RC-1 system).

TT-1
Tone transmitter, generates DTMF tone for acoustical coupling with two way radio (for use with RC-1 system).

ACCESSORIES FURNISHED

BC-1
Trickle Charger—automatically switches from fast to slow charge.

BC-2
Cigarette Lighter Adapter—allows the 1865B to operate from the alternator system of the vehicle. Includes 40 feet of cable.

Calibration Cable
To verify transmitter-to-receiver flatness.

Viewing Hood
For viewing in sun light.

Instruction Manual
Be sure to specify pilot frequencies when ordering optional pilots. Both the 1855B and 1865B will require ordering the appropriate pilot

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
BASE UNITS
Model 1855B
(450 MHz transmitter)
Model 5000
(600 MHz transmitter)
Model 1865B
(450 MHz receiver)
Model 6000
(600 MHz receiver)
Options for 1855B/5000
B-3
DP-STD-1855B
DP-SP-1855B
TP-STD-1855B
TP-SP-1855B
K-108
RC-1A
Options for 1865B/6000
DP-STD-1865B
DP-SP-1865B
TP-STD-1865B
TP-SP-1865B
ME-3 (standard in 6000)
BC-3A
BU-1
C-1
RC-1
MTT-1
TT-1

Leakage Field Strength Meter

- **Wide Tuning Range & Preselection**
- **MicroVolts/Meter & Bar Graph Readout**
- **Non-volatile Storage & RS232 Port**

The CLM-1000 is a field strength meter designed for comprehensive cable TV leakage testing. Its wide tuning range (50 to 550 MHz) with aeronautical bands preselected, makes this unit the most comprehensive instrument available for leakage detection and logging. To complement its wide tuning range, the CLM-1000 has built-in preselection for the critical aeronautical bands (72-76 MHz; 108-140 MHz; 225-400 MHz). External preselectors may be used for measurements outside these internally preselected bands.

In conjunction with an antenna, the CLM-1000 is used to make precise leakage measurements at distances up to 200 feet. The microprocessor automatically calculates the equivalent 3 meter measurement based upon the programmed distance factor. The measurement result is displayed on a 2 x 40 character LCD display in µV/meter, eliminating cumbersome conversion calculations.

The operator may enter antenna factor information and the estimated distance to the fault. The alarm field strength trip point is user settable, providing for variable sensitivity requirements. Nine programmable stored instrument settings make it easy to change the operating parameters with two key strokes.

The CLM-1000 also provides data logging, including location, distance, level at 3 meters, frequency, and repair required. All entries for data logging are made by a dual function 32 key keyboard. Logged information is stored to one of 100 memory locations. A built-in RS-232 interface allows direct hardcopy with a standard IBM compatible serial printer. Print-outs are formatted with all appropriate information for CLI logs.

CLIDE
FCC leakage report and Cumulative Leakage Index Software . Data from CLM-1000 may be up-loaded directly to report software.

LEAKAGE MEASUREMENT
MODEL CLM-1000

SPECIFICATIONS

Frequency Range
50 to 550 MHz in 6.25 kHz steps. Offsets are accommodated.

RF Preselection
72 to 76 MHz. 108 to 140 MHz, and 225 to 400 MHz. Band preselection may be implemented via keyboard.

Field Strength Measurement Range
10 µV/m to 1000 µV/m with a tuned dipole antenna.

RF Input Sensitivity
<0.5 µV using proprietary signal recovery techniques.

RF Input Accuracy
±1 dB.

Input Impedance
75 Ω.

Measurement Bandwidth
30 kHz Resolution
100 Hz effective using proprietary signal recovery techniques.

Audio Output
AM detection unless on an audio carrier in the channel tuning mode, superimposed alarm signal, control by front panel potentiometer.

Digital Interface
Dual port, RS232, front panel DB-25 connector.

GENERAL

Battery
Rechargeable NiCads, >2 hours continuous operation, vehicle operation with cigarette lighter adaptor, wall mount charger included.

Case
Impact resistant, Lexan® water resistant case.

Dimensions
6.5 in (16.52 cm) high x 8.75 in (22.23 cm) wide x 6.5 in (16.51 cm) deep.

Weight
Approximately 8 lbs.

Operating Temperature Range
- 10 to 130°F (-23 to 54°C) subscribers.

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
CLM-1000
CLIDE Software
CLM/CLIDE Combo

Leakage Detector/ Locator

- **Hand-held Leakage Receiver**
- **Locator Tone With Signal Strength Controlled Pitch Variation**
- **LEDs Indicate Leakage Source Channel**
- **Rubber Whip Antenna**

General Description
The CLR-4 is a hand-held leakage detection/location instrument used to scan four different cable video frequencies, or to monitor those frequencies one at a time. Scanning four different crystal controlled frequencies enables detection of frequency specific leakage. When a leak is detected, the instrument stops scanning, and a locator tone is emitted. This tone varies in pitch corresponding to changes in detected signal strength. A lock-out switch for each channel enables selective scanning.

The CLR-4 is easy to use, and can be used by general system personnel or a dedicated leakage crew. The instrument has a BNC connector and flexible rubber whip antenna.

SPECIFICATIONS

Frequency
Choose one of the following (standard or HRC) video carrier frequency configurations (I thru VI):

	I	II	III	IV	V	VI
2	•	•	•			
3	•	•	•	•	•	•
4				•	•	•
B	•			•		
D		•			•	
G			•			•
R	•	•	•	•	•	•

Plan II is standard—other plans and offsets are optional.

Channels
Four, Crystal Controlled

Sensitivity
1 microvolt, Typical tall channels. Channels B, D, and G: Will break squelch for 10 MV/m at 3 meters. Locator tone variation down to 20 μV/m at 3 meters.

Dynamic Range
Approximately 40 dB

IF Bandwidth
±9 kHz at -6dB, ±15 kHx at -50 dB Typical

IF
1 st: 10.7 MHz
2nd: 455 kHz

Scan Rate
6 Channels/Second, Nominal. Channels may be manually selected. Individual lock-out switches for each channel.

Audio Locator
Variable pitch tone locator, or video sync buzz switch selectable

GENERAL

Dimensions
7 cm (2.75 in) wide; 2.8 cm (1.1 in) depth; 15.2 cm (6.0 in) high

Weight
396.8 grams (14 oz.)

Power Requirements
6 Vdc (4 AAA batteries) 5 Vdc (4 NiCad rechargeable batteries) 110 VAC (from supplied AC adaptor/charger)

Current drain: 25 mA (squelched) 100 mA (full volume unsquelched)

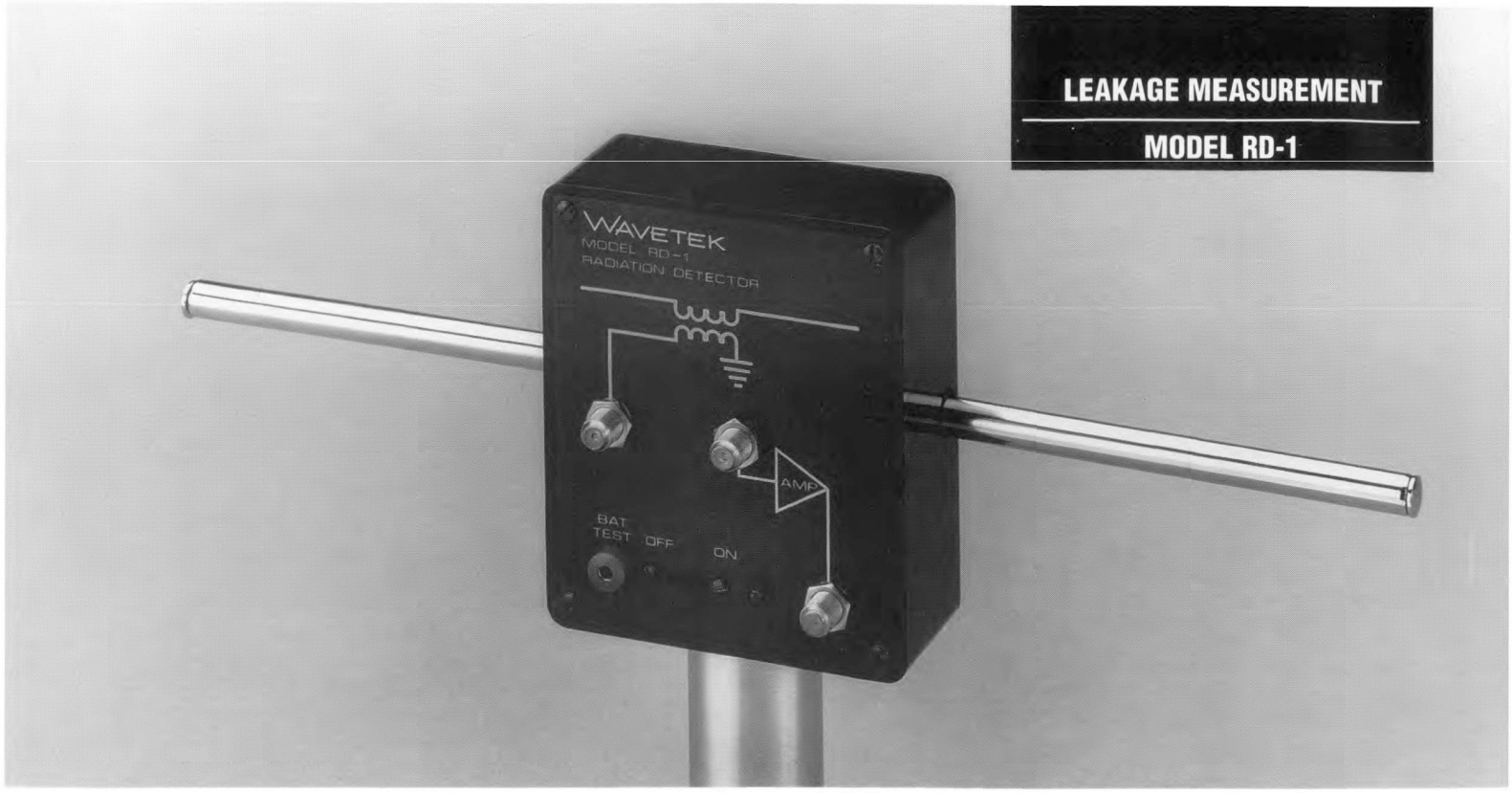
Audio Output
150 mw into 16 ohms, variable.

ACCESSORIES
Flexible rubber whip antenna, BNC; Battery charger.

OPTIONS
VMA-1: Vehicle magnetic mount antenna. Any frequency configuration other than plan II, and all offsets.

Upgrades/Modifications
Channel plan change. Frequency offsets.

ORDER INFORMATION
Model CLR-4
Channel Plan 2, 3, D, R
Model CLR-4
All other plans
VMA-1
Upgrade



Leakage Measurement

- **Low Noise, Battery Operated Preamplifier**
- **Dipole Tuning**
- **Loop-Through For Frequency Preselection**
- **5 Foot Extension Pole Included**

The RD-1 is a tuned dipole with a 16 dB gain battery operated amplifier. It is designed to test compliance with FCC CATV radiation specifications. The RD-1 is the most convenient dipole to use, no matter what you pay. The adjustable dipole whip antennas can be set for frequencies from 50 MHz to 250 MHz which covers the standard TV band, MID band, and SUPER band through channel 0. The whips are easily field replaceable and are available from stock.

The signal levels to be measured for radiation and signal leakage tests are in the range of -30 to -50 dBmV. Most signal level meters do a poor job below -30 dBmV and can't measure anything below -40 dBmV. The RD-1 contains a low noise, battery operated preamplifier to solve this problem. In many areas of the country, it is necessary to measure small leakage signals in the presence of strong local signals. Provisions have been made on the RD-1 to permit you to place a bandpass filter between the dipole and preamplifier to correct this problem. The amplifier may also be used separately as a portable field instrument.

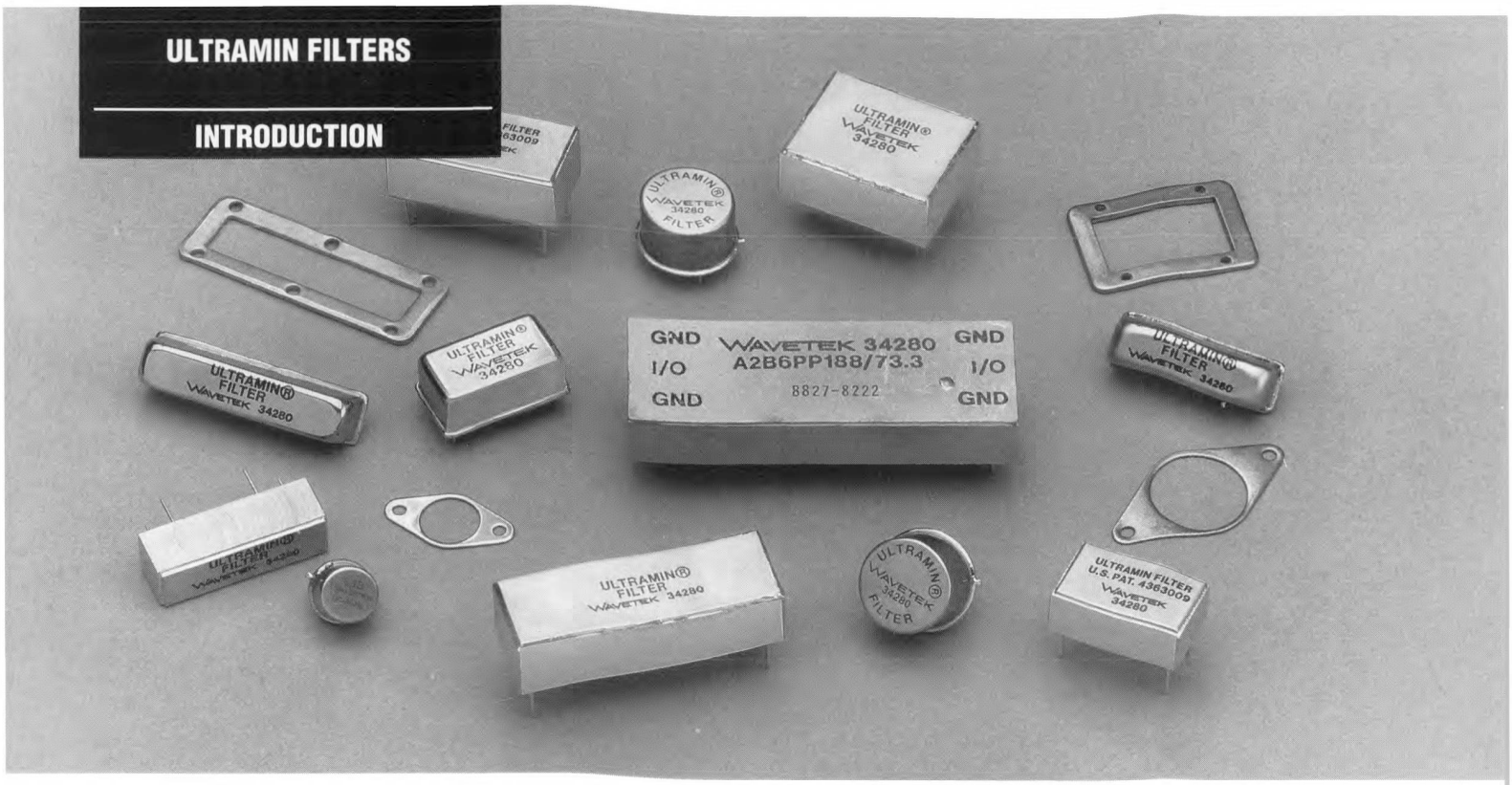
The pamphlet that is provided with the RD-1 lists the length of the dipole in inches for all channels to be measured. The chart also indicates the signal level to be measured to pass the FCC 20 microvolts per meter specifications. This eliminates the need for cumbersome formulas and calculations. You simply refer to the chart to find your passfail point in dBmV for every channel.

SPECIFICATIONS
MODEL RD-I
Dipole Tuning
50 MHz to 250 MHz.
Amplifier Noise Figure
6 dB.
Amplifier Bandwidth
±0.5 dB 50-250 MHz, useable 5-300 MHz.
Amplifier Gain
16 dB.

GENERAL
Dimension
10.8 cm (4 1/4") wide; 12.7 cm (5") high; 5.7 cm (2 1/4") deep
Power
4-9 volt batteries.
Weight
0.90 kg (2 lbs.)
Accessories
5 foot extension pole included.

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model RD-1



Ultramin® Filters

- **Minimum Size - Maximum Performance**
- **Printed Circuit Board Mount**
- **Mil-Spec Reliability**

Since 1979 Wavetek Ultramin® LC filters have been an industry leader in miniaturization. These small packages save valuable board space and weight, and are built to satisfy the most stringent environmental conditions such as shock, vibration, humidity, acceleration and temperature. Wavetek is a leading manufacturer of satellite reliability miniature filters.

The general capabilities of the Ultramin® series include a standard 10 MHz to 2000 MHz frequency range, with .5 MHz to 4000 MHz frequency range available on special order. Standard 3 dB bandwidths range from 5% to 50%, with 1% to 200% available on special order.

Our Computer Aided Design (CAD), Analysis, and Automated Test Equipment (ATE) systems provide the ability to design and manufacture for optimum performance and repeatability. Our CAD capability provides bandpass, lowpass, highpass, and bandstop realizations in a wide variety of designs including Chebyshev, Butterworth, Bessel, Gaussian, linear phase, and elliptic functions. In addition, bandpass attenuation characteristics can be symmetrical or shifted to the high or low side as required by the application. Our ATE system allows highly accurate performance data to be recorded at room temperature and/or over variations of temperature. By careful specification of element temperature coefficients, designs may be specified to provide extremely stable passbands or to optimize "Q" factors and insertion loss.

Wavetek Ultramin® filters can be amplitude matched, phase matched, and/or group delay matched in sets of two or more, or they can be matched to a "master" filter. Most matching specifications are given over the .5 dB or 1 dB bandwidths, but this can be extended to cover the entire 3 dB bandwidth if required. Matching can be achieved with custom designs as well as our standard low ripple Chebyshev designs. To discuss your specific requirements with one of our applications engineers, contact your local sales representative or contact the factory at 1-800-851-1202.

Ultramin® filters may be specified in a wide variety of both standard and custom packages.

Wavetek can often recommend a standard package to meet your requirements. If not, our engineers will design a custom package for you, incorporating axial pins, radial pins, or coaxial connectors as your requirement dictates.

Refer to the following pages for specific information on some of our more popular packages.

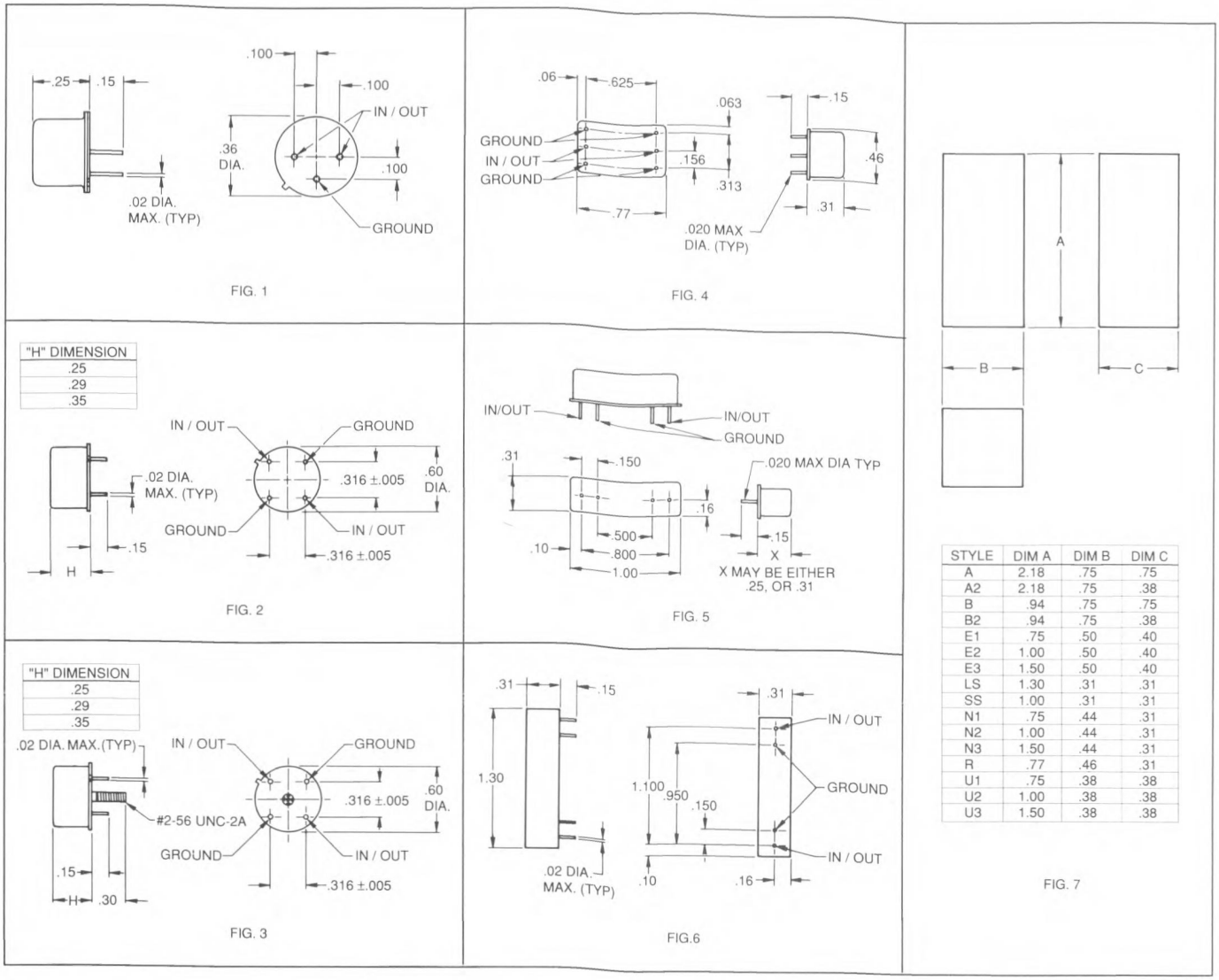
PACKAGE TYPE	NUMBER OF SECTIONS	FREQUENCY RANGE (MHz)	NOISE FLOOR (dB)	OUTLINE FIGURE
A	6-12	600	80	7
A2	6-12	600	80	7
B	2-6	600	60	7
B2	2-6	1000	60	7
E1	2-6	2000	60	7
E2	4-8	2000	70	7
E3	4-10	2000	80	7
LS	4-10	1700	80	6
SS	2-7	2000	70	5
N1	2-6	2000	60	7
N2	4-8	2000	70	7
N3	6-10	1500	80	7
R	2-7	1700	60	4
U1	2-6	2000	60	7
U2	4-8	2000	70	7
U3	6-10	2000	80	7
T5	2-3	500	30	1
T8	2-5	900	50	2
T8S	2-5	900	50	3

Ultramin® Series General Specifications

Parameter	Standard	Special
Frequency	10 MHz to 2000 MHz.	.5 MHz to 4000 MHz
Ave. Power	1 Watt	Consult Factory
VSWR	1.5:1	1.2:1
Impedance	50 Ohms	Consult Factory
3 db %		
Bandwidth	5 to 50	1 to 200
Shock	50 G's/11 ms	200G's/20 ms
Vibration	20 G's/0-500 Hz	50 G's/0-3000 Hz
Humidity	100% (PC Pins)	90% (all connectors)

All of the Ultramin® filters consist of lumped elements. When specifying microwave filters, specifications consisting of: passband frequencies, rejection levels and frequencies, insertion loss, temperature range, package requirements, etc. are useful in determining the filter topology that would provide the best performance for the user requirement.

Our manufacturing procedures and quality control system are designed to assure the ultimate in quality and reliability. As a result, Wavetek has been an industry leader in the design and manufacture of satellite reliability miniature filters for the past 8 years. Wavetek components can be specified to meet the most demanding Mil-Specs and hostile environments.



Notes: 1) All dimensions shown are in inches
2) Figure 7 shows outline dimensions. Input/Output configurations can be Radial/Axial Pins, or Axial Connectors

- **Popular Ultramin® Filter Packages**
- **Hermetic Seal**
- **Minimum size**
- **High Performance**

These more popular Ultramin® packages are representative of the flexible filter packaging offered by Wavetek. For unique packaging requirements, Wavetek can often recommend a standard package that will meet your needs, or quickly design a custom package to solve you filter problems.

OPTIONAL MOUNTING FLANGES

Mounting flanges can be provided for all of the above standard header packages (figures 1 thru 6).
Advantages are:
1. Improved grounding
2. Minimizing PWB pin stress in extreme environments

FACTORY/FOB
Indianapolis, IN.

Ultramin® filters are custom designed to meet your specific application. Contact your local sales representative or the factory at 800-851-1202 for a prompt quotation.

Ultramin® Commercial Filters

- **Low Cost**
- **Printed Circuit Board Mount**
- **High Reliability**

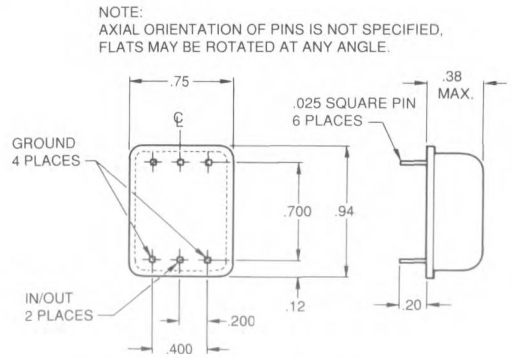
For years, Wavetek has been building specialized and highly reliable filters to meet critical military and aerospace requirements. Back in 1979, we introduced the Ultramin® line of miniature filters, which quickly made us an important supplier to these demanding military and telecommunications applications.

What we learned in building filters for these extreme conditions has taken us a long way in our development of low cost, highly reliable commercial grade filters for the telecommunications market. For instance, local area network applications have created the need for low cost, small size, IF bandpass filters. Wavetek's commercial version of the original Ultramin® line offers an ideal filter with a typical frequency range of 1 to 500 Mhz, 5 to 40% 3 dB bandwidth, an ultimate rejection of 50 dB absolute, and performance of two to six sections.

But in addition to providing the filter you need, we offer fast delivery and very competitive pricing.

Wavetek has successfully provided low cost commercial grade filters to numerous telecommunications customers at rates exceeding 2000 units per month. Even at these volumes, quality is still maintained at a level that puts Wavetek at the top of our customers preferred suppliers lists.

Just like the original Ultramin® series, the Ultramin® commercial series can be designed to meet your specific requirements. Our Computer Aided Design (CAD), Analysis, and Automated Test Equipment (ATE) system guarantee maximum performance and repeatability. Various designs and matching requirements can be achieved. To discuss your specific requirements with one of our applications engineers, contact your local sales representative or contact the factory at 1-800-851-1202.



All dimensions shown are in inches

Tunable Filters

- **High Selectivity**
- **Low Loss**
- **31 to 2000 MHz**

Wavetek's Series 5200/7200 Tunable Bandpass Filters are available in a variety of models covering the frequency range from 31 to 2000MHz. Each model tunes over a complete octave with a direct dial indicator providing center frequency readout to 1%. Tuning is accomplished via a reinforced belt drive in conjunction with precision ball bearings. This long life, reliable tuning system insures accuracy and repeatability. These filters are valuable for a wide variety of benchtop, laboratory, and field applications where a high degree of selectivity and low insertion loss are required. Standard models are offered in four pole, low ripple Chebyshev designs. The 3 dB bandwidth is a constant 5% of center frequency and the 30 dB/3 dB form factor is typically 2.7. Insertion loss is less than 1.5 dB. Other response characteristics are available such as three or five pole designs, or special bandwidths. Please contact your local Wavetek sales representative or the factory for further information.

SPECIFICATIONS

Frequency Range	Model
31-62 MHz	5201/7201
62-125 MHz	5202/7202
125-250 MHz	5203/7203
250-500 MHz	5204/7204
500-1000 MHz	5205
1000-2000 MHz	5206

Form Factor: 30 dB/3 dB, 2.9 typical.

Impedance:
Series 5200: 50Ω.
Series 7200: 75Ω.
VSWR: 1.5:1 max.
Insertion Loss: 1.5 dB max.
Calibration Accuracy: ±1% of indicated frequency.
Connectors: Type N female standard, others available.
Power: 50 watts average.

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
5200 Series
7200 Series
Model 5214

Precision Preselector

- **CATV Applications**
- **Low Loss**
- **55 to 440 MHz**

The Wavetek line of Precision Preselectors is designed to assist in composite triple beat, second order intermodulation, radiation, or any measurement where very low levels must be checked in the presence of much higher levels.

These units, used on the input of a spectrum analyzer or signal level meter, feature insertion loss of less than 1.6 dB, power rating of 60 watts, and a form factor of 2.9, the use of belt-drive tuning, coupled with precision ball bearings, insures accuracy and resettability of better than ±1%.

Field Preselector
The model PP-75 combines three separate preselectors into one field portable housing, designed for ease of use and portability. The PP-75 has ranges of 55-110 MHz, 110-220 MHz, and 220-440 MHz.

SPECIFICATIONS

Frequency Range	Model
55-110 MHz	PP-55/110
110-220 MHz	PP-110/220
220-440 MHz	PP-220/440
55-440 MHz (in three ranges)	PP-75

Impedance
75Ω.

3 dB Bandwidth

55-110 MHz	6% ± 1%
110-220 MHz	5% ± 1%
220-440 MHz	3 1/4% ± 1/2%

VSWR
1.5:1.

Insertion Loss
1.6 dB.

Form Factor
30 dB/3 db, 2.9 max.

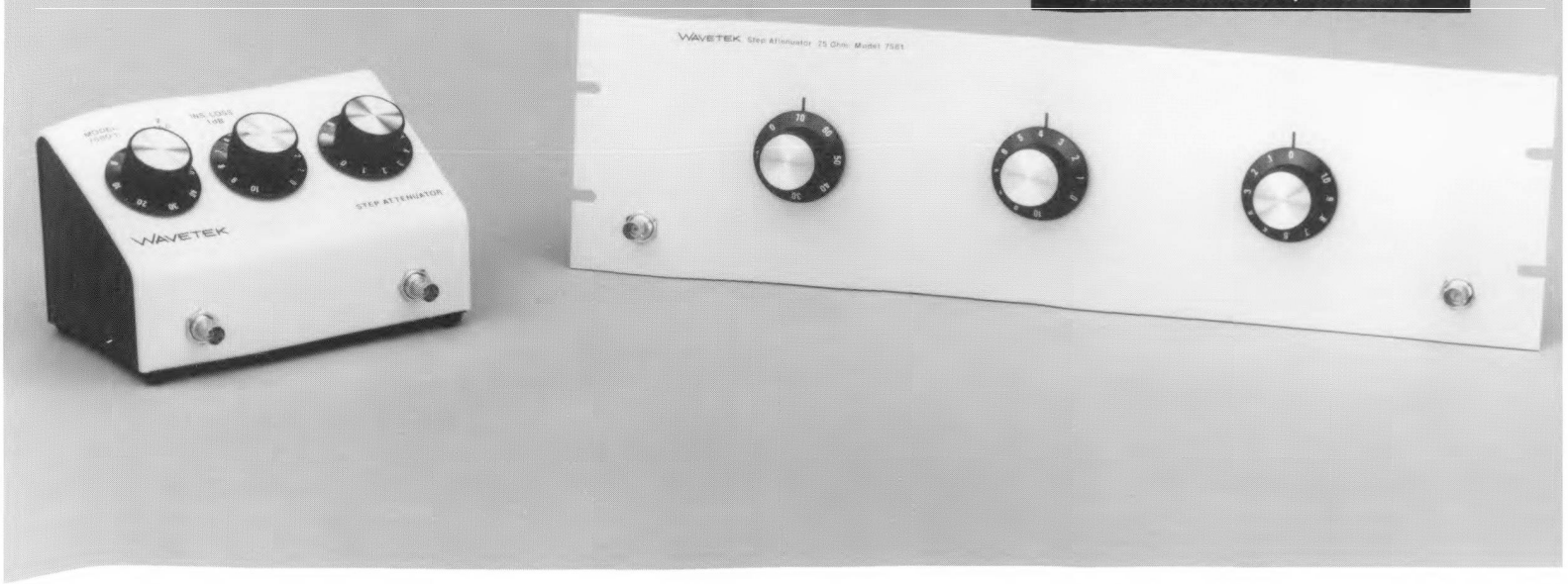
Calibration Accuracy
±1.0% of indicated frequency.

Power
60 watts maximum.

Connectors
Type BNC.

FACTORY/FOB
Indianapolis, IN

Models PP-75
Models PP-55-110
Models PP-110-220
Models PP-220-440



Step Attenuators

General Description
Models A5080.1 (50Ω) and A7580.1 (75Ω) Step Attenuators provide convenient packaging of the 5000 and 7500 series attenuators for bench top uses. Models 5081 (50Ω) and 7581 (75Ω) Step Attenuators provide ATE designers with a convenient rack mounted 5000 and 7500 series attenuators.

These models house three separate attenuators in 10 dB, 1 dB, and .1 dB steps.

BNC connectors are standard for all models. Type N or TNC connectors are available for Models A5080.1 and 5081. Type F connectors are available for the A7580.1 and is designated by using the model number 7580.1A.

SPECIFICATIONS
Frequency Range
DC to 1000 MHz
Impedance
50Ω (Models A5080.1 and 5081)
75Ω (Models A7580.1 and 7581)
Attenuation
0 to 81 dB in 0.1 dB steps
Accuracy
0.1 dB step, ±0.1 dB (DC to 500 MHz)
±0.3 dB (500 to 1000 MHz)
1 dB step, ±0.3 dB (DC to 500 MHz)
±0.4 dB (500 to 1000 MHz)
10 dB step, ±1.0 dB (DC to 500 MHz)
±2.0 dB (500 to 1000 MHz)
Maximum Input Power
0.5 Watt average

Insertion Loss
2.0 dB max. (DC to 500 MHz)
2.5 dB max. (500 to 1000 MHz)
VSWR
1.4:1 (DC TO 500 MHz).
1.8:1 (500 TO 1000 MHz).
Outline
Models A5080.1 and A7580.1 figure 1
Models 5081 and 7581 figure 2

FACTORY/FOB
Indianapolis, IN

PRICE

Model A5080.1	**BNG (50Ω)**
Model A7580.1	**BNG (75Ω)**
Model A7580.1A	**F (75Ω)**

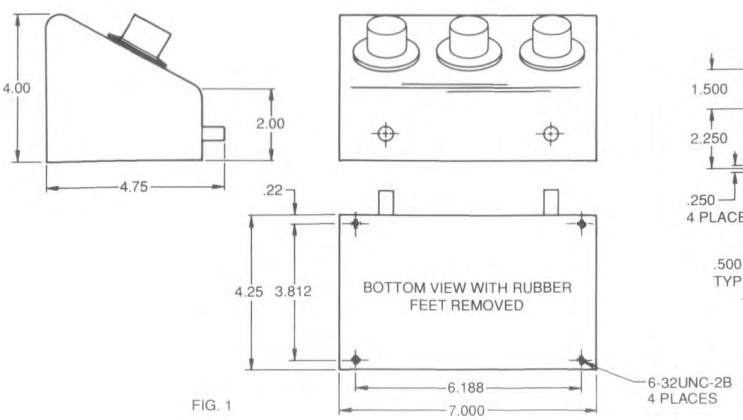


FIG. 1

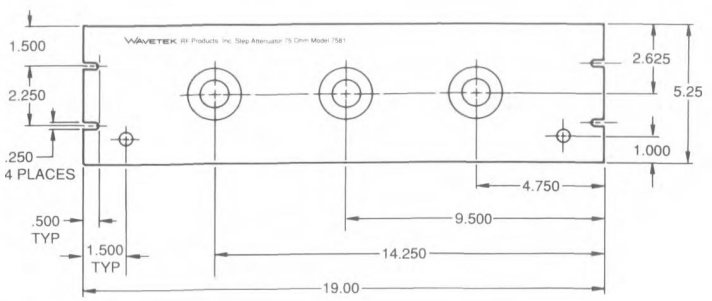
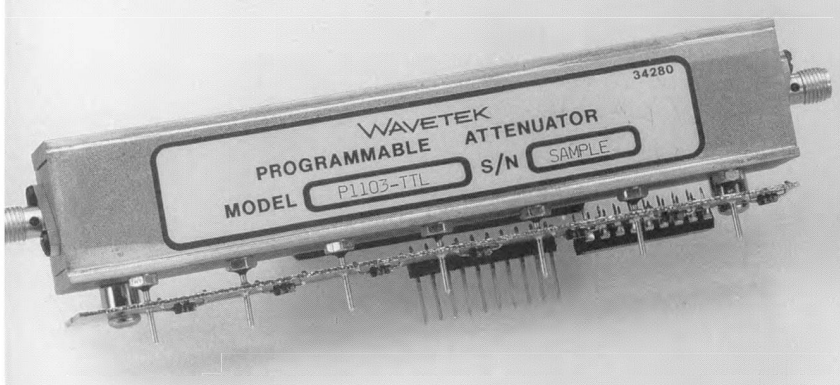
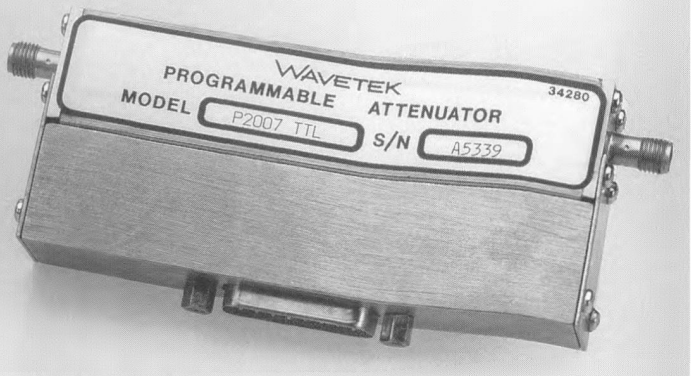


FIG. 2





Programmable Attenuators

- **TTL Interface Available**
- **DC to 2000 MHz**
- **.5 to 130 dB**

Wavetek programmable attenuators are for use in a variety of OEM applications where speed, accuracy, and reliability are required in signal level adjustment. The P1500 and P2000 series attenuators are the smallest relay attenuators available in this frequency range. All series are available in both standard and custom designs, and frequency response can be specified as high as 2500 MHz.

Model Numbering System

P 2 0 0 B – TTL

- TTL Option
- Configuration (Table 2)
- Series (Table 1)

Example: Model #P2008-TTL is a: 2000 MHz, 0-70 dB, 10 dB step, 4 cell, 50 ohm attenuator, packaged in compliance with outline figure number 2A. It also has 12 Vdc relays, TTL option, and has SMA female connectors.

Power Rating: .5 Watt continuous
Impedance: 50 ohm (75 ohm available upon request)
Individual Switch Life: 10,000,000 operations typical
Connectors: Type SMA, BNC (P551 thru P556 only) standard, others available consult factory. Add suffix B to end of model number for BNC connectors.
Relay Voltage: 12 Vdc standard, 5, 6, 9, 18, 26 Vdc available consult factory.
Operating Temperature: -40°C to +70°C.

Series	P550	P1100	P1500	P2000
Freq. Range (MHz)	550	1100	1500	2000
VSWR (Max.)	1.3:1	1.35:1	1.35:1	1.4:1
Thru Insertion Loss (Max.)	.3 dB/cell	.4 dB/cell	.45 dB/cell	.6 dB/cell
Incremental Accuracy (Max.)	+/- .3 dB OR 1 %	+/- .4 dB OR 2 %	+/- .5 dB OR 2 %	+/- .7 dB OR 3 %
Switching Speed	2 msec	6 msec	6 msec	6 msec
Configuration	1-9	1-9	1-9	1-9
Outline	1A,1B	1A,1B	2A,2B	2A,2B
Impedance	50	50	50	50

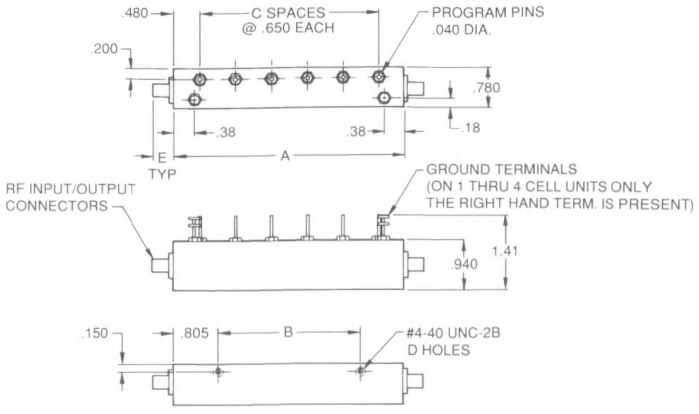
Table 1: Electrical Specifications

Configuration Number	Total Attenuation	Step Size	Number of Cells
1	15.5 dB	.5 dB	5
2	31.5 dB	.5 dB	6
3	63.5 dB	.5 dB	7
4	15.0 dB	1 dB	4
5	31.0 dB	1 dB	5
6	63.0 dB	1 dB	6
7	127 dB	1 dB	8
8	70 dB	10 dB	4
9	130 dB	10 dB	6

Table Two: Standard Configurations

DIMENSIONS (INCHES)

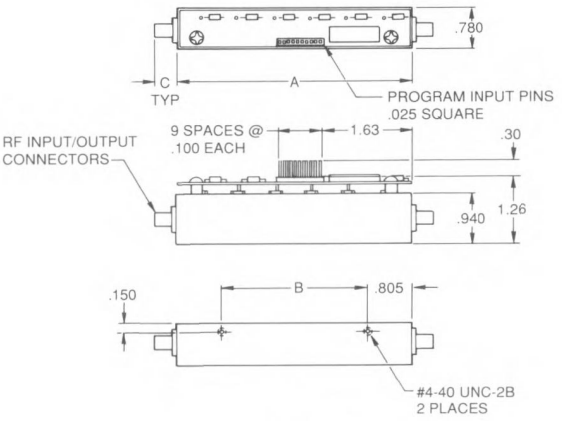
NO.OF CELLS	A	B	C	D	LENGTH E		
					SMA	BNC	N
2	1.61	-	1	1	.38	.61	.95
3	2.26	.650	2	2	.38	.61	.95
4	2.91	1.300	3	2	.38	.61	.95
5	3.56	1.950	4	2	.38	.61	.95
6	4.21	2.600	5	2	.38	.61	.95
7	4.86	3.250	6	2	.38	.61	.95
8	5.51	3.900	7	2	.38	.61	.95



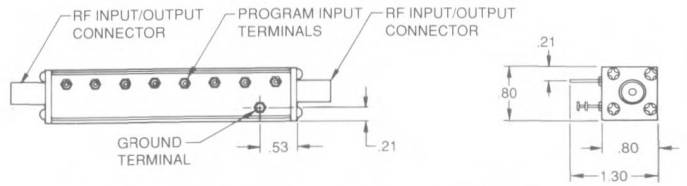
OUTLINE 1A

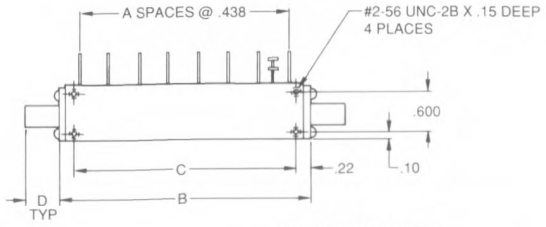
DIMENSIONS (INCHES)

NO.OF CELLS	A	B	LENGTH C		
			SMA	BNC	N
2	2.91	1.300	.38	.61	.95
3	2.91	1.300	.38	.61	.95
4	2.91	1.300	.38	.61	.95
5	3.56	1.950	.38	.61	.95
6	4.21	2.600	.38	.61	.95
7	4.86	3.250	.38	.61	.95
8	5.51	3.900	.38	.61	.95



OUTLINE 1B
(TTL OPTION)

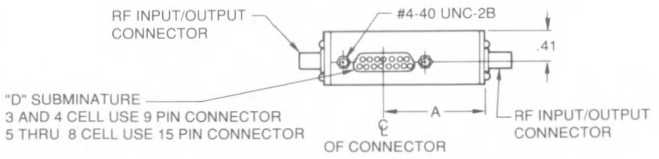


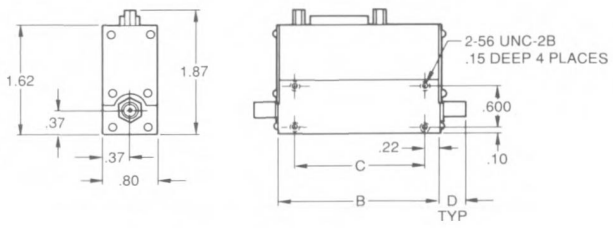


DIMENSIONS (INCHES)

NO.OF CELLS	A	B	C	LENGTH D	
				SMA	BNC
2	1	1.07	.625	.41	.61
3	2	1.50	1.062	.41	.61
4	3	1.94	1.500	.41	.61
5	4	2.38	1.938	.41	.61
6	5	2.82	2.375	.41	.61
7	6	3.25	2.812	.41	.61
8	7	3.69	3.250	.41	.61
10	9	4.57	4.125	.41	.61

OUTLINE 2A





DIMENSIONS (INCHES)

NO. OF CELLS	A	B	C	LENGTH D	
				SMA	BNC
3	.75	1.50	1.062	.41	.61
4	.97	1.94	1.500	.41	.61
5	1.41	2.38	1.928	.41	.61
6	1.41	2.82	2.375	.41	.61
7	1.85	3.25	2.812	.41	.61
8	1.85	3.69	3.250	.41	.61

OUTLINE 2B
(TTL OPTION)

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Series P550
Series P1100
Series P1500
Series P2000

TURRET ATTENUATORS

SERIES 5000/7500

Turret Attenuators

- **Broadband Operation**
- **Low VSWR**
- **High Repeatable Accuracy**
- **Ideal for OEM Applications**

The 5000 and 7500 series of Turret Attenuators operate over a very broad frequency range and are well suited for bench setups, field use, or incorporated into test instruments. RF system applications include navigation and communication receivers.

Configuration
The 5000 and 7500 series have BNC female connectors as standard, but are available with others such as SMA or type F at no additional cost.

7500 Series
The 7500 series Turret Attenuators are 75Ω devices and cover the frequency range of DC to 1000 MHz. They are ideal for instrument and benchtop CATV and TV applications.

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
7501
7510A
7535A
7570A
7580A
5001
5010A
5035A
5070
5080H

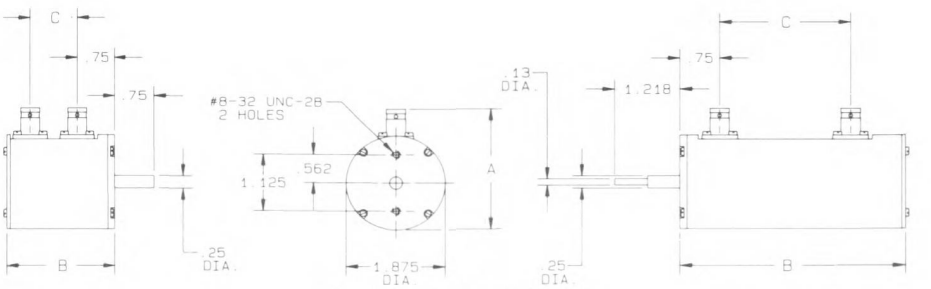
Models	7501	7510A	7535A	7570A	7580A
Attenuation (dB)	0-1 in 0.1 dB steps	0-10 in 1 dB steps	0-35 in 5 dB steps	0-70 in 10 dB steps	0-80 in 1 dB steps
Frequency Range (MHz)	DC to 1000				
Impedance (Ohms)	75				
Insertion Loss (dB)	1.2 dB	0.2 max	0.3 max	1.0 max	2.0 max
Accurancy (dB)*					10 dB Step: 1 dB Step:
To 500 MHz	±0.1	±0.2	±0.5	±0.5	±0.6 ±0.3
To 1000 MHz		±0.3	±1.0	±1.0	±1.0 ±0.4
VSWR	1.25:1 max	1.3:1 max	1.5:1 max	1.35:1 max	1.5:1 max
Max Input Power (Watts)	2	0.5			
Angle Between Steps		30°	45°		30° to 1 dB step 40° to 10 dB step
Configuration	1	1	1	1	2
Connectors	BNC Jack, F(DC - 500 MHz) Available				
Dimensions A	6.2 cm (2.44 in.) BNC, TNC; 6.4 cm (2.5 in.)				
B	5.4 cm (2.13 in.)		7.0 cm (2.75 in.)		10.7 cm (4.19 in.)
C	2.1 cm (0.84 in.)		3.8 cm (1.5 in.)		6.2 cm (2.44 in.)

* All accuracy is referenced to the minimum loss position

TURRET ATTENUATORS

SERIES 5000/7500°

5000 Series
The 5000 series Turret Attenuators are 50Ω devices, and cover the frequency range of DC to 2000 MHz. Their positive detent action provides long life for applications such as general purpose test and measurement instrumentation, Two-Way Communications and general laboratory accessories. Their construction is suitable for both military or commercial applications.

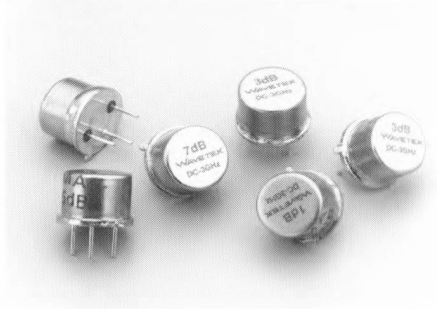


Dimensions are shown in inches

Configuration 1 *Configuration 2*

Models	5001	5010A	5035A	5070	5080H
Attenuation (dB)	0-1 in 0.1 dB steps	0-10 in 1 dB steps	0-35 in 5 dB steps	0-70 in 10 dB steps	0-80 in 1 dB steps
Frequency Range (MHz)	DC to 1200	DC to 2000			
Impedance (Ohms)	50				
Insertion Loss (dB)	1.3 dB	0.4 max	0.3 max	1.5 max	2.5 max
Accurancy (dB)*					10 dB steps: 1 dB steps:
To 500 MHz	±0.1	±0.2	±0.5	±0.5	±0.6 ±0.3
To 1000 MHz	(To	±0.3	±1.0	±1.0	±1.0 ±0.4
To 2000 MHz	1200 MHz)	±0.3	±3.0	±3.0	±3.0 ±0.5
VSWR	1.30:1 max	1.3:1 max to 1000 MHz 1.4:1 max to 2000 MHz	1.4:1 max to 1000 MHz 1.6:1 max to 2000 MHz	1.3:1 max to 1000 MHz 1.5:1 max to 2000 MHz	1.4:1 max to 1000 MHz 1.6:1 max to 2000 MHz
Max Input Power (Watts)	2	0.5			
Angle Between Steps		30°	45°		30° to 1 dB step 40° to 10 dB step
Configuration	1	1	1	1	2
Connectors	BNC Jack, (SMA, TNC and N available)				
Dimensions A	6.2 cm (2.44 in.) BNC, TNC; 6.4 cm (2.5 in.) SMA: 7.0 cm (2.75 in.) Type N.				
B	5.4 cm (2.13 in.)			7.0 cm (2.75 in.)	10.7 cm (4.19 in.)
C	2.1 cm (0.84 in.)			3.8 cm (1.5 in.)	6.2 cm (2.44 in.)

* All accuracy is referenced to the minimum loss position



Stripline/Microstrip Fixed Attenuators

- **MIL-A-3933 Qualified**
- **T05 Package**
- **Hermetic Seal**
- **DC to 3 GHz**

Wavetek ultraminiature fixed attenuators are useful wherever precise RF level adjustments are required in a printed circuit environment. These highly reliable attenuators have been qualified to MIL-A-3933 and are available in a wide variety of standard and custom values.

The attenuators are tested in specially designed, low vswr, stripline test fixtures to insure accurate measurement of their parameters. Performance verification data from our computer-controlled network analyzer is available upon request. In addition our stripline test fixtures are also available for modeling and inspection.

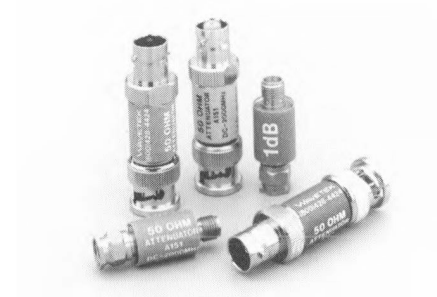
SPECIFICATIONS
Frequency Range: DC to 3 GHz.
Attenuation Values: 1 to 20 dB in 1 dB steps standard. Other values available.
Maximum Input Power: 0.5 watt, derated linearly to zero between +70° and +125°C.
Temperature Range: -55° to +125°C.
Temperature Coefficient: 0.003 dB/°C.
Accuracy
To 1 GHz: ±0.2 dB.
To 2 GHz: ±0.5 dB.
To 3 GHz: ±1.0 dB.

VSWR
To 1 GHz 1.2:1
To 3 GHz: 1.3:1

Model Numbering System
MA5 — xxdB
Insert whole numbers (Attenuation Value)

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Series MA5
Custom



Coaxial Fixed Attenuators

- **DC to 2 GHz**
- **1 to 20 dB**
- **Economical**

Wavetek Coaxial Fixed Attenuators are available in both 50Ω and 75Ω versions and provide any 1 dB value in the range of 1 through 20 dB. Due to the broad frequency range (DC to 2 GHz for Series A151 and DC to 1 GHz for Series A171), a variety of calibrated measurements may be made with a high degree of accuracy. Calibration data is available with each attenuator to further enhance overall utility.

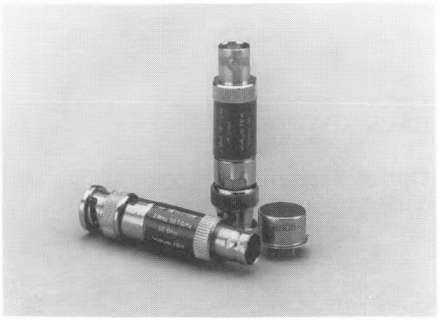
Special models are available for values thru 70 dB. Standard connectors are BNC or SMA for Series A151 and BNC or F for Series A171 in a male/female configuration.

SPECIFICATIONS
Frequency Range
Series A151: DC to 2 GHz.
Series A171: DC to 1 GHz.
Impedance
Series A151: 50Ω.
Series A171: 75Ω.
Attenuation: 1 to 20 dB in any 1 dB step.
Connectors
Series A151: BNC, SMA, N.
Series A171: BNC, F (500 MHz).

Accuracy
DC to 500 MHz: ±0.3 dB.
500 to 1 GHz: ±0.5 dB.
1 to 2 GHz (A151): ±1.0 dB.
Maximum Input Power: 1 watt average.
Operating Temperature: -20° to +125°C.

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Series A151
Series A171
Custom



RF Detectors

- **50Ω and 75Ω**
- **Economical**
- **Printed Circuit Board Mount**

Models D151, D152 and the new T8D 152 are 50Ω devices. Model D171 is a 75Ω device. Model M151 is a 50Ω monitor which samples a signal without significantly disrupting the RF path. The newly developed T8D152 is a printed circuit board mount detector packaged in a miniature T08 package. The unit is hermetically sealed and suitable for wavesolder and boardwash environments.

SPECIFICATIONS

Frequency Range	Model
0.2-1000 MHz.	D151
0.2-2000 MHz	D152
0.2-1000 MHz	D171
0.2-1000 MHz	M151
0.2-1500 MHz	T8D152

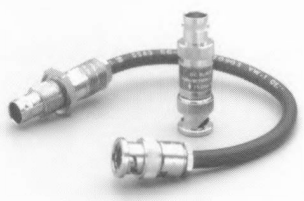
Impedance
D151: 50Ω.
D152: 50Ω.
M151: 50Ω.
T8D152: 50Ω.
D171: 75Ω.

Connectors
T8D152: pcb pins.
All Others: BNC male/female.
Maximum Input: 3.0V.

VSWR
D151: 1.3:1
D152: 1.5:1
D171: 1.3:1
M171: 1.5:1
T8D152: 1.5:1

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model D151
Model D152
Model D171
Model M151
Model T8D152



DC Blocks

- **Prevents Equipment Damage**
- **Low VSWR**
- **Minimum Insertion Loss**

Wavetek DC Blocks stop DC and attenuate 60 Hz signals that may be associated with any RF device in the freqency range of 1 to 1000 MHz. The B171 is for series insertion into a test line and the B172 is for panel mounting.

SPECIFICATIONS
Frequency Range: 1 to 1000 MHz.
VSWR: 1.5:1

Maximum DC Input: 100V.
Impedance: 75Ω
Insertion Loss: 0.2 dB.
Connectors: BNC male/female.

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model B171
Model B172

Matching Pads

- **Low VSWR**
- **Broad Frequency Range**
- **Flat Response**

Wavetek Matching Pads offer a convenient way to match any 50Ω device to a 75Ω system or vice versa, avoiding the expense of costly modification or new equipment purchases.

SPECIFICATIONS
Frequency Range: DC to 1000 MHz.
VSWR: 1.2:1
Maximum Input Power: 1 watt.
Impedance: 50/75W transformation.
Insertion Loss: 5.7 ±0.2 dB.
Connectors
M157: 50Ω BNC male.
75Ω female.
M175: 75Ω BNC male.
50Ω female.

FACTORY/FOB
Indianapolis, IN

ORDER INFORMATION
Model M157
Model M175

Rack Mounting

ORDERING INSTRUCTIONS
If you want to install a Wavetek instrument in a standard 19 inch rack, locate the instrument model number in the table below, which lists a style or styles that the factory will use to adapt the instrument for rack mounting. Each style has a short description. Styles noted as standard come with the instrument at no extra cost. **When placing an order, please specify both the instrument model number and style number.** If none of these styles meet your needs, contact your local Wavetek representative (pages 211 and 213).

Rack Mounts, Adapters and Slides

Instruments	Panel/ Adapter/Slides
20, 22, 23, 75	6, 17
52A, 53, 54	18, 19
132	1, 2, 10
145, 148A	1, 2, 8
166	10
171	8
172B	10*, S22
178	10*, S20
184, 185	8
188, 190	4, 5, 7
191, 193	8
270, 271, 273, 275	12, 13, S20
278	12, 13, S20
288	10
432, 442, 452	11, M128
716	11**
601, 602, 603	10*
650	16*, S22
680	10, S22
752A, 753A	11*, M128
801	8
816	11*, M134
852	11, M128
859	10*, S22
904, 907A	10*
952, 954, 955, 957	14, 15
962, 964, 965, 967	14, 15
1018B	1031
1061	Opt 90
1062, 1067-522	K015
1071	Opt 90
1080, 1081 Swp	K019
1081 DMM	Opt 90
1271, 1281	Opt 90
1560	Opt 04
1801C	K107
1855B	K108
1901C	K107
2000	350-31092, 350-31273

Rack Mounts, Adapters and Slides (Continued)

Instruments	Panel/ Adapter/Slides
2001	K015
2002B	K236
2405, 2407, 2410	K0317
2500A, 2500C	K0278, K0279
2510A, 2520A	K0295, K0294
3000	350-31092, 350-31273
4000-4900	Opt 90
5100, 5110	11*, M128
5120A	11*, Opt 08
5135A	11*, Opt 08
5155A	11*,Opt 08
8003	Opt 01
8501(A), 8502(A)	Opt 01

RACK MOUNT PANELS

Style 1 (Factory Only)

19 x 5.25 in. white solid panel. The instrument price will be increased.

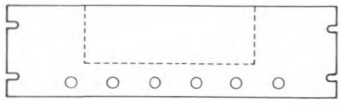
Style 2 (Factory Only)

19 x 5.25 in. white solid panel. Instrument is center mounted between six feed-through BNCs as shown. The instrument price will be increased.

Style 4 (Factory Only)

19 x 3.5 in. white solid panel. The instrument price will be increased.

Style 5 (Factory Only)

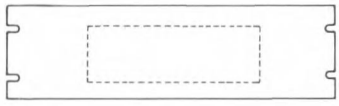


19 x 5.25 in. white solid panel. Instrument is center mounted above six feed-through BNCs as shown. The instrument price will be increased.

RACK ADAPTERS

Option 01: Reference Style 10 plus rack slides are included.

Style 6



19 x 5.25 in. light gray panel with cutout and support tray for 3.4 in. high instrument. (See table.) May be installed in field.

Style 7

19 x 5.25 in. white panel with cutout and support tray for 3.5 in. high instrument. (See table.) May be installed in field.

Style 8

19 x 7 in. white panel with cutout and support tray for 5.25 in. high instrument. (See table.) May be installed in field.

Style 9

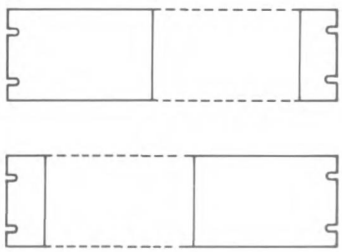
19 x 1.75 in. panel with eight feed-through BNC connectors.
Style 9-1 (White)
Style 9-1 (Lt. Gray)

Style 10

Pair of "ear" adapters that attach to the right and left sides of the standard instrument. Rack height is instrument height and instrument is centered in the 19 in. rack.

Style 11
Pair of ""ear" adapters (re style 10).

Style 12



Brackets and mounting hardware that allow right, left or center mounting of the instrument in a 19 in. rack.

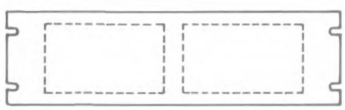
Style 13
Dual rack mount handles and brackets that attach a pair of standard instruments together for rack mounting. Rack slides are available for dual mounting only. (See rack slides.)

Style 14 (Factory Only)
Brackets and mounting hardware that allow right or left mounting of the instrument in a 19 in. rack. Instrument price will be increased.

Style 15 (Factory Only)
Dual rack mount brackets and hardware that attaches two instruments for side-by-side mounting in a 19 in. rack. Instrument price will be increased.

Style 16
Pair of "ear" adapters (re style 10).

Style 17



19 x 5.25 in. light gray panel with cutout and support tray for two 3.4 in. high instruments (See table). May be installed in field.

Style 18
Rack adapter (re style 7)

Style 19
Dual rack adapter (re style 17).

Option 90
Pair of ""ear" adapters (re style 10).

Style 350-21179
Pair of ""ear" adapters (re style 10).

Style 350-31092
Pair of ""ear" adapters (re style 10).

Style K015
Kit adapts the instrument for center mounting in a standard 19 x 5.25 in. rack.

Style K019
Kit adapts the instrument for center mounting in a standard 19 x 7 in. rack.

Style K107
Kit adapts the instrument for center mounting in a standard 19 x 9.875 in. rack.

Style K108
Kit adapts the instrument for center mounting in a standard 19 x 5.25 in. rack.

Style K0278
Kit adapts the instrument for center mounting in a standard 19 x 5.25 in. rack.

Style K0279
Kit adapts the instrument for center mounting in a standard 19 x 5.25 in. rack and contains rack slides and hardware.

Style K0294
Kit adapts the instrument for center mounting in a standard 19 x 5.25 in. rack and contains rack slides and hardware.

Style K0295
Kit adapts the instrument for center mounting in a standard 19 x 5.25 in. rack.

RACK MOUNTS

Style K236
Pair of "ear" adapters that attach to the right and left sides of the standard instrument. Rack height is instrument height.

Style K0317
Kit adapts the instrument for center mounting in a standard 19x5.25 in. rack.

RACK SLIDES
If your needs are not covered by these styles, consult the applicable instrument factory.

Option 04
Rack slides.
FOB San Diego, CA

Style S20
20 in. slides. (270 series instruments must be dual mounted, style 13.)
FOB San Diego, CA

Style S22
22 in. slides.
FOB San Diego, CA

Style M128
22 in. slides.
FOB San Diego, CA

Style M134
22 in. slides.
FOB San Diego, CA

Style 350-31273
Rack slides.
FOB San Diego, CA

SPECIAL PAINT
Special paint is available on solid panel styles 1 through 5 only. For either Wavetek's paint or customer-furnished paint, there is an added cost above rack mounted instrument price.
Special Paint
(Customer furnished)
Special Paint
(Wavetek furnished)

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* Standard with instrument.
** Standard with instrument. Pem nuts installed for Chassis Trak drawer slides Model C300S-122.

Customer Assistance

Wavetek maintains a staff of highly trained applications and service engineers to assist customers in selecting, operating, and servicing their Wavetek products. Whether it requires a telephone call or on-site consultation the Wavetek sales support group can provide the level of support you need.

Customer Training

Training is an essential aspect of obtaining maximum performance from your Wavetek product. Custom tailored training in both operation and maintenance of all Wavetek products is available to meet each customers specific needs. Contact your local sales representative or Wavetek for more details.

Extended Service

A full range of extended warranty and service agreements are available on most Wavetek products. Consult your local sales representative or Wavetek for details on the services available on specific products.

Replacement Parts

Wavetek maintains spare parts inventories at key locations throughout the world. Returning your Wavetek product to optimum operating performance is as close as your local sales representative or Wavetek. Wavetek also offers recommended spare parts kits for most products. All replacement parts come with a 90-day warranty. When placing an order, identify the part by the Wavetek part number found in the instruction manual. If you need assistance with the Wavetek part number, contact your local sales representative and give them the instrument model number, serial number, assembly number or name and the circuit reference designation. This information will help them quickly identify the correct part number.

Module Exchange

For some Wavetek products that use plug-in modules, the Wavetek module exchange program will allow you to quickly return your Wavetek product to full service if the problem can be isolated to a defective module. For information on which specific products are part of the module exchange program, contact your local sales representative or Wavetek.

Repair and Calibration Services

A worldwide network of service facilities can provide the service support necessary to keep your Wavetek product operating at optimum performance. A full line of repair services are available and include:

- Calibration traceable to National Standards.
- Fixed price repairs on most products.
- Calibration test data.
- 90-day warranty on repair services performed.

International Service Centers

Most international sales offices maintain their own service centers. You can locate your sales and service center on page 211.

United States Service Centers

Wavetek has set up a network of service centers across the United States to provide you with factory trained technicians. These centers are specialists in their fields and are listed below by the product areas they are authorized to service.

Before sending your equipment to Wavetek or one of our authorized services centers, contact your nearest Wavetek representative. An ap-parent malfunction may be correctable over the phone. If further aid is required, you will be directed to the nearest authorized service center or factory. Please obtain authorization before attempting to send the instrument to the factory. If it does become necessary to return an instrument, any symptoms, along with your name and phone number, should be written on a card and taped to the top of the instrument. The instrument should be properly packaged and shipped prepaid.

U.S. Service Centers

Service centers are listed under the product line for which they are authorized to service.

DATRON DMM & Calibrators

Tekserv
10 Kidder Road
Chelmsford, MA 01824
Telephone: 617/245-1762

Teledyne
19601 Nordhoff Street
Northridge, CA 91324
Telephone: 818/886-2211

Datron Calibration & Service
Wavetek RF Products, Inc.
5808 Churchman Bypass
Indianapolis, IN 46203
Telephone: 317/787-3332

WAVETEK CATV Products

NCS Industries
2255 E. Wyandotte Road
Willow Grove, PA 19090
Telephone: 215/657-4690

ComSe Sales
641 Grayson Highway
Lawrenceville, GA 30245
Telephone: 404/963-7870

CATV Services
2211 Warm Springs Court
Fremont, CA 94539
Telephone: 415/651-4331

Wavetek RF Products, Inc.
5808 Churchman Bypass
Indianapolis, IN 46203
Telephone: 317/787-3332

WAVETEK Microwave Products

Wavetek Microwave, Inc.
488 Tasman Drive
Sunnyvale, CA 94089
Telephone: 408/734-5780
Toll Free: 800-227-9764

WAVETEK RF Products

RMP Electronics Inc.
167 B New Highway
N. Amityville, NY 11701
Telephone: 516/789-2900

Wavetek RF Products, Inc.
5808 Churchman Bypass
Indianapolis, IN 46203
Telephone: 317/787-3332

WAVETEK San Diego Products

Electronic Services
740 Sierra Vista Ave., Building E
Mt. View, CA 94043
Telephone: 415/964-0200

Electrical Standards Repair Service, Inc.
7337 Greenbush Ave.
N, Hollywood, CA 91605
Telephone: 818/765-4224

Electronics Unlimited, Inc.
27832 Lincoln Road
Bay Village, OH 44140
Telephone: 216/835-0520

J. H. Metrology Co.
1801 Hicks Road, Unit F
Rolling Meadows, IL 60008
Telephone: 312/991-0290

RMP Electronics Inc.
167 B New Highway
N. Amityville, NY 11701
Telephone: 516/789-2900

SIRS
2739 Okeechobee Road
Ft. Pierce, FL 34947
Telephone 305/466-7472

Tek- Serv
127 Riverneck Road
Chelmsford, MA 01824
Telephone: 617/459-9480

XTEK
14824 NE 31st Circle
Redmond, WA 98052
Telephone: 206/885-6969

XTEK
15075C SW Koll Parkway
Beaverton, OR 97006
Telephone: 503/643-1133

Wavetek San Diego, Inc.
9045 Balboa Ave.
San Diego, CA 92123
Telephone: 619/279-2200

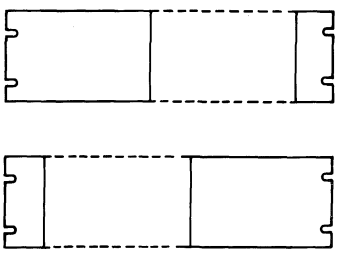
RACK MOUNTS

Style 10

Pair of "ear" adapters that attach to the right and left sides of the standard instrument. Rack height is instrument height and instrument is centered in the 19 in. rack.

Style 11
Pair of ""ear" adapters (re style 10).

Style 12



Brackets and mounting hardware that allow right, left or center mounting of the instrument in a 19 in. rack.

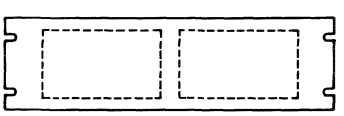
Style 13
Dual rack mount handles and brackets that attach a pair of standard instruments together for rack mounting. Rack slides are available for dual mounting only. (See rack slides.)

Style 14 (Factory Only)
Brackets and mounting hardware that allow right or left mounting of the instrument in a 19 in. rack. Instrument price will be increased.

Style 15 (Factory Only)
Dual rack mount brackets and hardware that attaches two instruments for side-by-side mounting in a 19 in. rack. Instrument price will be increased.

Style 16
Pair of "ear" adapters (re style 10).

Style 17



19 x 5.25 in. light gray panel with cutout and support tray for two 3.4 in. high instruments (See table). May be installed in field.

Style 18
Rack adapter (re style 7)

Style 19
Dual rack adapter (re style 17).

Option 90
Pair of ""ear" adapters (re style 10).

Style 350-21179
Pair of ""ear" adapters (re style 10).

Style 350-31092
Pair of ""ear" adapters (re style 10).

Style K015
Kit adapts the instrument for center mounting in a standard 19 x 5.25 in. rack.

Style K019
Kit adapts the instrument for center mounting in a standard 19 x 7 in. rack.

Style K107
Kit adapts the instrument for center mounting in a standard 19 x 9.875 in. rack.

Style K108
Kit adapts the instrument for center mounting in a standard 19 x 5.25 in. rack.

Style K0278
Kit adapts the instrument for center mounting in a standard 19 x 5.25 in. rack.

Style K0279
Kit adapts the instrument for center mounting in a standard 19 x 5.25 in. rack and contains rack slides and hardware.

Style K0294
Kit adapts the instrument for center mounting in a standard 19 x 5.25 in. rack and contains rack slides and hardware.

Style K0295
Kit adapts the instrument for center mounting in a standard 19 x 5.25 in. rack.

Style K236
Pair of "ear" adapters that attach to the right and left sides of the standard instrument. Rack height is instrument height.

Style K0317
Kit adapts the instrument for center mounting in a standard 19x5.25 in. rack.

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Rack slides.
FOB San Diego, CA

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20 in. slides. (270 series instruments must be dual mounted, style 13.)
FOB San Diego, CA

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22 in. slides.
FOB San Diego, CA

Style M128
22 in. slides.
FOB San Diego, CA

Style M134
22 in. slides.
FOB San Diego, CA

Style 350-31273
Rack slides.
FOB San Diego, CA

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(Customer furnished)
Special Paint
(Wavetek furnished)

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* Standard with instrument.
** Standard with instrument. Pem nuts installed for Chassis Trak drawer slides Model C300S-122.

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Tekserv
10 Kidder Road
Chelmsford, MA 01824
Telephone: 617/245-1762

Teledyne
19601 Nordhoff Street
Northridge, CA 91324
Telephone: 818/886-2211

Datron Calibration & Service
Wavetek RF Products, Inc.
5808 Churchman Bypass
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Telephone: 317/787-3332

WAVETEK CATV Products

NCS Industries
2255 E. Wyandotte Road
Willow Grove, PA 19090
Telephone: 215/657-4690

ComSe Sales
641 Grayson Highway
Lawrenceville, GA 30245
Telephone: 404/963-7870

CATV Services
2211 Warm Springs Court
Fremont, CA 94539
Telephone: 415/651-4331

Wavetek RF Products, Inc.
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WAVETEK Microwave Products

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488 Tasman Drive
Sunnyvale, CA 94089
Telephone: 408/734-5780
Toll Free: 800-227-9764

WAVETEK RF Products

RMP Electronics Inc.
167 B New Highway
N. Amityville, NY 11701
Telephone: 516/789-2900

Wavetek RF Products, Inc.
5808 Churchman Bypass
Indianapolis, IN 46203
Telephone: 317/787-3332

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740 Sierra Vista Ave., Building E
Mt. View, CA 94043
Telephone: 415/964-0200

Electrical Standards Repair Service, Inc.
7337 Greenbush Ave.
N, Hollywood, CA 91605
Telephone: 818/765-4224

Electronics Unlimited, Inc.
27832 Lincoln Road
Bay Village, OH 44140
Telephone: 216/835-0520

J. H. Metrology Co.
1801 Hicks Road, Unit F
Rolling Meadows, IL 60008
Telephone: 312/991-0290

RMP Electronics Inc.
167 B New Highway
N. Amityville, NY 11701
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SIRS
2739 Okeechobee Road
Ft. Pierce, FL 34947
Telephone 305/466-7472

Tek- Serv
127 Riverneck Road
Chelmsford, MA 01824
Telephone: 617/459-9480

XTEK
14824 NE 31st Circle
Redmond, WA 98052
Telephone: 206/885-6969

XTEK
15075C SW Koll Parkway
Beaverton, OR 97006
Telephone: 503/643-1133

Wavetek San Diego, Inc.
9045 Balboa Ave.
San Diego, CA 92123
Telephone: 619/279-2200

International Sales and Service Centers

Wavetek's sales and service centers were selected to provide the best sales support for our customers. They have extensive knowledged and experience in various product lines. These product lines appear in italics after sales and service center address.

T&M ..... General Test & Measurement Equipment
DMM ..... Voltmeter & Calibrators
CATV ..... CATV & Broadband Test & Measurement Equipment
COMP ..... RF & Microwave Components
MICROWAVE ..... Microwave Equipment

Should you need further assistance in locating your nearest sales and service center, or any other direct assistance from Wavetek, please contact the appropriate Wavetek sales office listed below.

Europe, Middle East & Africa Sales
European Sales Headquarters
Wavetek Electronics GmbH
Freisinger Str. 34
D-8045 Ismaning
Federal Republic of Germany
Telex: 841 5212996 WVTK D
Fax: 49 89 967170
Telephone: 49 89 960949-0

Direct Sales
Wavetek Electronics GmbH
Freisinger Str. 34
D-8045 Ismaning
Federal Republic of Germany
Telex: 841 5212996 WVTK D
Fax: 49 89 967170
Telephone: 49 89 960949-0

Datron/Wavetek
Hurricane Way, Norwich Airport
Norwich, Norfolk
NR6 6JB
England
Telex: 851 975173
Fax: 44 603 483670
Telephone: 44 603 404824

Asia, Pacific & South America Sales
Wavetek International Sales
9145 Balboa Avenue
San Diego, CA 92123
TWX: 230/756953
Fax: 619/450-0325
Telephone: 619/450-9971

Wavetek International Sales
19A, Chuang's Finance Centre
81-85 Lockhart Road
Wanchai, Hong Kong
Telex: 230 446 655 WVTK HKG
Fax: 852 5 865-6716
Telephone: 852 5 865-1903

ARGENTINA

REYCOM ELECTRONICA S.R.L.
Arcos 3631
1429 Buenos Aires, Argentina
Telex: 39025133, & 22122 REYCOM AR
Fax: 541 11-1721
Telephone: 541 701 4162/-0395
(T&M, MICROWAVE, CATV, COMPONENTS)

AUSTRALIA

SCIENTIFIC DEVICES AUSTRALIA PTY LTD
2 Jacks Road, P.O. Box 63
South Oakleigh
Victoria 3167, Australia
Telex: 790 32742 AA
Fax: 61 3 579 0971
Telephone: 61 3 579 3622
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

559A Willoughby Road
Willoughby, N.S.W. 2068, Australia
Telex: 790 22978
Telephone: 61 2 958 8064
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

Adelaide Branch Office
Unit 4/38 Commercial Rd.
Salisbury, South Australia
Australia
Fax: 61 8 281 4194
Telephone: 61 8 281-3788
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

AUSTRIA

WALTER REKIRSCH
ELEKTRONISCHE GERAETE GmbH & CO. KG
Obachgasse 28
A-1220 Wien, Austria
Telex: 847 134759
Fax: 43 222-257275
Telephone: 43 222-253626
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

BANGLADESH

SISCO INTERNATIONAL LTD
13/2 Toyenbee Circular Road
Motijheel Commercial Area
G.P.O. Box No.2545
Dhaka, Bangladesh
Telex: 65853 ERIL BJ
Telephone: 880 2 241491
(T&M, MICROWAVE, CATV, COMPONENTS)

BELGIUM

AIR PARTS ELECTRONICS BV
Avenue Huart-Hamoir 1, Box 34
B-1030 Brussels/Bruxelles, Belgium
Telex: 846 25146
Fax: 32 2-2418130
Telephone: 32 2-2416460
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

BRAZIL

SISTRONICS INSTRUMENTACAO E SISTEMAS LTDA
Av. Alfredo Egidio de Souza Aranha
75-3 & 4 Andares - Jd. Santo Antonio
CEP 04726 Sao Paulo, SP, Brazil
Telex: 11 57155 SNCS
Fax: 55 11 5238457
Telephone: 55 11 247 558
(T&M, MICROWAVE, CATV, COMPONENTS)

COMERCIAL GONCALVES
Rua Deocleciana 77
Cep 01106 Ponte Pequena
Sao Paulo SPA, Brazil
Telex: 391 22104 or 391 34272
Fax: 55 11 227 612
Telephone: 55 11 229404
(DMM)

CANADA

INTERFAX SYSTEMS, INC.
45 Voyager Court N.
Rexdale, Ontario M9W 2Y2, Canada
Telex: 06989222
Fax: 416/674-8986
Telephone: 416/674-8970
(T&M, MICROWAVE, DMM)

5575 St. Francois
St. Laurent, Quebec H4S 1W6, Canada
Telex: 05824845
Fax: 514/336-9607
Telephone: 514/336-0392
(T&M, MICROWAVE, DMM)

235 Stafford Road, Bay 103
Nepean, Ontario K2H 9C1, Canada
Telex: 0534715
Fax: 613/820-3213
Telephone: 613/726-8888
(T&M, MICROWAVE, DMM)

Discovery Park
3700 Gilmore Way, Suite 304
Burnaby, B.C. V5G 4M1, Canada
Telex: 04354677
Fax: 604/430-3035
Telephone: 604/430-1410
(T&M, MICROWAVE, DMM)

CABLETEL COMMUNICATIONS, INC.
120 Gibson Drive
Markham, Ontario L3R 2Z3, Canada
Fax: 416/475-9571
Telephone: 416/475-1030
(CATV)

CHILE

INTEREXPORT LTDA. ZENTENO 83
P.O. Box 9269
Santiago, Chile
Telex: 392 340496 INPORT CK
Telephone: 56 2 6980335, 56 26965948, 56 2 724121
(T&M, MICROWAVE, COMPONENTS)

CHINA

SCHMIDT & CO. (H.K.) LTD.
18/F, Great Eagle Centre
23 Harbour Road
Wanchai, Hong Kong
Telex: 780 74766 SCHMC HX
Fax: 852 5 838-265
Telephone: 852 5 833-022
(T&M, MICROWAVE, CATV, COMPONENTS)

TIANJIN ZHONG HUAN
SCIENTIFIC INSTRUMENTS CORP.
New No. 59 Zhao Jia Chang Street
Hong-Qiao Section
Tianjin, China
Cable: Tianjin 3671
Fax: 86 22 252625
Telephone: 75 1941, 3732
(DMM)

DENMARK

INSTRUTEK A/S
Christiansholmsgade
8700 Horsens, Denmark
Telex: 855 61656
Fax: 45 5-615658
Telephone: 45 5-611100
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

EASTERN EUROPE

AMTEST ASSOCIATES LTD.
Amtest House
75-79 Guildford Street
Chertsey,Surrey KT16 9AS, England
Telex: 851 928855
Fax: 44 932 561919
Telephone: 44 932 568355
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

ECUADOR

PROTECO COASIN CIA, LTDA
Av 12 de Octubre y Orellana
P.O. Box 228A
Quito, Ecuador
Telex: 393 2865 PROTEC ED
Fax: 593 2 561980
Telephone: 593 2 526759, 529685
(T&M, MICROWAVE, CATV, COMPONENTS)

EGYPT

ELECTRONIC ENGINEERING LIAISON OFFICE
P.O. Box 2891
19A Aswan Street
Horreya, Heliopolis
Cairo, Egypt
Telex: 927 22782
Telephone: 20 2-695705
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

FINLAND

PROFELEC OY
P.O. Box 67
SF-00421 Helsinki 42, Finland
Telex: 857 125225 PROFE SF
Fax: 35 80 5662998
Telephone: 35 80 566 4477
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

FRANCE

MB ELECTRONIQUE
606 Rue Fourny
Z.I. De Buc, B.P. 31
78530 Buc, France
Telex: 842 695414
Fax: 33 1-416 4756524
Telephone: 33 1-395 68131
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

WEST GERMANY, FEDERAL REPUBLIC OF

WAVETEK ELECTRONICS GmbH
Freisinger Str. 34
D-8045 Ismaning
Federal Republic of Germany
Telex: 841 5212996 WVTK D
Fax: 49 89 967170
Telephone: 49 89 960949-0
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

GREECE

AMERICAN TECHNICAL ENTERPRISES S.A.
Agiou Konstantinou 39
P.O. Box 3156
Athens 10210, Greece
Telex: 863 216046
Fax: 30 1 5249995
Telephone: 30 1 5240740/5240620
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

HONG KONG

Wavetek International Sales
19A, Chuang's Finance Centre
81-85 Lockhart Road
Wanchai, Hong Kong
Telex: 780 446 655 WVTK HKG
Fax: 852 5 865-6716
Telephone: 852 5 865-1903
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

EUROTHERM (FAR EAST) LTD.
21/F Kai Tak Commercial Bldg.
317-321 Des Voeux Road C
Hong Kong
Telex: 780 72449 EFELD HX
Fax: 852 5 8151540
Telephone: 852 5 411268
(DMM)

SCHMIDT & CO. (H.K.) LTD.
18/F, Great Eagle Centre
23 Harbour Road
Wanchai, Hong Kong
Telex: 780 74766 SCHMC HX
Fax: 852 5 838-265
Telephone: 852 5 833-022
(T&M, MICROWAVE, CATV, COMPONENTS)

ICELAND

PROTON HF
P.O. Box 127
Baldursgate 14
Keflavik, Iceland
Telex: 858 2327
Telephone: 354 2 922900
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

INDIA

TECHNICAL TRADE LINKS
42, Navketan Industrial Estate
Mahakali Caves Road
Andheri East
Bombay - 400 093, India
Telex: 953 11 79261 XNTL IN
Fax: 91 22 634 2204 or 22 507320
Telephone: 91 22 632 2412
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

A-5/6, Wagle Industrial Estate
Thane - 400 604, India
Telex: 953 11 71979 APEL IN
Telephone: 91 22 591861, 2 3
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

44, Residency Road
Bangalore - 560 025, India
Telex: 953 84 58125 APLB IN
Telephone: 91 81 2578977
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

4th Floor, 4E/14 Jhandewalan Extension
New Delhi - 110 055, India
Telex: 953 31 5133
Telephone: 91 11 777460
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

No. 6, 6th Floor 'Vasundhara'
2/7 Sarat Bose Road
Calcutta - 700 020, India
Telex: 953 21 5215 APLB IN
Telephone: 91 33 473877
(T&M, MICROWAVE, CATV, COMPONENTS, DMM)

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Toll Free: (800) 437-3100
(CATV)

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WKM ASSOCIATES, INC.
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Madison Heights, MI 48071
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Telephone: (313) 588-2300
(T&M)

W. WHITAKER & ASSOCIATES
620 S. Earl Avenue
Lafayette, IN 47905
Fax: (317) 447-5064
Telephone: (317) 447-3345
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(CATV)

MINNESOTA

DYTEC INSTRUMENTS, INC.
7600 Parklawn Avenue, Suite 339
Edina, MN 55435
Fax: (612) 831-5114
Telephone: (612) 831-7169
(T&M)

COMMUNICATIONS SUPPLY GROUP
5272 Valley Industrial Blvd. South
Shakopee, MN 55379
Fax: (612) 445-8423
Telephone: (612) 445-8424
Toll Free: (800) 451-9032
(CATV)

MISSISSIPPI

SOUTHERN MARKETING ASSOCIATES
700 Arcadia Circle, Suite D
Huntsville, AL 35801
Fax: (205) 534-6059
Telephone: (205) 534-6020
(T&M)

COMSE SALES
641 Grayson Highway
Lawrenceville, GA 30245
Fax: (404) 962-7539
Telephone: (404) 963-7870
Toll Free: (800) 241-1232
(CATV)

MISSOURI

DYTEC/SOUTH, INC.
2644 Metro Blvd.
Maryland Heights, MO 63043
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Telephone: (314) 739-0665
(T&M)

MEGA HERTZ SALES
6940 S, Holly Circle, Suite 200
Englewood, CO 80112
Fax: (303) 779-1749
Telephone: (303) 779-1717
Toll Free: (800) 525-8386
(CATV)

MONTANA

NORTHWEST TEST & MEASUREMENT
17200 N.W. Corridor Court
Beaverton, OR 97006
Fax: (503) 645-5186
Telephone: (503) 645-9000
(T&M)

GLADE COMMUNICATION EQUIP. CO
144 Railroad Ave., Suite 106
Edmonds, WA 98020
Fax: (206) 778-6933
Telephone: (206) 771-6891
(CATV)

NEBRASKA

DYTEC/SOUTH, INC.
8245 Nieman Road, Suite 100
Lenexa, KS 66214
Fax: (913) 894-1039
Telephone: (913) 888-0215
(T&M)

MEGA HERTZ SALES
6940 S, Holly Circle, Suite 200
Englewood, CO 80112
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Telephone: (303) 779-1717
Toll Free: (800) 525-8386
(CATV)

NEVADA Northern

WARD/DAVIS ASSOCIATES
3329 Kifer Road
Santa Clara, CA 95051
Fax: (408) 738-3995
Telephone: (408) 245-3700
(T&M)

CATV SERVICES
2211 Warm Springs Court
Fremont, CA 94539
Fax: (415) 651-8545
Telephone: (415) 651-4331
Outside CA: (800) 227-1200
(CATV)

NEVADA Nye & Clark Counties

WARD/DAVIS ASSOCIATES
7263 Engineer Road, Suite D
San Diego, CA 92111
P.O. Box 81104-W
San Diego, CA 92138
Fax: (619) 292-8364
Telephone: (619) 292-1000
(T&M)

CATV SERVICES
2211 Warm Springs Court
Fremont, CA 94539
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Telephone: (415) 651-4331
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(CATV)

NEW HAMPSHIRE

PAT JENKS ASSOCIATES
66 Cherry Hill Drive, Suite 100
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Telephone: (315) 451-9450
Toll Free: (800) 437-3100
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NEW JERSEY Northern

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Great Neck, NY 11021
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CABLE TECHNOLOGY ASSOCIATES, INC.
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Telephone: (315) 451-9450
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(CATV)

NEW JERSEY Southern

EASTERN INSTRUMENTATION OF PHILADELPHIA
301 Lakeside Drive
Southhampton, PA 18966
Fax: (215) 355-3469
Telephone: (215) 355-7700
(T&M)

NCS INDUSTRIES, INC.
2255 East Wyandotte Road
Willow Grove, PA 19090
Fax: (215) 657-0840
Telephone: (215) 657-4690
Toll Free: (800) 523-2342
(CATV)

NEW MEXICO

TECHNICAL MARKETING SPECIALISTS
3200 Carlisle Blvd., N.E., Suite 224
Albuquerque, NM 87110
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Telephone: (505) 889-4595
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6940 S, Holly Circle, Suite 200
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Toll Free: (800) 525-8386
(CATV)

NEW YORK

NORTHERN TECHNICAL SALES
101 Old Cove Road, Suite 114
Liverpool, NY 13090
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Liverpool, NY 13088
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(CATV)

UNITED STATES SALES CENTERS

NORTH CAROLINA

SOUTHERN MARKETING ASSOCIATES
901 Chalk Level Road, Suite H-3
Durham, NC 27704
Fax: (407) 682-7443
Telephone: (919) 479-6034
(T&M)

COMSE SALES
641 Grayson Highway
Lawrenceville, GA 30245
Fax: (404) 962-7539
Telephone: (404) 963-7870
Toll Free: (800) 241-1232
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NORTH DAKOTA

DYTEC INSTRUMENTS, INC.
7600 Parklawn Avenue, Suite 339
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5272 Valley Industrial Blvd. South
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Telephone: (612) 445-8424
Toll Free: (800) 451-9032
(CATV)

OHIO

WKM ASSOCIATES, INC.
6000 W. Creek Road, Suite 23
Independence, OH 44131
Fax: (216) 524-0276
Telephone: (216) 524-5930
(T&M)

733 Conress Park Road
Dayton, OH 45459
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Telephone: (513) 434-7500
(T&M)

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620 S. Earl Avenue
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Telephone: (317) 447-3345
Outside IN: (800) 433-8775
(CATV)

OKLAHOMA

DATA MARKETING ASSOCIATES
7060 S. Yale, Suite 901
Tulsa, OK 74136
Fax: (918) 494-8901
Telephone: (918) 494-2711
(T&M)

CABLE EQUIPMENT CORPORATION
800 E. Campbell Road, Suite 199
Richardson, TX 75081
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Telephone: (214) 699-0900
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OREGON

NORTHWEST TEST & MEASUREMENT
17200 N.W. Corridor Court
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NCS INDUSTRIES, INC.
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Telephone: (215) 657-4690
Toll Free: (800) 523-2342
(CATV)

PENNSYLVANIA Western

WKM ASSOCIATES, INC.
M-S Center
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Telephone: (412) 892-2953
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NCS INDUSTRIES, INC.
2255 East Wyandotte Road
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Toll Free: (800) 523-2342
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Toll Free: (800) 241-1232
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3939 Roswell Road, N.E., Suite 250
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Telephone: (404) 656-0603
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Telephone: (512) 338-4701
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Dallas, TX 75244
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Telephone: (214) 661-0300
(T&M)

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Telephone: (713) 954-5020
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Telephone: (512) 828-5741
(T&M)

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Telephone: (303) 691-5620
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Telephone: (303) 779-1717
Toll Free: (800) 525-8386
(CATV)

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(CATV)

WEST VIRGINIA

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WISCONSIN Eastern

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Toll Free: (800) 451-9032
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WISCONSIN Western

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5272 Valley Industrial Blvd. South
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Telephone: (612) 445-8424
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Telephone: (303) 691-5620
(T&M)

MEGA HERTZ SALES
6940 S, Holly Circle, Suite 200
Englewood, CO 80112
Fax: (303) 779-1749
Telephone: (303) 779-1717
Toll Free: (800) 525-8386
(CATV)

Order Information

Placing Your Order
Domestic:
Wavetek has local sales representatives in your area to assist with equipment selection, prices, delivery and special requirement information. Your order should be placed with:

- Your local Sales Representative Office as shown on page 213-215 of this catalog, or
- Your Wavetek T&M Order Department, 9145 Balboa Avenue, San Diego, CA 92123, P.O. Box 85434, San Diego, CA 92138

Direct Telephone Line: 800/223-9885
Fax: 619/565-7942

Export:
Wavetek has exclusive distributors/representatives in most countries to handle your purchasing needs. These representatives are prepared to assist you with product selection, pricing, delivery and related order information.

- A listing of International Sales Representatives is shown on pages 211 and 212 of this catalog.

In addition, Wavetek maintains Sales Offices in Europe (Federal Republic of Germany) and in the Far East (Hong Kong) to further support our customers and distributors.

- Wavetek Sales Offices are shown on pages 213-215 and inside the front cover of this catalog.

Since many products or configurations are changed or improved during the life of this catalog, we suggest that you always contact your local Sales Representative Office for current product and pricing information prior to placing your order.

Actual shipment will be made by the applicable factory. The FACTORY/FOB information is located on each Model's data page.

GSA Contracts
Many Wavetek products are sold under GSA contracts. If you are authorized to purchase under the GSA, contact your local Sales Representative Office or Wavetek T&M Order Department.

Terms of Sale
Domestic:
Standard payment terms are net 30 days with established credit.

Export:
Payment terms for orders placed from outside the USA are confirmed by irrevocable letter of credit or other terms that may have been arranged in advance.

All prices listed in this catalog are FOB factory and apply to domestic USA customers for USA purchases only.

Quality
Wavetek's Quality Assurance program uses MIL-Q-9858A and MIL-I-45208A as guides to develop the best commercial manufacturing practices. Wavetek's calibration system complies with MIL-STD-45662 and is traceable to the

National Institute of Standards & Technology (NIST). Certificates of Conformance/Compliance and Calibration/Traceability are available upon request at time of purchase.

Shipping Methods
Domestic:
Orders are shipped FOB factory direct from Wavetek via UPS or common carrier depending on size and weight restrictions except for GSA. Air freight is available upon request. Refer to the appropriate product specifications page for the factory/FOB source of individual instruments.

Export:
Shipments to destinations outside the USA are made via air freight forwarders from the individual factories. Many international distributors may have the instruments you require in stock to save you delivery time.

Price Changes
Wavetek reserves the right to change prices. Prices prevailing at the time an order is received will apply.

Product Changes
Wavetek, in a continuing effort to offer excellent products at a fair value, reserves the right to change specifications and models without notice.

Quotations
If you require a written quotation, contact your local Sales Representative Office or Wavetek T&M Order Department.

Wavetek Sales Offices

UNITED STATES & CANADA TECHNICAL INFORMATION

DATRON WAVETEK
9145 Balboa Ave., San Diego, CA 92123 Tel: 619/450-9971 Fax: 619/277-6221

WAVETEK MICROWAVE, INC.
488 Tasman Drive, Sunnyvale, CA 94089 Tel: 408/734-5780 . Fax: 408/747-1265

WAVETEK RF PRODUCTS, INC.
5808 Churchman Bypass, Indianapolis, IN 46203 Tel: 317/788-9351 Fax: 317/788-5999

WAVETEK SAN DIEGO, INC.
9045 Balboa Ave., San Diego, CA 92123 Tel: 619/279-2200 Fax: 619/565-9558

For Complete Sales & Technical Information
in Your Area Contact Your Local Representative Listed on Page 213

UNITED STATES & CANADA ORDER INFORMATION

CALL 1-800/223-WVTK (9885) or 619/565-9234 Fax: 619/565-7942

EUROPE, MIDDLE EAST & AFRICA TECHNICAL INFORMATION

WAVETEK ELECTRONICS, GmbH
Freisinger Strasse 34, D-8045 Ismaning, FRG Tel: 089/96 09 49-0 Fax: 089/96 71 70

DATRON INSTRUMENTS LIMITED
Hurricane Way, Norwich Airport, Norwich, Norfolk, NR6 6JB, U.K. Tel: 44-603-404824 Fax: 44-603-483670

For Complete Sales & Technical Information
in Your Area Contact Your Local Representative Listed on Page 211

ASIA, PACIFIC & SOUTH AMERICA TECHNICAL INFORMATION

WAVETEK INTERNATIONAL SALES
9145 Balboa Ave, San Diego, CA 92123 Tel: 619/450-9971 Fax: 619/450-0325

WAVETEK INTERNATIONAL SALES
19A Chuang's Finance Centre, 81-85 Lockhart Rd., Wanchai, Hong Kong Tel: 852-5-865-1903 Fax: 852-5-8656716

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in Your Area Contact Your Local Representative Listed on Page 211

WAVETEK®

- VXI INSTRUMENTS
- WAVETEST TEST DEVELOPMENT SOFTWARE
- MODULAR INSTRUMENTS
- FUNCTION & ARBITRARY WAVEFORM GENERATORS
- PULSE GENERATORS & WAVEFORM ANALYZERS
- RF SIGNAL & SWEEP GENERATORS
- FREQUENCY SYNTHESIZERS
- MICROWAVE SIGNAL & SWEEP GENERATORS
- MICROWAVE SCALAR ANALYZERS
- MICROWAVE CW & PEAK POWER METERS
- PRECISION DIGITAL MULTIMETERS
- CALIBRATORS & CALIBRATION EQUIPMENT
- DATA LOGGING SYSTEM
- SIGNAL PROCESSING FILTERS
- SIGNAL SWITCHING SYSTEM
- CATV SIGNAL LEVEL METERS
- CATV SYSTEM ANALYZERS & SYSTEM SWEEP
- RF COMPONENTS