WAVETEK

TEST AND MEASUREMENT INSTRUMENTATION, 1985

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WAVETEK®

How To Use This Catalog

This catalog contains descriptions, specifications, prices and ordering information for Wavetek's generator and measurement equipment along with 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 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 right of each page.

• **Equipment Model Numbers**—A model number index is on page 2. Also, instrument model numbers can be read in the upper left hand corner as you thumb the catalog pages.

• **Selection Guide**—Selection guides comparing features of many (but not all) instruments are on the following pages:

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

NEW Identifies new products

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Model Number Index

NEW **New products identified by bold type.**

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Order, Warranty & Service Information

Placing Your Order

Domestic: Wavetek has sales representatives in your area to assist with your equipment selection, prices, delivery and special requirement information. Actual shipment and invoicing will be made by the applicable factory. Your orders should be addressed to Wavetek, c/o your sales representative.

Export: Exclusive distributors/representatives are maintained in most countries to handle your purchasing needs and any after-purchase service requirements. Wavetek Electronics GmbH is available in Munich, West Germany to support all European, African and Middle-Eastern Customers and Distributors.

All customers for PROM and logic programmers outside North America are supported through the Wavetek-Digelec office in Zurich, Switzerland.

GSA Contracts

Many Wavetek products are sold under a variety of GSA contracts. If you are authorized to purchase under the GSA, contact your local Wavetek Representative or the applicable Wavetek factory directly.

Terms of Sale

Domestic: Standard terms are net 30 days with established credit.

Export: Payment and terms for orders placed from outside the USA are confirmed irrevocable letters of credit or cash in advance or other terms that may have been arranged in advance.

Wavetek reserves the right to change prices. Prices prevailing at the time an order is received will apply.

All prices are FOB factory and apply to domestic USA customers for USA purchases only. If you require a written quote, please contact the appropriate office as you would to place your order. All proforma invoices for international purchases must be supplied by Wavetek.

Certification

Wavetek's Quality Assurance program satisfies the requirements of MIL-I-45208A, MIL-C-45662A and good manufacturing practices. Wavetek's calibration accuracy is traceable to the National Bureau of Standards.

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. Air freight is available upon request.

All domestic shipments are FOB factory except under special contracts; e.g., GSA contracts. Refer to the 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.

Product Changes

Although product information in this catalog was current at the time of printing, Wavetek, in a continuing effort to offer excellent products at a fair value, reserves the right to change specifications and models without notice.

Warranty

Wavetek's product line has gained the reputation of excelling in both reliability and performance. The company's reputation is reflected by the following Warranty:

Wavetek warrants that all products of its own manufacture conform to Wavetek specifications and are free from defects in material and workmanship when used under normal operating conditions and within the service conditions for which they were furnished.

The obligation of Wavetek hereunder shall expire one (1) year after delivery and is limited to repairing, or at its option, replacing without charge, any such product which in Wavetek's sole opinion proves to be defective within the scope of this Warranty. In the event Wavetek is not able to repair or replace defective products or components within a reasonable time after receipt thereof, Buyer shall be credited for their value at the original purchase price.

Wavetek must be notified in writing of the defect or nonconformity. Shipment shall not be made without prior authorization by Wavetek.

This is Wavetek's sole warranty with respect to the products delivered hereunder. No statement, representation, agreement or understanding, oral or written, made by a distributor, representative or employee of Wavetek, which is not contained in this warranty, will be binding upon Wavetek, unless made in writing and executed by an authorized Wavetek employee. Wavetek makes no other warranty of any kind whatsoever, expressed or implied, and all implied warranties of merchantability and fitness for a particular use which exceed the aforestated obligation are hereby disclaimed by Wavetek and excluded from this agreement. Under no circumstances shall Wavetek be liable to Buyer, in contract or in tort, for any special, indirect, incidental or consequential damages, expenses, losses or delays however caused.

Service

Wavetek maintains a staff of technicians at its factories and service centers throughout the world to help you get the maximum use from your Wavetek instruments. These people are highly trained in the operation, maintenance and calibration of Wavetek equipment and will assist you with any technical problems that might be encountered.

Instrument Warranty Repair

Should a malfunction occur with any Wavetek instrument, contact your nearest Wavetek representative. An apparent 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.*

Instruments not covered under warranty will be evaluated and you will be supplied with a formal quote. Repair will begin when authorization is received in the form of a purchase order. Wavetek gives a 90 day guarantee on all out-of-warranty repairs.

Point of Manufacture

To determine the point of manufacturing for a particular instrument refer to that instrument's specification page, in this catalog, under the heading FACTORY/FOB. All inquiries regarding this instrument should be directed to the proper facility.

Addresses

Addresses for Wavetek offices are given on page 6. Wavetek Representatives and their addresses are given on pages 230 and 232.

WAVETEK

Operations

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Wavetek is a leading manufacturer of electronic test and measurement equipment. Wavetek products, general purpose and special electronic test and measurement equipment, are sold throughout the world to customers engaged in communications, education, design, development, maintenance, production and research activities for laboratory and industrial applications.

INDIANA DIVISION

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Wavetek Indiana produces a line of precision test instruments that includes signal and sweep generators, display oscilloscopes, service monitors, modulation meters and CATV test equipment. Also produced are a wide variety of RF and microwave components, such as filters, RF attenuators and detectors. These products are used extensively in a variety of applications in communications, aerospace, government, education and medicine.

- Signal Generators
- Sweep Generators
- CATV Test Equipment
- Signal Level Meters
- Service Monitors
- Display Oscilloscopes
- Microwave Components
- Mobile Test Equipment
- Group Delay Analyzers
- TV Tuner Test Systems
- Satellite Communications Systems Test Instruments

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Wavetek Pacific Measurements produces RF and microwave power meters and scalar network analyzer systems for both bench-top and ATE applications. The product range includes a peak power meter that measures the power inside an RF pulse and a fully automatic network analyzer system for microwave device and system characterization. The products are used in both military and commercial applications where highly accurate microwave measurements are essential.

- Portable Power Meters
- Systems Power Meters
- Peak Power Meters
- Scalar Network Analyzers
- Network Analyzer Systems

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Wavetek San Diego produces a full line of signal sources which includes function generators, pulse generators, frequency synthesizers and microwave signal generators for both bench top and ATE applications. This line is supported with instrumentation controllers, signal switching systems and signal processing filters. Products range from high quality, basic instrumentation, which appeals to schools, service shops and hobbyists as well as industry, to precision microprocessor controlled instruments for the most demanding laboratory and automated applications.

- Function Generators
- Pulse Generators
- Frequency Synthesizers
- Arbitrary Waveform Generators
- Signal Processing Filters
- Microwave Signal Generators
- Instrumentation Controller
- Signal Switching Systems

SCIENTIFIC DIVISION

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Wavetek Scientific designs, manufacturers and markets a line of FFT Spectrum Analyzers for applications in electronics, acoustics, vibration testing, machinery diagnostics, plant equipment maintenance, quality control testing, and machine design. In addition, it produces structural analysis systems and a variety of data acquisition accessories.

- FFT Based Spectrum Analyzers and Accessories

Operations (Cont.)

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Wavetek-Digelec is a leading manufacturer of PROM and logic programming equipment. The wide range of products is aimed at engineering, R&D, production and field service applications. Close cooperation with semiconductor manufacturers avails the users with the latest programming techniques. Programmers have written approvals by all major semiconductor manufacturers.

- Universal PROM and Logic Programmer
- E^2/EPROM Programmer and Simulator
- E^2/EPROM Portable Programmer
- Production Programmers
- Board Programmer
- Logic Programmer
- Ultraviolet Eraser

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Wavetek Munich serves as the sales and service support center for all Wavetek Divisions covering the European, Mid East and African marketplaces. The Munich office is staffed with highly trained personnel to provide technical assistance to our customers and the local distribution network.

GERMAN SALES OFFICE

WAVETEK ELECTRONICS GMBH
Hans-Pinsel-Strasse 9-10
8013 Haar bei München
Federal Republic of Germany
Tel: (0 89) 46 50 62
Telex: 521-2296 + WVTK D

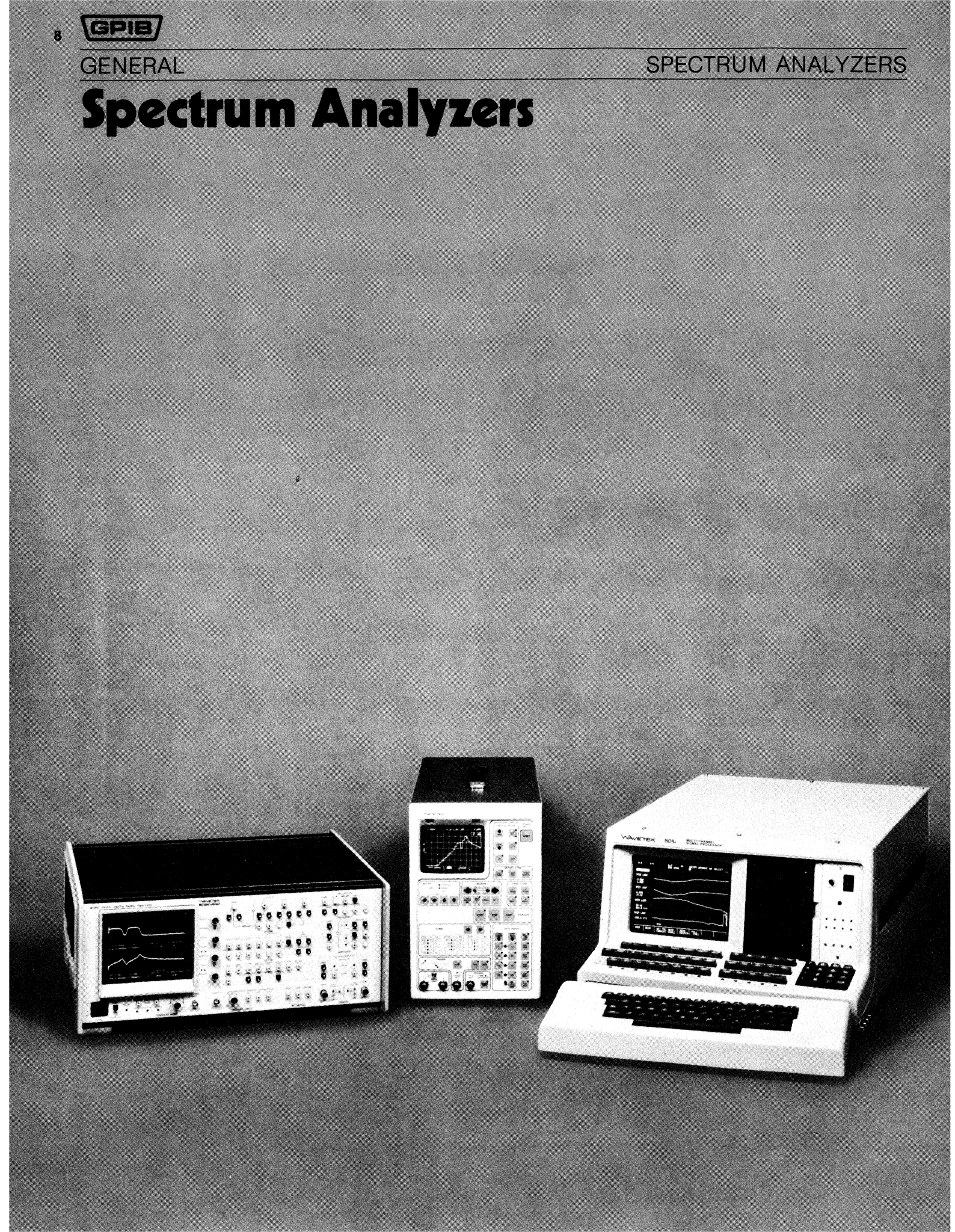
Wavetek products are sold directly into the Federal Republic of Germany marketplace through our German sales office, which provides sales and maintenance services for all Wavetek products and instruments from a select few other manufacturers.

UNITED KINGDOM SALES OFFICE

WAVETEK ELECTRONICS LTD.
Tag Lane
Hare Hatch, Reading, Berks RG10 9 LT.
United Kingdom
Tel: Wargrave (073522) 4121
Telex: 849301 + WVTK G

Wavetek products are sold directly into the UK marketplace through our Reading office. The staff is highly skilled in providing sales and maintenance service for all Wavetek product lines as well as representing other instrument manufacturers in the test and measurement field.

Spectrum Analyzers



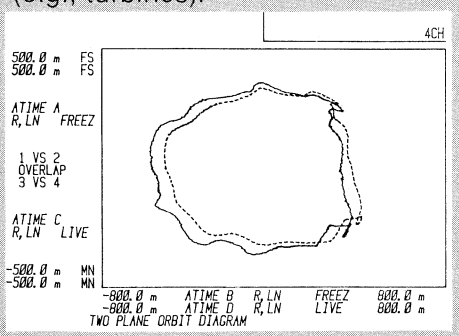
How to Select a Spectrum Analyzer

Wavetek manufactures the broadest line of spectrum analyzers available in the world. The following sections *Data Acquisition* and *Data Reduction* and the *Selection Chart* will aid you in selection of the optimum analyzer for your application.

Data Acquisition

Number of Channels. One of the first considerations in the selection of a spectrum analyzer is the determination of how many channels of input must be acquired and processed simultaneously. Wavetek markets five single channel analyzers, three dual channel analyzers, a four channel analyzer and a modal system incorporating one of our dual channel instruments.

Many applications in the area of vibration measurements use only a single sensor to provide the input signal. For these measurements, a single channel analyzer is sufficient. Other applications, such as acoustic noise source location, require that two signals be processed at the same time, necessitating the use of a dual channel analyzer. Four channel analyzers are ideal for structural analysis applications involving simultaneous data collection from three sensors (or from a single triaxial sensor) located on a structure. Another use for 4 channel analyzers is in the processing of signals from four sensors to determine orbit diagrams for large rotating systems (e.g., turbines).



Orbit Plot

Selecting an instrument that has the proper number of channels is critical to user satisfaction. Buying a two channel analyzer may be unwise if what is really needed for the task at hand is a very capable single channel analyzer.

Real Time Rate. Real time rate expresses the analyzer's ability to keep up with changes in the input data. A spectrum analyzer must perform a Fourier transform on the input data, and average that information with data collected previously. If it can accomplish these operations before the input buffer (typically 1024 points) becomes filled with new data, the analyzer is said to be operating in "real time". Mathematically, real time rate is the product of the number of averages per second times the number of lines on the display.

The real time rate of an analyzer is generally inversely proportional to the number of channels in that analyzer.

It is important to understand that many applications do not require significant real time rates. Vibration measurements, other than run-up or coast-down, for example, have characteristics that are relatively invariant with time. High real-time rates offer no particular advantage in such analyses.

Some situations, such as high-speed capture of transients or analysis of speech waveforms, do require good real-time rates. For those applications, Wavetek offers spectrum analyzers with real time rates from 2 kHz to 8 kHz.

Tracking Adapter. Vibration measurements on rotating machinery (pumps, fans, bearings etc.) are often complicated by slight variations in rotational speed. This produces confusing shifts in the frequency lines observed on a spectrum analyzer. Also, if the frequency changes during a measurement, all forms of averaging become impossible since spectral components smear together. The problem is easily eliminated through the use of a Wavetek 24D spectrum tracking adapter which synchronizes the analyzer to the device under test and compensates for changes in rotational speed.

Applied Stimulus. Some dual channel measurements require that the device under test be stimulated with an externally applied signal. It is often necessary to control the amplitude and frequency of this modulation signal. For these applications, the user should select an analyzer that can supply the necessary modulation characteristics. Wavetek's 5830A and 660B dual channel analyzers and the 804A four-channel analyzer come equipped with versatile modulation sources.

Data Reduction

Third Octave and Octave. Although an FFT spectrum analyzer is specifically designed to measure and display narrow-band spectrum information, alternative displays are occasionally useful. A popular display format that has had a long history of use is the so-called third octave display. In this type of display, the frequency range is divided into 30 segments and within each segment narrow-band amplitude information is integrated and presented in histogram format. Octave displays use 10 segments instead of 30.

Third octave and octave displays are often used in acoustic, military, and OSHA applications. They yield a simplified output compared to narrow-band analysis, and are used when low-resolution output is desirable.

Wavetek analyzers provide third octave and octave measurement capability in various ways. They are also available as built in options on the 5810A, 5809A, 446B, 512/S and 660B analyzers. For the 5820A and 5830A, optional octave and third octave software can be purchased from Wavetek to run on laboratory computers.

Derived Functions. Dual channel analyzers yield spectral data that is available for further mathematical analysis. Wavetek's dual channel analyzers provide coherence information — a measure of how much of the output spectrum is due to the input spectrum. Coherence values range from 0 — a complete lack of causal relation — to 1 — system response totally due to applied stimulus. Coherence information is valuable when attempting to isolate one vibration signal source from many others in situations where it is not possible to shut down any of the sources.

Other derived functions that are incorporated in Wavetek's dual channel analyzers include:

- Coherent Output Power
- Correlation (Auto, Cross)
- Cumulative Probability Distribution
- Probability Density
- Impulse Response
- Transmissibility
- Closed to Open Loop Servo Response

Spectrum Analyzer Application Notes

The following application notes are available at no charge. Please write or call:

Wavetek Scientific, Inc.
10 Volvo Drive
Rockleigh, NJ 07647
Telephone (201) 767-7900

General

AN-15 The Nature of Vibration
AN-17 Making Sense of Vibration Measurements
AN-19 What to Look For in a Single Channel Analyzer
AN-A2 Calibrated Amplitude and Frequency Measurements in Arbitrary Units with the Model 5830A
AN-21 Spectrum Analysis — Theory, Implementation and Applications
AN-22 Machinery Vibration Diagnostic Wall Chart
AN-23 User's Guide to the 804A
AN-24 Functions and Formats for the 804A
AN-25 Measurement of AC Impedance with the 804A

Gears

AN-6 Vibration Frequencies Generated by Gear Meshing

Motors

AN-5 Qualitative Evaluation of Automotive D-C Motors

Pumps

AN-13 Solving Pump Problems Using Spectrum Analysis

Fans

AN-A3 Two Channel Spectrum Analyzer Finds Causes of Vibration in Paper Mill Drying Fans
AN-12 How to Understand Frequency Spectra

Bearings

AN-16 New Instrumentation Techniques Accurately Predict Bearing Life

Balancing

AN-11 How to Balance With Your Real-Time Analyzer
AN-18 Simplified Balancing Balacing Calculator

Modal

AN-9 Understanding Vibration Measurements
AN-14 Solving Vibration Problems Using Modal Analysis
AN-27 Modal Analysis for Managers

Electronic

AN-A1 Direct Total Harmonic Distortion Measurements with the Model 5830A
AN-28 Total Harmonic Distortion Measurements with the 804A

Acoustics

AN-20 Acoustic Intensity Measurements with the 660B

SPECTRUM ANALYZER SELECTION GUIDE

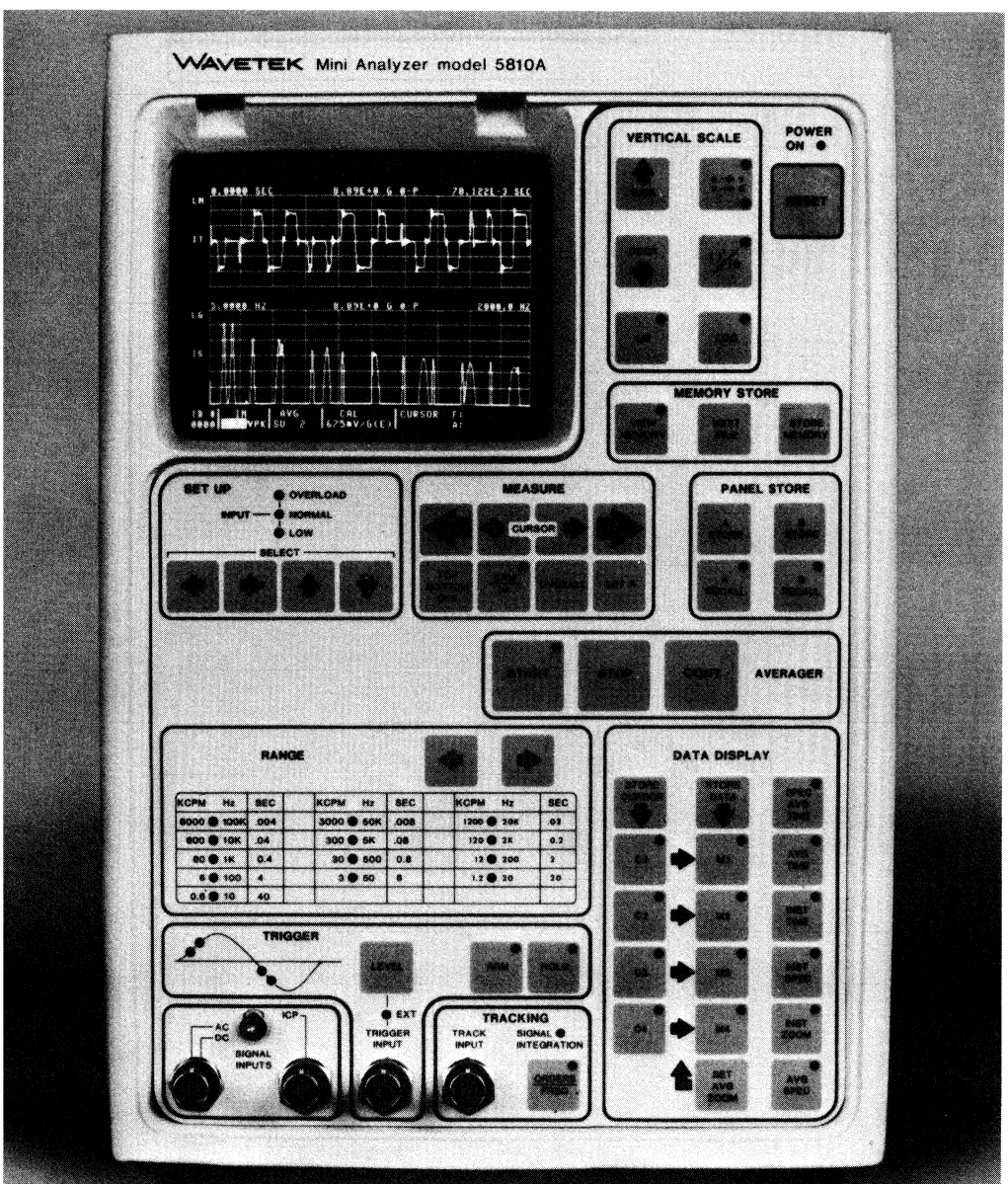
MODEL	5810A	5809A	446B	512/S	541A	5820A	5830A	660B	804A
Number of Channels	1	1	1	1	1	2	2	2	4
Frequency Range	To 100 kHz	To 100 kHz	To 100 kHz	To 100 kHz	To 100 kHz	To 50 kHz	To 100 kHz	To 100 kHz	To 40 kHz
Lines of Resolution	400	400	400	400	400	400/200	400/200	800/400	400/200
Resolution	0.0025 Hz	0.0025 Hz	0.0025 Hz	0.0004 Hz	0.0004 Hz	0.01 Hz	0.005 Hz	0.0002 Hz	0.0025 Hz
Storable Front Panel Settings (Nonvolatile)	3	3				100 Items Combined Storage Optional	5 Settings + 1 Trace/ Channel	9	400 Kbyte Mass Storage On Disk
Storable Data Traces (Nonvolatile)	205	Up To 205 Optional	30 (With Optional Tape Storage)				100 Items Combined Storage Optional	Optional 400 Kbyte	
Max. Real Time Rate	10 kHz	4 kHz (10 kHz Optional)	1.05 kHz	2 kHz	2 kHz			2.2 kHz	300 Hz
Trace Math Functions			5	2	2	3	13	Calculator Capability	
Automatic Mass Data Collection	•	Option						Option	Program
Zoom	•	•	Option	Option	•	•	•	Option	•
Word Processing Text									•
Data Annotation Text Entry	Via Controller	Via GPIB Option & Controller				Via Controller	Via Controller	•	•
Harmonic Cursors			•	•	•		•	•	•
Sideband Cursors				•	•		•		•
Time Averaging	•	•				•	•	•	•
Ratio/Difference Spectrum			•	•	•	•	•	•	•
Phase Display	•	•				•	•	•	•
Transfer Function & Coherence						•	•	•	•
Coherent Output Pwr						•	•	•	Program
Auto Correlation/ Cross Correlation							50 Points	1024 Points	1024 Points
Real/Imaginary Vs. Frequency, Nyquist							•	•	•
Prob. Dens. Histogram							•	•	
Cumulative Probability							•	•	
Waterfall	Plotter	GPIB Opt.					•		Program
Integration	•	•	•				•	•	•
Differentiation			•				•	•	•
Closed To Open Loop & Impulse Responses							•	•	Program
Digital Plotter Output	•	GPIB Opt.	•	Option	•	•	•	•	•
Comp. Video Output	•	•							•
Octaves, 1/3 Octaves	•	GPIB Opt.	Option	Option	Option			Option	Program
Built-In Signal Source			Option			3 Types	7 Types	1 Type	2 Types
Catalog Page	12	17	20	19	19	26	22	28	32

Single Channel Spectrum Analyzer

- **High Speed—10 kHz Real Time Rate**
- **Mass Memory for 205 Spectra**
- **Formatted Output**
- **DC to 100 kHz**
- **RMS, PSD, Single or Double Integration**

Introduction

The new Model 5810A is a single channel analyzer designed for studying continuous, rapidly changing, or transient events in vibration, acoustics or electronics. The 5810A is portable, low cost, and can be equipped with a variety of options for total data acquisition and data reduction capability. Simple to learn and easy to operate, the 5810A is ideal for use in the field, at the bench, or on the production line.



High Speed

The 10 kHz real-time rate of the 5810A provides 25 display updates per second during averaging. This capability is ideal for coast-down, speech analysis, and many other high-speed data acquisition functions.

Mass Memory

The large non-volatile memory of the 5810A allows fast, reliable storage of up to 205 spectra. This makes the 5810A particularly valuable for field work where unique data must be acquired on-site without interruption. Data stored in each of the 205 CMOS memories are protected by a battery back-up, conservatively rated at 90 days without intervening charge.

Data storage is very flexible. Records can be saved to memory one at a time, or sequentially at fixed intervals for unattended data logging. Also, data can be stored with and without averaging, and with and without time or rpm intervals.

Plotting Capability

The feature that separates the 5810A from most other single channel analyzers, is the variety of plots that can be produced on an external digital plotter. The instrument is supplied with 12 highly-annotated, built-in plot formats. Some plot formats require the use of the Model 24D Spectrum Tracking Adapter.

Formatted Output

Screen Plot: Amplitude vs frequency and/or Amplitude vs time.
Report Plot: Screen plot plus instrument setup parameters.

MODEL 5810A SPECTRUM ANALYZERS

Stack Plot: Amplitude vs frequency vs time or RPM.

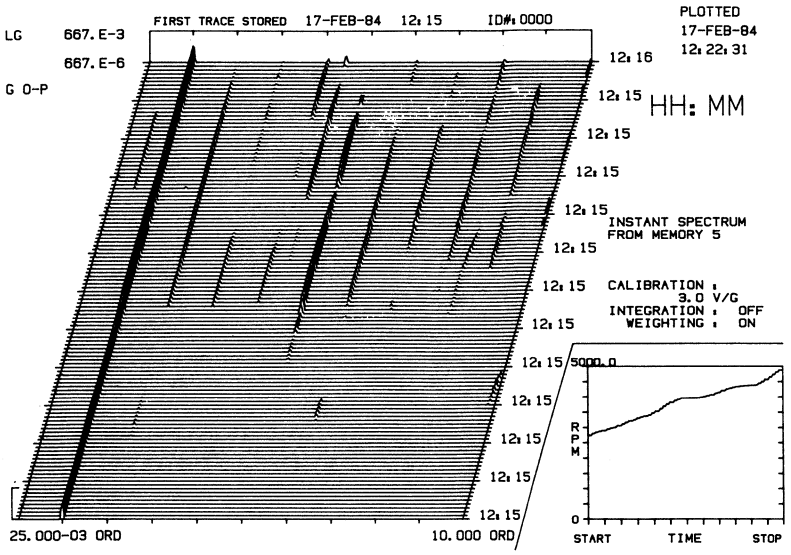
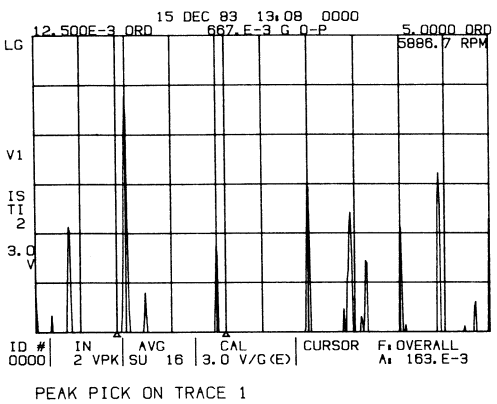


Figure 1. Amplitude vs. Frequency vs. Time or RPM

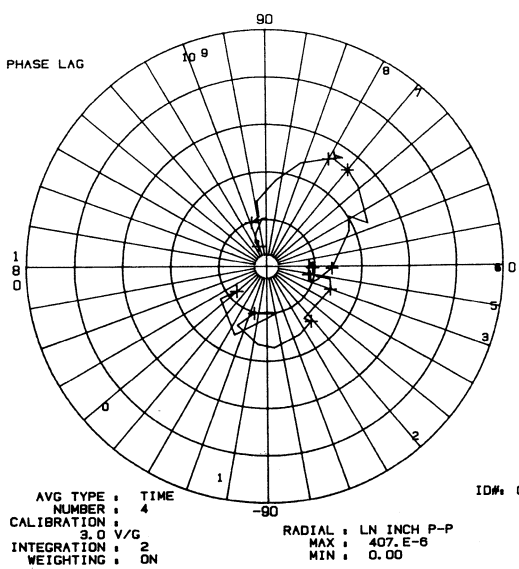
Peak Picking: Screen plot plus peak location and amplitude table.



G 0-P	ORDERS
7.38E-3	.37499
161.E-3	1.0000
4.53E-3	2.0000
19.5E-3	3.0000
10.2E-3	3.4624
7.14E-3	4.0125
26.1E-3	4.4375

Figure 2. Screen Plot Plus Peak location and Amplitude Table

Polar Plot: Amplitude and phase*



MARKER	RPM	INCH P-P
0	2028.9	69.9E-6
1	2341.9	87.3E-6
2	2732.6	126.E-6
3	3080.0	120.E-6
4	3421.0	81.5E-6
5	3556.1	75.7E-6
6	3821.4	116.E-6
7	3928.4	227.E-6
8	3982.0	223.E-6
9	4300.0	83.4E-6
10	5342.5	38.8E-6
MAX	3936.1	241.E-6

ID#: 0000 17-FEB-84 11:39:56
TO 17-FEB-84 11:42:59
10 ORDERS WAVETEK

*Figure 3. Amplitude and Phase**

*Requires 24D Spectrum Tracking Adapter.

Cursor Plot: Amplitude vs time; phase vs time*; phase vs RPM*; amplitude vs RPM*.

Time Expansion Plot: Magnifies a user-selectable portion of time history vs amplitude vs time trace. See figure 4.

1/3 or 1/1 Octave Plot: Conversion of narrowband data to 1/3 or 1/1 octave presentation.

Plots are annotated with the date, time of data collection, and set up parameters (calibration, units, etc.). The saving in data reduction time and the "instantly usable" character of the analyzer make it very popular in the vibration, acoustic and electronic fields.

Vibration Applications

The Model 5810A has a number of features that simplify vibration measurements.

Flexible Units of Measurement

Amplitudes can be expressed in many different units. Acceleration (in g's), velocity and displacement in either English or metric units. Amplitudes can also be expressed in volts, dB or engineering units (when a specific unit of measurement is unavailable). Many calibration constants can be used.

Built-in Integration

A front panel control permits analog integration of acceleration data to velocity, and velocity data to displacement. Automatic conversion of units occurs when integration process is enabled.

Stored Setup States

Three front-panel setup states can be stored in non-volatile memory to guarantee that data are collected reproducibly at different collection times.

Averaging

Reduces system noise. Either frequency or time domain averaging is available.

Automatic Data Collection

Vibration data can be collected and stored in memory under program control using the built-in plot codes. Time or rpm intervals between successive data collection operations can be preset. Averaging of data sets prior to storage can also be enabled.

Balancing

The Polar plotting routine built into the 5810A simplifies one step bal-

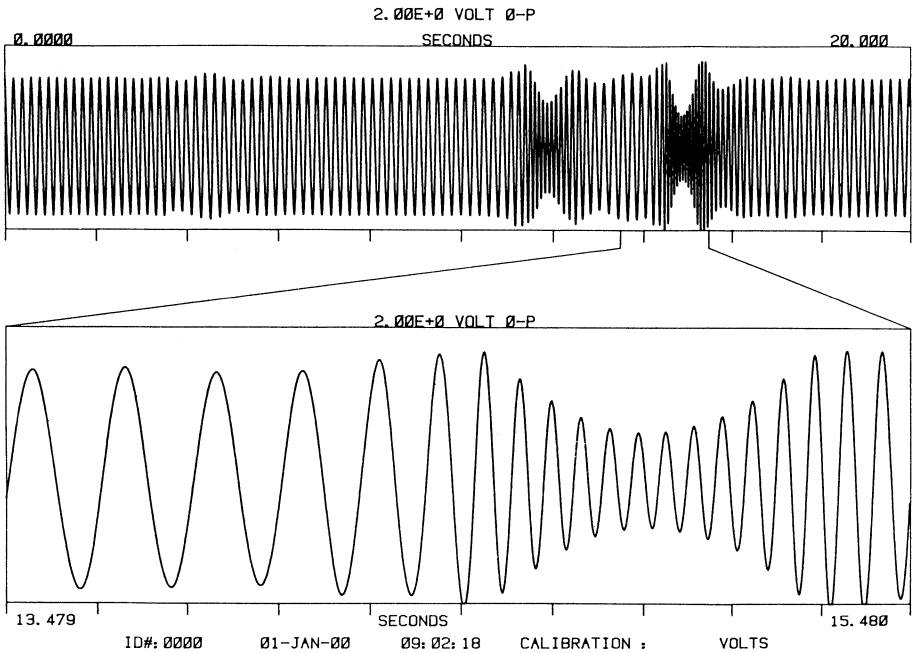


Figure 4. Magnified User Selected Portion of Time History

ancing without the need for a trial weight. Also, single or two plane balancing program supplied with Model 137 Tape Storage Adapter.

Phase

Relative phase at cursor aids in balancing.

Zoom

Zoom processing in the 5810A provides a 400-line display of any 10% of the selected baseband range. A display interval of ±5% about the baseband cursor position is selected in zoom mode.

Invoking zoom enables the acquisition of 10,240 data points, from which a 4000 line FFT spectrum is created. In zoom mode, the 5810A acquires 10 times as much information per spectrum as it does in baseband computation. One to four preset frequency zoom bands plus one baseband spectrum can be averaged and stored simultaneously, each of 400-line resolution.

Zoom processing is typically used to resolve components that are closely spaced and high in the frequency baseband.

Zoom processing is also used to measure frequency of a specific tonal component with high precision, or to obtain significant signal-to-noise enhancement when attempting to separate tonal components from a broad background. Figure 6 shows how a zoom spectrum permits measurement of the absolute speed accuracy of a recording process (shift in dominant "spike" between a recorded 1 kHz sinewave and playback) and the general character of wow and flutter response (sideband envelope).

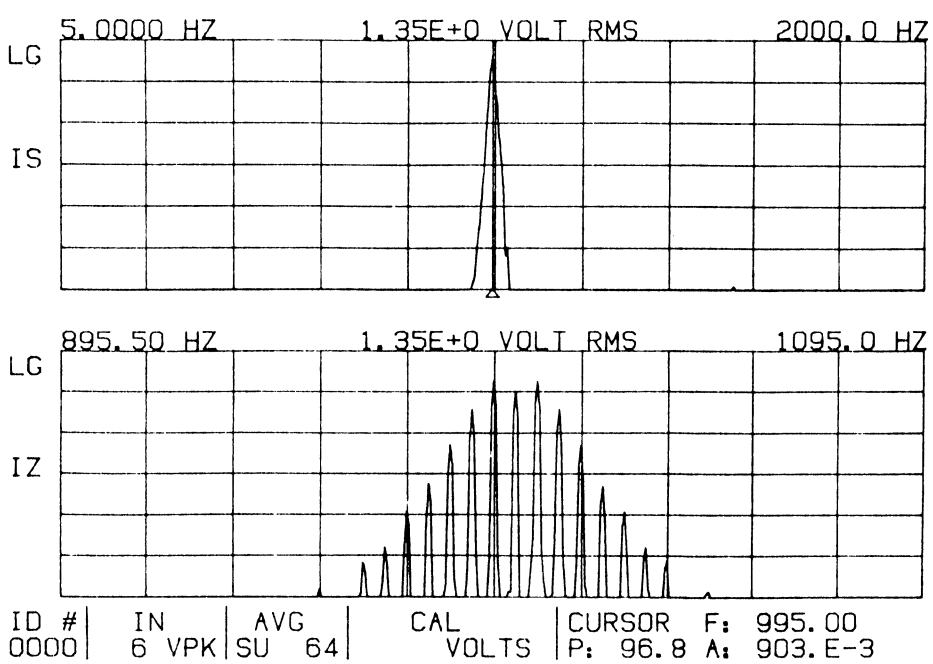


Figure 5. Zoom Processing. Baseband (upper trace) shows broad spike at 1000 Hz. Zoom (lower Trace) shows that the 1 kHz spike contains a family of modulation sidebands with a 5 Hz spacing.

10K Buffer

As described in the preceding section, the Model 5810A incorporates a large input buffer that permits data to be collected in groups of 10,240 points but examined in smaller subsets.

The 10K buffer provides capability for zoom, zoom averaging, and time panning operations. Time panning is equivalent to examining a high-speed movie frame by frame, and is used for analysis of transients when a suitable trigger is not available.

The 5810A can provide the instant spectrum of any contiguous 1024 point section within the buffer. This permits detailed investigation by time or frequency averaging of events far removed from the trigger signal—e.g., triggering from one cylinder of a reciprocating engine to guide analysis of another cylinder's performance. The large buffer is also useful for isolating intermittent vibration noise occurring during machinery startup or shutdown.

MODEL 5810A SPECTRUM ANALYZERS

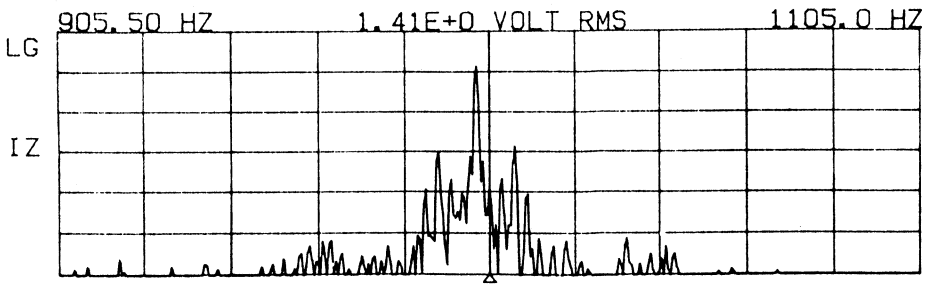


Figure 6. Instant Zoom Spectrum of Playback of a Recorded Pure Tone 1 kHz Sine wave on an Autio Cassette Recorder.

The 10K buffer is useful for reflection and reverberation applications—e.g., sonar work or measurement of acoustic chambers. A chirp can be used as the trigger and the 10K buffer utilized to capture the reflected signal. In measurements such as these, the operator often does not know when the returned signal will appear. Also, the 10K buffer provides an ideal way to measure resonance and critical frequency phenomena which initiate, build and die within milliseconds and must be captured in their entirety.

SIGNAL INPUT

Sensitivity
20 mV to 10 V FS (full scale) in 2-6-10 steps; 100 kΩ impedance.

Coupling
DC or AC (-3dB at 0.2 Hz).

Minimum Detectable Signal
Typically 70dB below FS after sum averaging (7 μV min.).

Amplitude Indicators
OVERLOAD:
In-band (digital).
Out-of-band (analog).
NORMAL: Between FS and −24 dB.
LOW: Below −24 dB.

Filtering
Separate anti-aliasing filter for each range; 120dB/octave initial rolloff; ±0.5dB flatness except ±1dB on 100kHz range

Accelerometer Input
Separate front panel input with 4 mA power source for ICP-type accelerometers.

ANALYSIS

Frequency Ranges (Fmax)
10 Hz (600 CPM) to 100 kHz (6000 kCPM) in 1-2-5 steps.

Zoom Expansion
Any 10% of Fmax as selected with cursor (2.5 mHz max. resolution).

Display Resolution
400 elements.

Weighting
Hanning or flat (uniform).

Amplitude Linearity
±0.1dB or ±0.5% FS, whichever greater, to 66 dB below FS.

Frequency Accuracy
0.0005% FS without warm-up.

Speed
10 kHz real-time bandwidth (25 baseband FFT's or 2.5 zoom FFT's per sec with any display and any averaging mode).

Sampling
2.56-by-frequency range.

Track Input
256 kHz max.

AVERAGING

Modes
Summation (power), exponential (power), peak(power), time (voltage).

Speed
Up to 25 spectra/s with display.

Number
1,2,4,16,64 . . . 2048,4096. Number of collected averages is displayed.

Zoom
Up to 4 separate zoom bands averaged simultaneously with baseband spectrum.

Control
START-resets count, erases memory, and starts averaging (light during averaging);
STOP-stops averaging;
CONTINUE-restarts without erasing or resetting count.
TRIGGERING (transient capture, time average).

Internal Signal
±1/4 or ±1/2 FS.

External Trigger Input
±0.625 V or ±2.5 V.

TRANSIENT CAPTURE

Manual Hold
Captures 10,240 samples; baseband spectrum from most recent 1024 or any 1024 selected with cursor.

Manual Arm
When triggered, captures 1024 post-trigger samples in baseband, 10,240 post-trigger samples in zoom.

Automatic Transient Averaging
If ARM before AVG START, unit automatically arms, captures, averages and re-arms, with 896 post-trigger samples captured in baseband, 10,240 in zoom, and 1024 in time average; if HOLD before AVG START, arm is manual but capture and averaging is automatic.

STORAGE

Volatile Memories
Any four traces.

Nonvolatile Memories
Any 205 traces stored on command or automatically at time increments; recalled manually or automatically by ID No. or date/time.

Setup Memories
3 non-volatile; 2 complete sets of control settings plus setup when power/down (becomes power/up); includes 4 cursor locations in each setup (12 max).

DISPLAY

Data
Single; dual combining instant time, instant baseband spectrum, instant zoom, averaged baseband or zoom, averaged time, spectrum of averaged time, or any stored memory.

Type
5-in. (diagonal) raster scan refreshed 60/s.

Vertical Scales
Linear: 2^{20} gain.
Log: 60 dB with 200 dB of gain (offset).

Horizontal Scale
Linear time or frequency.

DISPLAY ANNOTATION

Current Setup
ID No., sensitivity, averaging type and N, weighting, ampl. cal., units.

Data Display
Horizontal limits in Hz, CPM, sec., min., cell No. or %FS (order No. with Model 24D); vertical limits in user units.

Memory Data
Data and setup annotation plus

memory number, average type and N, cal. constant, units, weighting (also RPM with Model 24D).

Cursor Measurements
Amplitude, horizontal position and phase; phase repeatability 0.5°.

Overall Energy Calculation
RMS sum between two cursors or entire spectrum in user units.

AMPLITUDE CALIBRATION

Units
(0-P, English or metric), in./s or m/s (0-P), in. or m (P-P), Vrms, dBV, dB(EU), EUrms; for time 0-P only; relative or absolute.

Units Conversions
Single or double integrate, X^2/Hz (PSD) with scales and cursor readings in consistent units; in ORDERS (internal sampling), integrate is applied to input analog signal prior to digitizing (can be viewed); X^2/Hz applies to spectra only.

Calibration Constant
0.2 pV × 10^{-13} to 999 kV/unit.

GENERAL

Dimensions
21.6 cm (8.5 in.) wide; 30.8 cm (12.13 in.) high; 56.75 cm (22.75 in.) deep with front connectors and rear cord wind.

Weight
15.9 kg (35 lb) max.

Power
100, 110 or 220 V ±10% (specify at purchase); 50/60 Hz; 200 watts.

Operating Temperature
0° to 55°C (32° to 130° F); 95% non-condensing humidity max.

OPTIONAL ACCESSORIES

Model 24D Tracking Filter
Model 137 Tape Storage Adapter
Model 133 Digital Plotter
Model 132B Video Printer
Model 62A Tachometer
Model 62A-1 Optical Probe
Model 62A-2 Magnetic Probe
Model 50 Transducer Kit
Model 53A Accelerometer
Model 52 Instrumented Hammer Kit
Model 58 Microphone
Model 58A Microphone Calibrator
Model 99Q Carrying Case
(Fits analyzer only.)
Model 99T Transit Case
(Fits analyzer and minor accessores.)

FACTORY/FOB

Rockleigh, NJ

Single Channel Spectrum Analyzer

- **0.0025 Hz to 100 kHz**
- **3.5 kHz Real Time Rate (Optional 10 kHz)**
- **3 Nonvolatile Setup Memories**
- **Optional IEEE-488 and Plotting**
- **Optional Nonvolatile Data Memory to 205 Files**

Model 5809A is a basic analyzer with 4 kHz real time rate, volatile memory for 4 data traces, and nonvolatile storage for 3 front panel settings.

Combining low initial cost with the ability to enhance performance as needs grow, the 5809A can at any time be fitted with any of several options:

Option -10. GPIB IEEE-488 interface, octave and one-third octave processing, and formatting for 12 plots that can be generated on an IEEE-488 compatible plotter:

- Screen plots; amplitude vs. time or frequency and axis annotation.
- Report plot; screen plot plus setup listing and axis annotation.
- 3D Stack plots; amplitude vs. frequency vs. time or RPM.
- Peak Picking; screen plot plus peak location and amplitude.
- Cursor plots; amplitude or phase vs. time or RPM at 4 frequencies.
- Polar plot.
- Octave and one-third octave plots and screen displays.

Option -10 also provides automatic data acquisition capability.

Option -11. Nonvolatile memory for 100 data traces.

Option -12. Nonvolatile memory for 205 data traces.

Option -14. Increases real time rate to 10 kHz.

Option -15. Adds 105 additional traces to memory of Option -11.

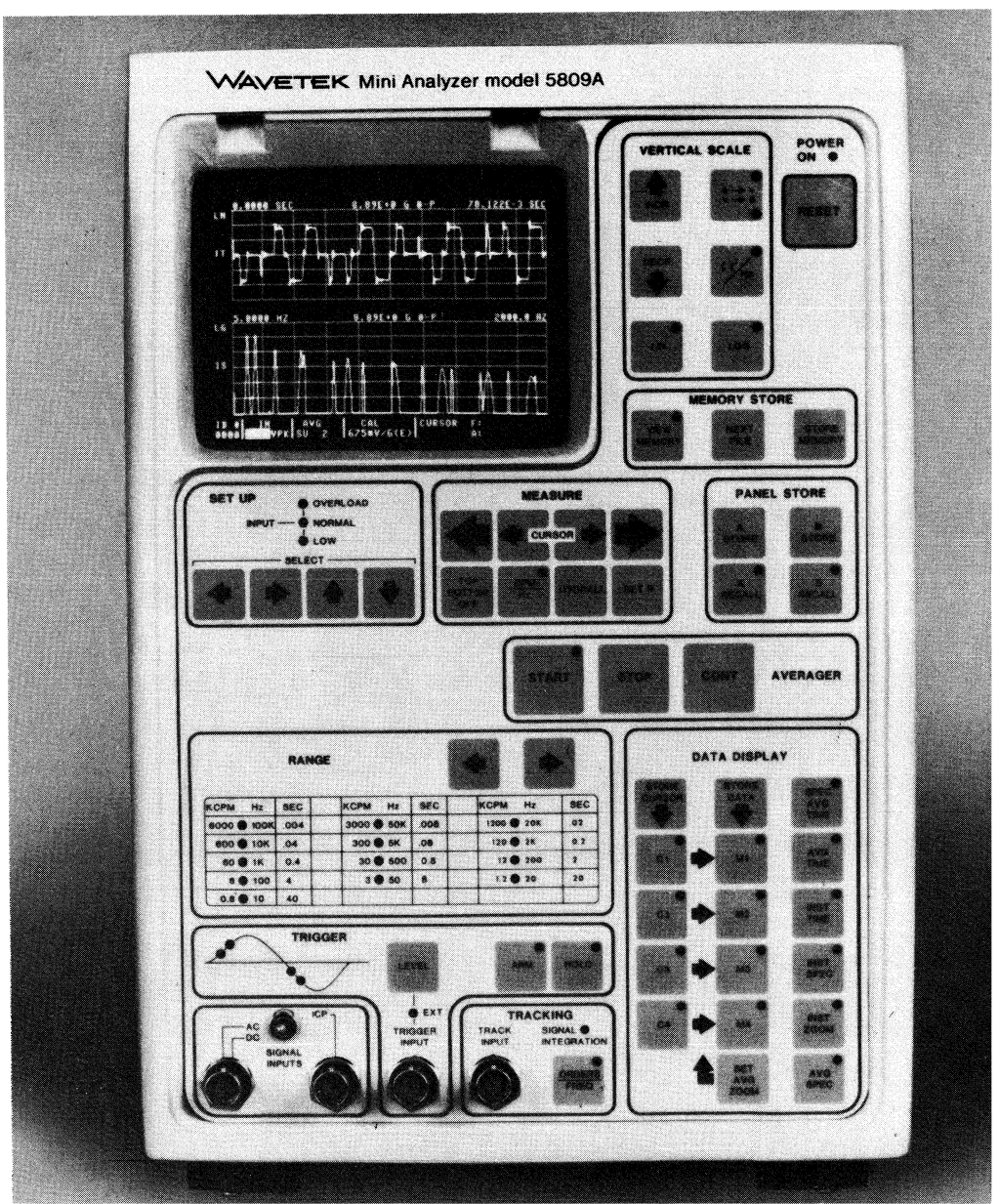
With Options -10, -12 (or -11 and -15) and -14, a Model 5809A would have all the capabilities of a standard 5810A.

Accessories

Accessories for Model 5809A are identical to those listed for Model 5810A, page 16.

FACTORY/FOB

Rockleigh, NJ



Single Channel Analyzer Plug-In

- **Frequency Range: DC to 100 kHz**
- **Resolution: 1 Hz**
- **Foreground/Background Display**
- **Dynamic Range: 90 dB**
- **Noise Floor: −160 dBV/Hz**

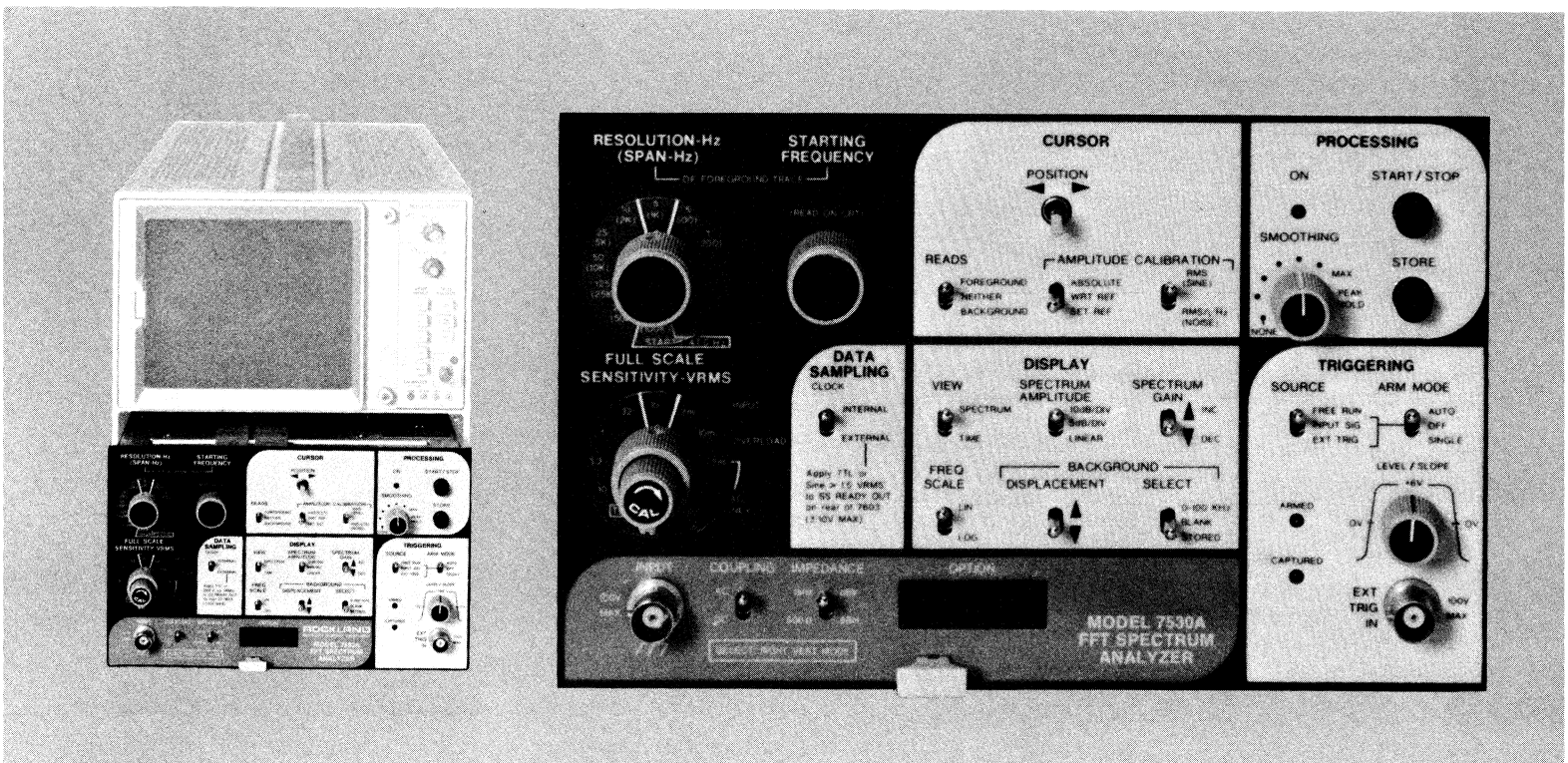
Model 7530A, a plug-in for the Tektronix® 7000 Series Oscilloscopes, gives you an oscilloscope and spectrum analyzer for less than the price of a spectrum analyzer alone.

Foreground/Background Display
From DC to 100 kHz, the components of the Fourier spectrum are quantitatively measured, and computed as a true power spectrum. The complete spectrum is displayed as the background, at reduced intensity, except for a brightened portion (the "analysis window", or "span") selected for detailed study. This detailed spectrum is presented, at full intensity in the foreground. Both spectra have 200-line resolution. The normal internal clock rate of the instrument, and the minimum span of 200 Hz, provide foreground resolution of 1 Hz up to 100 kHz. At reduced processing rates (via external clock), resolution may be increased as a tradeoff against processing speed.

These features, coupled with dynamic range in excess of 80 dB, and a noise floor of 10 nV/√Hz make the 7530 a true, general-purpose spectrum measurement instrument.

® Registered trademark Tektronix, Inc.

FACTORY/FOB
Rockleigh, NJ



Real Time Spectrum Analyzers

- **Frequency Range: DC to 100 kHz**
- **Dynamic Range: 70 dB**
- **Noise Floor: <−130 dBV/Hz**
- **Transient Analysis**
- **Storage**

Standard features include 0.5 Hz to 100 kHz analysis in 12 ranges, dual trace for direct comparisons, <−130 dBV/Hz noise floor, 70 dB dynamic range, X-Y recorder output, averaging, transient analysis, digital plotting on 541A and much more.

Model 512/S with options has been assigned Federal Stock Numbers (FSN) and Tri-Service Nomenclature (TSN) as follows:

	512/S-15-17	512/S-15-17-20
FSN	6625-01-079-5450	6625-01-082-3751
TSN	TS-3852(V)1/G	TS-3852(V)2/G

SPECIFICATIONS

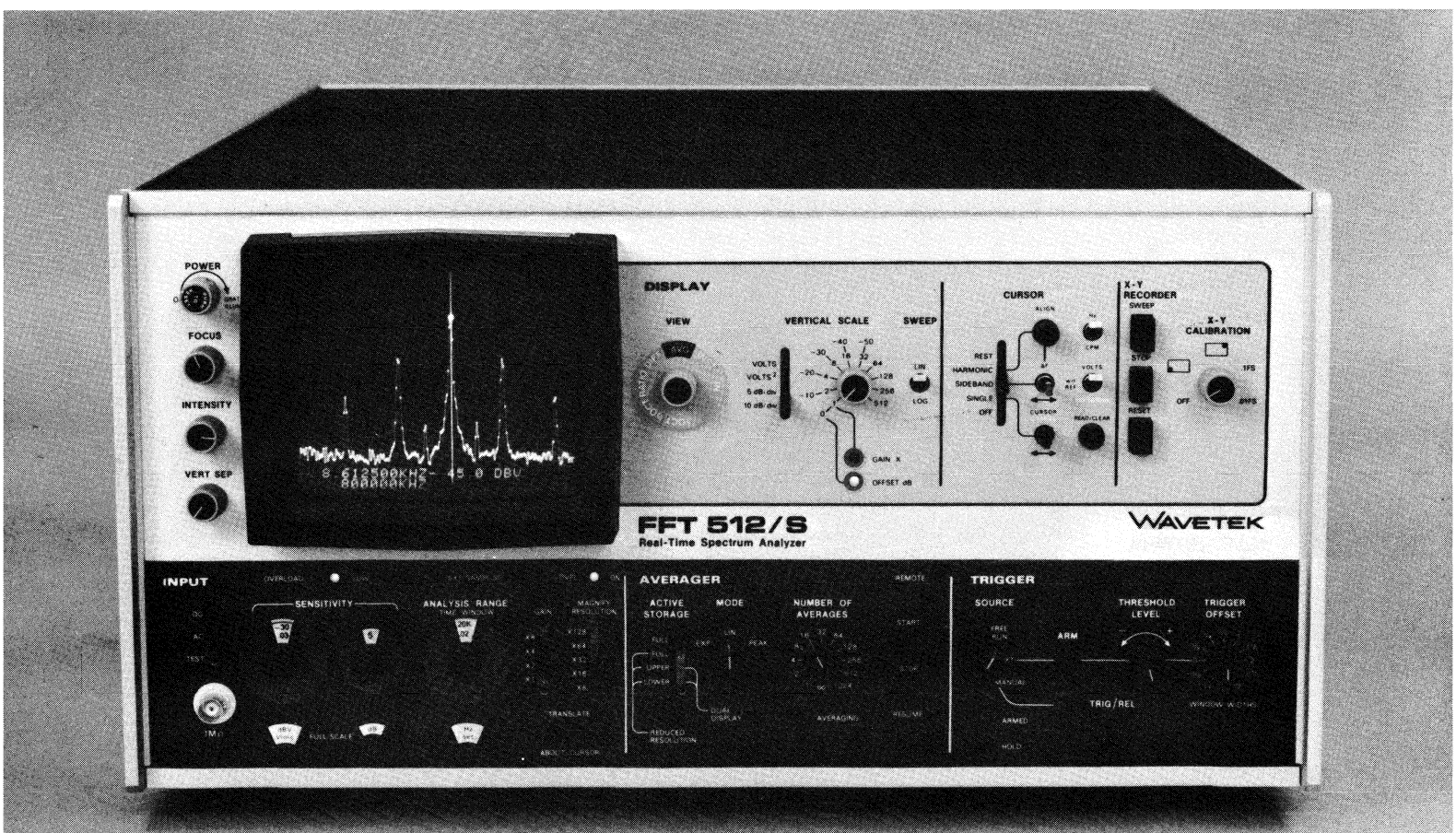
Accessories Supplied
Operating manual and rack adapters.
Environment
Operating Temperature: 0° to 50°C.
Dimensions
43.2 cm (17 in. wide, 22.2 cm (8¾ in.) high, 53.4 cm (21 in.) deep.
Weight
24.5 kg (54 lb) net, 36 kg (79 lb) shipping.
Power
100, 120, 220, or 240 V ± −10%. 48 to 66 Hz; less than 350 VA.

MODEL 512/S OPTIONS

12: 1/3 Octave and Octave Bandwidth
14: Digital I/O Interface
15: IEEE 488-78 Interface
16: Conversational IEEE 488-78 Interface
17: Narrow-Band Power Readout
(Standard on 541A.)
18: Ultra-Low Frequency Analysis Ranges
20: Zoom
Range Translator (Standard on 541A).
Mod 156: Diagnostic Plug-in
Mod 120: RFI Filter

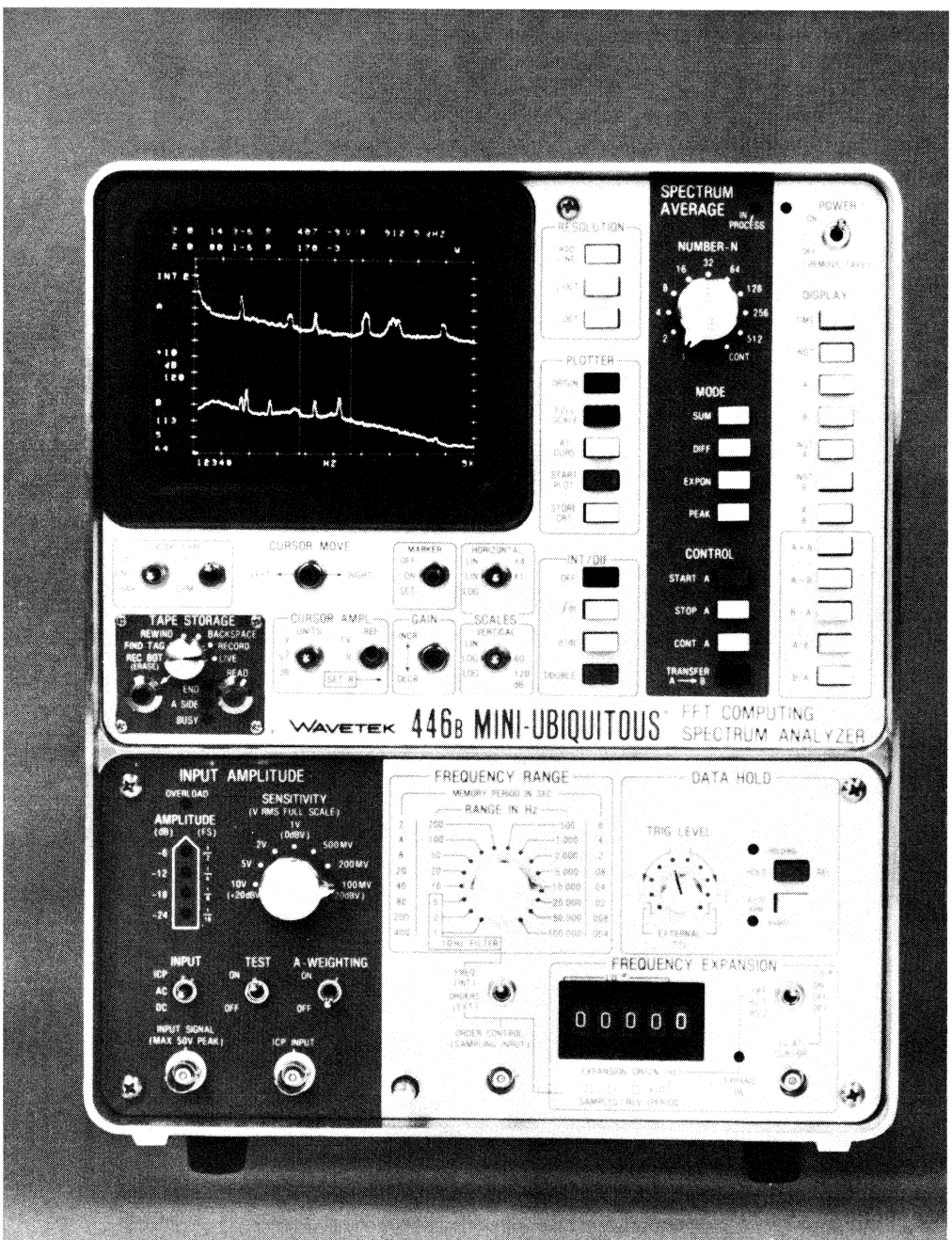
FACTORY/FOB

Rockleigh, NJ



Single Channel Spectrum Analyzer

- **Frequency Range: 0.0025 Hz to 100 kHz**
- **Annotated Data, Displays and Plots**
- **A-Weighting for Acoustics**
- **Addition, Subtraction and Ratioing of Traces**



Used in thousands of installations worldwide, Model 446B is a portable, yet versatile single channel 100 kHz instrument ideal for a variety of applications requiring accurate spectrum analysis.

The 446B provides the following displays:

- Time function, continous or captured
- Instantaneous spectrum of time functions
- Averaged power spectrum of two spectra (A or B)
- Instantaneous spectrum and averaged power spectrum (dual display) of A or B
- Averaged power spectrum of each A and B (dual display)
- Total of averaged power spectrum A plus averaged power spectrum B
- Comparison by displaying difference: Averaged power spectrum A minus averaged power spectrum B, or B minus A
- Transmissibility ratio: Averaged power spectrum A divided by averaged power spectrum B, or B divided by A

SPECIFICATIONS

Input Characteristics

Input Impedance: 100 kΩ.
Input Coupling: AC (−3 dB at <0.5 Hz), DC max. input ±50V DC.
Test Signal: Sine wave at 64% of display, replacing input signal.
Input Amplitude Sensitivity: (Vrms FS). 100mV (−20dB), 200 mV, 500 mV, 1V (0 dB), 2V, 5V, and 10V (+20 dB); max DC and AC input ±50V ref ground.
Input Amplitude Monitor: Lights indicate peak A/D converter signal levels:

OVERLOAD, −6 dB (>½ FS), −12 dB (between ¼ and ½ FS), −18 dB (between 1/8 and ¼ FS), and −24 dB (between 1/16 and 1/8 FS); all lights below the signal level illuminated; OVERLOAD light only if overload due to out-of-range signal.

Input Sampling: 12-bit A/D conversion at 2.56 times maximum frequency of range selected on internal sampling (FREQ); external sampling input (ORDERS) sets frequency coverage at 1/2.56 of sampling rate.

Input Filters: Lowpass anti-aliasing filters matched to each range with an initial rolloff of 120 dB/octave (7-pole elliptic); 10 Hz filter on 1, 2 and 5 Hz ranges; frequency response ±0.5 dB (except ±1.0 dB on 100 kHz range).

Digital Input: External digital data can be loaded in 2's complement form directly into memory.

A-Weighting: ANSI Spec S1.4-1971.

ICP Output: 4 mA, +14V, 1 sec TC.

External Sampling Input: 10V p-p max.

Analysis Characteristics (400-Line)

Frequency Ranges: 1 Hz to 100 kHz.

Amplitude Linearity: ±0.1 dB or ±0.05% of FS to 66 dB below FS, whichever is greater.

Frequency Accuracy and Stability: 0.01% of FS without warm-up.

Minimum Detectable Signal: −70 dB below FS typical; −75 dB with background subtraction.

Two-Tone Dynamic Range: ≥66 dB.

Intermodulation Distortion: −70 dB typical.

Amplitude Measurement Stability: ±0.1 dB from 10° to 50°C.

Transient Data

Manual Hold: Pushbutton retains the previous 1024 digital samples of input.

Auto-Hold: AUTO ARM pushbutton (or remote signal) allows next digital sample over a preset level or external TTL input pulse to actuate hold. Polarity and amplitude of auto-hold triggering selected as ±1/16, ±1/8, ±1/4, or ±1/2 of full input amplitude; lights indicate data being held or unit is armed.

Viewing Held Data: Time signal can be displayed and plotted; in automatic hold, trigger level indicated by brightened dot on CRT.

Data Weighting: Hanning weighting is removed automatically in ARMED or when data captured (in AUTO position of rear panel switch), or can be manually controlled.

Automatic Transient Averaging: Rear panel jumper provides automatic arm, capture and averaging of a succession of input transients (not valid for 1/3 or 1/1-octave mode with option-3).

Averaging

Modes:

SUM— Power spectra are added (true power averaging).

DIFF— Power spectra are subtracted linearly from the previous average.

EXPON— Average changes in time as the signal spectrum changes; operation equivalent to a "leaking integrator".

PEAK— Stores maximum spectrum amplitude at each frequency location during an averaging cycle.

Number of Averager Memories: Two for 400-line spectra (plus 2 for 1/3-octave spectra with option-3).

Number of Spectra Averaged-N: Determines time of averaging or time constant of exponential averaging; set from 1 to 512 in binary steps.

In Process Light: Flashes to indicate averaging is taking place.

Display

Functions displayed on CRT:

- Electronic Graticule
- Overall RMS Level
- Measurement Cursor
- Amplitude at Cursor
- Frequency at Cursor
- Marker
- Harmonic Marks
- Display Scales
- Display Gain/Attenuation
- Integration/Differentiation
- Annotation: frequency and time.

Output Characteristics

- CRT Outputs of X, Y and Z
- Plotting
- Store CRT

Digital Input/Outputs

- 16-bit parallel with 4-bit ID code.
- 8-bit parallel ASCII.
- RS232-C (output only for digital plotting); real and imaginary of spectrum available in digital form.

Avg Trig Out (Rear): Input buffer read, ready for next 1024 sample block.

Arm Trig In (Rear): Arms AUTO ARM; if connected to AVG TRIG OUT, transients can be automatically captured, averaged, and unit re-armed.

613 Z Axis: Logic level for storage of display on Tek 613.

Ext Trig In: Remote control of arm triggering.

Remote Control and Sense: Senses all front panel switches and amplitude lights; controls all front panel switches.

GENERAL

Environment

Storage Temperature: −55° to 85°C.

Operating Temperature: 0° to 55°C.

Dimensions

25.3 cm (10 in.) wide, 32.6 cm (12-7/8 in.) high (including feet and handle), 54.9 cm (21-1/2 in.) deep.

Weight

21.8 kg (48 lb) net nominal.

Power

90 to 130V or 180 to 260V, 48 to 66 Hz, 300 watts.

OPTIONS

−2: Expansion

Provides narrow frequency "windows" within which the 400 frequency elements of analysis can be concentrated. Window widths are as follows:

Option	Window Width (Hz)	Nominal Resolution (Hz)	Origin Setting (Hz)
-2(50)	50	0.125	25-99,900
-2(100)	100	0.25	50-99,800
-2(500)	500	1.25	250-99,000
-2(1K)	1,000	2.5	500-98,000
-2(2K)	2,000	5.0	1,000-96,000
-2(10K)	10,000	25	5,000-80,000
-2(20K)	20,000	50	10,000-60,000
-2(50/500)	50 or 500	0.125 or 1.25	
-2(/)	(Other pairs selected from above)		

−3: 1/3-1/1 Octave

Generates thirty 1/3-octave bands. Any 1/3-octave spectrum can be converted to 1/1-octaves.

−5: Self Test

Exercises the digital logic. Program step of fault, if any, is displayed.

−11: Digital Tape

Data Recorded: 1024-sample time function, 400-line frequency functions (instant or averaged), thirty 1/3-octaves or ten 1/1-octaves.

−13: IEEE-488 Interface

43-4: Interface (HP 9825A)

43-5: Interface (HP9845B/T)

ACCESSORIES

Model 133 Digital Plotter

Model 5738 Plot Translator

Model 99J Transit Case

FACTORY/FOB

Rockleigh, NJ

Dual Channel Signal Analyzer

- **Frequency Range: 0.005 Hz to 100 kHz**
- **Built-In Digital Frequency Synthesizer**
- **Nonvolatile Data and Setup Storage**
- **Transfer Function Accuracy: ±1°**
- **Correlation, Probability and Nyquist Displays**

Performance and Versatility
Model 5830A is a powerful spectrum analyzer offering advanced two channel processing capability. The many features of Model 5830A simplify measurement problems in applications such as vibration, acoustics and electronics.

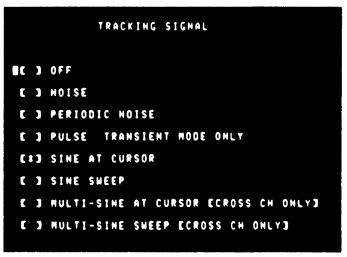
Ease of Operation
Permanent storage of five front panel configurations make the operation of the 5830A almost foolproof. Most frequently used functions are conveniently located and operated by illuminated push buttons, while more complex specific operations are contained in eight menus.

Confidence and Repeatability
Periodic self-calibration of the input sections are performed automatically to match both channels. Self-test modes give confidence in the operation of the instrument.

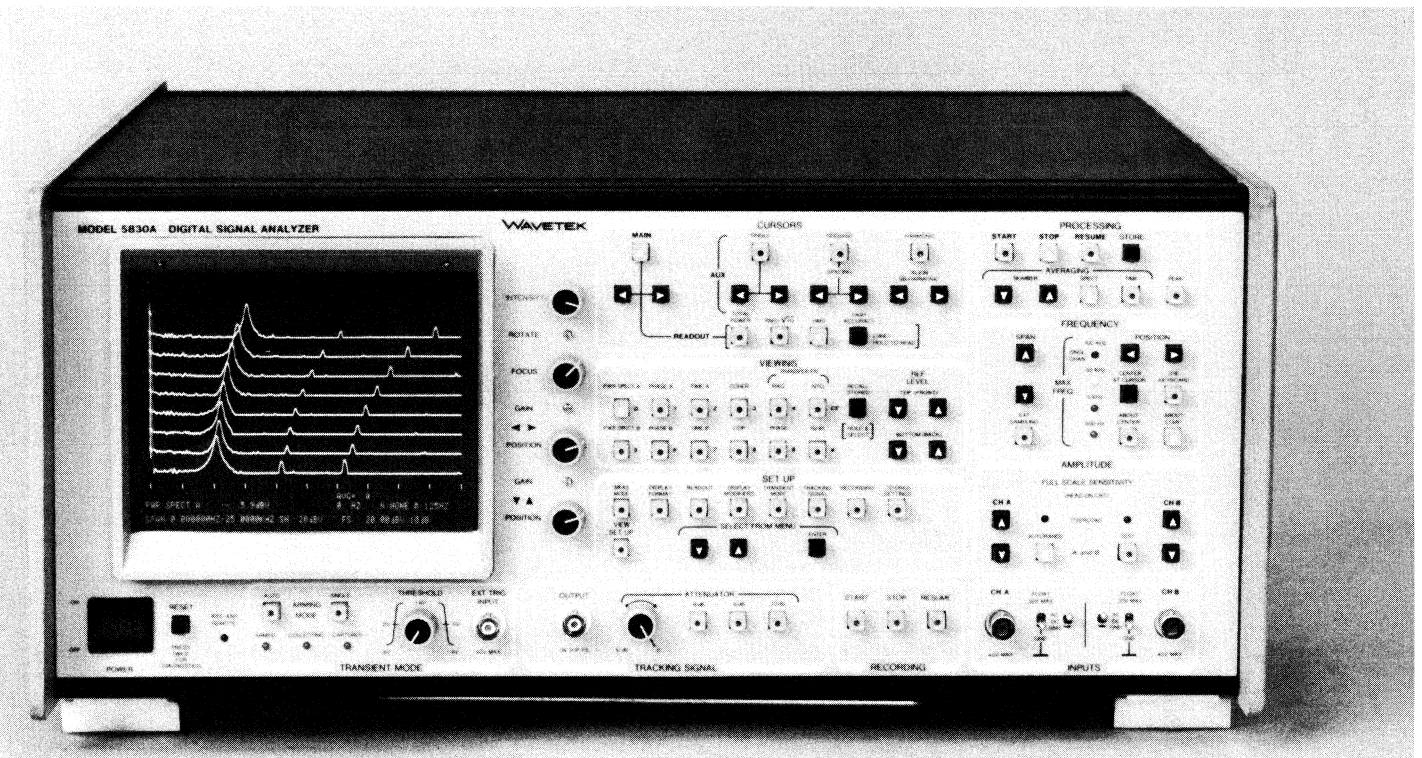
Low input noise, wide dynamic range, and excellent common mode rejection provide repeatable results to ensure that meaningful data is analyzed.

The *High Accuracy* feature for the cursor readouts provides unsurpassed performance when measuring discrete line spectra (e.g., periodic signals). There is no error due to the picket-fence effect (when the sine wave actually occurs at a frequency between two cursor locations).

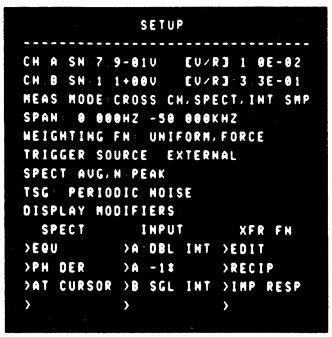
Built-In Synthesizer
Seven different synthesized sources can be delivered from the 5830A.



Simple Setup
Eight setup menus are employed to



simplify the operation of this powerful spectrum analyzer. Once the 5830A is configured as desired, the *Stored Settings* menu will permanently store this setup for later recall. Up to five different configurations can be entered. The *View Setup* menu gives the operator a quick summary of how the instrument is set up so errors will be minimized.



APPLICATIONS

Vibration

The 5830A incorporates a "waterfall" display, which is very useful for detecting changes in the spectrum since up to eight spectra can be displayed at once. (This feature is not available on Model 5820A.) External sampling can be used for engine run-up or coast down for order tracking in rotating machinery diagnostics.

The stored data and front panel features assist and simplify setup as well as provide a reference spectra for comparison testing.

The variety of excitation sources guarantees that the desired signal will be available for any analysis (random noise sine or multi-sine testing). Integration and differentiation on each input enables the user to display the captured spectrum data in familiar form (acceleration, velocity, displacement).

Acoustics

Direct correlation calculations provide time delay or position information when using two microphone triangulation methods. The high accuracy and equalization feature makes the 5830A ideal for acoustic intensity software packages since mismatch errors in the microphones can be "equalized" and removed from the measurements.

Electronics

Transfer function measurements of amplifiers and filters are simplified with the internal signal sources. Histogram and correlation measurements can be used to help characterize a signal as periodic or noise-like and can be used to detect non-linearities such as clipping. The auxiliary markers together with the total power readout can be used to display the harmonic distortion or energy in a band.

In servo analysis, the closed loop response can be converted into its open loop response with the push of a button.

NOTE: Many performance specifications of Models 5820A and 5830A are identical. Specifications for both are shown here for convenience. Specifications that refer to only one model are so noted.

DISPLAY

Format

Full Screen and Back: Electronic graticule with 8 vertical by 10 horizontal divisions.

Split Screen (Top and Bottom): Electronic graticule with 4 each vertical by 10 horizontal divisions.

Waterfall: (5830 only.) Most recent 8 traces of 200 lines or 4 of 400 lines (channel A or B only) each are displayed one under the other until averaging is stopped. Any frequency function or correlation can be displayed.

Nyquist: (5830A only.) TF real is displayed against imaginary in the full display.

Traces Displayed

Any two of the following traces may be simultaneously displayed: power spectrum A, power spectrum B, phase A, phase B, time A, time B, transfer function magnitude, transfer function phase, coherence, coherent output power.

(The following are 5830A only.) Impulse response, auto-correlation of channels A and B, cross-correlation, histogram of channels A and B. TF real and imaginary are displayed as pairs.

In single-channel measurements, two power spectra may be simultaneously displayed: the max frequency spectrum (0 to 50 kHz, 0 to 5 kHz or 0 to 500 Hz) and the selected span (zoomed) spectrum; the portion being zoomed-in is identified by the intensified portion of the trace.

Text (External Computer)

Maximum of four 50 character lines of alphanumeric text plus associated time-domain or frequency-domain plots; or a maximum of sixteen 50 character lines of alphanumeric text only.

Menus

Measurement Mode, Display Format, Readout Calibration, Display Modifiers, Transient Capture, Tracking Signal, Recording, and View Setup.

Storage

All spectral calculations of a measurement set; any two at a time may be recalled for display, along with their calibrations.

CRT Size

4 in. high by 5 in. wide.

INPUT CHANNELS

Input Impedance

1 MΩ, 50 pF nominal.

Absolute Max Input Voltage

200V peak for sensitivity settings between −10 dBV and +20 dBV; 40V peak for all other settings.

Input Coupling

AC with 0.5 Hz cutoff, DC (not recommended for sensitivity settings −50 dBV or higher) and grounded.

DC Isolation

Input low may be connected to chassis ground or floated up to 30V to break ground loops and reject common mode signals; in the float position, each input circuit is true differential.

Common Mode Rejection

>60 dB @ 50 to 60 Hz, DC coupled, FS sensitivity ≤ −20 dBV. Max. common mode voltage is 7.5V for sensitivity settings higher than −20 dBv, 75V for 0 dBV and −10 dBV settings, 200V for +10 dBV and +20 dBV settings.

Input Channel Crosstalk

< −150 dB.

POWER SPECTRUM AMPLITUDE

Full Scale Sensitivity Range

Log: The calibrated attenuator range is +20 dBV to −70 dBV single tone RMS maximum input level, in 1.0 ±0.4 dB steps.

Linear: The calibrated attenuator range is 10V to 320 μV single tone RMS maximum input level in 12 ± 2% steps.

Auto-range

When activated, FS sensitivity of both

channels is automatically adjusted, prior to start of processing; any data block which causes an overload will not be processed.

Display Modes
Log: 20 dB/div, 5 dB/div, 2.5 dB/div.
Linear: Constant voltage/division.

Reference Level
Separate controls for two traces provide for additional gain steps and attenuation steps of displayed function. Steps are 1 dB on the 80 dB range, 0.5 dB on 40 dB range and 0.25 dB on the 20 dB range.

Dynamic Range
2-Tone Amplitude Linearity: ±0.1 dB ±0.001% of FS down to >70 dB below FS.
Distortion Products: >70 dB below FS or −120 dBV, whichever is greater.
Typical Equivalent Input Noise: −154 dBV/√Hz (20 nV/√Hz) for frequencies greater than 100 Hz.
DC Response: >20 dB below FS.

AMPLITUDE ACCURACY

	Normal	High Accuracy
Accuracy at line center	±0.5 dB	±0.5 dB
Hanning Wt.	+0, −1.5 dB	±0.1 dB
Flat Wt.	+0, −4.0 dB	±0.1 dB
Overall Max. with Hanning	+0.5, −2.0 dB	±0.6 dB

Amplitude Resolution
0.1 dB (log), 0.1% (linear).

Overload Indicators
Individual overload indicators are provided for each channel. Overload occurs when input level exceeds full scale. Continuous overload indication will cause error message to be displayed. Occasional overload will only prevent processing of the data block which caused the overload, the remaining data blocks will be processed properly.

POWER SPECTRUM PHASE

Phase Display Range
Full Screen: From +180° to −180°, 45°/division.
Split Screen: From +180° to −180°, 90°/division.

Phase Resolution
0.1°.

FREQUENCY

Frequency Range
Single Channel 5830A Only: 0.01 Hz to 100 kHz.
5820A and 5830A Dual Channel: 0.01 Hz to 50 kHz.

Frequency Spans
- 50 kHz, 25 kHz, 10 kHz, 5 kHz, 1 kHz, 500 Hz, 200 Hz up to 50 kHz (5830A Dual Channel or 100 kHz 5830A Single Channel).
- 100 Hz, 50 Hz, 20 Hz to 5 kHz.
- 10 Hz, 5 Hz, 2 Hz to 500 Hz.

Frequency Modes
- About center
- About start
- About cursor (5830A only)
- Set from keyboard (5830A only)
- Start at zero (5820A only)

Display Modes
Linear or log frequency axis.

Frequency Accuracy
The center frequency of each calculated line is accurate to ±0.001%.

Frequency Resolution
Cursor Resolution: Limited by the calculated line spacing for the selected span and operating mode.
Cursor Frequency Readout Worst Case Error: ±0.5% or ±0.25% of span, depending on span and processing mode.
Improved Accuracy: When measuring frequencies of discrete spectra, cursor resolution is improved by at least a factor of 10 resulting in a worst case error ±0.05% of span.

Cursor Types
Main: Single line in display reads vertical and horizontal units, in annotation, independent of harmonic or sideband cursors.
5830A Single: One line only in display.
5830A Harmonic: A dot illuminates each line in the display at multiples of the first line; vernier adjustment.
5830A Sideband: Pairs of dots are placed symmetrically about a center; vernier alignment.

TRANSFER FUNCTION

Transfer Function Display Modes
Magnitude: Full-screen or split-screen, same display modes as power spectrum amplitude.
Phase: Full-screen or split-screen, same display as power spectrum phase.

Transfer Function Measurement Range
Magnitude: From +170 dB FS to −90 dB FS (log). From 3×10^{8} FS to 3×10^{-5} (linear).
Phase: +180° to −180°.

Transfer Function Accuracy
Magnitude: ±0.5 dB.
Phase: ±1°.

Transfer Function Resolution
Magnitude: 0.1 dB (log), 0.1% (linear).
Phase: 0.1°.

Edited Transfer Function
When selected, those portions of the transfer function where the coherence is below a preset level, are blanked from the display.

OTHER MEASUREMENTS

Coherence Function
Measured and displayed over a range of 0.0 (bottom line of display) to 1.0 (top line of display) 0.125/div. full-screen, 0.25/div. split screen.
Cursor Resolution: 0.01.

Coherent Output Power
Measured and displayed with the same specifications as power spectrum amplitude.

Total Power Readout
Provides readout of total power in selected span; calibration in dBV, VSQ or EU.

Power Spectral Density
Provides readout of noise power per unit bandwidth (1 Hz); calibration in dBV/√Hz, or EU.

Ratio and Difference
Measures the displays the ratio or difference between a present function and a previously measured and stored function.

Engineering Units (EU)
Allows the operator to calibrate both vertical and horizontal scales in terms of arbitrary units (e.g., 100 mV/g and CPM).

Time Function
The time-domain waveform is displayed; valid amplitude and time measurements may be made only in to 50 kHz span dual channel (or 100 kHz span single channel with 5830A).

5830A Correlation
Calculation is direct at sampling rate (Fs) and $\Delta\tau = 1/Fs$. Auto-correlation for channels A and B; cross-correlation AB with zero time in center of display.

5830A Integrate/Differentiate
Equivalent of single or double integration or differentiation of either input, carried through subsequent processing.

5830A Histogram
Amplitude probability density at ±64 levels for Channels A and B processed at sampling rate of range set. Integrating probability density yields cumulative distribution.

5830A Servo
Converts closed-loop transfer function measurements to open-loop (TF/(1-TF)).

5830A Impulse Response
Displays the inverse transform of transfer function. Phase Inversion. Multiplies phase of either input by −1(180° phase shift). Derivative of phase: rate of phase change vs F.

5830A TF Reciprocal
Inverts transfer function magnitudes.

AVERAGING

Modes
Spectrum and Time.

Types
Exponential in free-run, Linear otherwise; Peak, for storing the maximum value at each frequency.
Number of Averages
2 to 256 in binary sequence, displayed on the CRT.
Controls
Start, Stop, Resume, and Store.
Edit on Overload
If the input signal exceeds the sensitivity, the spectrum will not be processed so data contained in the averager will remain valid.

TRANSIENT CAPTURE

Transient Modes
- Free Run.
- Internal.
- External.
- Tracking Signal.
- IEEE-488.

Transient Controls
Threshold: Transient capture level can be selected by a continuous vernier; the + or − going transition can be selected.
Auto/Single: Transient capture may be armed and automatically rearmed after a transient is captured; or, a single transient may be captured.
Pretrigger: Fixed at 1/16 of the time record length.

BUILD-IN SIGNAL SOURCE

Output Signal Types
Noise: "White" or periodic; spectrum band-limited and translated to track the selected frequency span.
Pulse: Sine wave burst at a frequency equal to the center of the span.
Sine Wave: Matches MAIN cursor frequency settable to cursor resolution; 0.001% accurate; 3 Vp-p max.
Multiple Sine Wave: (5830A only.) 10 contiguous sine waves around MAIN cursor, phase staggered to simulate flat noise 10 lines wide.
Sweep: (5830A only.) Single sine wave steps one line per $1/\beta$ period (as determined by the span setting), frequency changes are phase coherent; multiple sine wave steps 10 lines per $1/\beta$ period; single or multiple frequencies only are analyzed at each step.
Level
0 to 40 dB attenuator in 10 dB steps, plus 0 to 10 dB vernier.

ANALOG OUTPUT/INPUT

Analog Plotter
Vertical: 0 to 1.5V FS.
Horizontal: 0 to 1.0V FS.
Pen Lift: Open collector, 30V max.
CRT Output or Direct Input
Vertical: 0 to 1.5V FS.
Horizontal: 0 to 1.0V FS.
Intensity: −1V max to −5V min.

REMOTE OPERATION

IEEE 488-1978 (GPIB) INTERFACE
Programming
All front panel controls except the CRT controls, AC POWER switch, THRESHOLD vernier, 0 to 10 dB TRACKING SIGNAL vernier, and GND/FLOAT switches are remotely programmable through the GPIB Interface.
Data Input
Data for any measurement that can be performed by the instrument plus alphanumeric text can be input via the GPIB.
Data Output
Instrument setup and any measurement that can be viewed on the CRT can be output through the GPIB.
Digital Plotting
Digital plots with user-definable size may be obtained on commonly available plotters including a two-color plotter; an external calculator or controller is not required.
Digital Data In
12-bit serial digital data may be input to the FFT processor of the analyzer, bypassing its input signal conditioners and A/D converter.

MISCELLANEOUS

External Sampling
An external TTL signal may be used as the sampling clock for digitizing input signals. Frequency calibration in this mode of operation is given in ORDERS. Max. frequency of this external signal is limited to 220 kHz, resulting in internal sampling rate of 110 kHz.
Self-Test
A self-test function is provided every time the instrument is turned on.
Auto-Calibration
Periodic check of the amplitude and phase match between channels is performed and adjusted to provide greater accuracies than were previously possible.
Self-Diagnostics
Front panel control activates a diagnostic routine to detect failures at a board level. Errors are recorded in a table on the CRT.
5830A Storage
Type: Nonvolatile and volatile.
Data: Two 400-line single channel spectra (total span and zoom) or one complete set of dual channel data (four 200-line spectra-PSA, PSB, cross-spectrum real and imaginary) sufficient to recall TF, coherence, COP or impulse response in any format: includes frequency and amplitude information to restore calibration.
5830A Panel Setups
5 complete sets of panel settings including all control and menu settings (except rotary controls and toggle switch settings; includes cursor type and position, tracking signal type).

GENERAL

ATE Operations
Rear panel inputs are available. Some specifications are slightly degraded when the rear panel inputs are ordered.
Environment
Operating Temperature: 0° to 45°C.
Storage Temperature: −20° to 70°C.
Dimensions
Bench Mount: 47.0 cm (18.5 in.) wide, 20.3 cm (8 in.) high, 47.8 cm (18.8 in.) deep.
Rack Mount: 48.3 cm (19 in.) wide, 17.8 cm (7.1 in.) high, 45.7 cm (18 in.) deep.
Weight
21 kg (46 lb) net, 27 kg (60 lb) shipping.
Power
115 or 230 V ± 10%, 48 to 66 Hz, less than 200 VA.

OPTIONS

01: Rack Slide
02: Front Panel Cover
140: Storage Adapter
5830A only.
40-2: Software
9915 PROMs (5830A only).
40-3: Software
85 tape (5830A only).

ACCESSORIES

Transit Case

FACTORY/FOB

Rockleigh, NJ

Dual Channel Spectrum Analyzer

- **Frequency Range: 0.01 Hz to 50 kHz**
- **Transfer Function Magnitude & Phase**
- **Engineering Units**
- **Direct Digital Plotting**
- **ATE Applications**

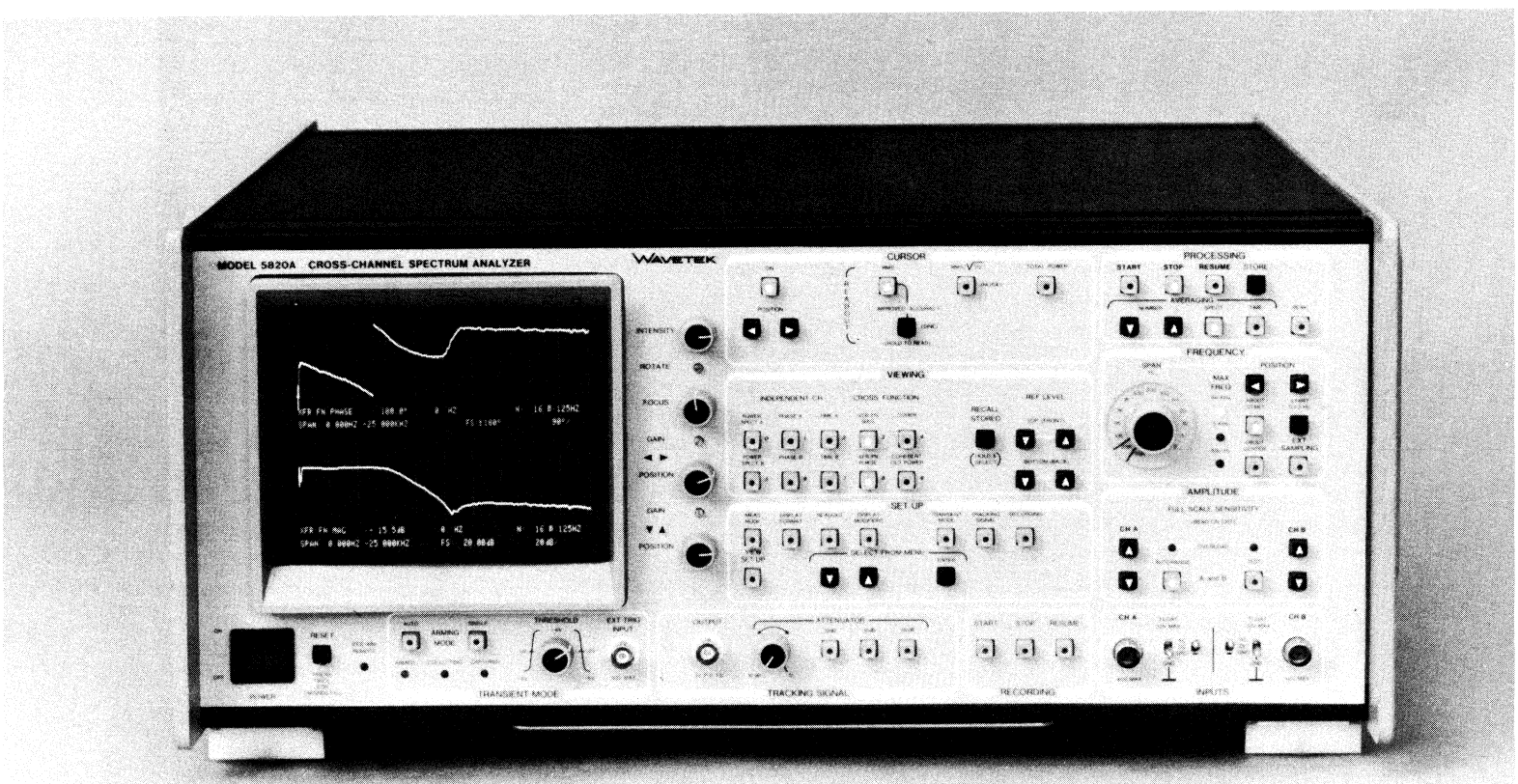
Ease of Operation
The Model 5820A spectrum analyzer is a powerful measuring tool that is simple to operate. Erroneous results are minimized with the fully calibrated and annotated display. Seven menus help set the Model 5820A to the desired configuration so the front panel is not cluttered with less frequently used features. An electronic graticule eliminates any parallax errors when reading data off the CRT.

Design Innovation
The "picket fence" effect is virtually eliminated with the IMPROVED ACCURACY feature. Amplitude and frequency errors due to the finite number of lines of resolution in any FFT analyzer are removed with the Model 5820A's unique computation.

Performance and Versatility
Model 5820A offers excellent performance at an affordable price. Standard design features include a 20 nanovolt noise floor, > 70 dB dynamic range, up to 0.01 Hz resolution, and better than 1 degree phase accuracy. Additional features include a display that allows both time and frequency functions to be displayed simultaneously and a front panel with illuminated pushbuttons which show exactly how the instrument is set up.

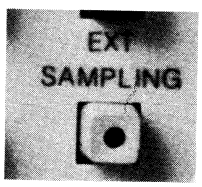
Hard Copy
The built-in GPIB interface has the ability to drive several digital plotters to produce an exact copy of the CRT. No external computer or controller is needed.

When combining the Model 5820A with a computer, the conversational GPIB programming language simplifies writing ATE programs.

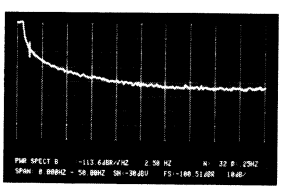


Flexibility
Many different modes of operation are available with the Model 5820A. It is a powerful dual channel spectrum analyzer capable of making precise transfer function (magnitude and phase) measurements, and yet its cost allows it to be used as a simple single channel analyzer.

Applications
Vibration
Model 5820A is designed with features suited for machine vibrations and machine diagnostic applications.
Engineering units allow the measurements to be displayed in convenient formats while the noise readout allow results to be normalized to a 1 Hz bandwidth.
Order tracking is also made possible with the ability to externally control the sample clock of the 5820A.



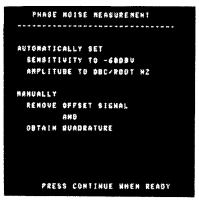
Stability Measurements
The excellent internal noise floor of -154 dBV/$\sqrt{\text{Hz}}$ (20 nV) makes the Model 5820A the obvious choice for low phase noise measurements. Phase noise less than 150 dBc/Hz can be measured at offset frequencies less than 1 Hz from the carrier.



Electronics
The internal noise sources and the transfer function capability make amplifier and filter measurements simple.

Data
Rapid memory storage of reference circuit measurements may be stored in memory so quick visual or mathematical comparisons can be made.

Production Line Testing
The simple programming language and the excellent repeatability in the results make it perfectly suited for quality assurance testing and inspection. Under GPIB control, prompting messages can be displayed on the CRT to alert testers of changes in test conditions.



Possible User Selected Prompt.

Specifications
Detailed specifications for the 5820A can be found on page 62 in the 5830A specification section for:

- Display Characteristics
- Input Channels
- Power Spectrum Amplitude
- Power Spectrum Phase
- Transfer Function
- Other Measurements
- Averaging
- Transient Capture
- Output Signal
- Remote Operation
- Miscellaneous
- General

FACTORY/FOB
Rockleigh, NJ

Dual Channel Spectrum Analyzer

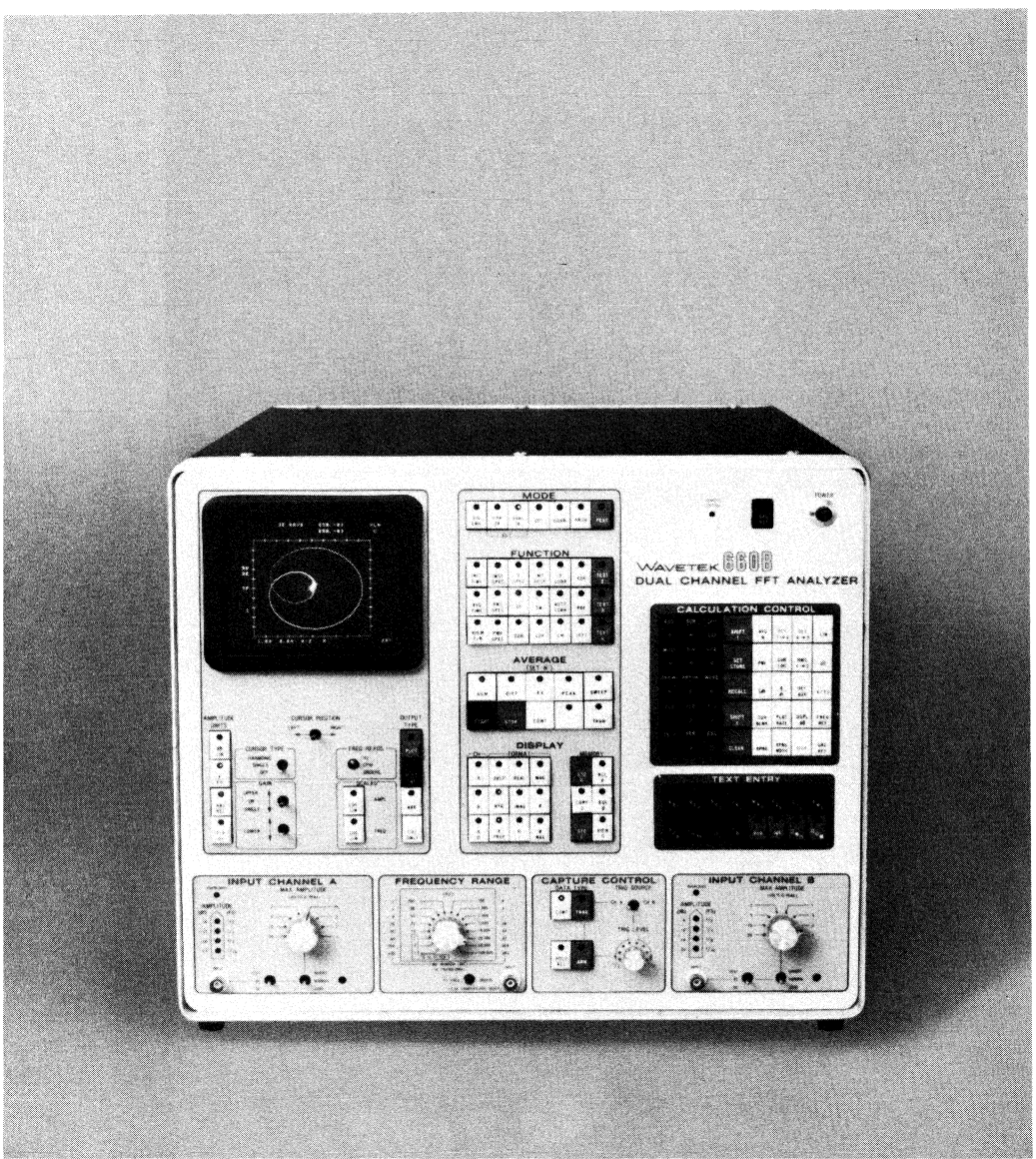
- **Frequency Range DC to 100 kHz**
- **400 Lines (2 Channels) or 800 Lines (1 Channel)**
- **14 Analysis Modes**
- **Curve and Panel Storage**
- **4 Hardware Options**

Model 660B is a versatile 100 kHz Dual Channel Spectrum Analyzer that is popular in the scientific and engineering communities throughout the world. It offers the performance needed for high accuracy work in vibration, acoustics, and electrical signal analysis.

Analysis modes are:

Time Mode (2-Channel):
- Averaged Time, A and B
- Averaged Time, A vs B
- Averaged Linear Spectrum

Probability Mode (2-Channel):
- Cumulative Distribution
- Probability Density



Frequency Mode (Dual 1K):
- Averaged Power Spectrum
- Averaged RMS Spectrum
- Cross-Spectrum
- Transfer Function
- Coherence
- Coherent Output Power
- Auto-Correlation
- Cross-Correlation
- Impulse Response

Frequency mode displayed as: equalized, integrated/differentiated, real/imaginary, mag/phase, Nyquist, normalized density (PSD), lin/log mag or frequency.

Averaging Modes

Nine different averaging modes optimize the statistics for stable, dynamic or transient signals. The number of spectra averaged can be set from 1 to 9999 using the keyboard. At any instant, the number of spectra actually analyzed can be monitored on the display, indicating the progress of the test or, if the test is aborted, indicating the statistical quality of the data already processed. Normally 50% redundant averaging is used, but the operator can chose zero redundancy or maximum redundancy (in sweep mode).

Sweep Mode Smooths Data

The maximum number of spectra for a "smooth" averaged spectrum can be obtained in this mode, which is useful for applications such as introducing energy to a structure under test at successive frequencies.

Sum Mode Calculates the Mean of Stationary Random Data (Ensemble Averaging)
If the statistics of the data are stationary, complete spectra (400 or 800 line) or time blocks (1024 or 2048 samples) are added and continually divided by the number of functions added. This provides a mean spectrum or mean time block of stable calibrated amplitude.

Difference Mode Removes Background Noise
If background "noise" is present, the unique difference averaging mode can be used to subtract the noise spectra from the average of signal-plus-noise, enhancing the recognition of spectrum features due to the signal alone. For example, difference averaging can be used to remove the effects of test system noise from measurements.

Exponential Mode Follows Changing Signals
If the signal statistics change in time (as happens during an automobile pass-by test) exponential averaging can be used to provide "moving" representation with the latest data contributing most and the oldest data contributing least to the average.

Peak Mode Preserves Maxima of Transitory Data
The profile of the highest amplitudes at each frequency may be preferred to a mean if maximum stress, acceleration, or force obtained at each frequency during a test is important. The peak mode provides this profile.

Four Transient Modes Provide Mean Impulse Data
Successive transients, such as impulse hammer blows, captured in the input memories of the 660B, can be averaged automatically to derive their mean spectrum and thus insure more repeatable data. All transients, except those overloading the input, contribute to the average. After each transient is processed, the Analyzer releases the transient and re-arms itself preparatory to capturing the next one. Transient averaging may occur in *Sum, Difference, Exponential* or *Peak* modes.

Coherence
The coherence function measures the linear causality between the selected excitation and resultant; where it is high, the operator is assured that these spectrum features are linearly caused by the selected excitation. In the 660B the coherence function is accessed with a single button.

Coherence Blanking
Once the regions of high coherence have been identified, they can be highlighted on the transfer function display. The 660B's unique "coherence blanking" removes from the display (but not from memory) all information not above a user-selected signal level.

Coherent Output Power
The Coherent Output Power Spectrum provides a measure of the effect of tonal signals, separated from excitations of low coherence.

In the 660B, the operator is free to switch back and forth, by pushbuttons, from transfer function to coherence (blanked or not), to coherent output power (COP) and back to the input power spectra. Cross-correlation or impulse response functions to measure time delay or damping can also be selected. The decision on which function is most "informative" need not be made prior to processing.

Harmonics
Peaks that are harmonically related are probably from the same signal source such as the rotation of a particular shaft. If the fundamental frequency is known and the 660B's cursor is positioned on it, the harmonics of that fundamental are highlighted with brightened dots. In this way, the harmonic peaks due to one source can be separated from others.

Equalization
In performing any dual-channel test, some inter-channel mismatch in amplitude and phase is inevitable. Even if it were possible to design an analyzer with perfectly matched input channels, the errors due to transducers, amplifiers, filters and recording media would still be present. The 660B contains a unique ability to store and cancel out these errors through *Equalization*. The data then appears to have been processed through a perfectly matched or "transparent" test system.

Equalization can be invoked prior to the measurement, in which case functions are continually equalized. Many equalizing transfer functions can be stored on the optional 160C dual-disk unit and recalled as desired, eliminating the need to recalculate them for each test setup.

Equalization applies not only to transfer function, but to transmissibility and Impulse response as well.

Interchannel Delay Cancellation
If a delay greater than one time window exists between corresponding data in channels A and B, a cross-spectrum measurement cannot be made. In this case (using the keyboard) the operator introduces a corresponding delay in the calculation of cross-spectra. The delay can be as great as 64 time windows on the frequency range selected. All significant data then falls within the "same" time window on both channels.

Orbit Diagram
Irregular patterns of rotation of a shaft may be viewed using a cross-plot of two position or motion transducers spaced 90 degrees apart. Such patterns may indicate problems such as bearing wear or oil whirl. The two input time waveforms can be displayed as an "orbit diagram" by the 660B, either instant or averaged, using the NYQ button while viewing a dual time display.

Panel Store
Nine complete setups of panel controls can be retained in the 660B for recall (and re-setup) at any time. These setups are retained even after power is removed.

Data Storage
The 660B contains a convenient internal memory, capable of storing time or frequency functions for later recall. Any functions on display,

whose total number of data points is no greater than 1024, can be retained with a push of the STO button. The stored function(s) can be recalled and compared visually with a single trace of current data. Using EQUALIZATION, a complex mathematical comparison can be performed producing the ratio of magnitudes (difference in dB) and difference of phases.

Since data and panel setups are stored simultaneously, the 660B checks current data for a similar setup before allowing comparison or equalization. Error messages appear, for example, if an attempt is made to compare frequency data taken on the 50 kHz range with stored data processed on the 100 kHz range.

Calibration

The time, frequency or magnitude axis may be calibrated and measured in the most relevant units. This may be in absolute units or relative to a reference.

Axis	Units Available
Time	Sec, Cycles (1/orders), Samples, Fractions of Full Scale.
Frequency	Hz, CPM, Orders, % Full Scale, Cells (to 400 or 800).
Magnitude	V, V^2, dBV (dB Referenced to 1V), E, E^2, dBE (dB Referenced to 1 Engineering Unit) Normalized per Hz (Density).

Third Party Software

Software is available from others to enable the 660B to perform the following functions on a suitable laboratory computer:

- Machinery Health Monitoring
- Operating Deflection Shape Analysis
- Acoustic Intensity
- Structural Analysis

Contact factory for details.

Options

Option -2D. Digital zoom expansion. Provides 36 different resolution bandwidths for analysis details.

Option -3. Octaves, one-third octaves, and A-weighting.

Option -7. Provides three different signal outputs: bandlimited noise concentrated in a zoom frequency range, digitally generated sine wave at cursor location, and periodic binary noise.

Option -8. Complex spectrum math option provides ability to enter as many as four equations in normal algebraic form. Math operations include data editing, force/response windows, basic arithmetical operations, and real or complex constants, as well as square root and conjugation.

Optional Accessories

Model 160C Data Recorder Adapter. Dual Disk unit digitally stores any displayed time or frequency function.

Model 133 Digital Plotter with Model 5738 Plot Translator. Produces annotated 8½ by 11-inch plots.

SPECIFICATIONS

Input Characteristics (Each input channel)

Maximum Amplitude: 0.1, 0.2, 0.5, 1, 2, 5, 10, 20 V (0-peak).

Coupling: AC (−3 dB at 0.5 Hz) or DC, normal or digitally inverted. Digital ZERO is effective input ground.

Impedance: 100 kΩ.

Test Signals:

- Single peak, approximately full scale amplitude, appears in each channel at 64% of analysis range (normal input is disconnected when test signal is on).
- (Rear panel) Digitally-generated random and digitally-filtered random noise outputs provide standard complex functions regardless of frequency range; random sequence over 1,000,000 samples clocked in sync with input ADC; amplitude 0 to 1 V; trigger restarts sequence after pre-sequence of 2048 samples to create pseudo-random noise.

Input Sampling: 12-bit A/D conversion at 2.56 times max frequency in the range selected; 256,000 per sec max external control.

Input Filters: Range switch automatically selects a pair of matched, low-pass, anti-aliasing filters, which provide at least 70 dB attenuation of those input frequencies which can cause aliasing (10 Hz filter used on 1, 2 and 5 Hz ranges); frequency response ±0.5 dB (except ±1.0 dB on 100 kHz range).

Transient Capture Control: Digital data in input buffer memories held manually by placing the HOLD/REL button in HOLD (light on), or automatically by triggering on the transient waveform in either A or B input channels at a preset trigger level (±1/2, ±1/4, ±1/8, or ±1/16 FS) after ARM is pushed (light on); anticipation or delay of the trigger set using the keyboard (T→A) from −1 to 63 time windows.

Input Amplitude Monitors: Lights indicate peak signal levels of −6 dB (>1/2 FS), −12 dB (between 1/2 and 1/4 FS), −18 dB (between 1/4 and 1/8 FS), −24 dB (between 1/8 and 1/16 FS) and OVERLOAD. Electronic graticule top and bottom in time display indicates amplitude limits.

Frequency Ranges

1 Hz to 100 kHz.

Stored Functions (Internal Memory)

STORE: Retains one 800-line spectrum, one 1024-sample time waveform, or two 400-line spectra on display; for cross-spectrum or TF, stores R and I regardless of display.

RECALL: Displays stored data; reverts back to current data display upon second actuation of pushbutton (LED off).

COMPare: Displays one stored trace and corresponding current traces if both processed in a similar manner.

EQL TF/TM: Equalizes current transfer function with stored TF (if both processed in a similar manner) by dividing magnitude of current by stored and subtracting phase of stored from current; also equalizes IR and TM.

Built-in Annotated Display:

Vertical Display: Linear full scale can be set to 1, 1.25, 1.5, 2, 2.5, 3, 4, 5, 6 or 8 × 10^k, or to cursor amplitude, or to any other number entered with keyboard. Log offset can be from +300 dB to −300 dB in 10 dB steps, display range from 20 dB to 160 dB in 20 dB steps via keyboard (DSPL dB).

Time Displays: Self-aligning electronic graticule; max input amplitude written on CRT in volts 0-peak.

Frequency Displays: Self-aligning electronic graticule; annotation includes display and scaling as well as input settings and running N or average if recalled.

Display Formats: Time A vs. time B; single or dual channel where applicable; cross-spectra magnitude and/or phase, or real and/or imaginary (Nyquist); for frequency, lin/log vertical and horizontal.

Calibration at Cursor

Marker: Single line cursor intensifies each waveform at its intersection to indicate location; in HARMONIC multiples of cursor frequency are illuminated with multiple dots.

Amplitude: E, E^2 or dBE (engineering units) using keyboard to establish E at cursor or sensitivity as V/E; reference (R) set for relative measurements; V, V^2 (power) or dBV; readings normalized per Hz (such as PSD) using the *per Hz* button.

Frequency: Hz (cps), CPM, cell number, fraction of FS or orders; reads absolute or as difference from reference frequency.

Time: Sec, ms, fraction of FS, cell number or cycles (1/orders).

Keyboard Settings

AVG N: Number of functions averaged (1 - 9999); running N can be displayed.

DLY T→A: Delay (or anticipation) between trigger signal and start of Channel A data window set in time windows from −1.000 to +63.000.

DLY A→B: Delay introduced between Channels A and B in time windows 0 to 64.000.

PNL: Stores 9 sets of complete panel settings with ID numbers for recall (see below).

CUR LOC: 9 cursor locations stored with ID numbers for recall.

RMS 1-2: Calculates total RMS power between any two stored cursor locations; cursor alternates between two locations in display. ∫dt, d/dt-effective time-domain integration or differentiation, single or double affects all functions until cleared (e.g., converts acceleration to velocity to displacement).

COH BLANK: Sets level of display blanking based on degree of coherence (0-1.00).

PLOT RATE: 5 X-Y plot speeds from very slow (No. 1) to very fast (No.5).

DSPL dB: 20 dB to 160 dB in 20 dB steps.

LIN: Amplitude at cursor on CH A or CH B set to a linear reference (recall is in V/EU).

dB: Amplitude at cursor on CH A or CH B set to a dB reference (recall is in V/EU).

V/EU: Calibration sensitivity of CH A or CH B set in engineering units.

FREQ REF: Cursor location set in display units; to which all future cursor locations are referenced.

ORDER REF: Cursor location set (in ORD), scaling future cursor locations proportionally (for example, if cursor at 0.1 FS is assigned "30", then FS will be "300").

DEFINE AUX: Auxiliary codes used for secondary operations.

PANEL STORAGE (PNL): Stores and recalls nine sets of these setup, processing and display settings:

- Cursor type
- Freq Read
- Display Gain (offset)
- Average Mode
- Average N
- Delay T→A
- Delay A→B
- Mode
- Function
- Display CH
- Display Format
- Display Memory
- Coherence Blank
- Plot Rate
- Display dB
- Input Amplitude
- ∫dt, d/dt
- Aux Code
- Cal V/EU (CH A and CH B)
- Capture Control
- Freq Ref
- Order Ref
- Xpnd Width*
- Xpnd (location)*

*With −2D Digital Expansion

Numeric Calculation

Numbers in entry field, manually entered or transferred from another field can be added, subtracted, multiplied or divided, or the square root or reciprocal taken.

Averaging (9 Types)

SUM: Adds N power spectra (N = 1 to 9999 set with keyboard); redundancy selectable 0% or 50%.

DIFF: Subtracts N power spectra from previous average.

EX: Follows the changing statistics of a signal exponentially with a time constant of (N) × (time window).

PEAK: Produces the profile of the max amplitudes at each frequency element during N spectra.

SWEEP: Averages with max redundancy.

TRANS: Averages power spectra of N transients automatically in SUM, DIFF, EX or PK modes, except those which overload input. After each capture, the transient trigger is automatically re-armed. Also used for time averaging.

Averaging Control

START: Erases memory and starts averaging.

STOP: Halts averaging.

CONT: Resumes averaging until N is reached; if averaging completed, restarts averaging without erasing memory.

Analog Outputs

X, Y and Z outputs for external CRT display. X, Y and pen lift for X-Y plotter. PLOT CAL provides lower-left and upper-right of grid for set-up. Amplitude-at-cursor output.

Digital Interfaces (Standard Built-in)

Full Duplex RS232 Serial Interface: Selectable baud rates of 110, 150, 300, 600, 1200, 2400, 4800, 9600. Internal programming communicates with digital plotters through the RS232 interface. When used to communicate with external devices, the outputs from the RS232 interface are printable in ASCII characters.

IEEE488 Interface: Full listener/talker.

High-Speed 12-Bit A/D Converter Output Interface: Uses 16-bit parallel words (two channels simultaneously). 16-bit digital input to time buffer.

Modem Operation: Interconnect cable gives full compatibility with standard modems and acoustic coupler. 660B may be controlled and its data received over voice grade telephone lines at up to 300 baud. This permits the user to remotely control the 660B.

GENERAL

Dimensions

35.56 cm (14 in.) high, 43.18 cm (17 in.) wide, 52.79 cm (20-7/8 in.) deep.

Weight

36.4 kg (80 lb) nominal.

Power

425 watts, 600 VA.

OPTIONS

-2D Digital Zoom
-3 Octaves, ⅓ Octaves and A-Weighting
-7 Signal Outputs
-8 Complex Math

ACCESSORIES

Model 160C Data Recorder Adapter
Model 133 Digital Plotter
Model S738 Plot Translator

FACTORY/FOB

Rockleigh, NJ

4 Channel Spectrum Analyzer

- **Four Channels**
- **Built-in Computer**
- **DC to 40 kHz**
- **Automatic Operation**
- **Data Manipulation**

Model 804A is particularly powerful in solving problems in general signal processing, structural testing, machine vibration analysis, underwater and airborne acoustics and electronic design. It is equally at home in the laboratory where sophisticated processing can be made routine through macroprogramming, and in the field where data can be annotated and stored for later review. Its ATE capabilities make it ideal for data acquisition during production tests by non-engineering personnel.

The 804A's design allows it to handle virtually any problem today or tomorrow as the needs become more complex. This one instrument combines four real-time FFT analyzers, a four-channel waveform analyzer, a controller/calculator and a word processor. It incorporates 512K of RAM and is based on dual 68000 microprocessors. It has its own mini-floppy disk, macroprogramming capability and text entry.

The ability of the 804A to process four input signals simultaneously makes it highly efficient, particularly for tests that are costly or difficult to repeat. Utilizing a triaxial transducer during impulse excitation of a structure, only one-third as many hammer blows are needed to obtain the three transfer functions. For a potentially damaging environmental test, one test cycle produces four vibration spectra.

Complex data can be manipulated by the use of the extended function library. Macroprogramming and associated editing operations allow a user-written program to be executed or retained on the disk for instant recall. Programs are written in SAMPL™ (Spectrum Analysis Macro Programming Language), an easy to use, high-level language, developed specifically by Wavetek for signal processing applications. The 804A has a 'learn' mode, which allows it to remember a sequence of keystrokes while in a manual operation. Automatic data interpretation and comparison to real or synthesized waveform standards make the 804A ideally suited for routine high volume testing. Automatic peak search and listing simplifies the data reduction tasks. Extensive text annotation and 8-color plotting provide final, report-ready documents.

Basic Operations Using Panel Keys
Many common operations can be implemented directly using front panel keys regardless of the display. These include input sensitivity, frequency range, averaging, triggering and disk operations.

Versatile Soft Keys
Any change in control settings can be made while viewing time or frequency functions without resorting to a menu. Eight "soft keys" are redefined on the CRT for each set of control choices. This simplifies operation by presenting only those control choices that are applicable, and eliminates over 200 front panel "hard keys".

Built-In Disk Drive Stores Data, Programs and Text Indefinitely
Unlimited nonvolatile storage is on mini-floppy disks. Simple soft key commands store data, programs, and/or text in any combination. Each dual-sided double-density disk holds up to 400 Kbytes.

Integral Word Processor Allows Description of Test
A unique ability to completely describe test conditions before, during or after the test, make pertinent notes or even write entire reports on the 804A anywhere.

4 Channels for Fast, Efficient Data Processing
Because the 804A can process up to four input signals simultaneously, it is two or three times as efficient as a two-channel analyzer. Less test time is required, and in many cases, tests that are difficult (or impossible) to repeat can be handled completely the first time.

Four input power spectra and three cross-spectra are all averaged at once. Three coherence and three coherent output power functions are also available. Four auto-correlation and three cross-correlation and impulse response functions can be generated. For structural tests, four-channel processing means that three-axis motion can be processed from one stimulus such as an impulse hammer blow.

In vibration shake tests or impulse shock tests where the test objects may be damaged, four locations can be processed simultaneously, often eliminating the need to repeat the test. For tape recorded data, four tape channels can be processed thus minimizing tape rewind and eliminating data sync between channels.

Four-trace displays monitor four data memories in any combination to show any four views of the same function or four functions separately, overlayed or in dual cross-plot format.

The transfer function of A and B inputs is shown simultaneously as real/imaginary and amplitude/phase with the four traces overlapped, each with its own minimum and full scale.

Processing To Fit The Signal
Different types of averaging are provided to match the signal dynamics in both the time and frequency domains.

The normal *sum, exponential* and *peak* modes can be used to automatically average successive transients as well as continuous data. In *sum preview* and *peak preview* the operator can choose to observe the transient before permitting it to be entered, thus preventing inadvertent corruption of the previous averaged data. In all modes, data from overloaded inputs are not averaged with previous data.

In addition to the normal Hanning and Flat weighting, the 804A provides Flat Top Weighting, which broadens the response to reduce interfilter 'ripple' or 'picket fence' effects. For impulse testing, a Force/Response weighting function is included.

Software
The following four software programs are available for the 804A at no charge. All programs use the 804A's SAMPL language.

- Modal Macro
- Total Harmonic Distortion: See Application Note 28.
- Acoustic Intensity
- AC Impedance: See Application Note 25.

INPUT CHARACTERISTICS

Numbers of channels
4

A/D Conversion
12-bits

Sensitivity
2 mV to 10 Vrms in 1-2-5 sequence; AUTO-SCALE set on command to prevent overload.

Coupling
DC or AC (-3 dB at <1 Hz); AC coupling only on 2, 5 and 10 mV ranges.

Attenuator Accuracy
± 0.2 dB.

Amplitude Linearity
± 0.1 dB or ± 0.05% FS, whichever is greater.

Distortion
75 dB below FS.

Spurious*
Typically 75 dB below FS; maximum 65 dB below FS or 50V, whichever is greater.

Noise*
72 dB below FS up to 35 kHz; 65 dB below FS above 35 kHz on 2 mV and 5 mV ranges.

Anti-aliasing Filter Flatness
± 0.5 dB.

Phase Match Between Channels
± 5° up to 30 kHz (unequalized).

Differential
Common Mode Rejection Ratio: Greater than 75 dB up to 200 Hz reducing at a rate of 20 dB per decade above 200 Hz on the 2 mV to 100 mV ranges; ± 10 V common mode range.
Impedance: 1 MΩ each input (2 MΩ total).
Single Ended Impedance
1 MΩ.

Maximum Input Level
+ 15 V peak for 2 mV to 100 mV ranges; ± 50 V peak for 200 mV to 10 V ranges without damage.

Input Monitoring
OVERload (red), NORMAL (green) 1/16 FS and LOW (yellow) lights.

Crosstalk*
100 dB alternate channel rejection up to 1 kHz reducing at a rate of 20 dB per decade above 1 kHz.

PROCESSING MODES

4-Channel
Channel A, B, C and D power spectra and cross-properties between channel A ("input") and channels B, C and D ("response") are processed and stored.

2-Channel
Channel A and B power spectra and cross-properties between channels A and B are processed and stored; 2-channel processing results in approximately a 2:1 increase in processing speed.

FUNCTIONS

Direct functions
- Input time history
- Instantaneous spectrum
- RMS spectrum
- Power spectrum
- Cross-spectrum
- Transfer function
- Coherence function
- Average time

Derived Functions
- Impulse response
- Auto-correlation
- Cross-correlation
- Transmissibility
- Equalized transfer function
- Equalized transmissibility
- Coherent output power
- Noncoherent output power

FREQUENCY COVERAGE

Baseband (Real Digital Filtering)
0-1 Hz to 0-20 kHz in 1-2-5 sequence and 40 kHz; resolution 1/400 of range.

Zoom Band (Complex Digital Filtering)
1 Hz to 20 kHz bandwidth in 1-2-5 sequence; resolution 1/200 of bandwidth; origin or center frequency settable 0 Hz to 40 kHz to within 0.0015 Hz.

DISPLAYS

Type
9 in. raster scan CRT; P4 (white) phosphor; approximate viewing area 12.7 cm (5 in.) × 16.3 cm (6.4 in.).

Data Format
Scale: Horizontal lin or log for any function; magnitudes lin or log.
Expand: Any portion vertical or horizontal to fill display.
Automatic Scaling: Highest data point becomes top of scale.
Single Display: Any function alone.
Dual Display: Any two functions split, overlap or cross-plot (one vs the other).
Quad Display: Any four functions separated vertically each with its axes, four overlap on one set of axes, two separate cross-plots of any function vs any other, or two overlapped cross-plots on one set of axes.

Text Format
Internal Storage: 10,000 characters.
Title Field: One line of 64 characters.
Data/Text
Text (Only)
Text Editing

Menu Display
Measurement Setup: Status control settings for data acquisition.
Display Setup: Displayed functions and display formatting.
Auxiliary Setup: Controls associated with disk, plotter and remote control.

TRANSIENT CAPTURE MODE

Manual Capture
Automatic Capture
Interchannel Delay
Trigger characteristics
Source: Channel A, B, C or D or external.
Level: − 99% to + 99% FS to 1% FS of selected input or 5 V peak in external.
Slope: Positive or negative.
External Trigger: − DC to 100 kHz (− 3 dB); ± 50 V peak without damage.

AVERAGING

Data
Synchronous time or frequency.

Number
1 to 10,000.

Redundancy
Overlap of data averaged set at 0% (no overlap), 50% or 75%, or for maximum processing rate for SUM, EXP or PEAK modes.

Averaging Modes
- Sum
- Sum Transient
- Sum Preview
- Exponential
- Exponential Transient
- Peak
- Peak Transient
- Peak Preview

WEIGHTING FUNCTIONS

- Flat (uniform)
- Hanning
- Flat top
- Impulse (force/response)
- User-defined

CALIBRATION

Vertical
Displays and cursors calibrated in V, dBV or any engineering units from 1 x 10^{-31} to 1 x 10^{+31} V/EU; desired units of measure may be entered for direct readout from the cursor amplitude field in the display.

Horizontal
Cursor readings in Hz, CPM, orders, sec, min or cycles; entered calibration constants from 1 x 10^{-31} to 1 x 10^{+31} Hz/order for any arbitrary horizontal scale.

CURSORS AND MARKERS

Cursor types
- Single
- Sideband
- Harmonic

Markers
Up to 10 markers may be placed anywhere on any display.

BUILT-IN DISK STORAGE

Contents
Data, programs and/or text.
Disk Type
5 1/4 in. double-sided mini-floppy.
Capacity
Up to 400 Kbytes (up to 60 single functions on one disk).
Expandability
Provision for 3 external drives.
Duplication
Entire disks or portions of a disk can be duplicated.

DIGITAL INPUTS/OUTPUTS

Plotter
Fully compatible with Hewlett Packard HP-GL or Tektronix Plot-50 digital plotters including 8-pen types and automatic paper advance via IEEE-488 interface.
RS-232 Interface
50 to 19,200 baud; selectable word length, number of stop bits and parity.
IEEE-488/1978 Interface
Talker/listener or controller mode selectable.

MATH CALCULATIONS

Modes
Single complex numbers (scalar mode), the contents of data memories (vector mode) or both (mixed mode).
Operation
Directly from keyboard or program.
Form
Reverse Polish Notation (R.P.N.) utilizing a four element stack to hold operands; separate stacks for scalar (x,y,z,t) and vector (X,Y,Z,T) operations.
Measured Data Entry
Parameters transferred to the entry field directly using redefined cursor control keys.
Operations
Soft Key: +, −, x, ÷, enter, exchange, roll, mode select (scalar, vector or mixed).
Keyboard: 1/x, $\sqrt{x}$, x^2, xjω, ÷ jω, e^x, 10^x, lin, log, complex conjugate.
Extended
Over 80 commands which include sine, cosine, FFT, IFFT, minimum and maximum.

PROGRAMMABILITY

Operations
Sequence of measurement, control or math operations.
Storage
Internal program buffer memory contents can be transferred to disk.
Instruction Set
Most keyboard, disk I/O, math and menu operations including "soft keys" are programmable.
Learn Mode
Most operations subsequent to depressing LEARN key are stored in mnemonic form including keyboard, disk I/O and math; RUN key executes program; SINGLE STEP executes one program step on command.
Direct Programming
Entered in SAMPL™—mnemonic form using text entry; line labels, subroutines and comments can be included.
List/Edit
Existing programs listed or edited as in text mode; programs can be combined using auxiliary buffer and INSERT BLOCK commands.
Program Memory
10,000 characters total for text, programs and as auxiliary buffer.

ANALOG INPUTS/OUTPUTS

External Sampling Input
Level: TTL square wave or sine wave of 1 Vrms or greater; AC coupled; ± 50 V peak without damage.
Frequency: 100 Hz to 102.4 kHz.
Signal Conditioning: Schmidt trigger.
Noise Signal Outputs
Narrowband: Pseudo-random or periodic with period equal to analysis time window; noise within the analysis window flat to ± 3 dB and 50% noise energy.
Baseband: Secondary noise source correlated with the narrowband output for system verification only.
Video Display Outputs
Composite Video: RS 170 compatible.
TTL Video: 0 to 2.5 V min, 5V max.
V sync: 1-2.5 V min, 5 V max, 16.6 msec period.
H sync: 0 to 2.5 V min, 5 V max, 62.4 ms period.

OPTIONS

Model 24D Tracking Filter
Model 62A Tachometer
Model 62A-1 Optical Probe
Model 62A-2 Magnetic Probe
Model 58 Microphone
Model 58A Microphone Calibrator
Model 132B Video Printer
Model 133: Two Pen Digital Plotter
Model 180-1: Single Storage Adapter
Model 180-2: Dual Storage Adapter
One Day or Two Day Training
Model 99S: Transit Case for 804A
Model 99U: Transit Case for 133

GENERAL

Calendar/Clock
Time and date saved with all disk files and displayed on menu pages.
Self-test
Diagnostics on power-up verifies operating system has been loaded correctly and that logic is operating correctly; 90% of digital circuitry checked.
Literature
Application Note 23: How to use the 804A.
Application Note 24: Function and formats within the 804A.
Application Note 25: AC impedance.
Application Note 28: Total harmonic distortion.
Dimensions
43.2 cm (17 in.) wide, 26.7 cm (10½ in.) high, 76.2 cm (30 in.) deep.
Weight
47.7 kg (105 lb).
Power
90-130 V or 200-250 V, 50/60 Hz (switch selectable), 380 VA total.

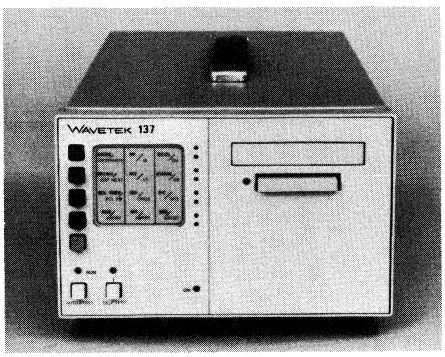
*Measured with 10 kΩ termination with 16 sum averages.

FACTORY/FOB

Rockleigh, NJ

Spectrum Analyzer Accessories

Model 137 Tape Storage Adapter



Model 137 complements the curve storage capability of the 5810A or 5809A storing over 160 traces on magnetic tape complete with setups, post-processing calculations and display formats. Alternatively, either 319 setups or the contents of 7 input buffer combinations can be stored.

Model 137, can save any function automatically and repetitively at a user-specified rate. The averager collects new data while the previous result is being transferred to tape storage. If Model 137 were to store data once every 5 minutes it would take nearly 14 hours to fill the tape.

The 137's easy to understand front panel, plus messages and warnings that appear on the analyzer's screen help to guide the user.

A tape supplied with the Model 137 incorporates programs for:

- Total Harmonic Distortion Calculation
- Phase Angle at Each Frequency
- Single or Dual Plane Balancing
- Automatic Storage and Data Reduction at Preset Time Increments (Display as well as Plot).

SPECIFICATIONS

STORAGE

Medium
Scotch C-100A or HP-200 Data Cartridges.

Capacity
Over 200 Kbytes.

Data Identification
Automatically incremented file number and four digit ID No. from 5810A (user set).

GPIB Interface
IEEE-488. Set for system controller, address 21. Settings may be changed by user.

Environment
Operating Temperature: 0° to +40°C.
Humidity: 20 to 80% non-condensing.
Storage Temperature: -40° to +60°C.
EMI: Within requirements of VDE0871 and CISPR publication 11.

Dimensions
145mm (5.71 in.) high; 213 (8.39 in.) wide; 446 mm (17.56 in.) deep.

Weight
4.9 kg (11.4 lb).

Power
100, 120, 220, 240 VAC (switch selectable) ±10%, 48 to 66 Hz, less than 45 watts.

OPTIONS

Model 37-3, Optional Tape
Permits an HP 85 computer to function like Model 137 Tape Storage Adapter.

ACCESSORIES

Model 99X Carrying Case

FACTORY/FOB

Rockleigh, NJ

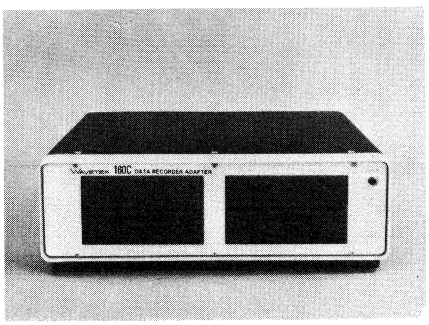
Model 140 Tape Storage Adapter

Model 140 is used with the Models 5820A and 5830A Dual Channel Spectrum Analyzers. Like Model 137, Model 140 allows the transfer of data between analyzer and magnetic tape. Data are stored in named, time-stamped files organized in a single level directory.

FACTORY/FOB

Rockleigh, NJ

Model 160C Data Recorder Adapter



Features

- Mass storage on two digital mini-floppy disks
- Dual-channel records reproduce any single or cross-spectrum analyzer function
- Analyzer setup, post-processing calculations, and display format recalled with data

The mass storage of data, analyzed by the Model 660B Dual Channel FFT Analyzer, becomes a necessity where new data must be compared to one of many previous records, or when off-line post-processing is required. Thousands of spectra may have been produced over many years and require storage.

SPECIFICATIONS

Recording Medium
Mini-floppy disk, single-side recording.

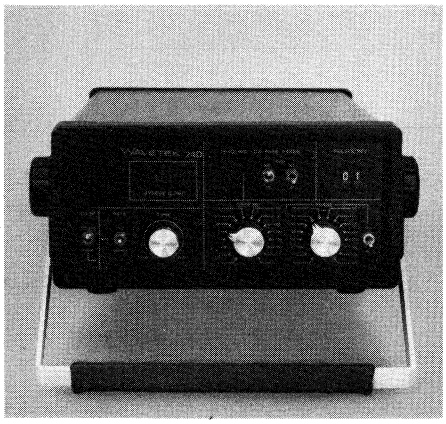
Disk Storage Capacity

- Thirteen 800-line averaged spectrum
- Thirteen Dual 1024-sample averaged time functions
- Thirteen sets of four 400-line averaged spectra—the power spectra of Ch A and Ch B and the real and imaginary of the cross-spectrum (from which most dual channel functions can be generated)
- Twenty-six display memory data traces
- Twenty-six dual-probability functions

FACTORY/FOB

Rockleigh, NJ

Model 24D Spectrum Tracking Adapter



- Auto-tracking to 120,000 rpm.
- Output proportional to rpm.
- Panel light tracking indicators.
- RPM digital readout.
- Bandpass and anti-aliasing filters.

When used with rotating machinery, Model 24D allows a spectrum analyzer such as a Wavetek 5810A to read in multiples (orders) of rotational speed, resulting in usable displays even when the speed changes.

Model 24D uses a tachometer signal on the device under test to synchronize the spectrum analyzer. If desired, the 24D can also use a built-in tracking bandpass filter to derive the required reference signal from analyzer vibration data. The result is order normalization, a spectrum whose horizontal axis is read in terms of multiples of rotational speed instead of frequency.

Regardless of speed changes, spectral components remain fixed on display if they have a fixed relationship to main shaft rotation. Synchronous sampling control compensates for frequency instabilities, resulting in the ability to analyze on the narrowest possible bandwidths.

The 24D Spectrum Tracking Adapter can operate in any one of three modes:

- Using the built-in tracking bandpass filter to track prominent components in vibration or sound signals.
- Locking on to a synchronized signal such as an optical pickup pulse at one per revolution.
- Generating a variable pulse rate to drive a strobe, which is visually "locked" to the machine.

The 24D works with Wavetek Spectrum Analyzer Models 5809A, 5810A, 446B, 5830A, 660B, 5830A and 804A.

SPECIFICATIONS

FREQUENCY MULTIPLIER SECTION

The frequency multiplier consists of a "digital oscillator" whose frequency is proportional to an input frequency, representing the equivalent of a once per revolution tachometer signal. The digital oscillator is used to generate the timing signal necessary to convert a spectrum analyzer's horizontal axis to "orders" rather than frequency. It is also used to generate a frequency equal to the once per rev input for external triggering of the spectrum analyzer and driving an optional strobe light. This output can be phase shifted relative to the tach input. In addition, the digital oscillator can be manually tuned.

Pulses Per Rev Divider

Division by 1 through 99 available via two digit thumbwheel switch. Output used as 1/rev input to multiplier. Maximum output to 120,000 RPM.

Tach Inputs

TTL:

Levels

Logic 0 = $\geq$ 0V, $\leq$ +0.8V

Logic 1 = $\geq$ +3V, $\leq$ +5V

Transition Time — 1 μsec or faster.

Maximum Frequency — 11,800 KRPM when pulses per rev divider set to 99.

Minimum Pulse Width — Not less than 10 μsec.

AUX: Analog — Accepts a unipolar or bipolar analog tach input which has a minimum amplitude of 100 mV RMS. This input is AC coupled through a 300 RPM high pass filter. The maximum DC input is ± 20VDC. Input impedance = 100 kΩ.

TBPF: (Tracking Bandpass Filter). The output of a built-in tracking bandpass filter can be used as a source of tach input. See TBPF section for complete details.

Outputs

TRACK: A TTL output signal which has a frequency proportional to that of the digital oscillator and to the number of orders selector switch. This output is used as a track input to the spectrum analyzer.

TRIG: A TTL output signal which has a frequency equal to that of the digital oscillator and which has a phase that is a function of the phase selector switches.

STROBE: Same as Trig above.

Controls

LOOP:

Open — allows the digital oscillator to be manually tuned.

Closed — In this mode, the digital oscillator will lock onto and track a once per rev input.

TUNE: Allows the user to manually adjust the frequency of the digital oscillator with three levels of sensitivity (fine, medium, and coarse).

ORDER SELECTION: Selects the correct multiplier output necessary to change the spectrum analyzer's horizontal axis from frequency to orders. Order displays are 1, 2, 4, 5, 8, 10, 20, 25, 40, 50, 80, 100, 200, and 400.

PHASE SELECTION: This control gives the user the ability to phase shift the TRIG and STROBE outputs from 0 to 360° in 32 steps (≈11°/step).

Indicators

STROBE: A 5 digit LED display indicating the frequency of the strobe output in RPM.

SIGNAL PRESENT: Yellow lamp indicating that tach signal is being received.

WITHIN RANGE: Green lamp indicating that once/rev signal is within range.

LOOP LOCKED: Red lamp indicating that digital oscillator's frequency is within a few percent of the once/rev input.

Slew Rate

In Hz/sec = $A^2/200$, A = Multiplier's input frequency in Hz.

Acquisition Time

Less than 8 cycles of the multiplier's input frequency.

TLPF SECTION

The Tracking Low Pass Filter (TLPF) is a continuously variable low pass anti-aliasing filter whose cutoff frequency is a function of the frequency of the strobe output and the orders selection switch.

TBPF SECTION

The Tracking Bandpass Filter (TBPF) is a ⅓ octave bandpass filter centered at the frequency of the strobe output. This filter can be used to extract a frequency component from a vibration signal source. The frequency component can be used as a once per rev tachometer input to the Multipler Section.

GPIB

An IEEE 488 interface is provided to allow digital communication to external devices.

DC RATE OUTPUT

DC voltage, a function of the strobe

Model 24D (Cont)

frequency, is provided for a driving source to an analog plotter.

Environment

Operating Temperature: 0° to 55°C.
Storage Temperature: −55° to +85°C.

Dimensions

22.9 cm (9 in.) wide; 11.4 cm (4.5 in.) high; 40.6 cm (16 in.) deep.

Weight

4.1 kg (9 lb).

Power

90 to 130 VAC, 180 to 260 VAC, 45 to 450 Hz.

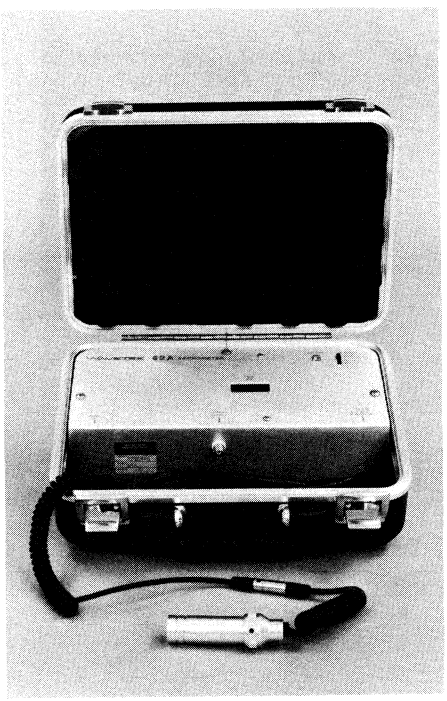
ACCESSORIES

Model 99Y Carrying Case

FACTORY/FOB

Rockleigh, NJ

Model 62A Tachometer



Model 62A, a self-contained tachometer, indicates an object's rotation speed on a five digit LED display and provides a TTL compatible pulse train. The pulse train can be used as a tach input to other pieces of equipment, such as the Model 24D Spectrum Tracking Adapter.

Two optional probe assemblies — one magnetic, the other optical— are available.

Model 62A can operate from a built-in rechargeable battery or from AC power.

SPECIFICATIONS

MODEL 62A TACHOMETER

Display

5 digits.
Units: RPM.

Maximum Frequency

Typically 12,000 RPM or 120,000 RPM via an internal jumper.

Output Pulse

TTL compatible positive pulse.
Logic 0: < +0.8 V.
Logic 1: ≥ +3.0 V).

Battery

6 V lead-acid.
Life per Charge: 5 hr min (continuous use at room temperature when fully recharged).
Recharge Time: 15 hr max.
Charging Mode: Constant voltage; Model 62A is plugged into the power line.

MODEL 62A-1 OPTICAL PROBE

Type

Incandescent.

Reach

6 ft. min.

MODEL 62A-2 MAGNETIC PROBE

Type

Electro Model 58248 digital magnetic pickup.

Reach

11 ft. min.

GENERAL

Environment

Operating Temperature: 0°C to +55°C.
Storage Temperature: −55°C to +85°C.

Dimensions

25.4 cm (10 in.) wide; 13.3 cm (5¼ in.) high; 30.5 cm (12 in.) deep.

Weight

31.2 kg (7 lb).

Power

110 VAC or 220 VAC, 50 to 60 Hz.

FACTORY/FOB

Rockleigh, NJ

Model 132B Video Printer

Model 132B copies any 5810A, 5809A, or 804A display in 12 seconds.

- Continuous feed, small, light; perfect for quick hardcopy in the field.
- Accepts composite video from any NTSC (American Standard) source (FOYA).
- Accepts separate horizontal, sync, vertical sync, and video.
- Accepts remote print command pulse.
- Normal or high resolution modes.
- Normal or reverse video (negative) printout.
- Shipped with interconnecting cable for separate sync, video output, and remote print from the 5810A or 5809A.

SPECIFICATIONS

RECORDING

Recording Method

Electrosensitive recording.

Resolution

Standard Resolution Mode: 640 dots (60 columns/line).
High Resolution Mode: 1280 dots (120 columns/line).

Number of Rasters to be Printed

Interlaced Scanning: 1000 max.
Noninterlaced Scanning: 500 max.

Picture Size

Standard Resolution: 3.8 × 5.0 in. (96 × 128 mm).
High Resolution: 3.8 × 10.1 in. (96 × 256 mm).

Recording Speed

Standard Resolution: 12 s/screen, typical.
High Resolution: 24 s/screen, typical.

Printout

Positive and negative (reversed) printing.

PAPER

Type

EX-855 recording paper.

Dimensions

127 mm (5 in.) wide, 70 m (230 ft) long, 75 mm (3 in.) roll dia.

INPUT SIGNAL

Composite Video Signal

Video white positive, 0.5 to 10 Vp-p.

Separate Video Signal

0.5 to 10 Vp-p (positive or negative).

Sync Signal

TTL level (positive or negative).

Scanning Method

Interlaced and noninterlaced.

Composite Video Signal Sync Range
Noninterlaced Scanning: 16.7 ± 5 ms vertical, 63.5 ± 5 μs horizontal.
Connector
Composite Video Signal: BNC receptacle.
Separate Video Signals: DIN-8P socket.

GENERAL

Environment
Temperature: 40° to 95°F (5° to 35°C).
Humidity: 20 to 90% RH (no condensation).
Dimensions
250 mm (9.8 in.) wide; 106 mm (4.2 in.) high; 370 (14.6 in.) deep.
Weight
4.8 kg (10.6 lb).
Power
117 or 240 VAC ± 10%, 50/60 Hz, 45 watt max.
Included Accessories
Power cord, roll paper shaft.

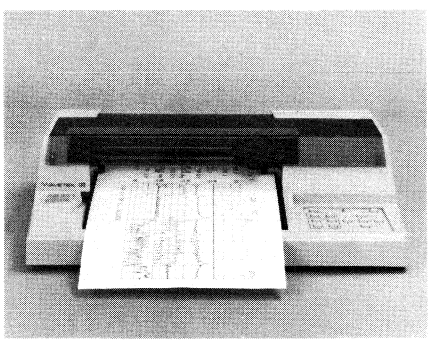
ACCESSORIES

Model 99W Carrying Case.

FACTORY/FOB

Rockleigh, NJ

Model 133 Digital Plotter



- Two color plots on plain paper.
- Fast drawing speed.
- Built-in GPIB interface.
- Compact size.

Model 133 Digital Plotter produces annotated two color plots on plain paper from outputs generated by Wavetek 5809A, 5810A, 5820A, 5830A or 804A Spectrum Analyzers.

A Model 5738 Plot Translator is required to use the Model 133 with Wavetek Model 444, 446B or 660B Spectrum Analyzers.

SPECIFICATIONS

Plotting Area
Media Sizes:
8½ × 11 in. (ANSI A) or 210 by 297 mm (ISO A4).
Max Plotting Area:
Y-Axis: Approx. 191 mm (7.5 in.).
X-Axis: Metric setting — Approx. 273 mm (10.7 in.).
English setting — Approx. 258 mm (10.2 in.).
Resolution
Smallest Addressable Step Size: 0.025 mm (0.001 in.).
Repeatability
With a given pen, 0.1 mm (0.004 in.).
From pen to pen, 0.2 mm (0.008 in.).
Pen Velocity, Each Axis
Pen down:
Maximum — 38.1 cm/s (15 in./s).
Programmable — 1 to 38 cm/s in 1 cm/s increments.
Pen up:
50.8 cm/s (20 in./s).
Acceleration
Approx 2 Gs.
Interface
GPIB (IEEE 488-1978) implements the following GPIB functions as defined in IEEE-488-1978: SH1, AH1, T2, TE0, LE0, SR1, RL0, DC1, DT0, L2, PP0 (listen-only or address less than 7, otherwise PP2).
Graphic Language
HP-GL (Hewlett Packard Graphics Language) commands over GPIB.
Pens
Number: 2, automatic pen changing.
Type: Fiber tip.
Media
Paper or HP overhead transparency film. Paper is standard American 8½ by 11 in. (ANSI-A) or international 210 by 297 mm (ISO-A4).

GENERAL

FCC Certification
Certified by the FCC to conform to limits set for radio frequency interference when used with a Class B computing device.
Accessories Supplied
Operators Manual, Interconnection Guide, Reference Card, Paper—50 sheets (ANSI A), Pens—4 pen package (0.3 mm fiber tip, 1 each: red, blue, black, green), Cable—1 meter GPIB.
Environment
Operating: 0° to +55°C.
Storage: −40° to +75°C.
Dimensions
432 mm (17 in.) wide; 127 mm (5 in.) high; 343 mm (13.5) deep.
Weight
6.1 kg (13.5 lb) net; approx. 12.6 kg (28 lb) shipping.
Power
100, 120, 220, 240 VAC −10%, +5%, 48 to 66 Hz, approximately 25 watts.

ACCESSORIES

Accessories include Model 99U Transit Case and Model 5738 Plot Translator. The latter converts RS232 output of 444, 446B or 660B Spectrum Analyzers to HPGL commands necessary to drive the Model 133 Plotter. Model 5738 is not required for use with 5809A, 5810A, 5820A, 5830A, or 804A analyzers.

FACTORY//FOB

Rockleigh, NJ

Other Accessories

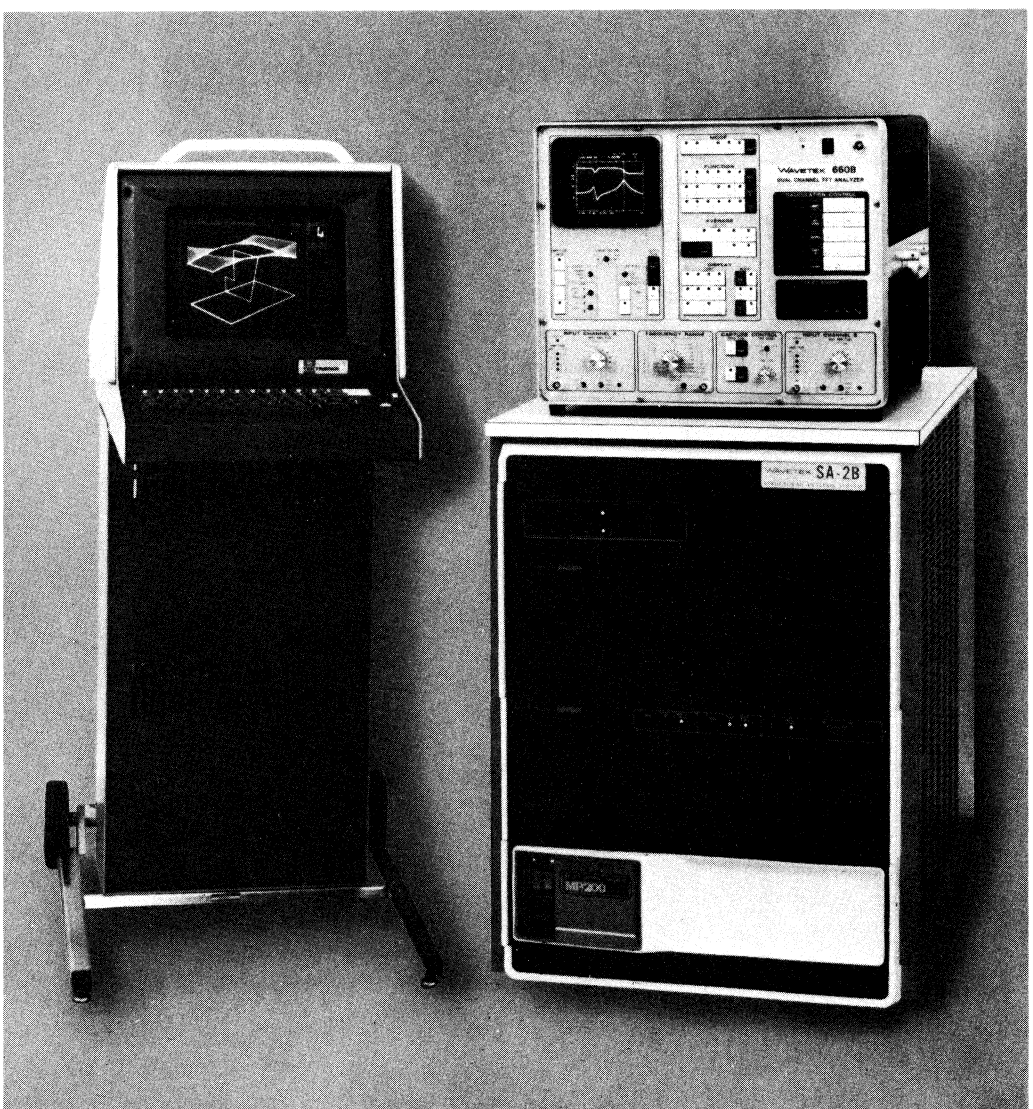
Wavetek Scientific offers a variety of accelerometers as well as microphones and instrumented hammer kit. Consult factory for details.

Structural Analysis Systems

- **Modal Testing**
- **Structural Modification**
- **Finite Element Analysis**
- **Forced Response Analysis**

Complete Structural Analysis Systems
Wavetek offers several Structural Analysis Systems for modal analysis, structural modification simulation, and finite element analysis. These systems consist of a Wavetek two-channel or four-channel spectrum analyzer coupled with a computer and a full complement of appropriate software. An example is the Wavetek 6602B system shown below.

These systems allow structural dynamics problems to be solved experimentally and analytically, or to serve as part of a solution when only part of the final assembly can be tested.

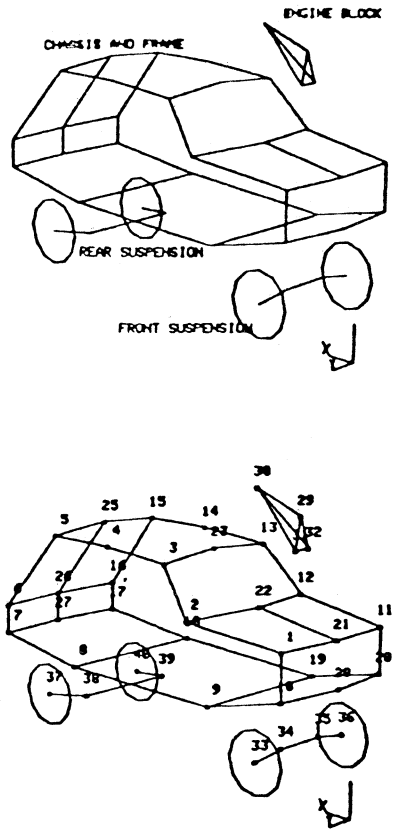


Structural Analysis Systems do not require a dedicated operator. User prompting in conversational English eliminates the need to memorize instruction mnemonics and allows system operation by the non-specialist and casual user.

After the source of a vibration problem has been isolated, the question often arises, "How effective will the proposed physical changes to the structure be in reducing vibration?" With Wavetek Structural Analysis Systems, structural modifications can be simulated to predict the dynamic properties of the modified structure before the expense of an actual change is incurred. Wavetek's resident Finite Element package provides the ability to analytically model structural response to static, thermal or dynamic loading.

Combined experimental and analytical capabilities make Wavetek Structural Analysis Systems ideal for all types of structural analysis applications including design, testing, and troubleshooting.

Modal Testing
Frequency response functions for a test structure can be experimentally measured and curve-fitted to extract the structure's dynamic (modal) properties (natural frequencies, damping and mode shapes).



Modal testing involves creating a pictorial representation of the test object or its component assemblies by entering the spacial locations of test points and graphically interconnecting them. Animated mode shape displays highlight design weaknesses.

Modal analysis is a powerful tool for...

- Troubleshooting the source of vibration problems.
- Establishing a dynamic model for a structure or structural component too complex or costly to model analytically.
- Verifying the accuracy of analytical (finite element) models.

Operating Deflection Surveys

From frequency response data collected with two response transducers (a fixed and roving accelerometer instead of a force and response transducer), animated displays can be generated of structural deformation under various operating conditions.

Structural Modification Program

The Structural Modification Program (SMP) allows engineers and designers to predict the effect of physical changes on a structure's dynamic properties before they are implemented. These changes include:

- The alteration of the cross-sectional properties of structural members by means of localized mass, damping and stiffness changes.
- The addition or removal of structural elements.

To aid the user in selecting the most appropriate modification, SMP can determine where the structure is most sensitive to a modification and how large a modification must be in order that the modified structure have a specified resonance frequency.

SMP can also be used to interconnect independently analyzed structures and predict the dynamic properties of the assembled system. This is often referred to as Dynamic Subsystem or Building-Block Analysis.

Curve Fitting

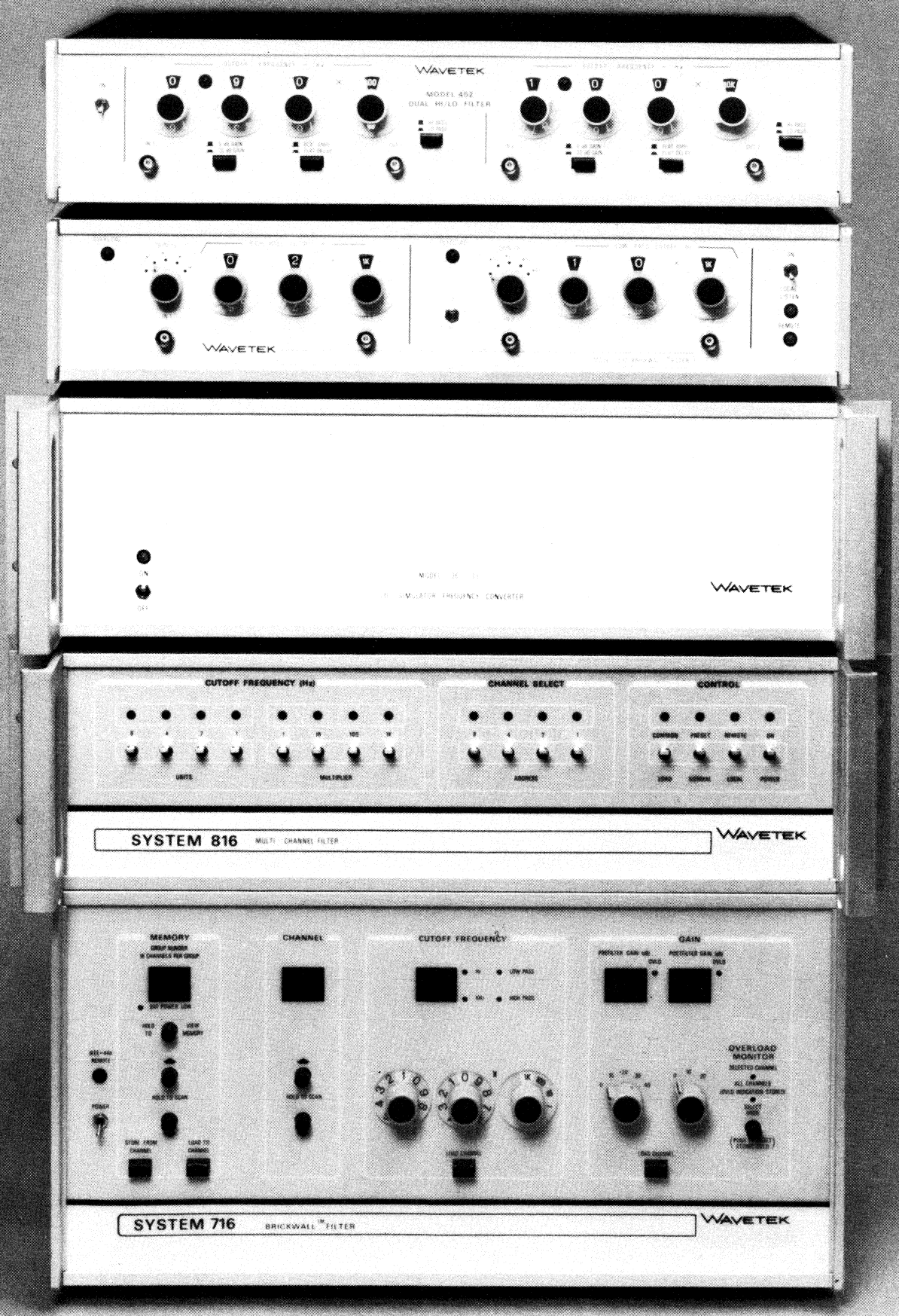
The natural frequency, damping and mode shape (modal parameters) for each of the test structure's modes are obtained by curve-fitting to measured frequency response data. Wavetek Structural Analysis Systems offer a choice of several curve-fitting techniques, including:

- Peak pick
- Circle fit
- Iterative lease-squares multiple-degree of freedom fit.

More Information

For more details on Structure Analysis Systems consult Wavetek Scientific, Rockleigh, N.J.

Signal Processing Filters



FILTER SELECTION GUIDE

	Bench Top				Programmable Bench Top			Multi-Channel Programmable	
	432	**442**	**452**	**852**	**751A**	**752A**	**753A**	**716**	**816**
Frequency Range									
Lower (Hz)	1	10	0.1*	0.1*	1	1	1	1	0.1,1,10
Upper (kHz)	110	1100	111	111	100	100	100	100	1.5,15, 150
Resolution (digits)	2	2	3	3	2	2	2	2	1
Rolloff Rate, per channel (dB/octave)	24	24	24	48	115	115	115	115	48
Filter Function									
Low Pass	•	•	•	•		•	•	•	•
High Pass	•	•	•	•			•	•	•
Bandpass	•	•	•	•	•		•	•	•
Band Reject	•	•	•	•			•	•	•
Notch	•	•	•	•			•	•	
No. of Channels	2	2	2	2	1	2	2	16	16
Broadband Noise (rms)	250μV	500μV	100μV	200μV	10μV	10μV	10μV	10μV	710μV
Max. Attenuation, (dB)	80	80	90	90	80	80	80	80	80
Programming									
Front Panel	•	•	•	•	•	•	•	•	•
TTL					Option	Option	Option		Standard
GPIB					Option	Option	Option	Standard	Option‡
Featured on Catalog Page	54	54	52	52	50	50	50	46	48

*0.01 Hz with Option 01.
‡Separate Instrument.

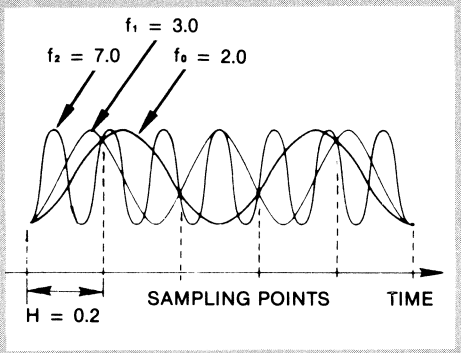
GENERAL SIGNAL PROCESSING FILTERS

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 sinewaves, 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 5 kHz, a signal (f_o) at 2 kHz will yield the same set of sample points as a 3 kHz signal (f_s-f_o), a 7 kHz signal ($f_s + f_o$), an 8 kHz 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.

A filter is used to remove any measurement errors due to aliasing or noise.

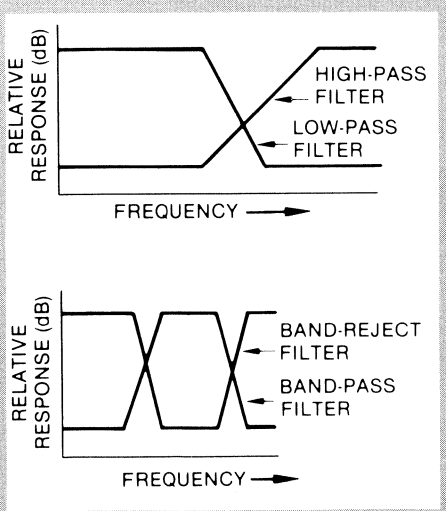
Filter Types

Low-Pass Filters pass signals from DC to the cutoff frequency and attenuate all higher frequency signals.

High-Pass Filters attenuate signals from DC to the cutoff frequency and pass all higher frequency signals (but only up to some limiting frequency).

Band-Pass Filters pass signals between two cutoff frequencies which may be far apart (wide band-pass) or very close (narrow band-pass).

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 have maximally flat passbands with moderately sharp cutoffs, but have moderately nonlinear phase response.

Bessel filters are characterized by excellent phase linearity at the expense of sharpness of cutoff frequency and passband flatness.

Elliptic filters provide extremely fast rolloff rates (115 dB/oct) with good passband flatness, but have a nonlinear phase response similar to Butterworth filters.

Phase-Shift (Delay)

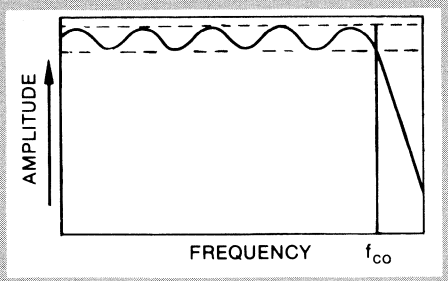
All filters exhibit delay or phase shift between frequencies in the input and output signals. A given delay time corresponds to a specific phase shift at a particular frequency. For constant delay of all frequencies in the passband, the corresponding phase shift must be exactly proportional to frequency (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).

Cutoff Frequency

Cutoff frequency marks the beginning of the transition region (the end of the passband). The common definition has been the frequency at which the transfer function shows 3 dB of attenuation with respect to the input signal.

In any filter displaying significant passband ripple, such as an elliptic filter, it is more meaningful to specify cutoff frequency as the frequency at which the attenuation increases (and continues to increase) beyond the

passband ripple. This reduces amplitude errors in signal processing to the ripple specification of the filter.

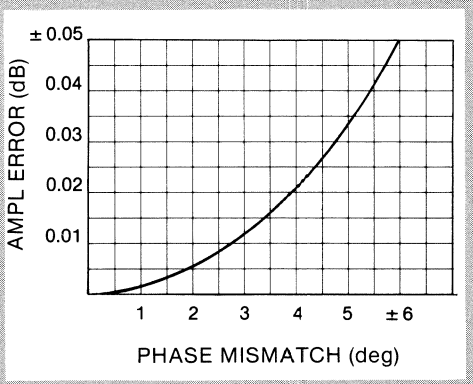


Preferred Method of Defining Cutoff for Filters with Significant Passband Ripple

In linear phase filters, like the Bessel type, the phase response is the more important characteristic. Therefore, the 45 degree per pole phase shift frequency is defined as the cutoff frequency rather than the 3 dB point.

Programming Filters
The ability to adjust a filter's cutoff frequency converts the filter from a component to a versatile subsystem or instrument. When this adjustment is performed rapidly and efficiently by signals from a remote location, the utility and applications range of the filter are greatly increased — especially when the filter is interfaced with a system based on the IEEE STD 488-1978 instrumentation bus.

Significance of Phase Match
In applications such as cross-channel multiplications and multi-channel simultaneous sampling, phase mismatch between filters introduces errors in amplitude calculation. The significance of this error is often exaggerated. A ±0.44 dB error will result from a filter-to-filter mismatch of approximately ±3 degrees in simultaneous sampling. In cross multiplication of two signals the amplitude error due to a filter phase mismatch of ±3 degrees is less than ±0.0125 dB. Phase mismatch will result in a direct error for the phase response of the transfer function but it will not introduce any errors in the magnitude response. However, a phase mismatch will only delay the location of the peak in a cross correlation calculation with no change in the amplitude value.



Amplitude Error due to Phase Mismatch Cross Multiplication

Typical Applications
The large choice available of rolloff characteristics offers great flexibility in choosing the proper filter for each application:

Band Limiting Data — Unwanted signals outside the band of interest can be attenuated by any of the Wavetek filters. Depending on the actual needs of the application, a different family of filters can be selected. Models 751A, 753A and 716 offer the highest rolloff (115 dB/octave), to provide the best rejection of out-of-band signals. Models 852 and 816 provide 48 dB/octave and Models 432, 442 and 452 provide 24 dB/octave rolloff.

With the available gain and the large dynamic range (80 to 90 dB), complex signals can be band limited and conditioned before they are presented to an A/D converter. In addition, higher frequency components or low frequency line related spurious signals can be removed which improves the performance of the system.

Digital Signal Processing — In the processing of any digitized signal, an ANALOG filter is a necessity if the signal is not exactly known. Any spurious signals, harmonics, or noise components near the sampling frequency that are present in the original signal will be aliased or "folded-back" into the frequency range of interest and interpreted as real data. A very "sharp" filter (i.e., one with a steep rolloff) is required in order to achieve the widest analysis bandwidth possible for a given sampling rate.

Excellent phase match between channels in Models 752A and 716 helps reduce any errors in the analog conditioner so that meaningful results can be obtained.

Acoustic Studies—The preciseness and repeatability in setting the frequency of the filters makes them ideal for creating known noise bandwidths for hearing studies. The multiple channel capability of the 816 and especially the 716 are also useful in providing many simultaneous channels of noise with different characteristics. Thus different sounds may be carefully conditioned and sent to different sets of speakers to provide simultaneous stimulus of the ear.

Distortion Measurements—The excellent performance required for the measurement of distortion in audio systems can be achieved by using Wavetek filters. Model 452 provides both 90dB of dynamic range and distortion response, thus providing a means to reject the fundamental frequency before measuring the distortion. Models 753A and 716 while providing 80 dB of dynamic range have the advantage of automating the rejection of varying fundamentals. This may be accomplished under computer control over the IEEE STD 488-1978 instrumentation bus (GPIB). The advantages provided by the filter allows a measuring device with less than 80 dB dynamic range to be used to measure the distortion of a very clean source.

Multi-Channel Brickwall® Filter

- **Frequency Range: 1 Hz to 100 kHz**
- **Rolloff: 115 dB/Octave**
- **Nonvolatile Memory - 16 Settings/Channel**
- **Pre- and Post-Filter Gain**
- **Phase Match: 1°**

Brickwall® Performance
System 716, a multichannel programmable filter system, provides near-ideal passband (0.3 dB p-p) and stopband (115 dB/oct) characteristics in both high pass and low pass filter configurations. Some typical applications include: anti-aliasing for digital signal processing, signal conditioning for separating specified bandwidths of information, and enhancing signal- to-noise ratio.

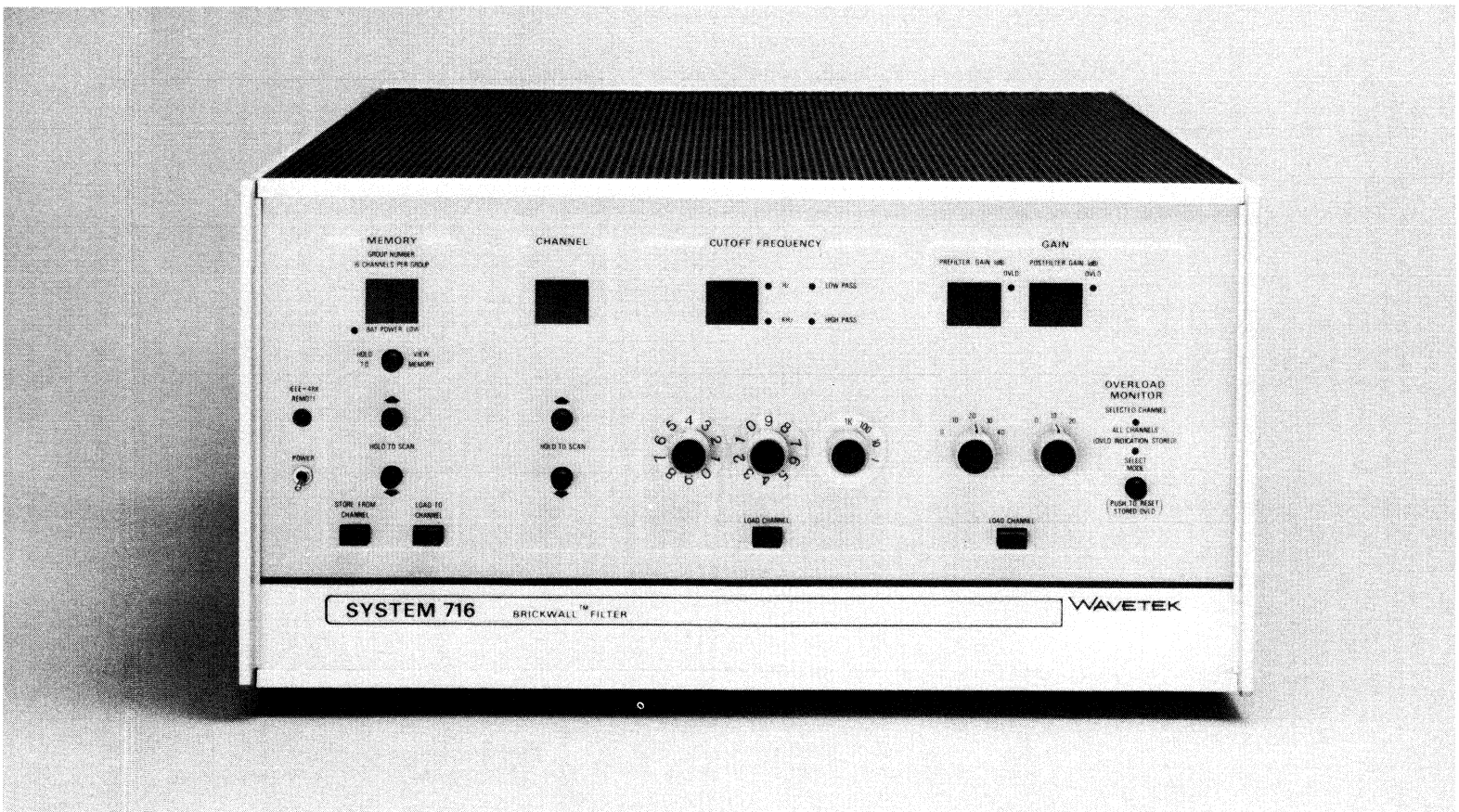
GPIB Programming
An intelligent GPIB interface provides control of all functions including memory, cutoff frequency, gain and overload detection. Self-diagnostics automatically give a check of hardware upon power-up.

Nonvolatile Memory
A RAM (with battery backup) stores up to 16 groups of complete system setups for up to 1000 hours. To restore a programmed setup (gain and cutoff frequency for 16 channels), simply load the desired group number from memory.

Overload Detection
Human engineered overload detection scheme allows monitoring of a single channel or all the channels at once. When all the channels are monitored, an overload is stored and the microprocessor automatically sets the readouts to display the overloaded channel.

Versatility
The patented* System 716 consists of mainframe and a number of plug-in filter cards. The mainframe provides local, on-card, and remote programming, readout facilities, power and input/output connections for up to 16 independent channels. One filter card is required for each channel.

*U.S. Patent 4,246,542



OPTIONS 001 AND 002

FILTER CARDS

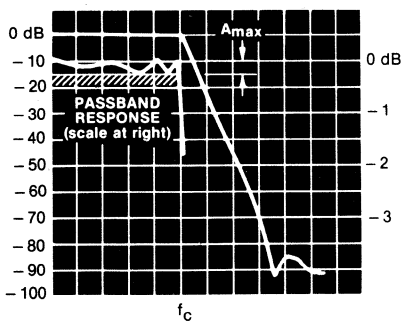
Functions
Low pass (001) or high pass (002); rolloffs of 115 dB/octave.

Cutoff Frequency Range
Local Control: 1 Hz to 99 kHz.
Remote Control: 1 Hz to 100 kHz.

Programming and Resolution
Two 10-position switches and one 4-position multiplier switch.

Multiplier	Frequency	Resolution
×1	1 to 99 Hz	1 Hz
×10	100 to 990 Hz	10 Hz
×100	1k to 9.9 kHz	100 Hz
×1k	10k to 99 kHz	1 kHz

Gain
Pre-Filter Gain: 0, +10, +20, +30, +40 dB (±0.2 dB). One 5-position switch.
Post-Filter Gain: 0, +10, +20 dB (±0.2 dB). One 3-position switch.

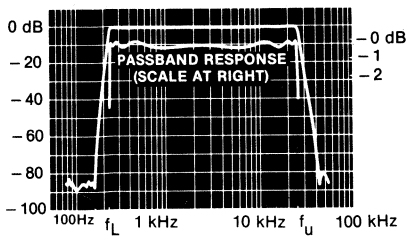


Low-pass Characteristic
High-pass is "Mirror Image".

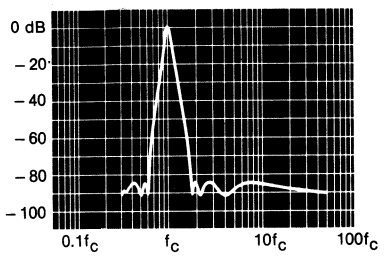
Input Characteristics
Impedance: 1 MΩ, 50 pF, nominal.
Full-Scale Signal: ±10V @ 0 dB gain; divide by gain for other than 0 dB gain settings.
Absolute Maximum Input: ±100V.

Filter Characteristics
Passband Ripple: 0.3 dB, p-p.
Stopband Attenuation: 80 dB, minimum; 85 dB (typical).
f_s/f_c Ratio: 1.7 low pass; 0.6 high pass.

Output Characteristics
Impedance: 50Ω, nominal.
Full-Scale Signal: ±10V into 5 kΩ.
Equivalent Input Noise (at max pre-gain): –150 dBV/√Hz above 50 Hz.
Harmonic Components (1 kHz Input Frequency): 80 dB below full-scale.
Intermodulation Products (Input frequencies of 70 kHz and 90 kHz): 80 dB below full-scale.
DC Offset: Low pass adjustable to 0 volts. High pass: ±10mV.
Drift (@ 0 dB gain): ±50 mV, 15°C to 40°C.



Normal Bandpass f_U/f_L = 100.



Minimal Bandpass
(Note Freedom from "Tenting" Loss.)

Crosstalk Between Channels (Input Source 50Ω or less):
RT0**: 85 dB below full scale.
RTI*: 110 dB below full scale.
Line Related or Spurious Components (Input Source 50Ω or less):
90 dB below full-scale.

Phase Match Between Channels
Low Pass: ±½° typical, ±1° max (DC to 0.8 f_c); ±1° typical, ±2° max (0.8 f_c to f_c).
High Pass: ±½° typical, ±1° max (1.3 f_c to 100 kHz); ±1° typical, ±2° max (f_c to 1.3 f_c).

Amplitude Match Between Channels
Low Pass: ±0.1 dB (DC to 0.8 f_c); ±0.2 dB (0.8 f_c to f_c).
High Pass: ±0.1 dB (1.3 f_c to 100 kHz); ±0.2 dB (f_c to 1.3 f_c).

MODEL 716-11 MAINFRAME

Memory
Sixteen selectable groups; each group has storage for 16 channel settings.

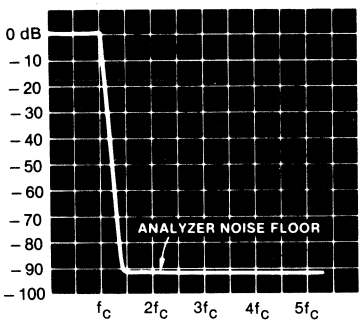
Battery Back-Up For Memory
Trickle charged, when unit is powered; 1000 hours nominal back-up and an LED low battery indicator.

Display
Seven-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.



Two LP Channels Cascaded

Self-Test Diagnostics
Microprocessor checks unit on power up; failure mode indicated on 7-segment displays.

Input/Output Connectors
BNC's on rear panel.

GENERAL

Environment
Operating Temperature: 0°C to 40°C.
Storage Temperature: –20°C to +50°C.

Dimensions
43.2 cm (17 in.) wide; 22.2 cm (8¾ in.) high; 53.4 cm (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
115/230V ±10%, 48 to 400 Hz, 150 watts (less than 7 watts/channel).

*Referenced to Input
**Referenced to Output

FACTORY/FOB

San Diego, CA

Programmable Multi-Channel Analog Filter

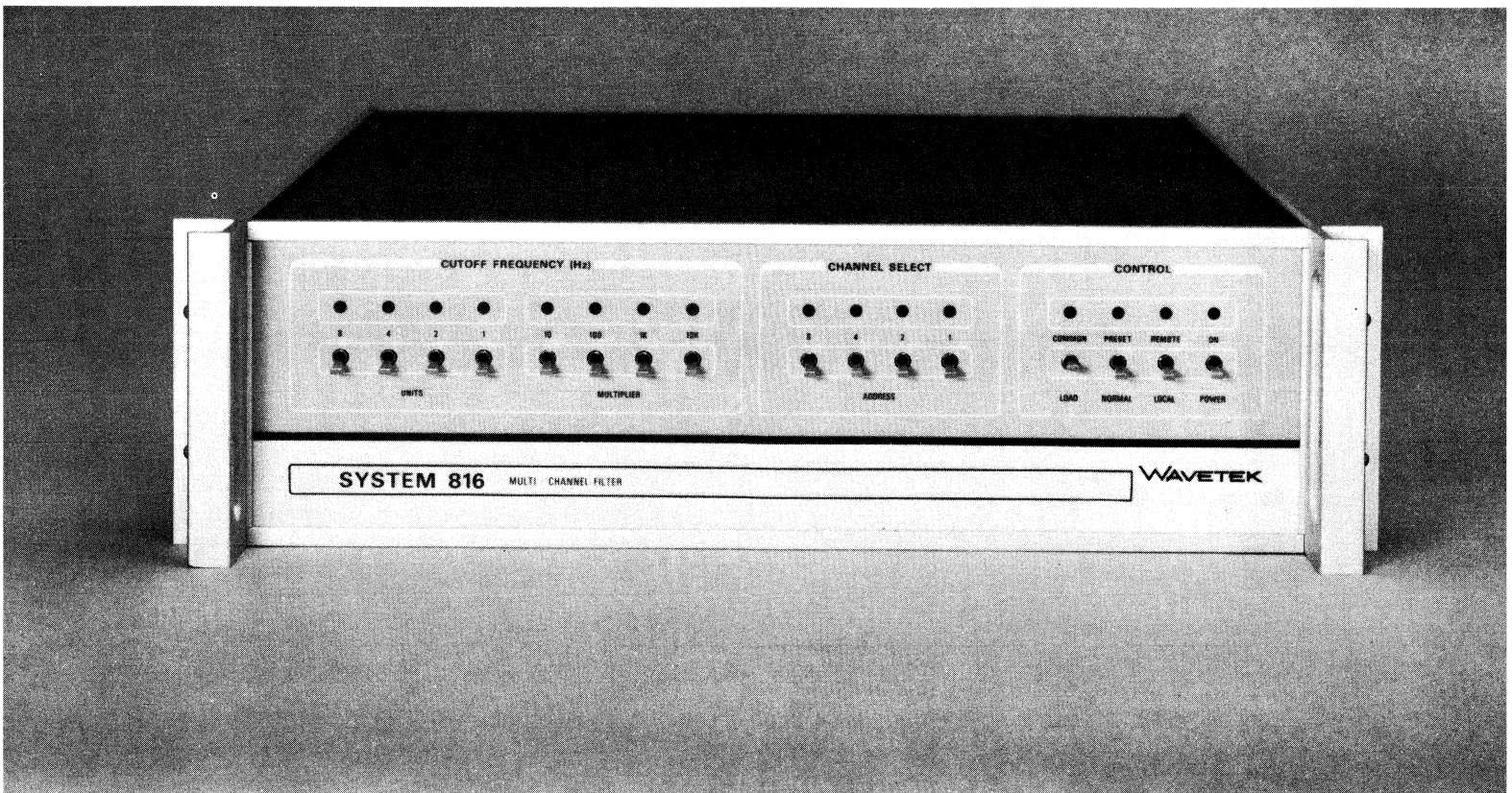
- **Frequency Range: 0.1 Hz to 150 kHz**
- **Up to 16 Independent Channels In 5¼ in. Panel**
- **Rolloff: 48 dB/Octave**
- **Responses: Butterworth and Bessel**
- **Dynamic Range: 80 dB**
- **Local, Remote, and On-Card Programming**

Design
System 816 is a versatile, fully programmable, multi-channel 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 low-pass configuration may be altered to high-pass, and thus, by combining two channels, bandpass and band-reject filters may also be realized.

Applications
Among its many applications, System 816 is widely used in spectrum analysis for band-limiting analog signals prior to sampling and analog-to-digital conversion to prevent the "aliasing" of out-of-band components into the frequency band of interest. In this application, as the sampling frequency is changed, the cutoff frequency of the filters is automatically programmed to a corresponding value typically less than half the sampling frequency, to obtain optimum out-of-band signal rejection.

System 816 is ideally suited to automated data acquisition and signal processing in such fields as sonar, vibration, speech, medicine, geophysics and process control.

Versatility
System 816 consists of mainframe and a number of plug-in filter cards. The mainframe provides local, on-card, and remote programming, readout facilities, power and input/output connections for up to 16 independent channels. One filter card is required for each channel. The user may thus purchase the mainframe and as many filter cards as initially required. System 816 may then be expanded in the future by only purchasing additional filter cards.



SYSTEM 816 SIGNAL PROCESSING FILTERS

FUNCTIONS

Butterworth: Low pass and high pass that may be combined for band pass and band reject filters.
Bessel: Low pass only.
Rolloff: 48 dB/octave/channel.

Cutoff Frequency

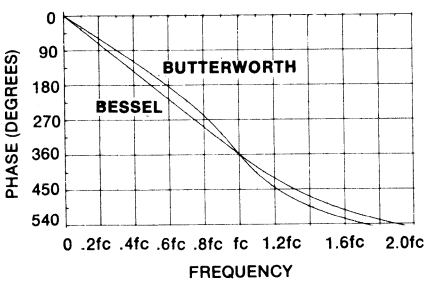
Accuracy: ±2% (±3% on highest multiplier).
Resolution: 15 different values (1 to 15) for each of 4 multiplier ranges:

Option Sets (See Cutoff Freq. Range Options table below)	Multiplier
11, 001, 005	×10, ×100, ×1K, ×10K
12, 002, 006	×1, ×10, ×100, ×1K
13, 003, 007	×0.1, ×1, ×10, ×100

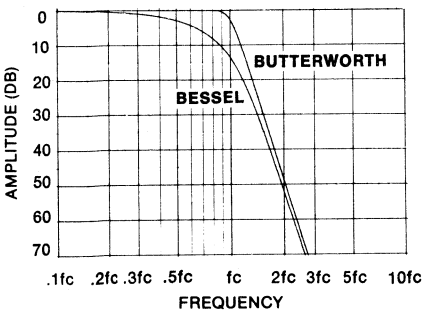
Filter Card Compatibility

Mainframes differ only in front panel marking of multiplier ranges. Mixing in a common mainframe of Butterworth, Bessel, and/or Filter Cards having different frequency ranges is permissible provided:

1. Notation of card type and channel address is made in the software when in REMOTE mode.
2. User is otherwise made aware of card type and channel address when in LOCAL mode.



Typical Phase Response



Typical Amplitude Response

Filter Bypass

Obtained by selecting no MULTIPLIER range and a UNITS value of 15. In this configuration, the filter operates as a DC amplifier with unity gain. Either low pass Butterworth or Bessel cards may be used in the bypass mode.

Gain

0 dB ±0.25 dB.

Input Characteristics

Circuit: single-ended; DC isolated from power ground.
Impedance: 1 MΩ 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.

Model 1488A

Optional GPIB

The Model 1488A-13 provides the following IEEE 488-1978 functions: AH1, L1 (listen only), DT1. It contains special logic for programming sequential (NORMAL) and simultaneous (COMMON) modes as well as PRESET mode.

GENERAL

Accessories Supplied

Three mating connectors and operating manual.

Environment

Operating Temperature: 0°C to +50°C.
Storage Temperature: −20°C to +70°C.

Dimensions

Mainframe: 48.3 cm (19 in.) wide; 13.3 cm (5¼ 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

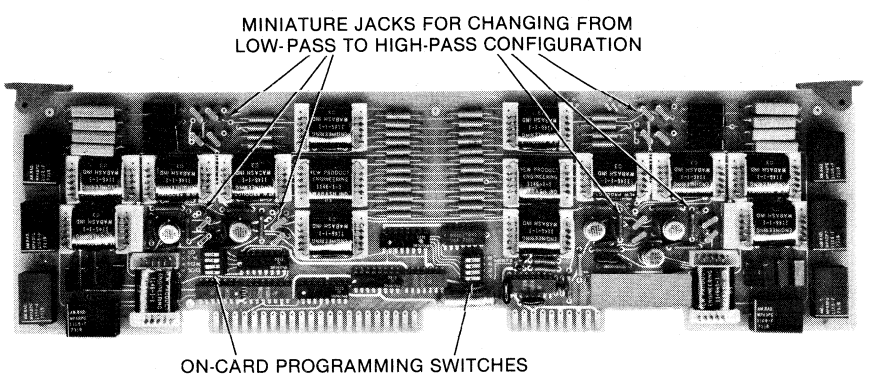
115/230V ±10%, 50 to 60 Hz, 200 watts, max. (less than 13 watts per channel).

FACTORY/FOB

San Diego, CA

CUTOFF FREQUENCY RANGE OPTIONS

Mainframe	Filter Cards: Butterworth (LP, HP)	Filter Cards: Bessel (LP only)	Overall Frequency Range
11	001	005	10 Hz to 150 kHz
12	002	006	1 Hz to 15 kHz
13	003	007	0.1 Hz to 1.5 kHz



Filter Card Assembly — Butterworth

Programmable Brickwall® Filters

- **Frequency Range: 1 Hz to 100 kHz**
- **Rolloff: 115 dB/Octave**
- **Resolution: 2 Digits**
- **Overload Detectors**
- **Options: GPIB and BCD Interfaces**

Design
Models 751A, 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.

Filtering
The slope or rolloff rate of any filter is the measure of how cleanly it discriminates between frequencies that should be passed and those that should be removed through attenuation.

The slope of the 750 series comes close to the infinitely steep slope of the ideal (but unrealizeable) filter. It keeps out unwanted frequencies like a Brickwall® .

Features
Programming of high and low filter cutoff frequencies, pre-filter gain, and post-filter gain is by front panel controls and optionally, by digital programming through a BCD parallel-input, buffered interface or an IEEE 488-1978 (GPIB) bus interface.

Model 751A Bandpass Filter
Model 751A offers a single channel of bandpass filtering with independent control of high pass and low pass sections and up to 40dB of prefilter gain and 20dB of post-filter gain.

Model 752A Dual Low Pass Filter
Model 752A is a dual-channel low pass unit. The channels are identical, and usable independently, or in series. In cascade, the two channels offer the exceptionally high rolloff of 230dB/octave.

Model 753A High Pass/Low Pass Filter
Model 753A provides independent high pass and low pass channels. Each channel permits up to 40dB of prefilter gain.

*U.S. Patent 4,246,542

MODELS 751A, 752A & 753A — SIGNAL PROCESSING FILTERS

FUNCTIONS

Model 751A: Bandpass with independent control of high pass and low pass sections.
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.
1 Hz to 100 kHz with remote control (BCD only).

Control (Each Channel)
Two 10-position switches, one 4-position multiplier switch; remotely by 12-bit code.

Resolution

Multiplier	Frequency (Local)	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
-0.3 ± 0.1 dB at f_c

Stability
± 200 ppm/°C

Gain (Prefilter)
0 to +40 dB (± 0.2 dB) in 10 dB steps. One 5-position switch or 3-bit code.

Gain (Postfilter)
(Model 751A only.) 0, +10, +20 dB (± 0.2 dB). One 3-position switch, or 2-bit code.

INPUT CHARACTERISTICS

Coupling
Low Pass channel: DC, AC with 0.3 Hz nominal cutoff.
High Pass channel: DC.
Impedance: 1 MΩ, 50 pF, nominal.

Full-Scale Signal
± 10V at 0 dB gain; ± 100V absolute max.

Equivalent Input Noise
-150 dBV/$\sqrt{}$Hz with +40 dB gain.

OUTPUT CHARACTERISTICS

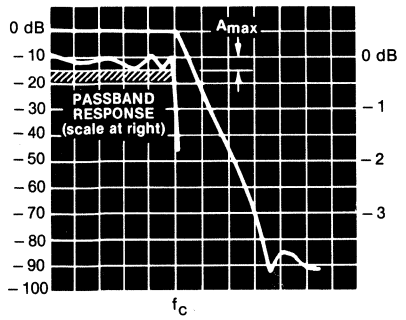
Impedance
50Ω nominal.

Full-Scale Signal
± 10V, into 5 kΩ.

Noise (1 MHz BW)
>80 dB below full-scale referred to output at any prefilter gain. (0 dB post filter gain (Model 751A only).
<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).

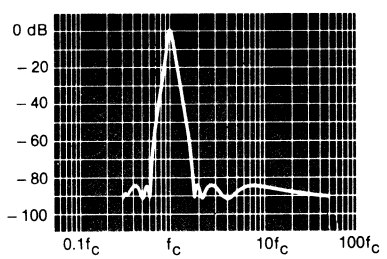


Low-pass Characteristics (Pass-band Response Detail) High-pass Is "Mirror Image".

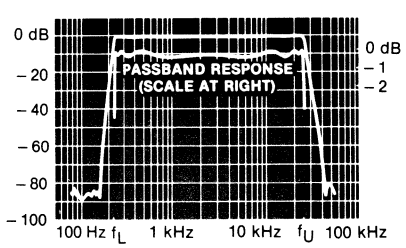
Intermodulation Products
>70 dB below full-scale for 90 kHz and 70 kHz input frequencies.

DC Offset
Adjustable to 0V. Adjustable to ± 10 mV (High Pass Filter Model 753A).

Drift
± 50 mV max, 0°C to +40°C at 0 dB gain setting.



Minimal Bandpass Characteristic (Both Sections Set to Same f_c).



Normal (or Narrow) Bandpass Characteristic.

FILTER CHARACTERISTICS

Type
7-pole, 6-zero elliptic (Cauer).

Rolloff
115 dB/octave.

Passband Response
Low Pass channel: 0.3 dB, p-p.
High Pass channel: 0.3 dB, p-p (-3 dB at approx. 400 kHz).

Stopband Attenuation
Low Pass channel:
-0.3 dB (DC to f_c),
-40 dB at 1.34 f_c,
-60 dB at 1.53 f_c.
-85 dB at 1.7 f_c.

High Pass channel:
-0.3 dB at f_c,
-40 dB at 0.75 f_c,
-60 dB at 0.65 f_c.
-85 dB at 0.6 f_c.

Maximum Stopband Attenuation
Low Pass channel: 85 dB typ; 80 dB min. to 10 MHz.
High Pass channel: 85 dB typ; 80 dB min.

Amplitude Match
(Model 752A only.)
± 0.1 dB, DC to 0.8 f_c,
± 0.2 dB, 0.8 f_c to f_c.

Phase Match
(Model 752A only.) $\pm 1/2°$ typ, $\pm 1°$ max, DC to 0.8 f_c.

GENERAL

Accessories Supplied
Operating manual and rack mounting kit.

Input/Output Connections
BNC's on front and rear panel.

Environment
Operating Temperature: 0°C to +40°C.
Storage Temperature: -20°C to +70°C.

Dimensions
43.2 cm (17 in.) wide, 8.9 cm (3½ in.) high, 33 cm (13 in.) deep.

Weight
8.2 kg (18 lb) net, 10.5 kg (23 lb) shipping.

Power
115/230V $\pm 10\%$, 50 to 60 Hz, 25 watts.

OPTIONS

001: BCD Interface
A total of 35 bits (lines) for programming are provided.
Programming delay is 500 μs plus filter settling time, which is a function of cutoff frequency being programming.

002: IEEE 488-1978 Bus Interface (GPIB)
Provides the following IEEE functions:
AH1 (Acceptor Handshake),
L1 (Basic Listener with Listen only),
DT1 (Device Trigger).

FACTORY/FOB

San Diego, CA

Dual HI/LO Variable Analog Filters

- **Frequency Range: 0.01 Hz to 111 kHz**
- **Resolution: 3 Digits**
- **Cutoff Frequency Accuracy: ± 2%**
- **Responses: Butterworth and Flat Delay**
- **Dynamic Range: 90 dB**
- **Low Noise**

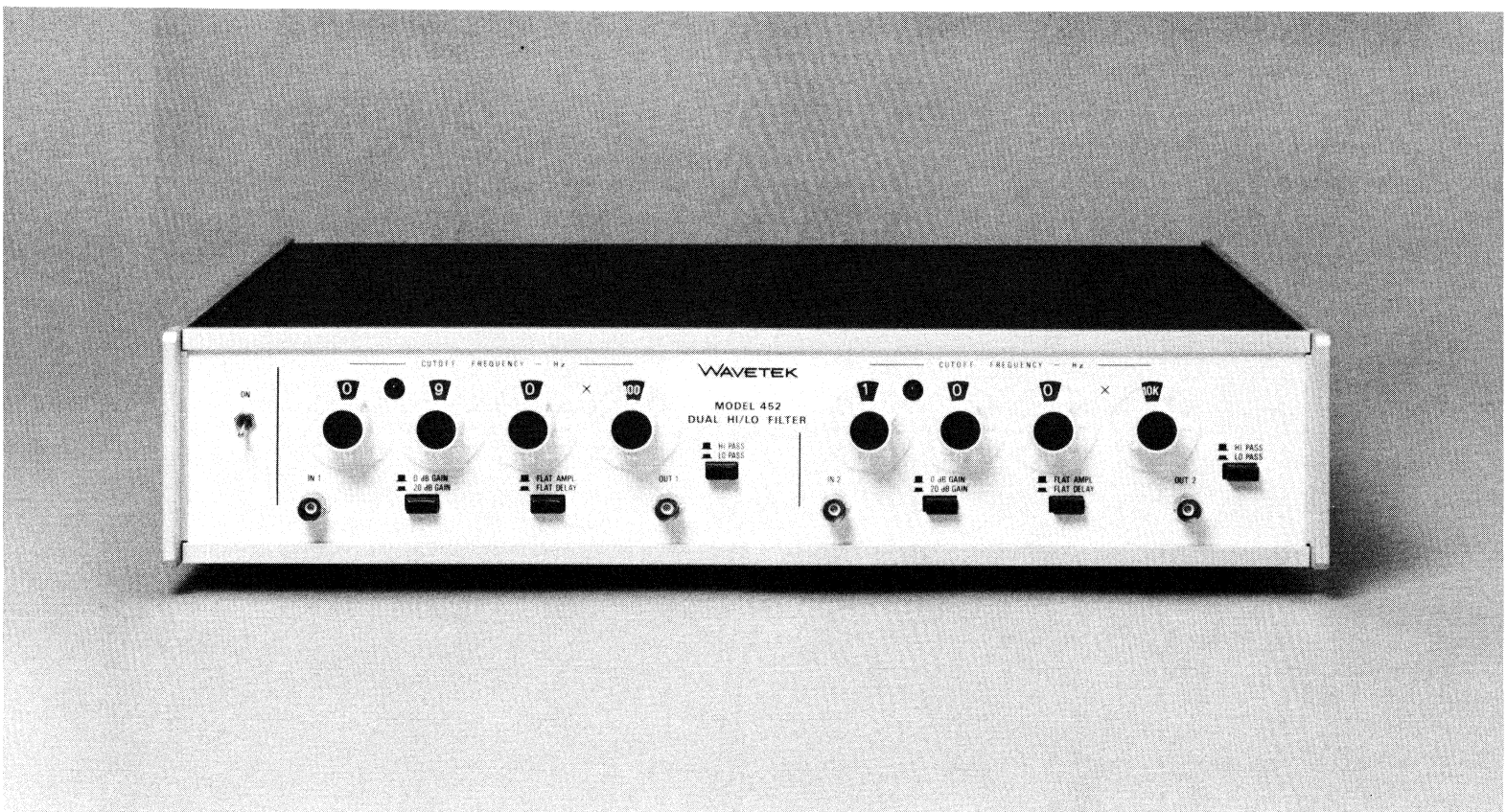
Design
The Models 452 and 852 Dual HI/LO Filters each consist of two identical filter channels contained in a common cabinet. Each filter channel has separate input/output terminals, offers high pass and low pass functions, 0 dB and 20 dB gain, Butterworth/Flat Delay responses and 3-digit resolution for cutoff frequency selection.

Versatility
Individual channels may be readily interconnected for series or parallel operation, resulting in bandpass (or doubled rolloff) and band reject functions respectively.

Each filter channel provides switch selectable Flat Amplitude (Butterworth) response for frequency domain applications and Flat Delay response for transient-free time domain applications.

The Models 452 and 852 are electrically and mechanically similar, each covering 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 48 dB/octave/channel. The factory installed Option 001 will extend the cutoff frequency range and resolution on the Models 452 and 852 to 0.01 Hz.

Implementation
Frequency determining passive elements of the filters are stable precision metal film resistors and close tolerance polycarbonate or mica film capacitors. The active elements are FET-input IC operational amplifiers which provide highly stable gain, and very low noise and distortion. This combination of active and passive elements produces a filter having high cutoff frequency accuracy and resettability, excellent temperature stability and long term stability. Another result of precise control of frequency-determining elements is close amplitude and phase match between channels.



FUNCTIONS

Low Pass, High Pass, Band Pass, Band Reject, Notch.

Frequency Range and Resolution

Three 11-position switches and one 4-position multiplier (option 001 adds fifth position to multiplier).

Multiplier	Frequency (Hz)	Resolution (Hz)
×1*	0.01 to 11.1	0.01
×10	0.1 to 111	0.1
×100	1 to 1.11k	1
×1k	10 to 11.1k	10
×10k	100 to 111k	100

*Option 001 only

Attenuation Rate per Channel

452/452-001: 24 dB/octave.
852/852-001: 48 dB/octave.

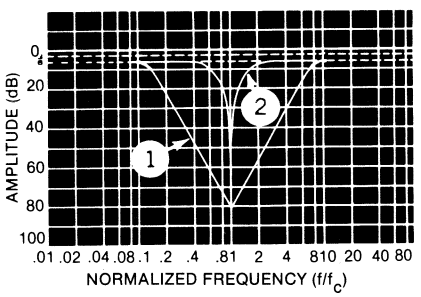
FLAT AMPLITUDE (BUTTERWORTH) RESPONSE

Passband Gain (452/452-001)

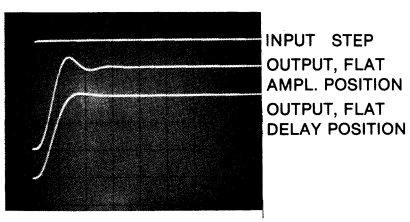
Low Pass: 0 dB/20 dB, ±0.25 dB.
High Pass: 0 dB/20 dB, ±0.25 dB. (±0.5 dB in ×10k Multiplier position); −3 dB at approx. 2 MHz.

Passband Gain (852/852-001)

Low Pass: 0 dB/20 dB, ±0.5 dB.
High Pass: 0 dB/20 dB, ±0.5 dB (±1 dB in ×10k Multiplier position): −3 dB at approx. 1 MHz.



Band Reject (1) and Sharp Notch (2) Obtained by Parallel Connection of 24 dB/Octave Filter Channels



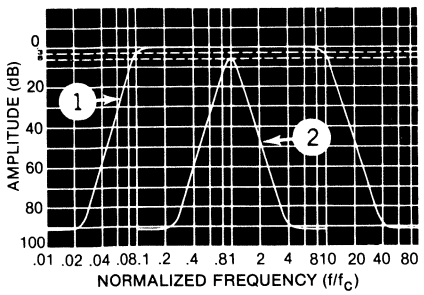
Transient Response - Low Pass Mode (Model 452/452-001 only)

Attenuation at Cutoff

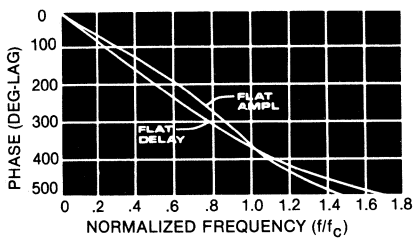
3 dB.

Maximum Stopband Attenuation

90 dB.



Band Pass (1) with LP = 0.01 HP and Minimum Bandwidth Band Pass (2) with LP = HP Obtained by Series Connection of 48/Octave Filter Channels.



Phase Characteristics - Low Pass Mode (Model 852/852-001 only)

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)

452/452-001: $1/(2f_c)$ seconds.
852/852-001: $1/f_c$ seconds.

Attenuation Cutoff

452/452-001: Approx 9 dB.
852/852-001: Approx 17 dB.

INPUT CHARACTERISTICS

Circuit

Single-ended, diode protected.

Impedance

1 MΩ shunted to 50 pF; 75 pF in 20 dB gain (852/852-001).

Full-Scale Signal at 0 dB Gain

±10V (7.1 Vrms), DC to 300 kHz, decreasing to ±4V (2.8 Vrms) at 1 MHz (divide these by 10 at 20 dB gain).

Absolute Max Input

±100 V.

Max. DC Component (High Pass)

±100V, 0 dB gain.
±10V, 20 dB gain.

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 ($R_L \geq 5$ kΩ), ±15 mA max. current.

Broadband Noise at Either Gain Setting (100 kHz detector bandwidth)

452/452-001: 100 μVrms.
852/852-001: 200 μVrms.

Harmonic Components

Input f = 1 kHz
452/452-001: 90 dB below full-scale.
852/852-001: 80 dB below full-scale.

AC Line-Related Spurious Components

452/452-001: 110 dB below full scale.
852/852-001: 100 dB below full scale.

DC Offset at 25°C

452/452-001: 0 ±2.5 mV DC.
852/852-001: 0 ±2.5 mV DC.

GENERAL

Environment

Operating Temperature: 0°C to +50°C.
Storage Temperature: −20°C to +70°C.

Dimensions

43.2 cm (17 in.) wide; 8.9 cm (3½ 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

001: Range Extension

Extends low frequency range and resolution to 0.01 Hz; performance specifications remain the same, except AC line-related spurious components degraded by 6 dB when operating in the optional range. Factory installed.

002: 600Ω Output Impedance.

004: Rack-Mount Kit

Field installable.

FACTORY/FOB

San Diego, CA

Dual HI/LO Variable Analog Filters

- **Frequency Range: 1 Hz to 1.1 MHz**
- **Resolution: 2 Digits**
- **Cutoff Frequency Accuracy: ±5%**
- **Responses: Butterworth and Flat Delay**
- **Rolloff: 24 dB/Octave/Channel**
- **Low Noise**

Design
Models 432 and 442 Dual HI/LO Filters each consist of two identical filter channels contained in a common cabinet. They feature digital tuning performance at prices very competitive with older-style continuously tuned filters. Backlash, parallax and other resettability problems inherent in continuously tuned filters are eliminated by the digital cutoff frequency selection of the Models 432 and 442.

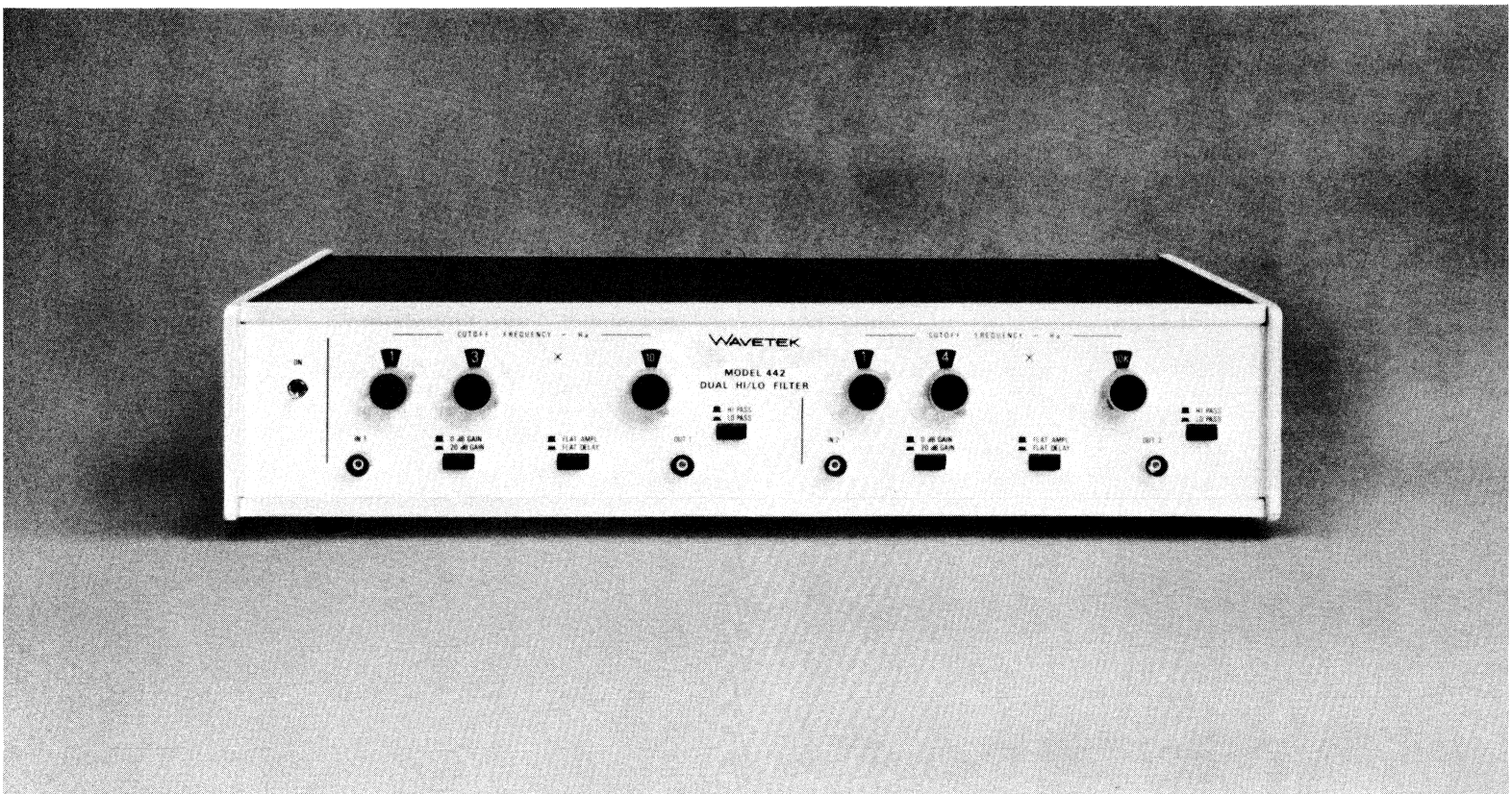
Each filter channel has separate input/output terminals, offers high pass and low pass functions, 0 dB and 20 dB gain, Butterworth and Flat Delay response and 2-digit resolution for cutoff frequency selection.

Versatility
Individual channels may be readily interconnected for series or parallel operation, resulting in bandpass (or double rolloff) and band reject (including notch) functions, respectively.

Each filter channel provides switch selectable Flat Amplitude (Butterworth) response for frequency domain applications and Flat Delay response for transient-free time domain applications.

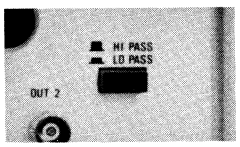
Range
Model 432 covers the cutoff frequency range of 1 Hz to 110 kHz; Model 442 covers 10 Hz to 1.1 MHz. Rolloffs are 24 dB/octave/channel.

Implementation
Frequency determining passive elements of the filters are stable precision metal film resistors and close tolerance capacitors. Active elements are IC operational amplifiers which provide stable gain with very low noise and distortion. This combination of elements produces a filter with high cutoff frequency accuracy and excellent temperature and long term stability.



FUNCTIONS

Low pass, high pass, band pass, band reject, notch.



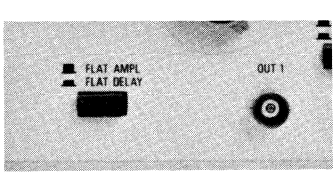
Frequency Range and Resolution
2 digit resolution as follows:

Multiplier	Frequency (Hz)	Resolution (Hz)
×1(432)	1 to 110	1
×10	10 to 1.1k	10
×100	100 to 11k	100
×1k	1k to 110k	1k
×10k(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 f_c.
Attenuation at Cutoff: 3 dB.
Maximum Stopband Attenuation
80 dB (Input f≤1 MHz).
Flat Delay
Low Pass Delay (Typical):
$1/(2f_c)$ sec.
Attenuation at Cutoff: Approx. 9 dB.

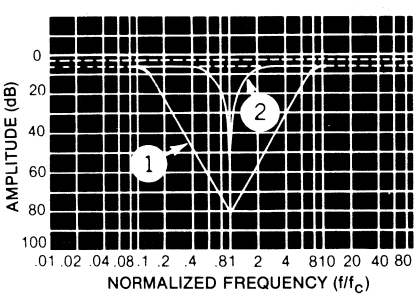


INPUT CHARACTERISTICS

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. ±0.7 (0.5 Vrms) at 20 dB gain.
Model 442: ±7V (5 Vrms) DC to 1 MHz. ±0.7 (0.5 Vrms) at 20 dB gain.
Absolute Maximum Input
±100V.
Maximum DC Component
High Pass: ±100V, 0 dB Gain, ±10V, 20 dB Gain.

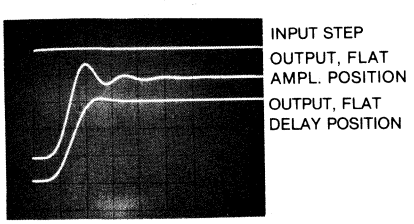
OUTPUT CHARACTERISTICS

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.
Broadband Noise at Either Gain Setting
Model 432: 250 μVrms maximum for 100 kHz detector bandwidth.
Model 442: 500 μVrms maximum for 1 MHz detector bandwidth.

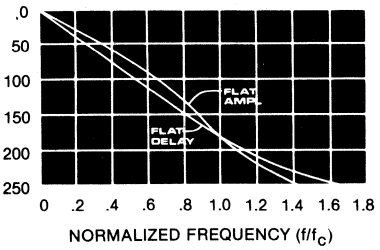


Butterworth (Flat Amplitude) Response Showing Band Reject (1) and Sharp Notch (2). Obtained by Parallel Connection of 2 Individual 24 dB/oct Filter Channels.

DC Offset at 25°C
Model 432: 0 ± 1 mV dc.
Model 442: 0 ± 50 mV dc.
Harmonic Components
Model 432: 80 dB below full-scale signal, (Input f = 1 kHz).
Model 442: 70 dB below full-scale signal, (Input f = 10 kHz).



Transient Response - Low Pass Mode



Phase Characteristics - Low Pass Mode

AC Line-Related Spurious Components
100 dB below full scale.
Drift vs Temperature
1 mV/°C.

GENERAL

Environment
Operating Temperature: 0°C to +50°C.
Storage Temperature: −20°C to +70°C.
Dimensions
43.2 cm (17 in.) wide; 8.9 cm (3½ in.) high; 33 cm (13 in.) deep.
Weight
4.5 kg (10 lb) net; 6.5 kg (14 lb) shipping.
Power
115/230V ±10%, 50 to 500 Hz, 5 watts.

OPTIONS

002: 600Ω Impedance
Model 432 only.
004: Rack Ears

FACTORY/FOB

San Diego, CA

Frequency Synthesizers

SYNTHESIZER SELECTION GUIDE

MODEL	5100	5120A	5130A	5135A	5155A	System 36	5101	System 51
Frequency Range								
Low	DC	100 kHz	100 kHz	100 kHz	100 kHz	100 kHz	1 Hz	1 Hz
High	3 MHz	160 MHz	160 MHz	160 MHz	1000 MHz	430.1 MHz	3 MHz	3 MHz
Frequency Resolution	0.001 Hz	0.1 Hz	0.1 Hz (Local) 0.001 Hz (Remote)	0.1 Hz (Local) 0.001 Hz (Remote)	0.1 Hz	0.1 Hz (Local) 0.001 Hz (Remote)	1 Hz	1 Hz
Switching Characteristics								
Switching Speed	1.5 μs	20 μs	3-20 μs	1-10 μs	1-20 μs	3-20 μs	1.5 μs	2 μs
Phase Continuous	•		*	*	*	*	•	•
Output Level	1 Vrms 10 Vp-p (2 MHz)	+3 to +13 dBm	+3 to +13 dBm	+3 to +13 dBm	+3 to +13 dBm	+3 to +13 dBm	1 Vrms**	1 Vrms**
Frequency Response	±0.25 dB (<500 kHz) ±0.5 dB (<3 MHz)	±0.5 dB	±0.5 dB	±0.5 dB	±0.5 dB (<500 MHz) ±1.0 dB (≥500 MHz)	±0.5 dB	±0.25 dB (<500 kHz) ±0.5 dB (<3 MHz)	±0.25 dB (<500 kHz) ±0.5 dB (<3 MHz)
Spectral Purity								
Spurious	−40 to −70 dBc	−70 dBc	−70 dBc	−70 dBc	−70 dBc/ −64 dBc	−70 dBc	−40 to −70 dBc	−40 to −70 dBc
Harmonic	−40 to −55 dBc	−35 dBc	−35 dBc	−35 dBc	−25 dBc	−35 dBc	−40 to −55 dBc	−40 to −55 dBc
Phase Noise (30 kHz Bandwidth)	−40 to −50 dBc	−70 dBc	−70 dBc	−70 dBc	−70 dBc/ −64 dBc	−70 dBc	−40 to −50 dBc	−40 to −50 dBc
Reference Standard								
Internal	8 MHz (Standard)	10 MHz (Option)	10 MHz (Option)	10 MHz (Option)	10 MHz (Option)	High Stability (Standard)		8 MHz (Standard)
External	1, 8 MHz (Standard) 5, 10 MHz (Option)	5, 10 MHz (Standard) 1 MHz (Option)	5, 10 MHz (Standard) 1 MHz (Option)	5, 10 MHz (Standard) 1 MHz (Option)	5, 10 MHz (Standard) 1 MHz (Option)	5, 10 MHz (Standard) 1 MHz (Option)	8 MHz (Standard)	1, 8 MHz (Standard)
Local Control	Standard	Standard	Standard	Standard	Standard	Standard		Standard
Remote Control								
TTL	Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard
GPIB (Option)	•	•	•	•	•	•		
Featured on Catalog Page	64	62	62	62	60	***	***	***

*Over limited frequency range
**Other fixed levels available
***Consult factory for more details.

General
All Wavetek Frequency Synthesizers employ direct synthesis techniques for the generation of stable, accurate signals in the DC to 1000 MHz frequency range. All frequencies are referenced back to a frequency standard and are, therefore, extremely accurate and stable.

Direct vs. Indirect
All frequency synthesis methods fall into two major categories — direct or indirect. In the first approach, direct frequency synthesis, a sequence of arithmetic operations (either analog or digital) are performed directly on the output of a harmonic generator driven by a reference standard to produce the desired output frequency.

With indirect synthesis, the output frequency is actually produced by a variable voltage-controlled oscillator (VCO) phase-locked to the reference standard.

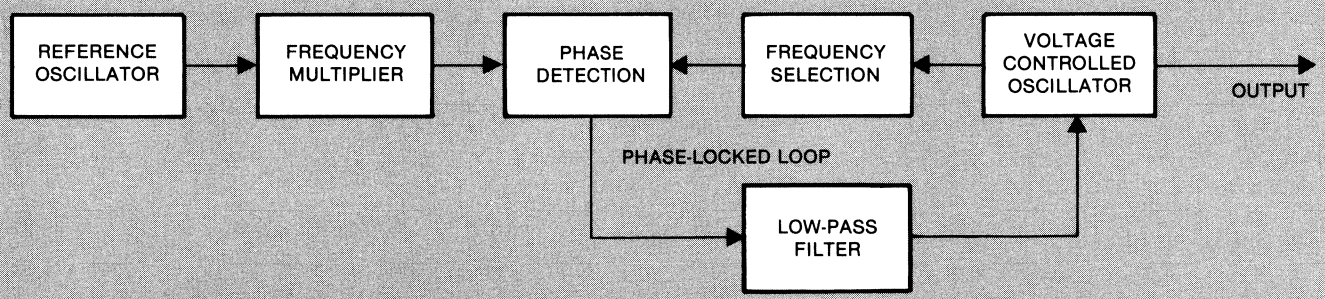
Advantages
Switching speed, fine resolution, and a spectrally pure output are the main advantages of direct synthesis. Short-term frequency stability or "phase noise" in direct synthesis is very good at frequencies close to the carrier frequency; while the stability of the VCO, the gain and the bandwidth of the phase-lock loop determine the phase-noise of the indirect synthesizers.

Direct-Digital Synthesis
The Model 5100 utilizes a patented*, unique synthesis employing all-digital techniques. The phase accumulator generates the linearly increasing digital phase values of the sinusoid at a fixed output sample rate. For each output sample, this phase value advances by an increment directly proportional to the frequency setting. The ROM is a sine function table that converts the phase information of the accumulator into digital samples of a sinusoidal waveform. The subsequent D/A converter and low pass filter reduce the digital approximation to a pure sinusoid.

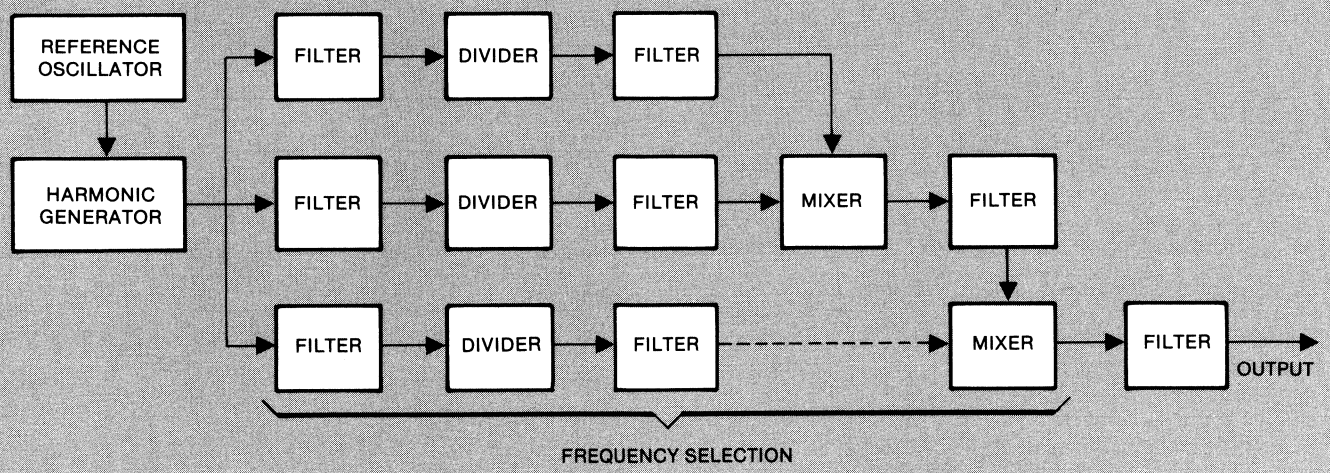
The Models 5120A, 5130A, 5135A, and 5155A combine this direct digital technique with the direct analog synthesis methods to yield a unique combination of useful features.

Phase Continuity
Because of the digital nature of the synthesis, true phase and amplitude continuity are achieved when switching between two frequencies on all synthesizers except the Model 5120A.

*U.S. Patent 3,735,269



Indirect Analog Synthesis



Direct Analog Synthesis

Switching Speed
The direct digital synthesis technique also gives Wavetek synthesizers ultra-fast switching speeds. When a phase continuous frequency hop is performed (all models except Model 5120A), only the programming delay limits how fast a frequency change occurs. The all-digital synthesizers, Models 5100 and 5110, and System 51 are always phase continuous with programming delays of 1.5 μs, 1.5 μs and, 2 μs respectively, and update rates of 625 ns, 625 ns and 1 μs respectively. The VHF frequency synthesizers have a 2 μs to 3 μs programming delay depending on the synthesizer.

In the noncontinuous switching mode (Δf >100 kHz), the synthesizer design minimizes the switching transient, so receivers and other sensitive devices will not be adversely affected by the high spurious energy generated in the transient. Model 5135A provides the ultimate in VHF switching speed performance with a switching transient of less than 1 μs for any change less than 10 MHz. The programming delays for the Model 5135A are consistently less than 2 μs for any frequency change less than 10 MHz. If the frequency increment is "anticipated" by the controller in the system, only the 1 μs transient will be seen.

Control
Range multipliers are not used on any model, which results in constant resolution throughout the frequency range. All instruments have built-in standard TTL interfaces for remote programming of frequency and amplitude. GPIB interfaces are available either as separate standalone instruments, or built-in modules.

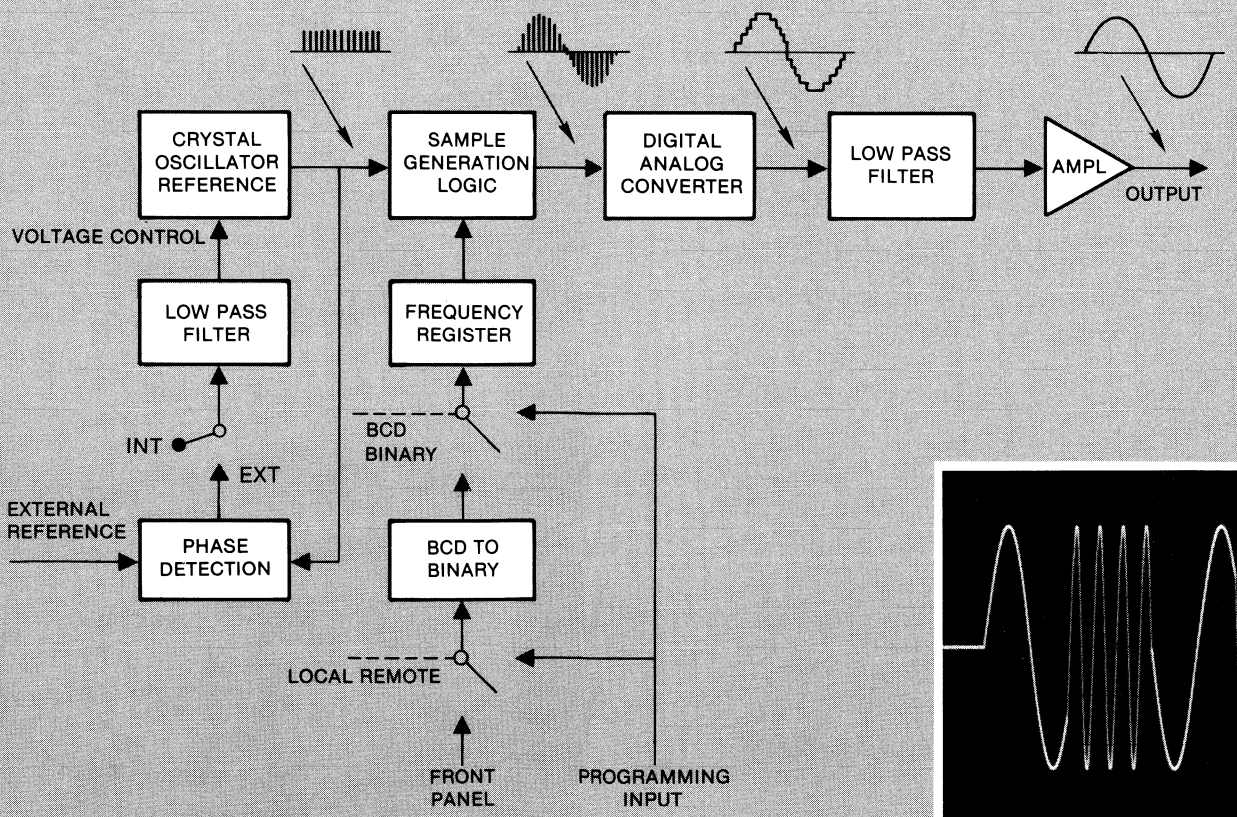
Reference Output
The reference standard is available on all instruments so more than one instrument may be driven by the same reference standard.

OEM
All frequency synthesizer instruments are available as remote-only versions with blank front panels. All remote performance characteristics of the standard front panel versions are retained on these "hands-off" models, at a lower unit cost than the standard front panel instruments.

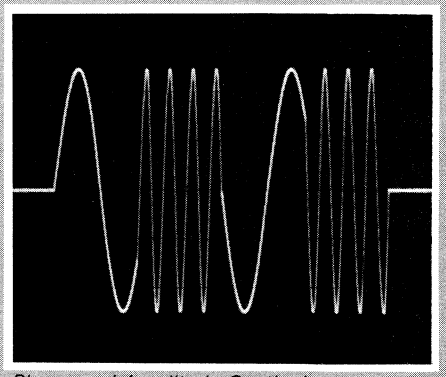
Systems
System 51 satisfies the requirements for multichannel programmable synthesizer appplications, particularly where high speed, phase continuous switching in the DC to 3 MHz band is essential. Up to 48 channels housed in a RETMA rack are standard.

System 36 is ideal as a Transmit/Local Oscillator. It up-converts multiple outputs of the Model 5130A to as high as 430 MHz. High-speed, phase-continuous switching, excellent stability and signal purity make the System 36 an extremely viable source for satellite tracking and other radars.

Contact the factory for more information on System 36 and System 51 synthesizers.



Direct Digital Synthesis Block Diagram



Phase and Amplitude Continuity

UHF Frequency Synthesizers

- **100 kHz to 1 GHz Frequency Range**
- **0.1 Hz Frequency Resolution**
- **Less Than 1 μs Switching Speed**
- **Phase Continuous Switching**
- **Very Low Close-in Phase Noise**

Remote and Local Control
Models 5155A and 5156A, Programmable UHF Frequency Synthesizers, combine patented* direct digital synthesis with time-proven direct analog techniques. Model 5155A is both front panel and remote programmable, while the 5156A, designed for OEM and ATE systems, is remote only.

Fast Switching
Standard BCD interface allows fast (less than 1 microsecond) phase-continuous frequency switching. Phase continuity is maintained for frequency changes less than 100 kHz. Fine frequency resolution of 0.1 Hz throughout the entire band and excellent close-in phase noise make the 5155A and 5156A ideal for signal multiplication. Their main output varies between +3 dBm and +13 dBm with 0.1 dB resolution.

Low Noise
Careful design layout, and filtering have reduced the dynamic switching spurious response to the level of the static spurious response (−70 dBc) whenever phase continuous switching occurs. In addition, very low close-in phase noise (−100 dBc/Hz at 10 Hz offset frequency) is maintained below 500 MHz; performance that is not found in even more expensive synthesizers.

Applications
Whether as general purpose or dedicated instruments, Models 5155A/5156A are the right choice for a variety of applications. As local oscillators, they offer the simplicity, stability, and resolution to maintain performance in frequency coded radars. Secure communication transmissions need their fast spurious-free switching to make detection virtually impossible. For cellular radio requirements, low close-in phase noise, fast switching, and fine resolution make these instruments well suited in both testing and cell site maintenance.

*U.S. Patent 3,735,269

MODELS 5155A & 5156A FREQUENCY SYNTHESIZERS

FREQUENCY

Range
0.1 to 999.999 999 9 MHz.
Resolution
0.1 Hz.
Control (Model 5155A)
Keyboard entry in MHz, kHz, or Hz units.

MAIN OUTPUT

(Not specified below 500 kHz.)
Level
+3.0 dBm to +13.0 dBm into 50Ω (nominal).
Resolution
0.1 dB or 10mV.
Flatness* (At +13 dBm)
<500 MHz: ±0.5 dB.
≥500 MHz: ±1 dB.
Control (Model 5155A)
Keyboard entry in dBm, V, or mV units.
RF Output On/Off (Model 5155A)
Illuminated button (>80 dB on/off ratio).
Connector
Model 5155A: Type N (front panel).
Option 003: BNC (rear panel).
Model 5156A: BNC (rear panel).

REFERENCE OUTPUT

Frequency
10 MHz.
Level
0.4 Vrms into 50Ω, approximately sinusoidal.

DISPLAY (Model 5155A)

Frequency
10 digit LCD readout in Hz with fixed decimal point for 0.1 Hz resolution.

Output Level
3 digit LCD readout for 3.0 to 13.0 dBm or 0.31 to 1.00V.

DISPLAY MODIFIER (Model 5155A)

Control
Illuminated on/off button causes rightmost digit to blink.
Digit Select
Left/right arrows (◄ ►) select digit to be modified by shifting blinking digit.
Modify Digit
Increments/decrements (▲ ▼) selected digit. Output updated as display changes.

SPECTRAL PURITY

Non-Harmonic*
<500 MHz: −70 dBc.
≥500 MHz: −64 dBc.
Harmonic (At +13 dBm)
<500 kHz: Not specified.
≥500 kHz: −20 dBc* (−25 dBc typical).

Residual SSB Phase Noise (f = 500 MHz)**

Offset Frequency	Guaranteed S/N (dBc/Hz)
10 Hz	−95
100 Hz	−100
1 kHz	−110
10 kHz	−120
100 kHz	−125

Offset Frequency	Typical S/N (dBc/Hz)
1 Hz	−90
10 Hz	−100
100 Hz	−110
1 kHz	−120
10 kHz	−128
100 kHz	−130
1 MHz	−130

REMOTE PROGRAMMING CHARACTERISTICS

Logic
TTL, parallel BCD, negative-true logic with double buffering.
Frequency Control
10 digits; remote enable latch lines for all digits.
Output Level Control
2 digits with remote enable latch through separate 14 pin connector. 00 to 99 corresponding to +13 to +3.1 dBm output.
GPIB (Option 006)
Models 5155A: SH1, AH1, T6, TE0, L3, LE0, SR1, RL2, PP1, DC1, DT0, C0, E1.
Model 5156A: SH0, AH1, T0, TE0, L1, LE0, SR0, RL0, PP0, DC2, DT1, C0, E1.
Programming Delay
<10 MHz increment: 2 μs.
≥10 MHz increment: 0.5 μs.
Switching Transient*
<10 MHz increment: <1 μs.
≥ 10 MHz increment: <20 μs.
Phase Continuity*
Phase continuous for any frequency change using only the 6 increments (digits) below 100 kHz.
Amplitude Settling Time
50 μs.

REFERENCE FREQUENCY STANDARDS

Internal 10 MHz
None Supplied (Option 000)
External reference must be supplied.
High Stability (Option 001)
Aging Rate: $\pm 4 \times 10^{-9}$/day.
Temperature Stability: $\pm 1 \times 10^{-8}$, 0°C to +40°C.
TCXO (Option 002)
Aging Rate: $\pm 4 \times 10^{-6}$/year.
Temperature Stability: $\pm 1 \times 10^{-6}$, 0°C to +40°C.

External Reference Input
5 or 10 MHz (Standard):
0.4 Vrms into 50Ω (nominal).
1 MHz (Option 007):
0.4 Vrms into 50Ω (nominal).

GENERAL

Environment
Operating Temperature: 0°C to +40°C.
Storage Temperature: −20°C to +70°C.
Dimensions
48.3 cm (19 in.) wide; 13.3 cm (5¼ 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 440 Hz; 85 VA.

OPTIONS

One crystal option (000, 001, or 002) must be selected.
000: External Reference Only
No internal frequency reference; external capability only.
001: High Stability Crystal Reference
See Reference Frequency Standards.
002: TCXO Reference
Temperature compensated crystal reference. (See Reference Frequency Standards.)
003: Rear Panel BNC Output (5155A)
Replaces front panel type N connector.
006: GPIB (IEEE 488-1978)
In addition to BCD programming.
007: 1 MHz External Reference Input
Adds 1 MHz to standard 5 and 10 MHz external reference capability.
008: Rack Slides

ACCESSORIES

BCD Programming Connectors (P/N 351-5001 50-pin male and 351-1401 14-pin male.

*These specifications are guaranteed. All other specifications are either nominal descriptions or typical values.

**Reduce specifications by 6 dB for frequencies above 500 MHz.

FACTORY/FOB

San Diego, CA

Programmable VHF Frequency Synthesizers

- **Frequency Range: 0.1 to 160 MHz**
- **Constant Resolution: 0.001 Hz**
- **High Speed, Spurious-Free Switching**
- **True Phase Continuity***
- **Direct Synthesis: No Phase-Lock Loops**

Performance and Versatility
The Models 5120A, 5130A 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. Their sophisticated, high reliability design (MTBF >30,000 hours) combines the patented* *direct digital* synthesis technique of the Model 5100 with the field-proven *direct analog* synthesis methods.

The economical Model 5120A provides 0.1 Hz resolution and 20 μs switching speed. The Models 5130A and 5135A contains all the features of the 5120A plus phase-continuous frequency switching and finer resolution (under remote control). In addition, the Model 5135A offers very fast frequency hopping (<1 μs) that makes it the ultimate instrument for applications requiring frequency agility, such as FSK, coherent radar, and secure communications.

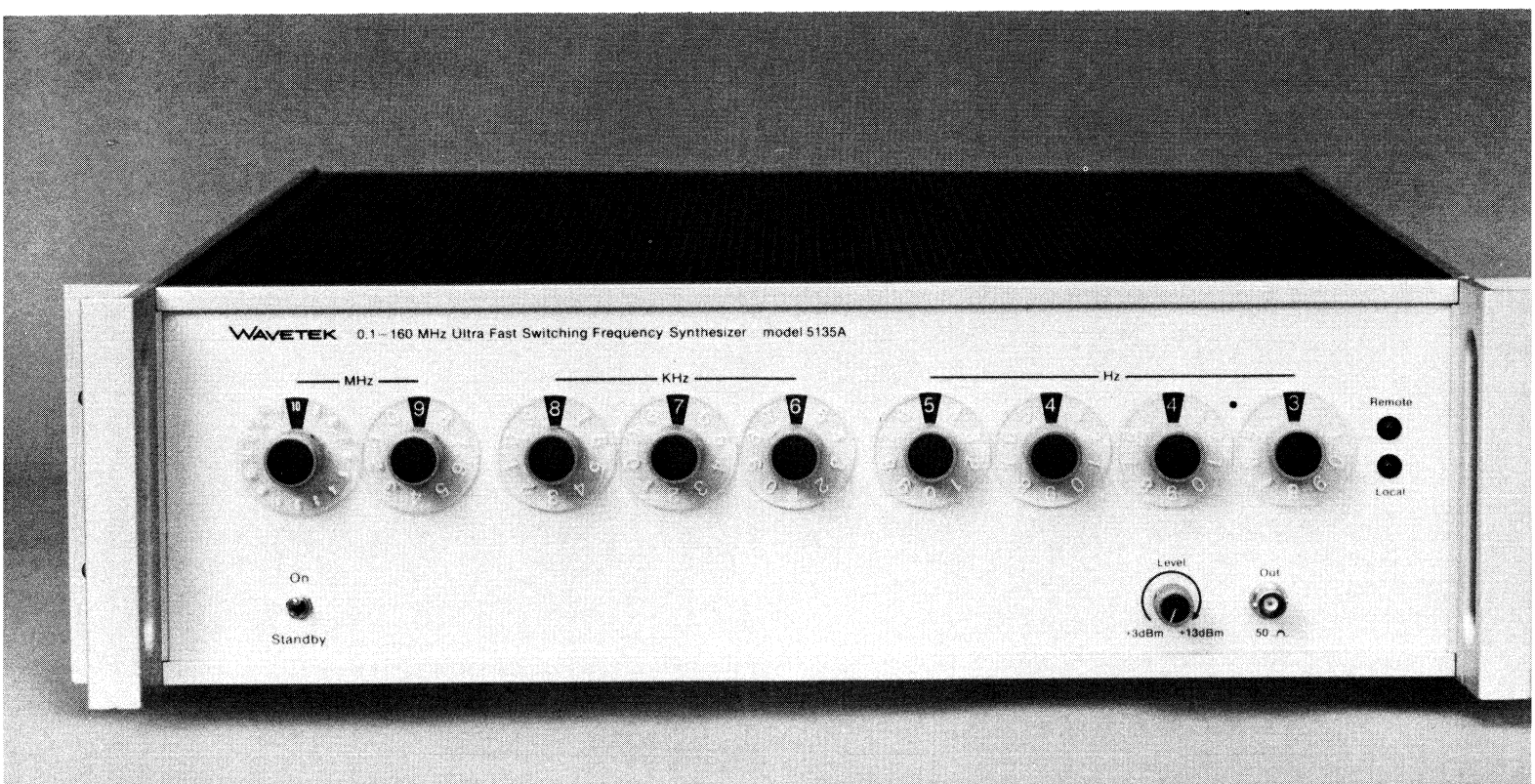
Remote Programming
All instruments provide the flexibility of standard BCD programming or an optional built-in GPIB interface. In the Models 5130A and 5135A, the remote programming extends the frequency resolution to 0.001 Hz.

Spurious-Free Switching
Frequency hopping of the digits below the 100 kHz increment maintains the spurious response specification even when frequencies are changed at a 20 kHz rate (higher rates up to 200 kHz are possible with no noticeable reduction in spurious response).

ATE Versions
Remote only versions of the Models 5120A, 5130A and 5135A are available for those applications not requiring front panel control. Specify the Models 5121A, 5131A or 5136A, respectively.

Systems
A multi-channel system, System 36, is available for higher frequencies than the normal output of the 5120A. Consult factory for details.

*U.S. Patent #3,735,269



MODELS 5120A, 5230A & 5135A FREQUENCY SYNTHESIZERS

FREQUENCY

Range
Local: 0.1 to 159.9999999 MHz.
Remote: 0.1 to 159.9999999 MHz. (Model 5120A)
0.1 to 159.999999999 MHz. (Models 5130A/5135A)

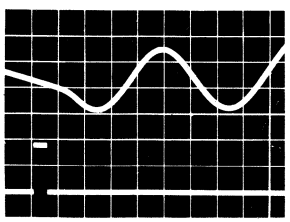
Resolution
Local: 0.1 Hz.
Remote: 0.1 Hz (Model 5120A).
0.001 Hz (Models 5130A/5135A).

Control
Local by continuous rotary switches. Remote by TTL, parallel BCD, negative-true logic; remote enable line for all digits.

REMOTE PROGRAMMING CHARACTERISTICS

Switching Time*
Model 5120A: <20 μs
Model 5130A: 3-20 μs
Model 5135A: <1μs (digits <10 MHz), <5 μs (10 MHz digit).

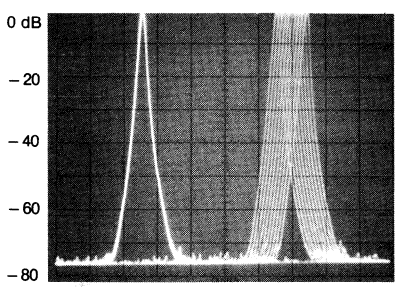
Phase Continuity (Model 5130A/5135A)
Phase continuity maintained between chosen frequencies using any combination of the 8 digits below 100 kHz increment.



NOTE: DELAY MEASURED FROM LEADING EDGE OF TRIGGER PULSE.
SWEEP SPEED 2 μs/div.

Phase Continuity

Switching Spurious (Model 5130A/5135A)
Spectral purity specification not degraded when switching frequencies below 100 kHz band, and using decades through 10 kHz only.



Spurious-Free Switching

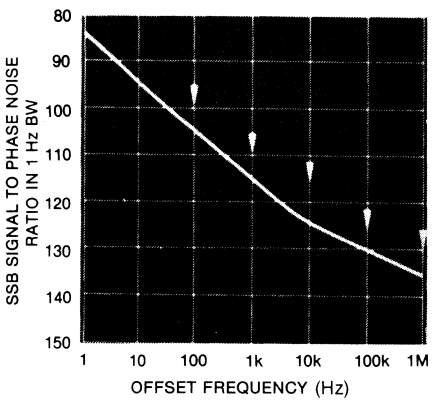
SPECIAL PURITY

Non-Harmonic*
70 dB below fundamental, 0.1 MHz to 160 MHz (Typically better than 75 dB).

Harmonic*
35 dB below fundamental at full output, 1 MHz to 160 MHz (typically better than 40 dB).

Phase Noise Spectral Density*
Guaranteed SSB S/N ratio measured in 1 Hz bandwidth.

Offset Frequency	Guaranteed S/N
100 Hz	– 100 dB
1 kHz	– 110 dB
10 kHz	– 120 dB
100 kHz	– 125 dB



Typical Phase Noise Performance.

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 by continuous adjustment. Remote by external dc voltage; 0.6 to 2 V typical range from + 3 dBm to + 13 dBm.
Settling Time: 50 μs.

Auxiliary Reference Output
10 MHz, 0.4 Vrms nominal into 50Ω, approximately sinusoidal.

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°C to 40°C.
TXCO (Option 002)
Aging Rate: $\pm 4 \times 10^{-6}$, 0°C to 40°C.
Temperature Stability: $\pm 1 \times 10^{-6}$, 0°C to 40°C.

External Input Capability
1 MHz (Option 007): Receives 1 MHz, 0.4 Vrms into 50Ω, nominal.
5 or 10 MHz (Standard): Receives 0.4 Vrms into 300Ω, nominal.

GENERAL

Environment
Operating Temperature: 0° to + 40°C. Storage Temperature: – 20°C to + 70°C.

Dimensions
48.3 cm (19 in.) wide, 13.3 cm (5¼ in.) high, 48.3 cm (19 in.) deep. Includes rack ears.

Weight
15 kg (33 lb) net, 18 kg (40 lb) shipping.

Power
115/230 Vac ± 10%, 50-400 Hz, 75 VA.

*These specifications are guaranteed. All other specifications are either nominal descriptions or typical values.

OPTIONS

One crystal 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 Crystal Reference (TCXO).
003: Rear Panel Output
Rear panel output in lieu of front panel output.
006: IEEE 488-1978 Interface
Permits remote digital control of frequency and amplitude; follows standard protocol.
007: 1 MHz Ext Ref Input
Adds 1 MHz external reference input capability.
008: Chassis Drawer Slides

ACCESSORIES

BCD Programming Connectors (Models 5130A/5135A).

FACTORY/FOB

San Diego, CA

Programmable Frequency Synthesizers

- **Frequency Range: DC to 3 MHz**
- **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**

Versatility
Models 5100 and 5110 Programmable Frequency Synthesizers provide spectrally pure output frequencies in 0.001 Hz steps from DC to 3 MHz. Model 5100 may be programmed locally and remotely; Model 5110 is intended for remote-only applications.

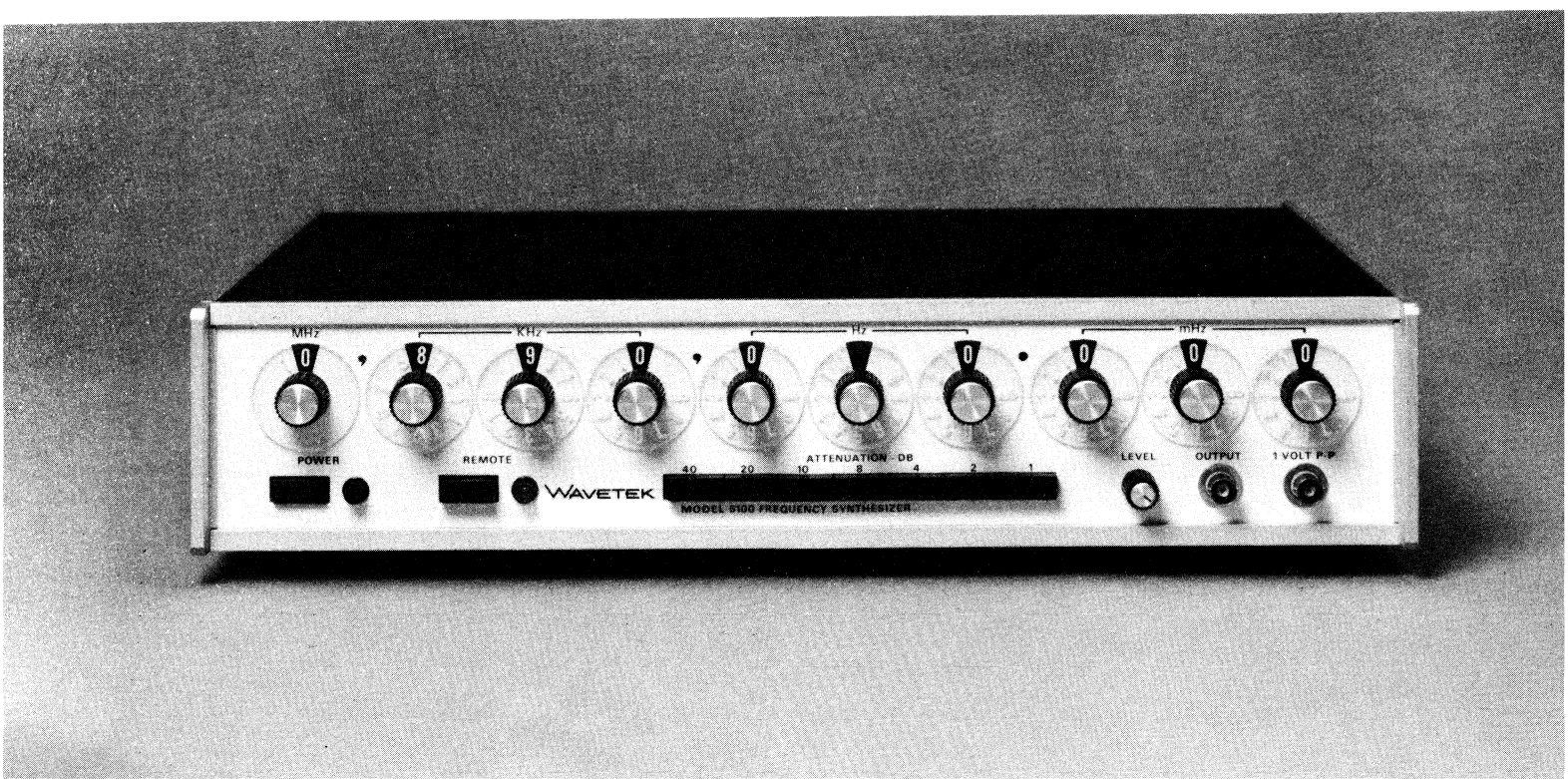
Synthesis Technique
A patented* direct digital synthesis technique is used to generate the output frequency directly from an internal crystal reference, which may be phase locked to an external 1 MHz standard, if desired.

Design
In addition to excellent short term stability, digital synthesis also provides other improvements in performance. Digital operation means inherent programmability and very fast switching. In binary word format, Models 5100 and 5110 synthesizers maintain *amplitude and phase continuity in switching between any two frequencies* (i.e., no switching transient) with a programming delay of only 1.5 μs before switching. Thus, linear frequency sweeping or frequency hopping (including FSK signaling) are easily programmed with the 5100 and 5110.

Features
Excellent spectral purity is also possible with digital synthesis since output distortion is determined entirely by the number of bits per sample and the linearity of the D/A converter. Another feature of digital synthesis is the ability to precisely control the phase of output frequency. In the Models 5100 and 5110 the phase may be asynchronously reset to zero at any time for as long as desired (or as little as 125 ns). Hence, for example, sinusoidal bursts are easily produced with each burst beginning at exactly zero phase.

Systems
Multi-channel systems, such as the System 51, and the modular synthesizer, Model 5101, are also available. Consult the factory for details.

*U.S. Patent 3,735,269



MODELS 5100 & 5110 FREQUENCY SYNTHESIZERS

FREQUENCY

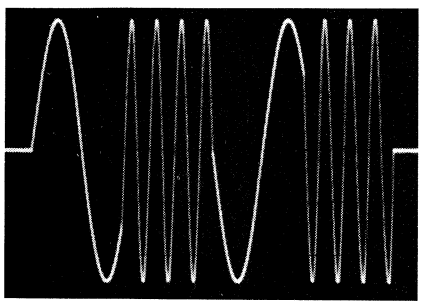
Range
DC to 2,000,000.000 Hz.
DC to 3,000,000.000 Hz (Option 013).

Resolution
Constant 0.001 Hz.

Control
Local: Ten 10-position rotary switches.
Remote: 31 bits in binary or 37 bits in BCD format.
Optional: GPIB. Model 1488A-12.

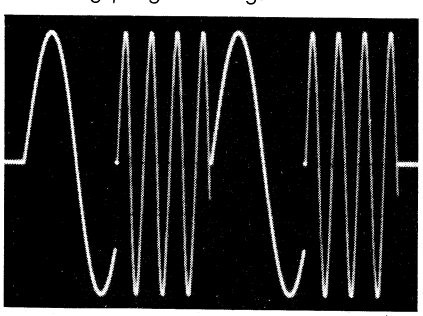
SWITCHING CHARACTERISTICS

Programming Delay
1.5μs per binary *word* with phase and amplitude continuity. 20 μs per BCD *word* with output reset to zero phase during delay.



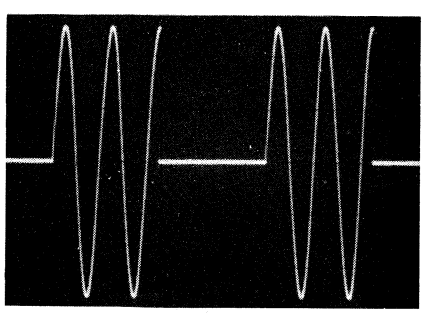
Binary Programming Mode.
(Note Amplitude and Phase Continuity is Maintained.)

20 μs minimum per 4 BCD and binary *bytes* with output reset to zero phase during programming.



BCD Programming Mode.
(Note Return to Zero Phase Between Steps.)

Update Rate
625 ns per binary *word*. 18 μs per BCD *word* and *byte* modes.



Sinusoidal Bursts with ZERO PHASE Line.

Zero Phase Reset
800 ns to and from ZERO phase (output asynchronously set to ZERO phase).

MAIN OUTPUTS (FRONT AND REAR PANEL BNC'S)

Fixed Output
Model 5100: 1Vp-p no load, 0.5 Vp-p into 50Ω.
Model 5110: 1Vrms, 0.5 Vrms into 50Ω.
Option 004: 10 Vp-p output replaces 1V fixed output (Model 5110 only).

Variable Output (Model 5100 only)
5 Vp-p into 50Ω (max).
10 Vp-p into open circuit (max).

Auxiliary Output
1 or 8 MHz square wave reference at TTL levels capable of driving 30 TTL loads.

Level Control
Model 5100 only: 0 to 85 dB attenuation in 1 dB steps plus 0 to 10 dB continuous control.
Option 002 (5100/5110): Remote program control (7 bits) of 85 dB attenuation in 1 dB steps from 0 to 85 dB.

SPECTRAL PURITY

Spurious Components
Standard: −70 dB to 100 kHz; −60 dB to 500 kHz; −50 dB to 2 MHz.
Option 013: −45 dB, 500 kHz to 2 MHz; −40 dB to 3 MHz.

Harmonic Components (at 1 Vrms)
Standard: −55 dB to 100 kHz; −50 dB to 500 kHz; −45 dB to 2 MHz.
Option 013: −40 dB, 500 kHz to 3 MHz.

Phase Noise
30 kHz band excluding 1 Hz centered on carrier.
Standard: −50 dB to 2 MHz.
Option 013: −40 dB, 2 MHz to 3 MHz.

Attenuator Response to 60 dB
±0.5 dB to 500 kHz.

CRYSTAL REFERENCES

Internal
8 MHz TCXO: Standard on Model 5100; (Option 006 for Model 5110).
Temperature Stability: $\pm 1 \times 10^{-6}$ from 0°C to +50°C.
Aging Rate: $\pm 5 \times 10^{-6}$/year.
Option 001 - High Stability (Oven Controlled)
Temperature Stability: $\pm 1 \times 10^{-8}$ from 0°C to 50°C.
Aging Rate: $\pm 2 \times 10^{-9}$/day.

External
External reference requires a TTL level input (1 TTL load) that is Schmitt-trigger conditioned.
1 MHz Reference: Phase locks to internal reference.
8 MHz Reference: Replaces internal crystal reference. Required for units without internal crystal reference (Model 5110 without options 001/006).
5/10 MHz reference: Please consult the factory.

GPIB

Model 1488A-12 provides following IEEE 488-1978 functions: AH1, L1 (listen only) DT1. Programs frequency (phase continuous) and amplitude (with option 002) as well as all ZERO PHASE modes.

GENERAL

Environment
Operating Temperature: 0°C to +50°C.
Storage Temperature: −20°C to +70°C.

Dimensions
Model 5100: 43.2 cm (17 in.) wide; 8.9 cm (3½ in.) high; 33 cm (13 in.) deep.
Model 5110: 48.3 cm (19 in.) wide; 8.9 cm (3½ in.) high; 33 cm (13 in.) deep.

Weight
9.6 kg (21 lb) net; 11.4 kg (25 lb) shipping.

Power
115/230V ±10%, 50 to 60 Hz, 65 watts.

OPTIONS

001: High Stability Crystal Reference
002: Remote Programmable Attenuator
004: 10 Vp-p Output
(Model 5110 only). Not available with option 013.
006: Temperature Compensated Crystal Reference
013: 3 MHz Frequency Range
(Original order only.)
020: Auxiliary TTL Output.
GPIB
Use Model 1488A-12.

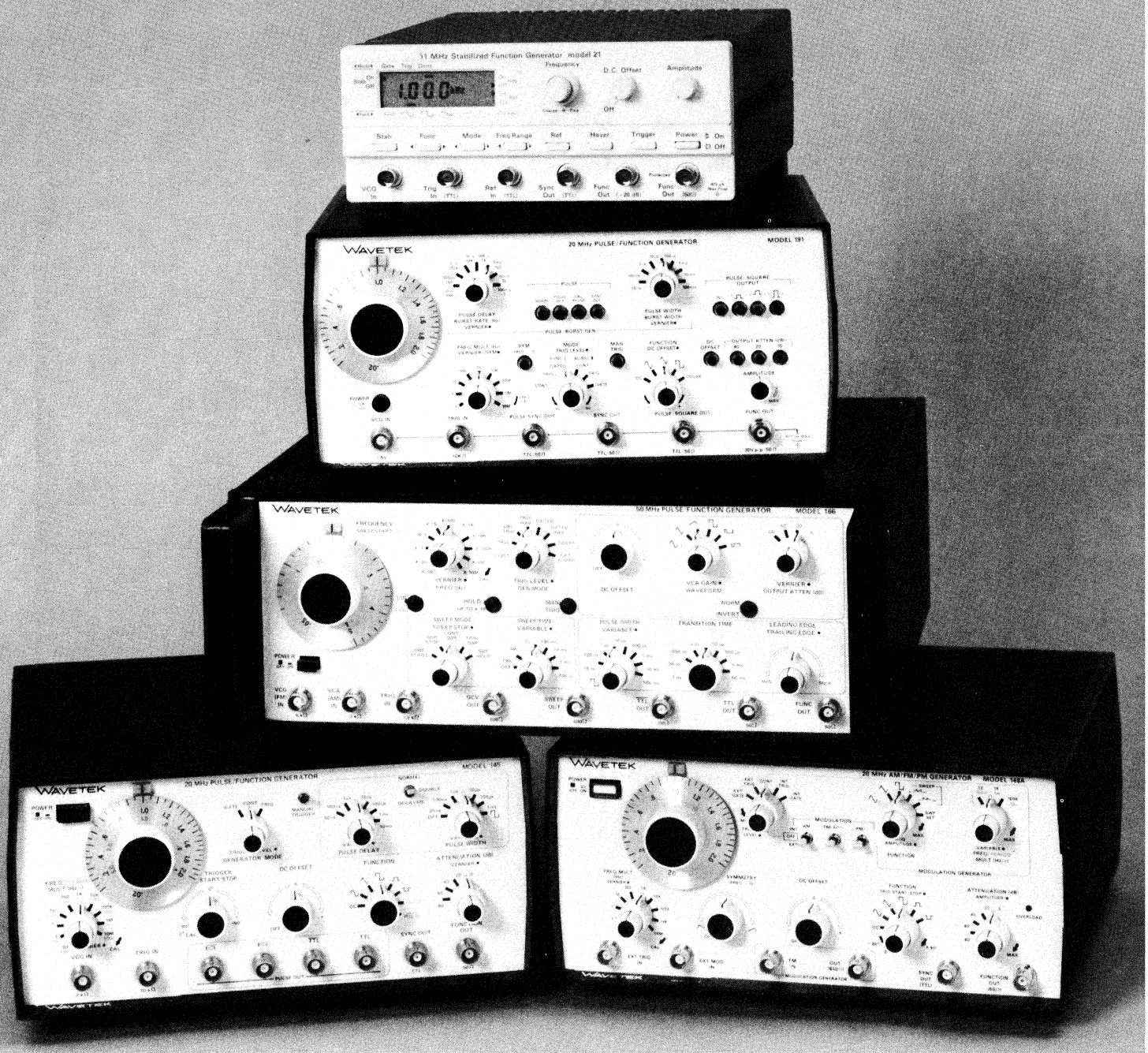
ACCESSORIES

Rack Adapters
Programming Connector

FACTORY/FOB

San Diego, CA

Function Generators



FUNCTION GENERATOR SELECTION GUIDE

Top Frequency (MHz)	2			4		5		11		12	20						30	50
MODEL	132	171	20	182A	188	184	185	21	22	23	143	145	148A	190	191	193	164	166
Low Frequency (Hz)	.2	.1	2m	4m	4m	.1m	.1m	.1m	.1m	10m	.1m	.1m	.2m	2m	2m	2m	30μ	.1m
Accuracy (± % F.S.)	2	.005	5	5	5	2	2	2	.09	.005	3	3	2	3	3	3	2	2
Int Linear Sweep					•	•	•		•				•			•	•	•
Int Log Sweep					•		•		•									•
Int Step Sweep							•										•	
Trigger & Gate			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Amp & Freq Modulation										•			•			•		•
Phase Modulation													•					
Synthesizer Accuracy		•								•								
Variable S/N Ratio	•																	
Variable Symmetry						•	•				•		•	•	•	•	•	
Variable Rise/Fall																	•	•
Start/Stop Control†											•	•	•				•	
Pulse Generator††												•			•			•
Digital Display		•						•	•	•								
Haverwave								•			•	•	•					•
Hold/Continue								•										•
Output Protection			•					•	•	•								
Battery			•															
GPIB & RS232 Programming										*								
Catalog Page	76	86	68	88	88	90	90	70	72	74	78	78	80	92	94	96	82	84

NOTE: All models feature Ext Voltage Control (VCG) and DC Offset Control.

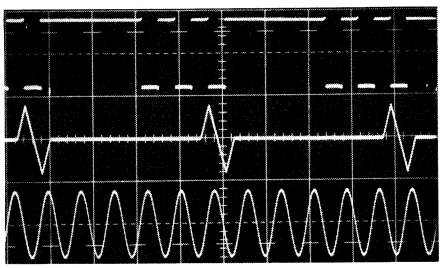
*Option
†Start/Stop at selected waveform phase angle
††Also see *Pulse Generator Selection Guide* below.

PULSE GENERATOR SELECTION GUIDE

MODEL	145	166	191	271	278	801	802	859
Low Frequency (Hz)	0.0001	0.0001	0.002	0.01	0.01	5	5	0.5
High Frequency (MHz)	20	50	20	12	12	50	50	50
Delay Control	•		•	•		•	•	•
Minimum Rise Time* (ns)	<20	<7	<15	<15	<15	<7	<5	<5
Transition Control		•				•		•
Double Pulse	•		•	•		•	•	•
Counted Pulse Burst				•	•			•
External Width Mode		•		•	•	•	•	•
Internal Load Control							•	
Auxiliary Outputs (ECL) (See Note Below)	•					•		
Trigger Level Control	•	•	•	•	•	•		•
Trigger on Either Edge				•	•	•		•
Trigger Burst			•	•	•	•		•
Amplitude Modulation		•						
Frequency Modulation	•	•		•	•			
Waveforms other than Pulse	•	•	•	•	•			
Internal Sweep		•						
Programmable GPIB				•	•			•
Catalog Page	78	84	94	112	122	98	100	124

NOTE: All models feature Period and Width Control, Complement Pulses and TTL Auxiliary Outputs.

2 MHz Function Generator



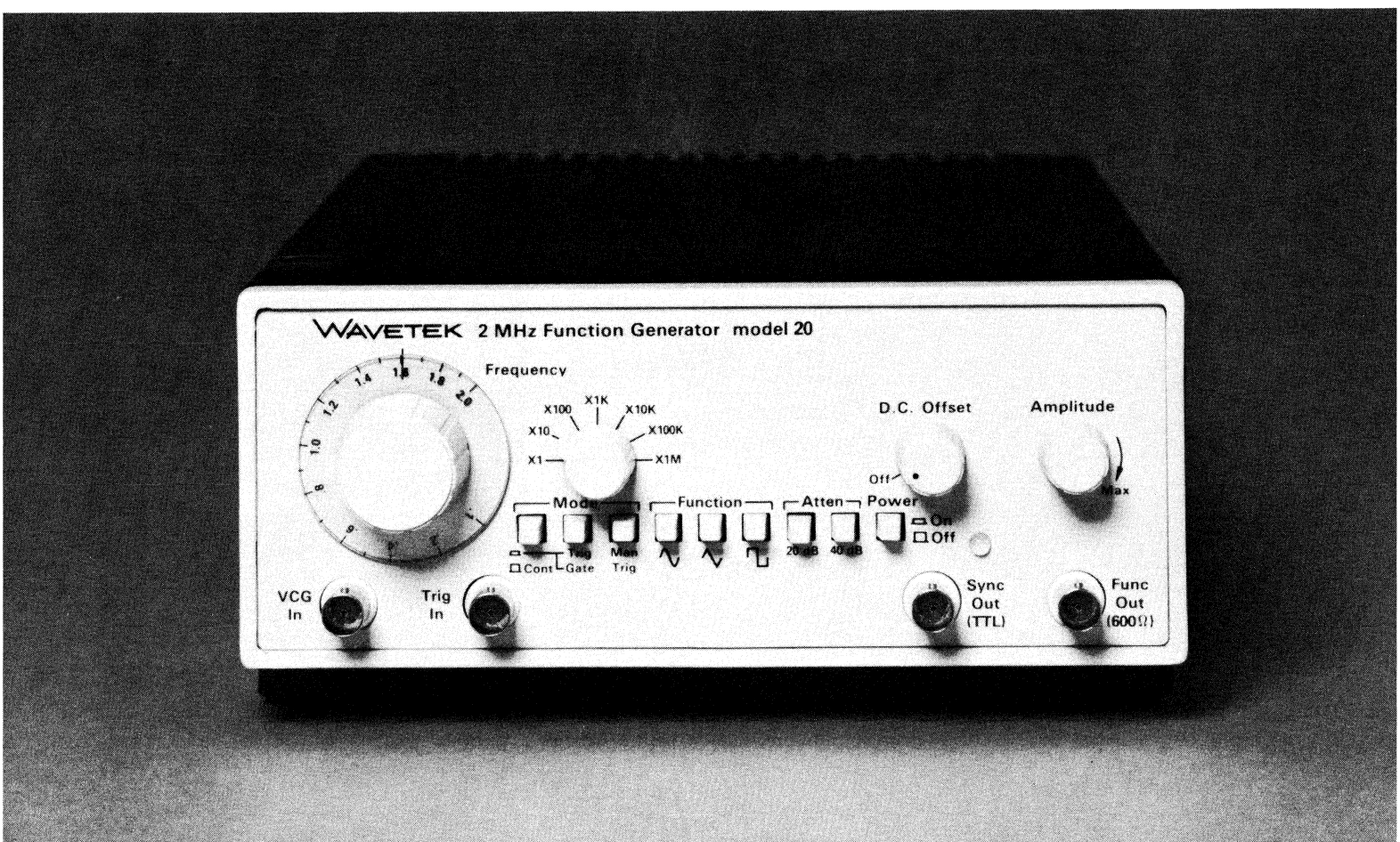
- **Multiple Power Operation**
- **0.002 Hz to 2.1 MHz Frequency Range**
- **Triggered and Gated Modes**
- **20 Volt Peak-to-Peak Output with Protection**
- **TTL Pulse Output**

Wide Frequency Range
Wavetek's Model 20 covers a wide 0.002 Hz to 2.1 MHz frequency span in seven overlapping ranges. Each multiplier setting gives you a full 1000:1 frequency range. Frequency may be set with the calibrated dial or externally modulated or swept over the three decades available per range.

Triggered and Gated Waveforms
Triggered and gated modes give the instrument additional flexibility. In triggered mode, the output is a dc baseline until a manual or external signal initiates a single cycle of the selected waveform. Gated mode is similar to triggered except that the generator produces a burst of waveform cycles for the duration of the external triggering signal.

Output Protection
Model 20 produces high level outputs to 20 volts peak-to-peak (10V p-p into 600Ω termination). Attenuation is 0 dB, −20 dB or −40 dB selectable with 20 dB variable for a total 80 dB of amplitude range. The function output is fuse protected against accidental connection to power line potentials.

Multiple Power Operation
The generator operates directly from the line using external transformer/battery charger, from an external dc or ac source, or internally from Nicad batteries. (Batteries not included.)



MODEL 20 FUNCTION GENERATORS

VERSATILITY

Waveforms
Sine ∿, triangle △, square ⊓ and dc.

Operational 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: Similar to triggered mode, except output continues for duration of gate signal. Last waveform cycle started is completed.

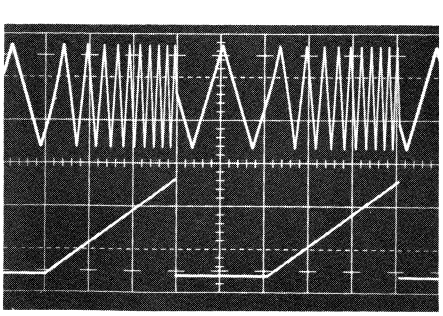
Frequency Range
0.002 Hz to 2.1 MHz in 7 overlapping ranges.

Function Output
∿, △, ⊓, selectable and variable to 20V p-p (10V p-p into 600Ω) at Function Out BNC connector. Step and vernier attenuators provide complete amplitude control down to 2 mV p-p (1 mV p-p into 600Ω). Peak output current is 8.3 mA maximum. Source impedance is 600Ω.

DC Offset and DC Output
Waveform offset and dc output selectable and variable thru Function Output. DC output obtainable by not selecting a waveform function. DC offset control has a continuous range of ± 10V (± 5V into 600Ω) with a calibrated zero offset OFF position. DC offset plus signal peak limited to ± 10V (± 5V into 600Ω) and both attenuated proportionally by the output attenuator.

TTL Pulse Output
TTL pulse (50% duty cycle) at generator frequency. Drives up to 20 TTL loads.

VCG — Voltage Controlled Generator
BNC input, up to 1000:1 frequency change with external 0 to ± 2.1V signal. Upper and lower frequencies limited to maximum and minimum of selected range.
Slew Rate: 2% of range per μs.
Linearity: ± 0.5% thru X 100K range; ± 2% on X 1M range.
Input Impedance: 2kΩ.



VCG Input (lower) and Generator Output

Trigger and Gate
BNC input accepts analog or TTL compatible external signal to trigger or gate the generator. Input impedance is 10kΩ shunted by 10 pF. Trigger threshold is + 0.7V, generator triggers on positive-going transition and gates on during positive portion of triggering signal. External signal can have maximum repetition rate of 2 MHz and minimum pulse width of 50 ns.

FREQUENCY PRECISION

Dial Accuracy
± 5% of full scale.

Time Symmetry
Square wave variation from 0.1 to 2.1 on dial less than:
± 1% to 100 kHz;
± 5% to 2.1 MHz.

AMPLITUDE PRECISION

Sine variation with frequency less than:
± 0.2 dB on all ranges thru X 100K, referenced to 1 kHz;
± 3 dB to 2.1 MHz, 600Ω load and 600Ω cable (or ≤3 feet of 50Ω cable).

WAVEFORM CHARACTERISTICS

Sine Distortion
Less than:
0.5% on X 1K and X 10K ranges; 1% on X 1, X 10, X 100 and X 100K ranges. All harmonics 25 dB below fundamental on X 1M range.

Triangle Linearity
Greater than 99% to 210 kHz.

Square Wave Rise and Fall Time
At function output, less than 150 ns for 10V p-p output into 600Ω termination, with ≤3 feet of 50Ω cable.

GENERAL

Environment
Temperature Range: 20°C ± 10°C for specified operation, operates 0°C to + 50°C, − 40°C 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% 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 with maximum of 2g at 55 Hz.
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
3 kg (6.6 lb) net; 4 kg (8.8 lb) shipping.

Power
Wall transformer/battery charger operates the generator from 90 to 110V, 48 to 66 Hz (Opt 001); from 105 to 128V, 48 to 66 Hz (Opt 002); or from 198 to 256V, 48 to 66 Hz (Opt 003). Either transformer is less than 10 VA.

Unit will also operate from any external AC source of 10 to 18 Vrms or any external dc source of + 12 to + 25 Vdc. Power consumption will be less than 10W at lower input values.

User supplied rechargeable batteries, six "C" size Nicads with standard 1800 mAHr rating will deliver approximately 4 hours continuous operation from a full charge. Recharge cycle is 15 hours from full drain (indicated by flashing power indicator) with unit on or off while connected to any of the external power sources described above.

NOTE: All specifications apply for dial between 0.1 to 2, amplitude at 10 Vp-p into 600Ω termination.

OPTIONS

Model 20 must be ordered with option 001, 002 or 003. Batteries are not included.

001: Transformer/Batt Charger
90 to 110V, 48 to 66 Hz.

002: Transformer/Batt Charger
105 to 128V, 48 to 66 Hz.

003: Transformer/Batt Charger
198 to 256V, 48 to 66 Hz.

FACTORY/FOB

San Diego, CA

11 MHz Stabilized Function Generator

- **100 μHz to 11 MHz Range**
- **Crystal Stabilized to 0.09%**
- **External Reference and Waveform Hold**
- **LCD Display With Annunciator**
- **Triggered, Gated and Haver Waveforms**

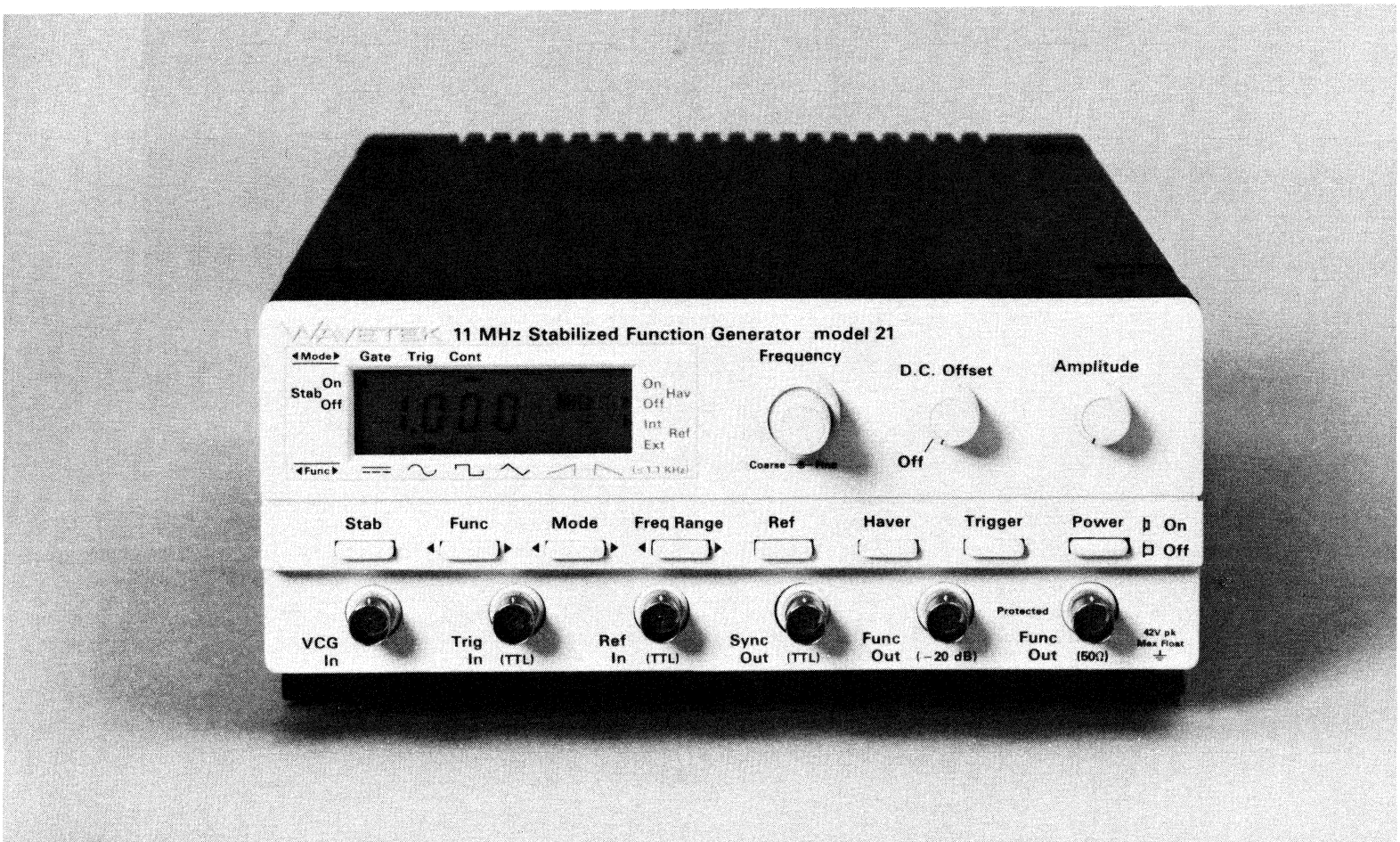
Crystal Stabilized Operation
Model 21 features frequency stabilized operation. Stabilization extends tight short-term specs (0.09% of range) to indefinite periods throughout the entire 100 μHz to 11 MHz range.

Low-Frequency Waveform Synthesis
Waveforms below 1.1 kHz are synthesized digitally to provide additional features of up and down ramps, haverwaves, instantaneous hold/continue, and operation down to ultra-low frequencies with external reference.

Triggered, Gated, and Haver Waveforms
These waveforms give the instrument additional flexibility. In triggered mode, output is a DC baseline until a manual or external signal initiates a single cycle of the selected waveform. By selecting "Haver" a haverwave is produced. This waveform is a useful simulation of a shock pulse used in mechanical testing. Gated mode is similar to triggered except the generator produces a burst of waveform cycles for the duration of the external triggering signal.

LCD Display
Frequency is monitored by a 3½ digit LCD display. Display annunciators point to selected parameters to show the instrument setup at a glance.

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 respect to the first. Both outputs can be varied 20 dB, which gives a full 40 dB output range.



MODEL 21 FUNCTION GENERATORS

VERSATILITY

Waveforms
Sine ∿, triangle △, square ⊓ and dc ⎓; additionally, below 1100 Hz ramp up ◿, ramp down ◺ and haverwaves ⩘, ⩗.

Operational 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.
Haver: Same as triggered or gated modes except waveform starts at 270° phase.

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

Frequency Control
Value or VCG.
Value: Range is selected with front panel key; frequency within range is set with coarse and fine tune controls.
VCG: 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.
Input Impedance: 5kΩ.
Slew Rate: 0.1 V/μs (max.).

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 main output for total amplitude range of 40 dB.

DC Offset and DC Output
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): Output attenuated 20 dB with respect to main output.
Sync Out: TTL pulse (50% duty cycle) at generator frequency. Will drive 10 LS TTL loads.

Inputs
VCG In: BNC input for voltage control of generator frequency in nonstabilized modes.
Trig In: BNC input accepts TTL compatible 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.
Ext Ref: BNC input for external reference operation or electrical waveform hold.

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. Annunicators indicate selection of modes and functions.

External Reference
External Reference switch provides selection of internal or external control of waveform output frequency and also provides a means of holding or releasing the waveform manually, electrically or through external contact closure. External Reference connector accepts either TTL compatible signal (1.1 MHz maximum repetition rate, 200 ns minimum pulse width) or contact closure. Operation with external reference provides output frequency 1/1000 of reference frequency. Contact closure to ground stops waveform; opening contact causes waveform to start again exactly where it stopped.

FREQUENCY PRECISION

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 less than: ±0.1% to 1100.00 Hz (across bottom five specified ranges), ±1% to 110.00 kHz,
±5% to 11.00 MHz.

AMPLITUDE PRECISION

Sine Variation with Frequency
Referenced to 1 kHz.
All ranges to 110.0 kHz: < ±0.2 dB
To 11.00 MHz: < ±1.5 dB.

WAVEFORM CHARACTERISTICS

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 p-p amplitude.

Stability
Amplitude, frequency (nonstabilized) and dc offset after 30 minute warm-up:
±0.10% of range for 10 minutes.
±0.50% of range for 24 hours.
Frequency (stabilized):
±0.09% of range for ⩾10 minutes, 0 to 50°C.

GENERAL

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: 25° ±10°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 256V, 48 to 66 Hz, less than 35 VA.

NOTE: All specifications apply for display between 100 and 1100 frequency counts; amplitude at 10 Vp-p into 50Ω.

FACTORY/FOB

San Diego, CA

11 MHz Stabilized Sweep Generator

- **100 μHz to 11 MHz Range**
- **Crystal Stabilized to 0.09%**
- **Linear and Logarithmic Sweep**
- **LCD Display**

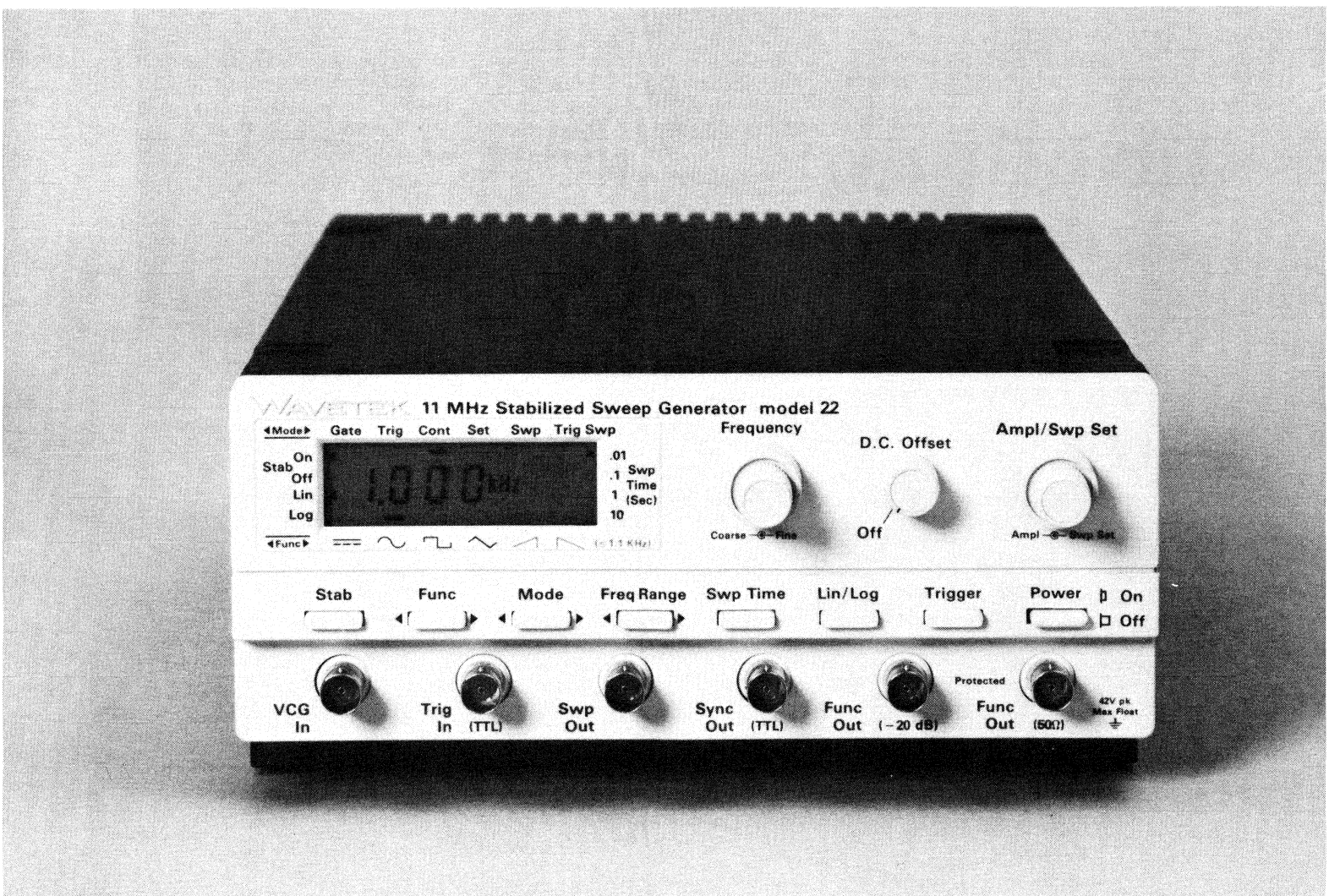
Crystal Stabilized Operation
Model 22 features frequency stabilized operation. Stabilization extends tight short-term specs (0.09% of range) to indefinite periods throughout the entire 100 μHz to 11 MHz range.

LCD Display
Frequency is monitored by a 3½ digit LCD display. Display annunicators point to selected parameters to show the instrument setup at a glance.

Low-Frequency Waveform Synthesis
Waveforms below 1.1 kHz are synthesized digitally to provide additional features of up and down ramps.

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.



VERSATILITY

Waveforms
Sine ∿, triangle ∿, square ⊓ and dc; additionally, below 1100 Hz, ramp up ⟋ and ramp down ⟍.

Operational 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 Control
Value: Range is selected with front panel key; frequency within range is set with coarse and fine tune controls.
VCG: 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.
Input Impedance: 5kΩ.
Slew Rate: 0.1 V/μs (max.).

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.

DC Offset and DC Output
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): Output attenuated 20 dB 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.

Inputs
VCG In: BNC input for voltage control of generator in nonstabilized modes.
Trig In: BNC input acccepts TTL compatible 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.

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.

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.
Sweep Output: 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.

FREQUENCY PRECISION

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 PRECISION

Sine Variation with Frequency
Referenced to 1 kHz.
To 110.0 kHz Range: < ±0.2 dB.
To 11.00 MHz: < ±1.5 dB.

WAVEFORM CHARACTERISTICS

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:
±0.10% of range for 10 minutes.
±0.50% of range for 24 hours.
Frequency (Stabilized):
±0.9% of range for ⩾10 minutes, 0 to 50°C.

GENERAL

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: 25°C ±10°C for specified operation, operates 0°C to +50°C, −20°C 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 256V, 48 to 66 Hz, <35 VA.

NOTE: All specifications apply for display between 100 and 1100 frequency counts; amplitude at 10 Vp-p into 50Ω.

FACTORY/FOB

San Diego, CA

12 MHz Synthesized Function Generator

- **10 mHz to 32 MHz Range**
- **4¼ Digit Synthesized Frequency ±0.005% Accuracy**
- **AM, FM, Trigger and Gate**
- **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 μHz 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 1 MHz) by using the NULL control.

Low-Frequency Waveform Synthesis
Waveforms below 1 kHz 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 set-up after power down. Memory is maintained with a long-life lithium battery.

MODEL 23 FUNCTION GENERATORS

VERSATILITY

Waveforms
Sine, triangle, square and dc; additionally, below 1000 Hz, ramp up, and ramp down and, in triggered or gated modes, haverwaves.

Operational Modes
Continuous, triggered, gated and continous synthesized.

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.

Frequency 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 1200:1 VCG change.

Amplitude Range
0.01 to 10 Vp-p into 50Ω (0.02 to 20 Vp-p into ≥50 kΩ). Selected value may also be displayed in Vrms (50Ω) or, for sine wave, dBm (50Ω).

DC Offset Range
− 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).

Outputs
Overload Protected.
Function Output: Source of primary waveforms. Source impedance is 50Ω. Peak output current is 100 mA maximum.
TTL Output: TTL compatible pulse with 50% duty cycle at selected frequency. Level is ≤0.2V 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 into − 2V.

Inputs
VCG In: BNC input for voltage control of generator frequency in non-synthesized modes.
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 amplitude modulation (AM) or suppressed carrier modulation (SCM) envelope.

FREQUENCY PRECISION

Resolution
4 digits in synthesized modes. 3 digits in all other modes. Additional ¼ digit for frequencies above 10 MHz.

Accuracy
50 ppm in synthesized mode. ± 2% in all other modes.

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 AND DC OFFSET PRECISION

Amplitude and Offset 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;
3 digits or 0.1 mV when absolute peak amplitude plus offset ≤0.05V.

Amplitude Accuracy
± 2% of selected value and:
± 1 mV for 0.01 to 0.1Vp-p (peak amplitude + offset ≤0.05V).
± 5 mV for 0.1 to 1Vp-p (peak amplitude + offset <0.5V).
± 20 mV for 1.01 to 10Vp-p.

Offset Accuracy
± 40 mV in dc function.

Amplitude Repeatability (24 hr)
± 1% ± 10 mV.

Offset Repeatability (24 hr)
± 1% ± 20 mV.

Amplitude Flatness
For sine wave output at 5 Vp-p: 0.1 dB to 100 kHz, 1.5 dB to 12 MHz. Reference is 1 kHz.

WAVEFORM CHARACTERISTICS

Sine Distortion (THD at 5 Vp-p)
<0.5%, 0.01 Hz to 9.99 kHz, <1.0% 10.0 kHz to 99.9 kHz.
No Harmonics above:
− 40 dBc, 100 kHz to 999 kHz,
− 27 dBc, 1 MHz to 12 MHz.

Time Symmetry
± 1% ± 8 ns.

Square Transition Time
<20 ns.

Square Peak-to-Peak Aberrations
<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/°C for 0 to 50°C. Crystal is 6.144 MHz with 0.005% accuracy and aging rate of 20 ppm/year.

Spurious Signals
Typically 70 dB below fundamental to 1 MHz and 40 dB below fundamental to 12 MHz (in synthesizer mode only, Function Out).

Integrated Signal to Phase Noise
Typically 30 dB below the signal to 1 MHz measured over ± 15 kHz bandwidth excluding carrier ± 10 Hz (in synthesizer mode only).

DISPLAY

2 lines × 16 character alphanumeric LCD. Viewing angle is adjustable.

GENERAL

Environment
Temperature Range: 25°C ± 10°C for specified operation, operates 0°C to + 50°C, − 20°C 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% 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 with maximum of 2g at 55 Hz.
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 128, 180 to 256V, 48 to 66 Hz, less than 40 VA.
NOTE: All specifications apply for programmed amplitude of 10 Vp-p into 50Ω.

OPTIONS

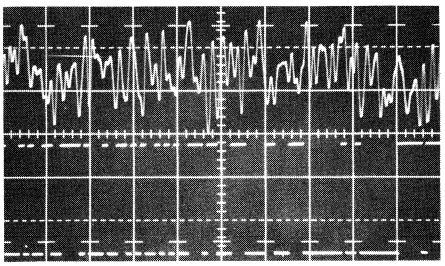
001 GPIB Programming*
IEEE 488-1978 compatible. Non-isolated. Double buffered.
Subsets: SH1, AH1, T6, TE0, L4, SR1, RL1, PP0, DC1, C0, E2.
Address: 0-30, internal switch selectable.

002 RS232C Programming*
DB-25 connector. DCF configuration. Bi-directional. Full Duplex with CTS/RTS handshaking. Data format is 8 bits with no parity and one stop bit. Data rate selectable from 50 to 19,200 Baud.

FACTORY/FOB

San Diego, CA

VCG/Noise Generator



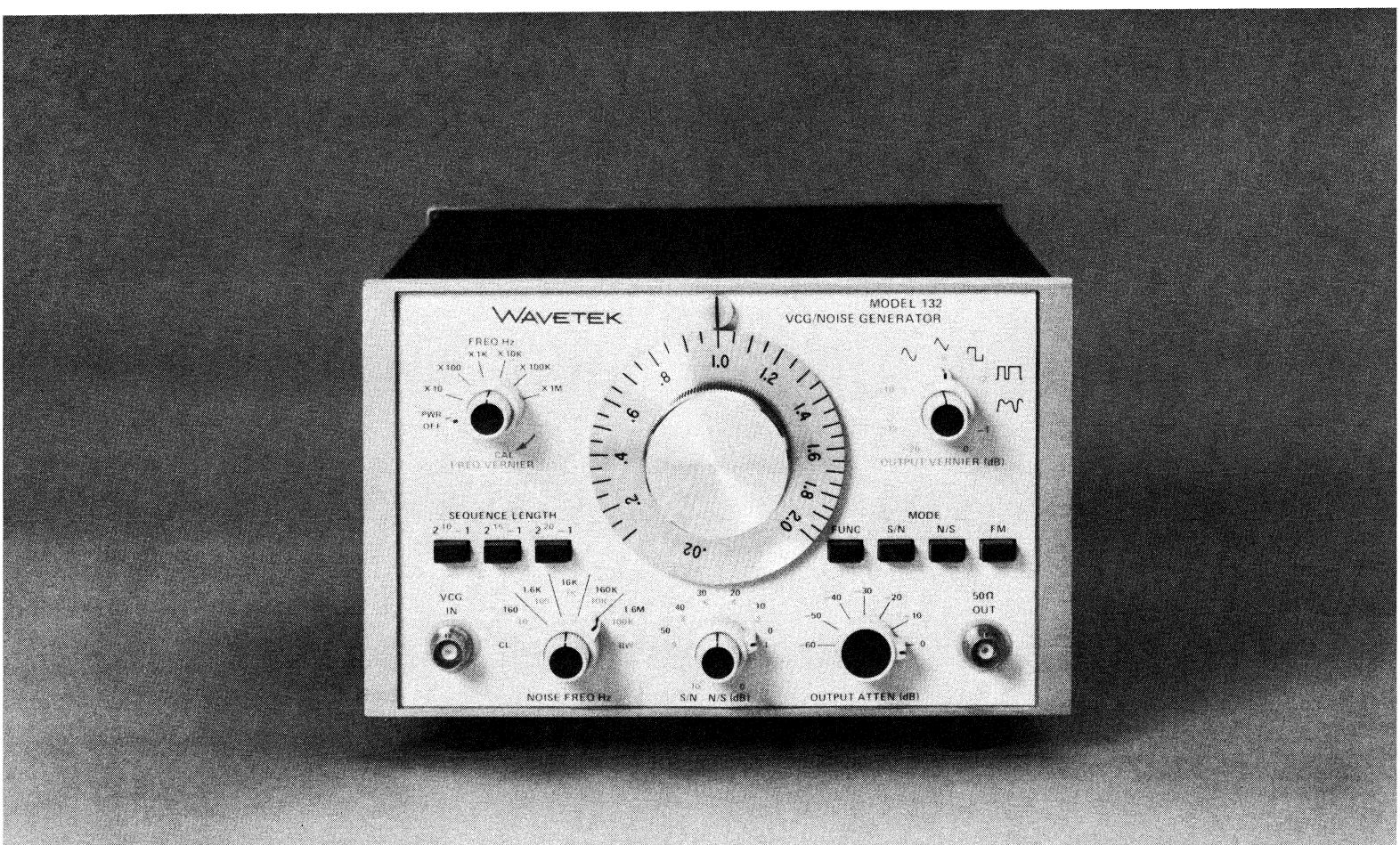
- **Pseudo-Random Analog and Digital Noise**
- **Calibrated Signal-to-Noise Ratios**
- **2 MHz Frequency Range**
- **Adjustable Incidental FM**

Pseudo-Random Analog and Digital Noise
To test your systems with random inputs, the Model 132 provides a digital pseudo-random sequence with selectable sequence length and variable clock rates up to 1.6 MHz. Analog noise is available with continuously variable bandwidth up to 100 kHz for your use as a stimulus for mechanical or vibration testing.

Variable Signal-to-Noise Ratio
The analog noise can be combined with the sine, square or triangle waveforms in the signal-to-noise or noise-to-signal mode. The ratios can be varied over a 60 dB range with calibrated front panel control. You can test modem performance, noise immunity and system performance in the presence of noise, easily and accurately.

Random FM Modulation
In the FM mode, the noise provides a variable random jitter or incidental FM to the signal frequency. Typical applications would be the testing of discriminator circuits or phase lock loops to determine performance in the presence of noise.

2 MHz Frequency Range
Besides the pseudo-random analog and digital noise, the Model 132 is a source of precision sine, square and triangle waveforms with a frequency range of 0.2 Hz to 2 MHz. This unique instrument gives you the typical function generator versatility, quality and accuracy for your general laboratory applications.



VERSATILITY

Waveforms

Sine ∿ , square ⊓⊔ , triangle ∧∨ , digital ⎍⎍ noise, analog ⎍⎍ noise, signal-on-noise N/S and noise-on-signal S/N selectable.

Operational Modes

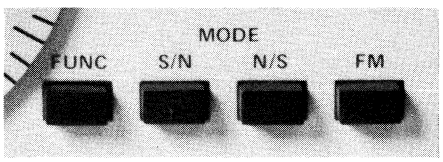
Function: Provides the selected waveform at the main output.

Signal-to-Noise: Adds noise to a selected signal of constant amplitude. The signal-to-noise ratio is variable from 0 to 60 dB.

Noise-to-Signal: Adds a selected signal to a constant amplitude noise. The noise-to-signal ratio is variable from 0 to 60 dB.

Frequency Modulation: Provides random modulation of the frequency of the generator. The S/N-N/S (dB) ratio control also controls the amount of frequency deviation.

NOTE: When noise is added to the signal output, specifications apply up to 200 kHz and the square wave rise time is derated by a factor of 10. In the clock range of 1.6 MHz, the maximum calibrated signal-to-noise ratio is 30 dB.



Mode Controls

Frequency Range

For ∿ , ⊓⊔ , ∧∨ , 0.2 Hz to 2 MHz in 6 overlapping ranges with decade dial and frequency vernier.

NOTE: Noise not controlled by dial or range switch.

Main Output

∿ , ⊓⊔ , ∧∨ , ⎍⎍ and ⎍⎍ selectable and variable to 20 Vp-p (10 Vp-p into 50Ω). Voltage attenuation 0 to 60 dB in 10 dB steps with overlapping calibrated vernier. Output impedance 50Ω; 600Ω available. Short circuit current is 100 mA.

DC Offset

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

Sync Output

Greater than 1 Vp-p square wave into open circuit 600Ω output impedance.

VCG—Voltage Controlled Generator

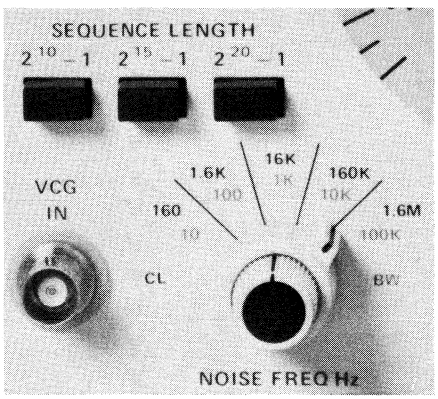
Frequency change up to 1000:1 with external 0 to ±5V signal. Upper frequency limited to maximum of selected range.

Slew Rate: 0.1V per μs.

Input Impedance: 1 kΩ.

Digital Noise

⎍⎍ is 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.



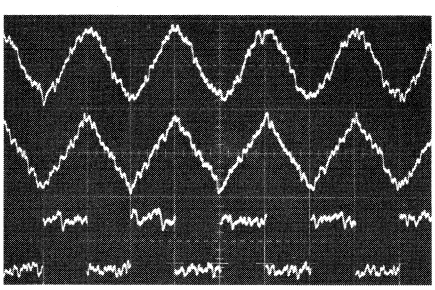
Pseudo-Random Noise Controls

Analog Noise

⎍⎍ is 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 and Analog Noise

FREQUENCY PRECISION

Dial Accuracy

±2% of full scale for 1 Hz to 2 MHz.

Time Symmetry

±1% through ×100K range.

AMPLITUDE PRECISION

Amplitude Change With Frequency

Sine variation less than:

±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.

WAVEFORM CHARACTERISTIC

Sine Distortion

Less than:

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

Less than 50 ns terminated into 50Ω.

GENERAL

Stability

Amplitude, frequency and dc offset.

Short Term: ±0.05% for 10 min.

Long Term: ±0.25% for 24 hours.

Environment

Specifications apply at 25°C ±5°C. Instrument will operate from 0°C to +50°C.

Dimensions

21.6 cm (8½ in.) wide; 13.3 cm (5¼ in.) high; 29.2 cm (11½ in.) deep.

Weight

3.6 kg (8 lb) net; 5.4 kg (12 lb) shipping.

Power

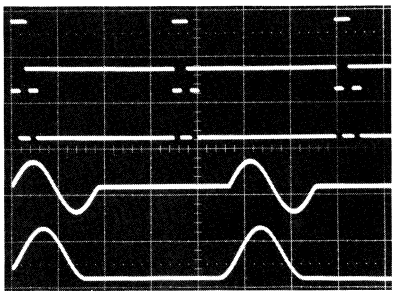
105 to 125V or 200 to 250V; 50 to 400 Hz; less than 55 VA.

NOTE: Specifications apply when frequency dial is between 0.1 and 2.0 and output is 10 Vp-p into 50Ω load.

FACTORY/FOB

San Diego, CA

20 MHz Pulse/Function Generators



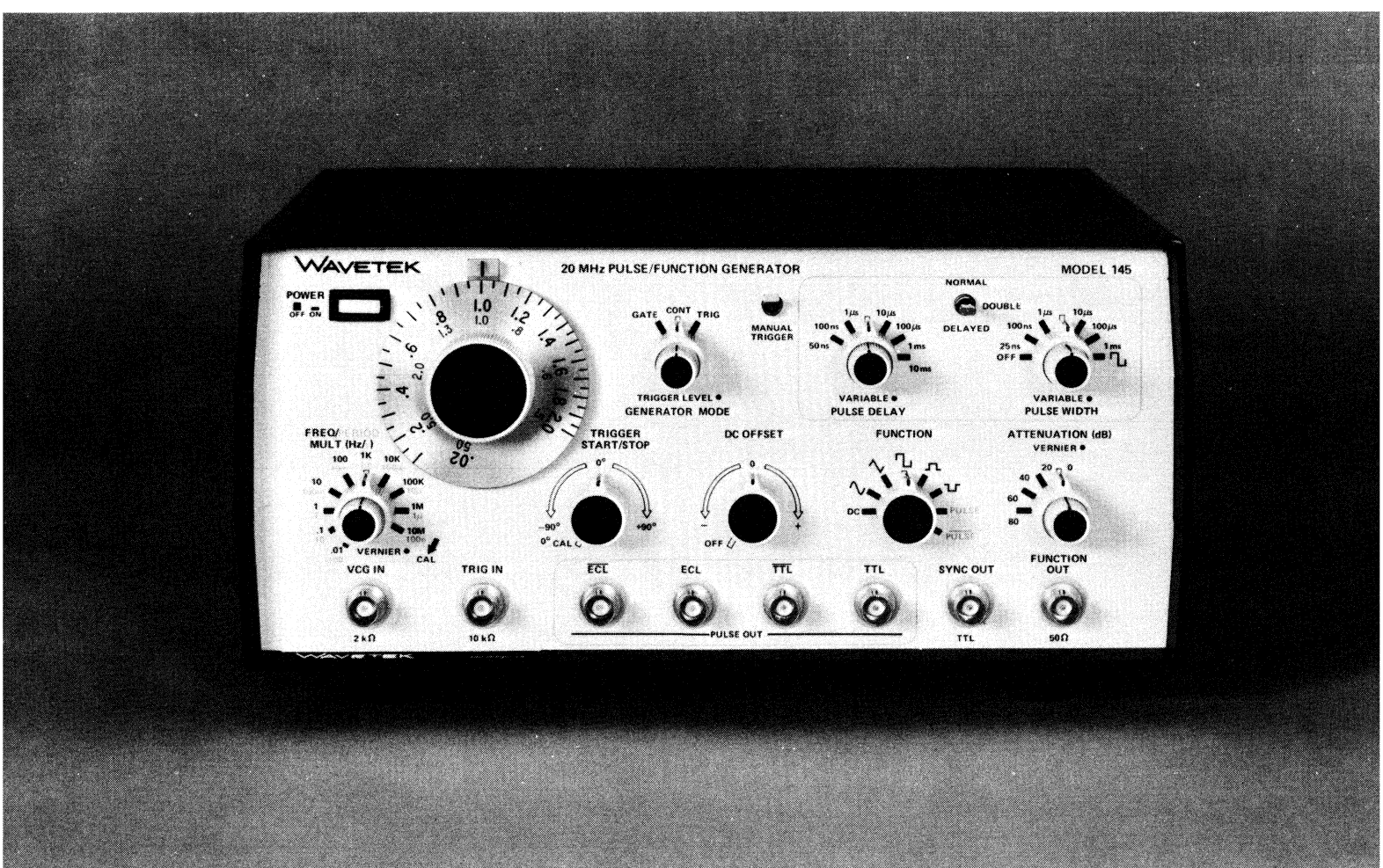
- **Frequency From 0.0001 Hz to 20 MHz**
- **Full 30 Volt Peak-to-Peak Output**
- **Continuous, Triggered and Gated Operation**
- **Fixed TTL and ECL Outputs (145)**
- **Delayed and Double Pulse Outputs (145)**

Models 143 and 145
Both 20 MHz function generators are precision sources of sine, square and triangle waveforms, and positive and negative pulses. The frequency range is variable from 0.0001 Hz (2.78 hour period) to 20 MHz, and the frequency can be modulated, swept or dc controlled over a 1000:1 range by an external voltage. Output can be continuous or the generator can be triggered or gated by an external control signal or front panel switch.

30 Volts Peak-to-Peak
A calibrated 20 dB per step attenuator and 20 dB vernier give 80 dB control for a 1.5 mV p-p to 30 Vp-p output signal.

Variable DC and Start/Stop Point
Other key features of both models are DC offset, triggered waveform start/stop point control and an X-Y recorder frequency axis drive.

Model 145
In addition to the features described above, Model 145 provides pulse outputs with calibrated repetition rates up to 20 MHz. Convenient fixed amplitude outputs are available for TTL and ECL. The variable pulse output gives pulses up to a full 30V peak-to-peak. For further utility you can select delayed or double pulses and continuous, triggered or gated output. Pulse width and delay are independently controllable.



VERSATILITY

Waveforms
Selectable sine ∿, square ⊓, triangle △, positive square ⎍, negative square ⎎, TTL sync pulse and dc.
(143 only.) Symmetry of waveforms may be varied for sawtooth and variable duty cycle pulses.
(145 only.) Fixed amplitude pulses of TTL, $\overline{\text{TTL}}$, ECL and $\overline{\text{ECL}}$, all simultaneously available with function output.

Operational Modes
Continuous: Generator oscillates continuously at selected frequency.
Triggered: Generator is quiescent until triggered by an external signal or manual trigger, then generates one cycle at selected frequency.
Gated: As triggered mode, except generator oscillates for the duration of the gate signal. Last cycle started is completed.

Frequency Range
0.0001 Hz to 20 MHz in 10 overlapping ranges with approximately 1% vernier control.

Function Output
∿, ⊓, △ selectable and variable to 30 Vp-p (15 Vp-p into 50Ω). ⎍, ⎎, to 15 Vp (7.5 Vp into 50Ω). All waveforms and dc can supply 150 mA peak current and may be attenuated to 60 dB in 20 dB steps with an additional 20 dB vernier.

DC Output and DC Offset
Selectable through FUNCTION OUT output. Controlled by front panel control or by applying an external voltage. Adjustable between ±15 Vdc (±7.5 Vdc into 50Ω) with signal peak plus offset limited to ±15 Vdc (±7.5 into 50Ω). External offset sensitivity approximately −1 V/V with output into open circuit. DC offset and output waveform attenuated proportionately by the 60 dB output attenuator.

Sync Output
A TTL level pulse. Will drive 50Ω termination.

GCV—Generator Controlled Voltage
At GCV OUT connector, a 0 to +2V signal proportional to generator frequency. 600Ω source impedance.

VCG—Voltage Controlled Generator
Up to 1000:1 frequency change with external 0 to 2 volt signal to VCG IN connector. Upper and lower frequencies limited to maximum and minimum of selected range.
Slew Rate: 2% of range per μs.
Linearity:
±0.2% for 10 Hz to 200 kHz;
±0.75% for 0.001 Hz to 2 MHz.
Impedance: 2 kΩ.

Trigger and Gate
Input Range: 1 Vp-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° to 2 MHz.

Symmetry
(143 only.) Symmetry of all waveform outputs is continuously adjustable from 1:19 to 19:1 for variable duty-cycle pulses, sawtooth ramps and distorted sine waves.
NOTE: When SYMMETRY control is used, indicated frequency is divided by approximately 10.

FREQUENCY PRECISION

Dial Accuracy
From ×.01 Hz to ×1 MHz: ±3% of full range.
×10 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 PRECISION

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.

Step Attenuator Accuracy
±0.3 dB per 20 dB step at 2 kHz.

WAVEFORM CHARACTERISTICS

Sine Distortion
×100 Hz to ×10 kHz: <0.5%.
×.01 to ×10 Hz and ×100 kHz: <1.0%.
×1 MHz: All harmonics 34 dB below fundamental.
×10 MHz: All harmonics 26 dB below fundamental.

Square Wave Rise/Fall Time
At FUNCTION OUT <20 ns for 15 Vp-p output into 50 Ω load.

PULSE GENERATOR

(145 only.)

Pulse Outputs
Variable amplitude pulse, and simultaneous fixed ECL, $\overline{\text{ECL}}$, TTL and $\overline{\text{TTL}}$ pulses and TTL sync pulse. All outputs can drive 50Ω terminations.

Operational Modes
Continuous, triggered and gated plus the following.
Normal Pulse: Adjustable width pulse in phase with sync signal.
Delayed Pulse: Pulse delayed with respect to normal pulse. Pulse delay and pulse width adjustable.
Double Pulse: Two pulses for every period. Time between pulses and pulse width adjustable. Minimum period 100 ns.

Pulse Period Range
50 ns to 10,000s in 10 overlapping ranges with approximately 1% vernier control.

Pulse Width
25 ns to 1 ms in 5 overlapping ranges with vernier control. Includes OFF and square wave.

Pulse Delay
50 ns to 10 ms in 6 overlapping ranges with vernier control.

Duty Cycle
Duty cycles to 70% for periods >100 ns (<10 MHz); for periods <100 ns (>10 MHz) duty cycles are approximately 50%.

Function Output
Variable to 30 Vp-p into 50Ω). DC offset and attenuation are same as for function generator.

Pulse Rise/Fall Times
At FUNCTION OUT, <20 ns for 15 Vp-p output into 50Ω load.

GENERAL

Stability
Short Term: ±0.05% for 10 min.
Long Term: ±0.25% for 24 hours.
Percentages apply to amplitude, frequency and dc offset.

Environment
Specifications apply at 25°C ±5°C. Instrument will operate from 0°C to 50°C ambient temperatures.

Dimensions
28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 27.3 cm (10¼ in.) deep.

Weight
Model 143: 4.2 kg (9.3 lb) net; 5.5 kg (12 lb) shipping.
Model 145: 4.5 kg (10 lb) net; 5.9 kg (13 lb) shipping.

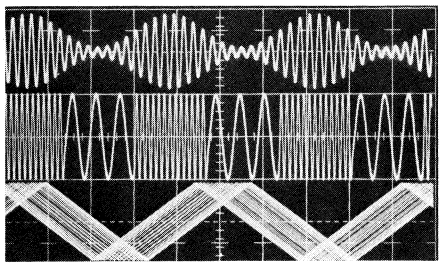
Power
90 to 105V, 108 to 126V, 198 to 231V and 216 to 252V selectable; 48 to 400 Hz; less than 30 VA.

NOTE: All specifications apply from 0.1 to 2.0 on frequency dial, when FUNCTION OUT is at maximum and 50Ω terminated, and (143 only) with SYMMETRY control at OFF. Symmetry and vernier affect frequency calibration. Maximum possible asymmetry is a function of frequency setting. Model 145 function generator specifications apply when PULSE WIDTH control is OFF.

FACTORY/FOB

San Diego, CA

20 MHz AM/FM/PM Generator



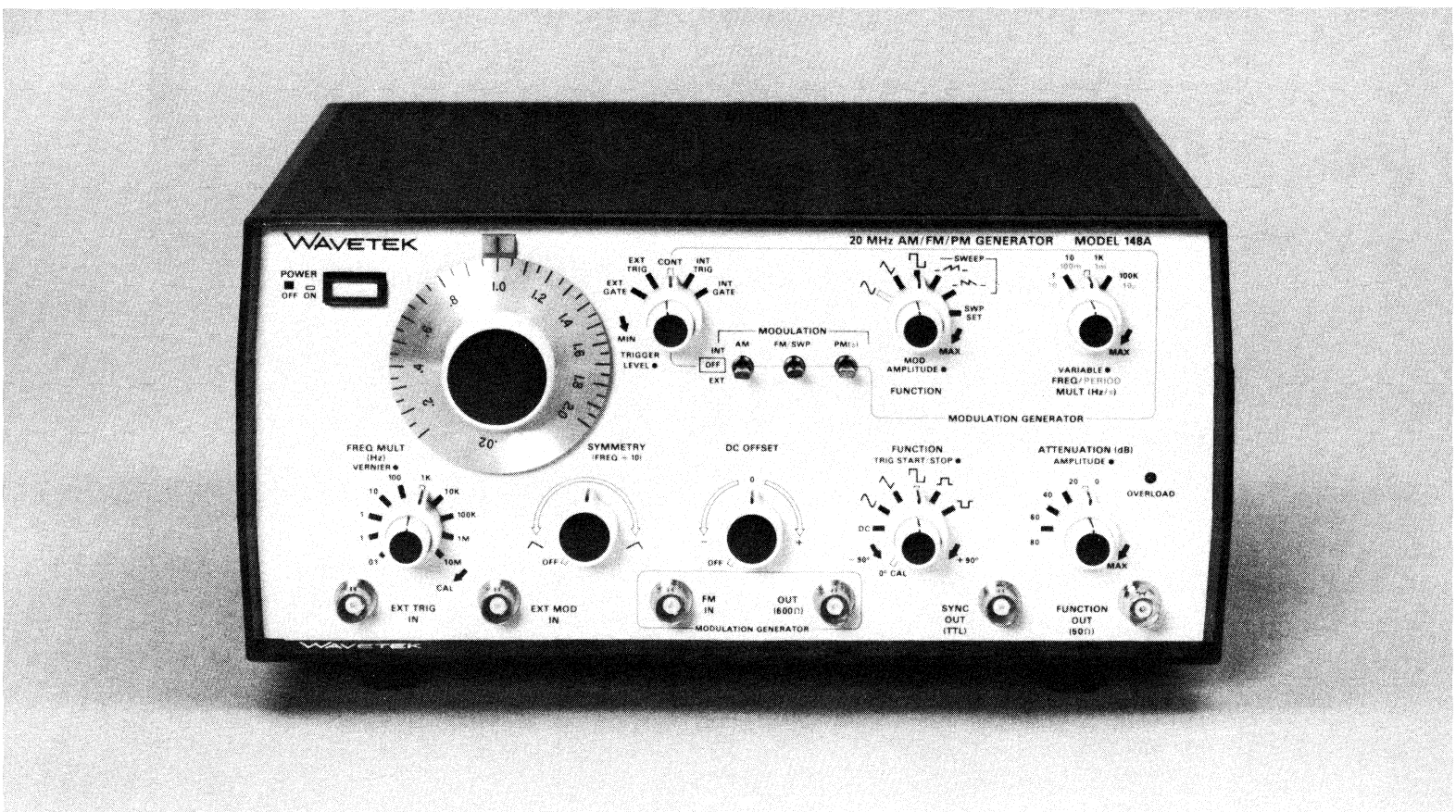
- **Two Complete Generators**
- **Internal or External AM, FM and Phase Modulation**
- **0.0002 Hz to 20 MHz, 30V Output**
- **Sweep, Trigger and Gate**
- **30 Volt Peak-to-Peak Output**

Two Complete Generators
Wavetek's Model 148A AM/FM/PM Generator gives you a one instrument source of modulated waveforms. It has two generators: a main function generator, with full function generator versatility, and a modulation generator, a convenient source for modulating and triggering waveforms or a second, independent signal source.

Internal or External Modulation
Modulation may be internal or external in any combination. Amplitude may be modulated from zero through 100% and in a suppressed carrier mode; frequency may be modulated or swept to three decades; and phase may be modulated a full plus or minus 50 degrees.

Function Generator
The main generator generates from 200 μHz to 20 MHz in continuous, triggered and gated modes with a 30V peak-to-peak maximum amplitude. A unique overload LED indicates output clipping due to excessive amplitude plus offset. Variable symmetry and trigger stop/start controls provide additional special waveforms, and a four step attenuator with vernier provides 80 dB of amplitude control. A variable trigger level control accepts main generator triggering signals from the modulation generator or trigger signals from an external source.

Generates Complex Waveforms
Main generator frequency, amplitude and triggering source are independently or simultaneously controlled by the modulation generator or external signal. The model 148A can generate an unlimited variety of complex waveforms.



VERSATILITY

Instrument consists of a main generator and a modulation generator which can be connected internally for amplitude, frequency or phase modulated signals or for self-triggering and tone burst signals.

MAIN GENERATOR

Waveforms
Sine ∿ , triangle △ , square ⊓ , positive square ⎍ , negative square ⎎ , TTL pulse and dc.

Operational Modes
Continuous, external trigger and gate, and internal trigger and gate.

Modulation Modes
AM: Internal - waveform amplitude is modulated from 0 to >100%.
AM: External - AC signal gives suppressed carrier operation.
FM: Internal modulation or external ac or dc signal provides voltage control of frequency. Up to 1000:1 frequency change possible; linear within limits of selected range.
Sweep: Ramp signal sweeps the main output signal frequency from low to high or vice versa. frequency sweeps to 1000:1 within the selected range. Internal ramp can be held at limits for precision upper and lower frequency setting.
PM: Internal or external modulation signal causes instantaneous carrier frequency shift proportional to rate of signal amplitude change, producing up to ±50° carrier phase shift. Enabled for main generator frequency range ×100 and above.

Frequency Range
0.0002 Hz to 20 MHz in 10 overlapping ranges with vernier.

Function Output (50Ω)
∿ , △ , ⊓ selectable and variable to 30 Vp-p (15 Vp-p into 50Ω). ⎍ , ⎎ up to 15 Vp (7.5 Vp into 50Ω). All waveforms and dc give 150 mA peak current and attenuate to 60 dB in 20 dB steps plus 20 dB continuous control.

DC Output and DC Offset
Between ±15 Vdc (±7.5 Vdc into 50Ω) with signal peak plus offset limited to ±15 Vdc (±7.5 Vdc into 50Ω).

Sync Output (TTL)
TTL level pulse which will drive 10 TTL loads.

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

Symmetry
Symmetry of all waveform outputs is continuously adjustable from 1:19 to 19:1. Varying symmetry provides variable duty-cycle pulses, sawtooth ramps and nonsymmetrical sine wave.
NOTE: When SYMMETRY control is used indicated frequency is divided by approximately 10.

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° to 2 MHz.

FREQUENCY PRECISION

Dial Accuracy
±(1% of setting +1% of full range) on ×100 thru ×1M ranges.
±(2% of setting +2% of full range) on ×.01 thru ×10 and ×10M ranges.

Time Symmetry
±0.5% on ×100 thru ×100K 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 PRECISION

Amplitude Change With Frequency
Sine variation less than:
±0.1 dB through ×100K ranges;
±0.5 dB on ×1M range;
±3 dB on ×10M range.

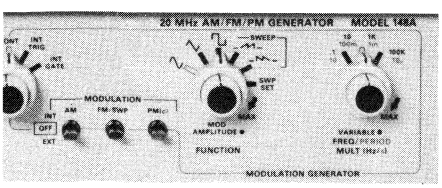
Step Attenuator Accuracy
±0.3 dB per 20 dB step at 2 kHz.

WAVEFORM CHARACTERISTICS

Sine Distortion
<0.5% on ×100 to ×10K ranges.
<1.0% on ×0.01 to ×10 and ×100K ranges.
All harmonics 30 dB below fundamental ×1M range.
All harmonics 26 dB below fundamental on ×10M range.

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

MODULATION GENERATOR



Modulation Generator

Waveforms
Selectable ∿ , △ , ⊓ , ◿ and ◺.

Frequency Range
∿ , △ , ⊓ : 0.1 Hz to 100 kHz in three 100:1 ranges.
◿ , ◺ Sweep: 0.2 Hz to 200 kHz (2× setting).

Output (600Ω)
∿ , △ and ⊓ are fixed level 10 Vp-p. ◿ and ◺ are fixed level 0 to +5V.

Frequency Modulation (FM IN)
Voltage control of modulator frequency with sensitivity of 20% of range/volt. Input impedance is 5 kΩ.

WAVEFORM CHARACTERISTICS

Sine Distortion
<5%.

Time Symmetry
<1% from 1 Hz to 10 kHz.
<5% from 0.1 Hz to 100 kHz.

GENERAL

Stability
Short Term: ±0.05% for 10 min.
Long Term: ±0.25% for 24 hr.
Precentages apply to amplitude, frequency and dc offset.

Environment
Specifications apply at 25°C ±5°C. Instrument will operate from 0°C to +50°C ambient temperatures.

Dimensions
28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 27.3 cm (10¾ in.) deep.

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

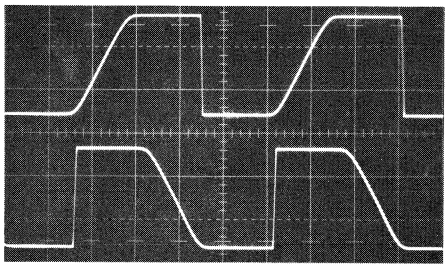
Power
90 to 105V, 108 to 126V, 198 to 231V and 216 to 252V selectable; 48 to 400 Hz; less than 40 VA.

NOTE: Unless otherwise noted, all specifications apply from 0.1 to 2.0 on frequency dial, when FUNCTION OUT is at maximum and 50Ω terminated, with SYMMETRY control at OFF. Symmetry and vernier affect frequency calibration. Maximum possible asymmetry is a function of frequency setting.

FACTORY/FOB

San Diego, CA

30 MHz Sweep Generator



- **30 μHz to 30 MHz Frequency Range**
- **Variable Rise and Fall Times**
- **Trapezoidal Waveforms**
- **Trigger and Gated Operation**
- **Sweep Up or Down**

30 μHz to 30 MHz Frequency Range
Model 164 provides an extremely wide frequency range for both high and low frequency applications, 30 μHz to 30 MHz. This broad range will cover many of your generator applications.

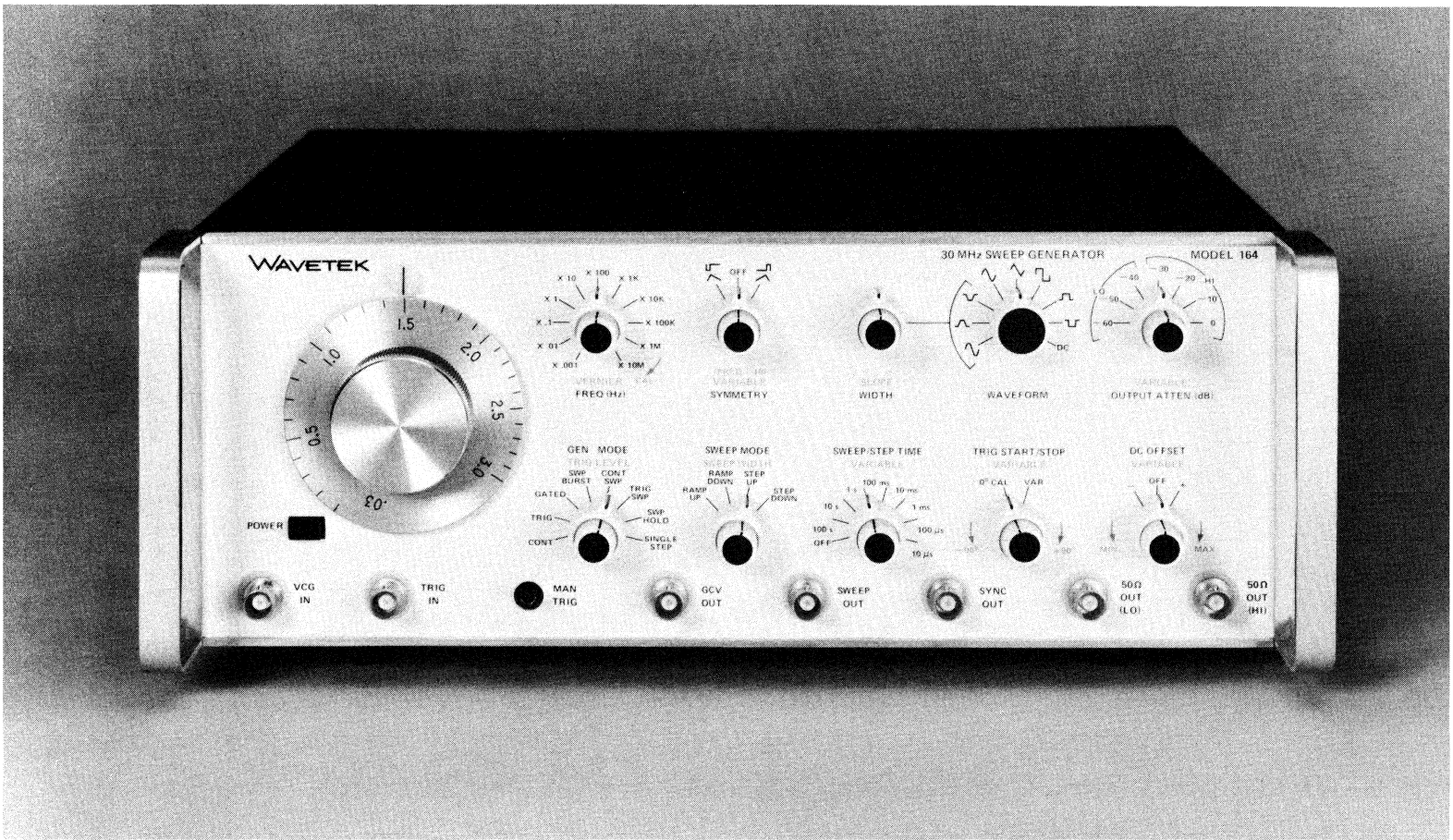
Model 164 is a function generator with full trigger and gate capability as well as a sweep generator with internal sweep and step sweep.

Variable Rise and Fall Time
For pulse applications, Model 164 provides positive, negative and balanced pulse outputs. Duty cycle, rise and fall times and dc offset levels of these outputs are all independently variable.

Trigger and Gated Operation
Single cycles or "bursts" of cycles of the selected waveform can be produced by triggering the generator with an external signal or with the manual front panel switch. Trigger start/stop point can be adjusted to give haversine outputs as well as complex waveforms.

Sweep Up or Down
Besides the conventional low-to-high frequency sweep, Model 164 will sweep high-to-low. Sweep width is fully adjustable to 1000:1 and sweep time is continuously adjustable from 10 microseconds to 100 seconds. Sweep hold mode stops the generator at the sweep limit so that you can easily and accurately adjust the total sweep width.

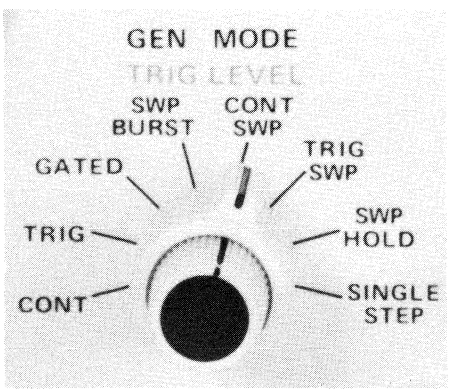
Incremental Frequency Steps
Step sweep is another sweep mode on the Model 164. The sweep width is divided into 10 steps, giving 11 frequencies. You can step sweep through 11 frequency steps automatically or make one step with each press of the manual trigger switch. Steps can be up or down in frequency.



VERSATILITY

Waveforms
Sine ∿, square ⊓, triangle △, positive square ⎍, negative square ⎎, trapezoid ⏢, positive trapezoid ⏢, negative trapezoid ⏢, ramp ◿ and stair step (up and down).

Operational Modes
Continuous: Main generator oscillates continuously at selected frequency.
Triggered: Generator quiescent until triggered by an external signal, then generates one cycle at selected frequency.
Gated: As triggered mode, except main generator oscillates for the duration of the external signal. Last cycle started is completed.
Continuous Sweep: Recurring low-to-high or high-to-low frequency oscillations. Range and rate selectable.
Triggered Sweep: Low-to-high or high-to-low frequency oscillation with each trigger input; then returns to initial frequency after sweep.
Sweep Hold: Sweep from start frequency to stop frequency and continued oscillation at stop frequency.
Sweep Burst: Main generator quiescent until gated, then in sweep hold mode for duration of gate; return to quiescent state when gate signal is removed.
Single Step: Main generator steps to next frequency with each trigger in stair sequence. After 10th step, returns to initial frequency.



Mode Control

Frequency Range
0.00003 Hz to 30 MHz in 11 decade ranges with dial and frequency vernier.

Main Output
∿, △, ⊓ and ◿ selectable and variable to 20 Vp-p (10 Vp-p into 50Ω). ⎍, ⎎, ⏢ and ⏢ to 10V peak (5V peak into 50Ω). DC voltage adjustable to ±10V, 50Ω source. Output peak current is 100 mA minimum for all waveforms and dc. 0 to 60 dB attenuation in 10 dB steps with a 20 dB vernier; maximum overall attenuation 80 dB. High level 0 to −50 dB and low level −40 to −80 dB outputs.

DC Output and DC Offset
Waveform offset and dc output selectable through 50Ω outputs. Adjustable between ±10V (±5V into 50Ω). DC offset and output waveform are attenuated proportionately by the attenuator.

Sync Output
Approximately 0 to +4V into open circuit; 50Ω source. Rise and fall times typically 10 ns into 50Ω. Sync waveform normally square is rectangular with SYMMETRY control on.

Sweep
Sweep/Step Time: 10 μs to 100s in 7 ranges selectable.

Sweep Output
Sweep Signal: 0 to +5V ramp or stair step.
Source Impedance: 600Ω.

GCV—Generator Control Voltage
0 to +5V output proportional to main generator frequency
Source Impedance: 600Ω.

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.
Input Impedance: 5 kΩ.
Slew Rate: 2% of range per μs.
Linearity: ±0.5% for 0.0003 Hz to 3 MHz.

Symmetry Control
Symmetry of all waveform outputs is continuously adjustable from 1:19 to 19:1. Varying symmetry provides variable duty cycle pulses, sawtooth or nonsymmetrical trapezoidal waveforms.

NOTE: When SYMMETRY control is used, indicated frequency is divided by approximately 10.

Slope and Width Control
For trapezoidal waveforms ⏢, ⏢ and ⏢ only. Ratio of period to rise or fall time is variable from 2:1 (triangle) to greater than 100:1 with 12 ns minimum rise and fall time.

Trigger and Gate
Input Range: 1V p-p to ±50V.
Impedance: 10 kΩ, 33 pF.
Pulse Width: 25 ns min.
Repetition Rate: 20 MHz max.
Adjustable Triggered Signal Start/Stop Point Approximately:
−90° to +90° to 3 MHz.
−90° to 0° for 3 to 30 MHz.

FREQUENCY PRECISION

Dial Accuracy
±(1% of setting +1% of full scale) or 0.0003 Hz to 300 kHz.
±(3% of setting +2% of full scale) for 300 kHz to 30 MHz.

Time Symmetry
±0.5% for 30 Hz to 300 kHz.
±1.0% for 0.0003 to 30 Hz.

AMPLITUDE PRECISION

Amplitude Change With Frequency
Sine variation less than:
±0.1 dB to 300 kHz.
±0.2 dB to 3 MHz.
±2.5 dB to 30 MHz.

Amplitude Symmetry
1% of amplitude range to 3 MHz.

Step Attenuator Accuracy
±0.25 dB per 10 dB step.

WAVEFORM CHARACTERISTIC

Sine Distortion (Continuous Mode)
<0.5% for 10 Hz to 100 kHz.
<1.0% for 0.0003 Hz to 300 kHz.
All harmonics at least 26 dB down to 30 MHz.

Triangle Linearity
Greater than 99% for 0.0003 to 300 kHz.

Square Wave Rise and Fall Time
Less than 12 ns terminated into 50Ω load.

Total Aberrations
Less than 5%.

GENERAL

Stability
Amplitude, dc offset and frequency.
Short Term: ±0.05% for 10 minutes.
Long Term: ±0.25% for 24 hours.

Environment
Specifications apply at 25°C ±5°C. Instrument will operate from 0°C to +55°C.

Dimensions
36.8 cm (14½ in.) wide; 13.3 cm (5¼ in.) high; 34.3 cm (13½ in.) deep.

Weight
6.8 kg (14.9 lb) net; 8.6 kg (19 lb) shipping.

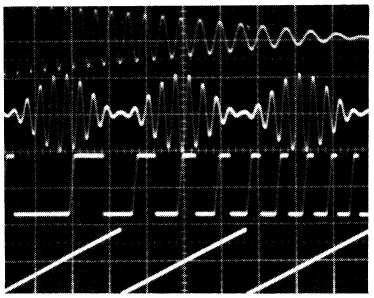
Power
90 to 110V, 105 to 125V, 180 to 220V or 210 to 250V; 50 to 400 Hz; less than 50 VA.

NOTE: Specifications apply from 10 to 100% of a selected frequency range with SYMMETRY control at OFF. Symmetry and vernier affect frequency calibration. Maximum possible asymmetry is a function of frequency setting.

FACTORY/FOB

San Diego, CA

50 MHz Pulse/Function Generator



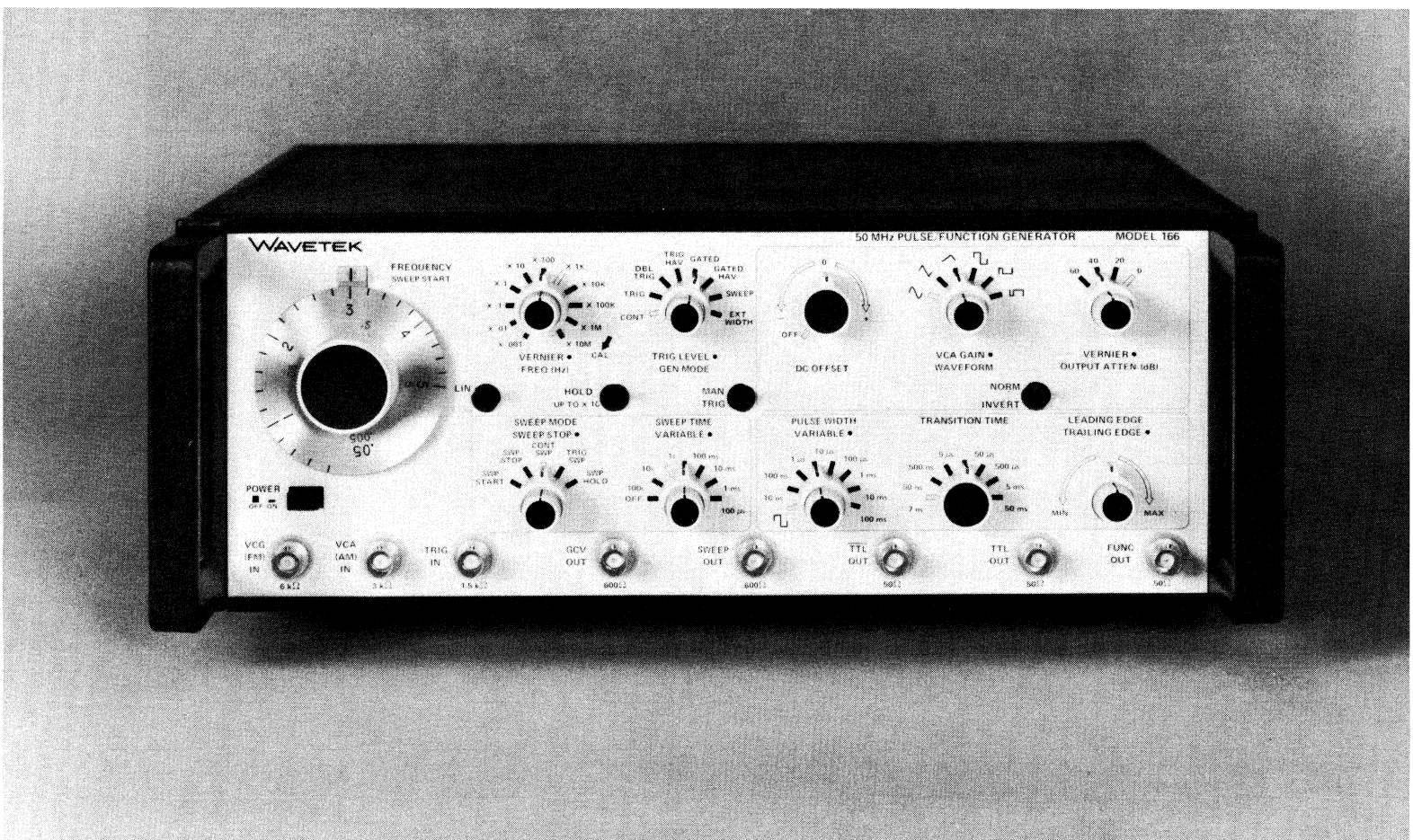
- **0.0001 Hz to 50 MHz Range**
- **30 Volt Peak-To-Peak Output**
- **Lin/Log Sweep Plus AM and FM**
- **Pulse Width and Transition Time Control**
- **Independent Pulse Width and Rate**

Pulse and Functions
The Model 166 Pulse/Function Generator fills your requirement for a truly versatile laboratory instrument. It is a swept sine, square and triangle function generator for your analog applications and a pulse generator with width and transition control for your digital testing requirements. And for all its versatility, the Model 166 controls, clustered for function, are readily understandable and direct-acting.

0.0001 Hz to 50 MHz Range
The frequency range of 0.0001 Hz to 50 MHz gives you the frequency and repetition rates in greater ranges than normally found in function or pulse generators alone. The sine, triangle, square, haverwave and ramp waveforms and the pulses can be output in a variety of mode of triggering and sweep.

You can tailor Model 166 pulses for your testing requirements. Pulses are fully shape controlled in amplitude, width and transition times. Simultaneously with the variable pulse output, TTL and $\overline{\text{TTL}}$ pulse outputs give you automatic logic-compatible pulses. An external width mode lets you reconstruct external pulses for logic conversion or noise removal.

AM and FM
To round out the versatility of the Model 166, the output pulse as well as the functions can be amplitude and frequency modulated with an AC signal or amplitude and frequency controlled with a remote DC signal. Amplitude modulation can be to 200% for suppressed carrier operation.



VERSATILITY

Instrument operates as a sweep/function generator or a pulse generator.

SWEEP/FUNCTION GENERATOR

Selectable Waveforms
Sine ∿, triangle ∿, square ⊓ and ramp ⟋. All can be inverted. Ramp up-down ratio can be as large as 1:1000. All can be amplitude and frequency modulated.

Operational Modes
Continuous: Generator oscillates continuously at selected frequency.
Triggered: Generator quiescent until triggered by external signal or manually, then generates one cycle.
Double Triggered: As triggered, except two cycles are generated.
Triggered Haverwave: As triggered mode. Output is one cycle starting at −90° (or +90°).
Gated: As triggered, except output continues for duration of gate.
Gated Haverwave: As gated. Output is a burst of cycles starting at −90° (or +90°).
Continuous Sweep: Generator frequency continuously sweeps up from start to stop frequency.
Triggered Sweep: Generator oscillates at sweep start frequency until triggered, then generates one sweep to the stop frequency and returns to the start frequency.
Sweep and Hold: As triggered sweep mode, except the generator remains at stop frequency until the trigger signal falls, then returns to start frequency.

Frequency Range
0.0001 Hz to 50 MHz in 11 ranges. Maximum sweep 1000:1 in lin or log.

Sweep Time Range
100s to 100 μs in 6 ranges.

Function Output
Variable to 30 Vp-p (15 Vp-p into 50Ω). Voltage attenuation 0 to 80 dB: to 60 dB in 20 dB steps, plus 20 dB continuous vernier.

Low Frequency Hold
Function output will hold at the instantaneous voltage level when the hold switch is depressed. Effective in the 0.001 Hz to ×10 Hz ranges.
Amplitude Drift: Less than 0.2% of amplitude per minute.

DC Offset
DC offset of all waveforms is adjustable to ±10V (±5V into 50Ω). Waveform plus offset is limited to ±15V (±7.5V into 50Ω).

GCV Output
0 to +5V (nominal, open circuit) proportional to frequency of main generator.
Output Impedance: 600Ω

Sweep Output
0 to +5V (nominal, open circuit) ramp.
Output Impedance: 600Ω.
Sweep Time: 100s to 100μs.

VCG (FM)—Voltage Controlled Generator
Up to 1000:1 frequency change with external 0 to +5V signal.
Mode: Linear or logarithmic.
Slew Rate: 2% of range per μs.
VCG Linearity: 0.0005 Hz to 50 kHz ±0.5% of range.

Voltage Controlled Amplitude (VCA)
0 to ±5V gives 0 to 30V amplitude change. AC input allows 0 to 200% modulation (suppressed carrier).
AC input Range: 5V minimum for 100%, 10V minimum for 200% AM.
Input Impedance: 4.99 to 10 kΩ, depending on gain control.
Input Bandwidth: 10 kHz.

Trigger Input
Trigger Signal: 1 Vp-p minimum.
Trigger Level: ±5V.
Input Impedance: 1.5 kΩ, 30 pF.
Maximum Repetition Rate: 25 MHz.

FREQUENCY PRECISION

Dial Accuracy
(For ∿, ∿, ⊓ and linear dial setting of 0.5 to 5.)
±2% of full scale for 0.0005 Hz to 5 MHz.
+15%, −6% of full scale for 5 to 50 MHz.

AMPLITUDE PRECISION

Amplitude Change With Frequency
Sine and square variations less than:
±0.1 dB to 100 kHz;
±0.2 dB to 1 MHz;
±3 dB to 50 MHz.

Step Attenuator Accuracy
±0.3 dB to 20 dB step to 100 kHz.

WAVEFORM CHARACTERISTICS

Sine Distortion (Test at 10 Vp-p)
Less than:
0.5% for 10 Hz to 100 kHz.
All harmonics greater than:
30 dB down for 100 kHz to 5 MHz;
20 dB down for 5 to 50 MHz.

Triangle Linearity
Greater than:
99% for 0.005 Hz to 100 kHz.

Square Wave Aberrations (Test at 10 Vp-p)
Less than 5% of p-p voltage.

PULSE GENERATOR

Pulses
Variable amplitude positive or complementary pulses ⊔, ⊓. Pulse amplitude, width and rise/fall times are independently adjustable and independent of frequency. TTL and $\overline{\text{TTL}}$ pulses are simultaneous with main pulse. Pulses may be amplitude and frequency modulated. All pulses can drive 50Ω terminations.

Operational Modes
Continuous, Triggered, Double Triggered, Gated and Continuous Sweep. (See Sweep/Function Generator).
External Width: An external signal at the trigger input determines the output pulse width and period.

Pulse Period Range
Pulse period is selectable from 20 ns to 10,000s (50 MHz to 0.0001 Hz) with approximately 1% vernier.

Pulse Width
10 ns to 100 ms in 7 ranges. Maximum duty cycle is 70% for periods to 200 ns, decreasing to 50% for 20 ns periods. Control has nominal 50% duty cycle detent.

Transition Time
7 ns to 50 ms in 7 ranges, independently variable for leading and trailing edges.

Function Output
0 to ±15V into open circuit (0 to ±7.5V into 50Ω). Voltage attenuation 0 to 80 dB: to 60 dB in 20 dB steps, plus 20 dB continuous vernier.

TTL and $\overline{\text{TTL}}$ Pulses
Transition times less than 4 ns into 50Ω termination.

GENERAL

Stability
Amplitude, dc offset and frequency in linear mode to 500 kHz.
Short Term: ±0.05% for 10 minutes.
Long Term: ±0.25% for 24 hours.

Environment
Specifications apply at 25°C ±5°C after 30 min warm-up. Instrument operates from 0°C to ±50°C.

Dimensions
36.2 cm (14¼ in.) wide; 13.3 cm (5¼ in.) high; 38.1 cm (15 in.) deep.

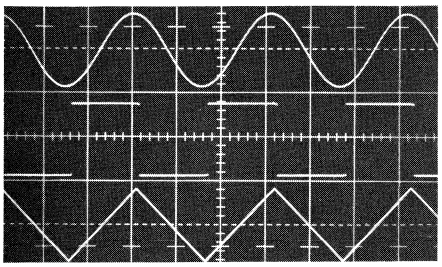
Weight
8.8 kg (19.4 lb) net; 10.9 kb (24 lb) shipping.

Power
90 to 105V, 108 to 126V, 198 to 209V and 216 to 252V; 50 to 66 Hz; 50 VA nominal.

FACTORY/FOB

San Diego, CA

Synthesizer / Function Generator



- **Combination Function Generator/Synthesizer**
- **4½ Digit or 1000:1 Dial Control**
- **0.005% Frequency Accuracy**
- **−70 dB Spurious Noise**
- **0.1 Hz to 2 MHz Frequency Range**

Combination Function Generator/ Synthesizer
Model 171 combines a function generator and 4½ digit resolution frequency synthesizer in one package.

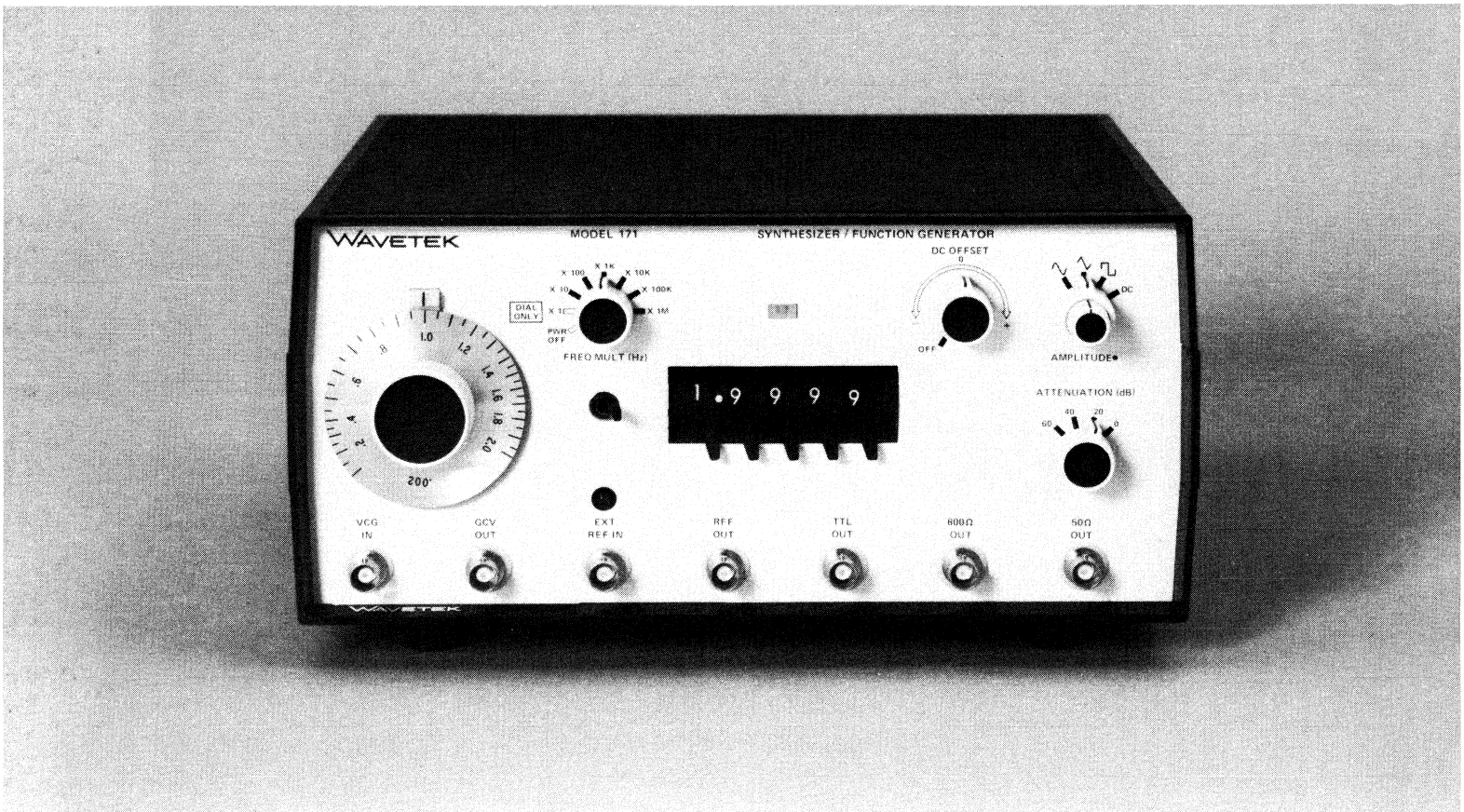
4½ Digit or 1000:1 Dial Control
Frequency control is by dial or digital switch. You can use digital control in the synthesizer mode with frequency resolution from 0.001 Hz on the lowest decade range to 100 Hz on the highest range. Resolution is a full 4½ digits (1.9999). Dial control, in the generator mode, provides ± 3% full scale accuracy with infinite resolution.

0.005% Frequency Accuracy
In the synthesizer mode, the output waveform is phase locked to an internal crystal providing ± 0.005% frequency accuracy with frequency stability of 0.0001% per °C.

−70 dB Spurious Noise
In the synthesizer mode, the spurious signals are typically 70 dB below the fundamental for frequencies up to 20 kHz.

0.1 Hz to 2 MHz Frequency Range
Model 171 frequency range is 0.1 Hz to 2 MHz in the function generator mode. In the synthesizer mode, range is from 1 Hz to 2 MHz. You have either mode, function generator or synthesizer, with the flip of a switch.

Two Simultaneous Outputs
Model 171 features two simultaneous outputs with a maximum of 10 volts peak-to-peak into matched termination. The outputs are from 50 and 600Ω sources. The output is continuously variable from 0 to − 80 dB with a combination step and vernier attenuator.

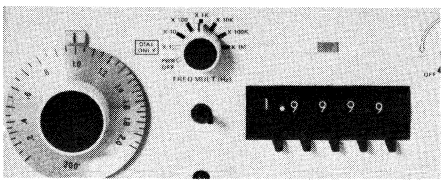


MODEL 171 FUNCTION GENERATORS

VERSATILITY

Waveforms
Sine ∿, triangle ∿, square ⊓ and DC selectable. TTL pulse ⎍ and 1 MHz reference pulse ⎍.

Operational Modes



Dial or Digital Switch Selection

Synthesizer: Operates as a synthesizer with function generator outputs locked to the synthesizer frequency. The frequency is determined by the frequency multiplier switch and the digital switch settings. The digital switch is operable between 0.1000 and 1.9999 on all ranges above the ×1 range.

Function Generator: Operates as a conventional VCG. The frequency is controlled by the dial, multiplier and external VCG voltage on all ranges.

Frequency Range
0.1 Hz to 2 MHz in 7 overlapping decade ranges with dial; 6 overlaping ranges with digital switch.

NOTE: Digital switch valid with all frequency multipliers except ×1 (first range). Frequency ratio of 1000:1 on dial, 20:1 on digital switch.

Main Output
∿, ∿, ⊓ variable to 20 Vp-p (10 Vp-p with matching load at either 50Ω or 600Ω) output. Attenuation from 0 to 80 dB: 60 dB in 20 dB steps with a 20 dB vernier.

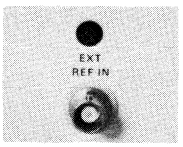
DC Offset and DC Output
DC offset of waveform and dc output are selectable and variable through ±10V (±5V into matching load). Waveform plus offset is limited to ±10V peak (open circuit). Step attenuator attenuates dc level.

TTL Pulse Output
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. Output impedance 600Ω.

VCG—Voltage Controlled Generator
VCG in function generator mode only. Up to 1000:1 frequency change with external 0 to ±2V signal. Upper frequency is limtied to maximum of selected range.
Input Impedance: 2 kΩ.
Slew Rate: 0.1 V/μs.

External Synthesizer Reference Input
Frequency: 1 MHz
Waveform: Sine or Square.
Level: 1 to 10 Vrms
Impedance: 5 kΩ.



Ext Ref Input

Synthesizer Reference Output Signal
TTL 1 MHz pulse train (in synthesizer mode only).

FREQUENCY PRECISION

Synthesizer Mode
Accuracy: 0.005% of setting.

Range	Digital Resolution
1.000 Hz to 20 Hz	0.001 Hz
10.00 Hz to 200 Hz	0.01 Hz
100.0 Hz to 2 kHz	0.1 Hz
1.000 kHz to 20 kHz	1.0 Hz
10.00 kHz to 200 kHz	10 Hz
100.0 kHz to 2 MHz	100 Hz

Locking Time: Within .01% of final frequency in <300 ms on ×1K, ×10K, ×100K and ×1M range.

Function Generator Mode
Dial Accuracy: ±3% of full scale for 0.1 Hz to 2 kHz. ±5% of full scale to 2 MHz.
Time Symmetry: ±1% on all ranges except ×1M range.

AMPLITUDE PRECISION

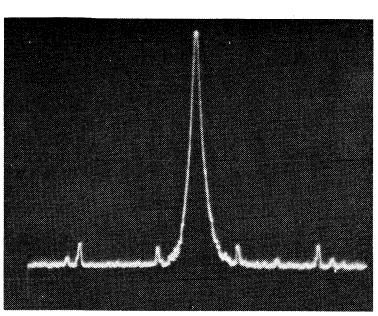
Amplitude Change With Frequency
Sine variation less than:
±0.1 dB for 0.1 Hz to 200 kHz.
±0.5 dB for 200 kHz to 2 MHz.

Step Attenuator Accuracy
±0.3 dB per 20 dB step.

WAVEFORM CHARACTERISTICS

Sine Distortion
Less than:
0.5% for 0.1 Hz to 20 kHz.
1.0% for 20 kHz to 200 kHz.
All harmonics 30 dB below fundamental on ×1 MHz range.

Spurious Signals
Typically 70 dB below fundamental to 20 kHz and 40 dB below fundamental to 2 MHz (in synthesizer mode only).



Typical Spectral Purity in the Synthesizer Mode

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
Greater than 99% to 200 kHz.

Square Wave Rise and Fall Time
Less than 75 ns.

TTL Pulse Rise and Fall Time
Less than 25 ns (15 ns typical).

GENERAL

Synthesizer Stability
Frequency: 1 ppm/°C.
Internal Crystal Frequency: 4 MHz.
Aging Rate: 20 ppm/year.

Function Generator Stability
Amplitude, dc offset and frequency.
Short Term: ±0.05% for 10 minutes.
Long Term: ±0.25% for 24 hours.

Environment
Specifications apply at 25°C ±5°C. Instrument will operate from 0°C to +50°C.

Dimensions
28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 27.3 cm (10¾ in.) deep.

Weight
3.9 kg (8.5 lb) net; 5.5 kg (12 lb) shipping.

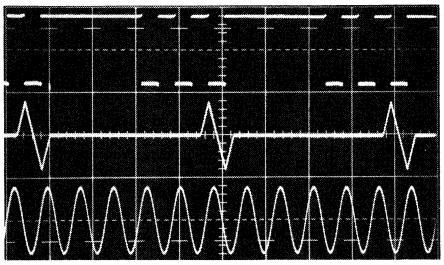
Power
90 to 110V, 105 to 125V, 180 to 220V or 210 to 250V; 50 to 400 Hz; less than 20 VA.

NOTE: All specifications apply when frequency dial is between 0.1 and 2.0 or digital switch is between 0.1000 and 1.9999, amplitude is at 10 Vp-p and output is from the 50Ω BNC into a 50Ω load.

FACTORY/FOB

San Diego, CA

4 MHz Function Generators



- **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 (188)**

Wide Frequency Range
Models 182A and 188 cover a wide 4 mHz to 4 MHz frequency span in seven overlapping ranges. Each multiplier setting gives a full 1000:1 frequency band.

In addition, the Model 188 also has a 10,000:1 logarithmic frequency range.

Trigger and Gate
In triggered mode, your manual or external TTL signal initiates a single waveform cycle. Gated mode is similar except there is a burst of waveform cycles for the duration of the signal.

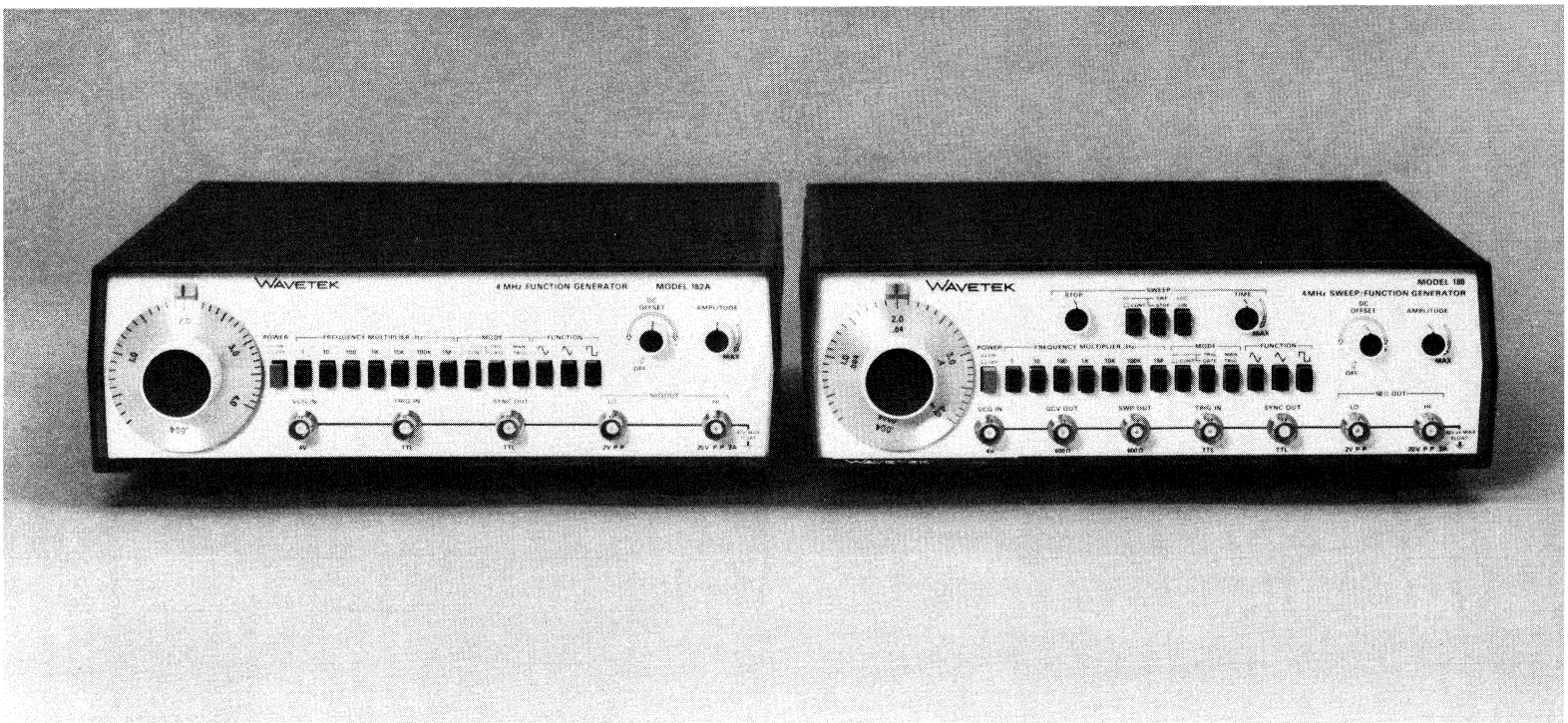
Sweep (Model 188)
In addition to trigger and gates modes, Model 188 has a ramp generator to sweep its main generator. With sweep, the output frequency repeatedly sweeps up at the desired rate in a selected linear (3 decades) or logarithmic (4 decades) mode.

Output
High level output is a full 20 volts peak-to-peak from a 50Ω termination) with maximum peak current of 100 milliamperes. This high power output allows you to drive low impedance and capacitive loads without saturating or degenerating the waveform output. In addition to high level output, both instruments have a low level (down 20 dB from the high level) output. Both outputs can be varied a full 30 dB.

Voltage Controlled Generator
You can externally modulate or sweep the generator frequency in each of its 1000:1 ranges with dc or ac signals. (Model 188 range is 10,000:1 in logarithmic mode.) For example, you can sweep the entire 40 Hz to 40 kHz audio band without switching ranges.

DC Offset With Calibrated Zero
Convenient front panel dc offset control lets you easily raise or lower the output waveform with respect to normal signal ground. Turning the DC offset switch off balances the waveform at a calibrated zero offset.

TTL Pulse Output
For your convenience, these models have an auxiliary TTL pulse output at generator frequency for synchronization or for digital applications.



MODELS 182A & 188 FUNCTION GENERATORS

VERSATILITY

Waveforms
Sine ∿ , triangle △ , square ⊓ , TTL pulse ⎍ and dc.

Operational 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 starting at 0° and at selected frequency.
Gated: As triggered mode, except output continues for duration of gate signal. Last waveform started is completed.
Sweep: (188 only.) Recurring low-to-high frequency oscillation. Range, rate and mode (linear or logarithmic) selectable.
Sweep Stop: (188 only.) Frequency sweeps to high sweep limit. Used to set high frequency limit.

Frequency Range
0.004 Hz to 4 MHz in 7 overlapping decade ranges.

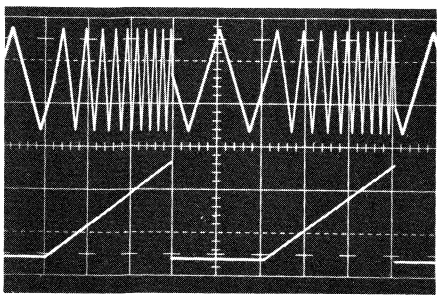
Function Output (50Ω OUT)
∿ , ⊓ , △ selectable and variable to 20 Vp-p (10 Vp-p into 50Ω) HI output, and to 2 Vp-p (1 Vp-p into 50Ω) LO output. Both outputs varied with a 30 dB vernier. Peak output current is 100 mA maximum (HI output). Source impedance is 50Ω.

DC Offset and DC Output
Waveform offset and dc output selectable and variable through HI and LO BNC outputs. DC output selectable by not selecting a waveform function. HI output is ±10V max (±5V into 50Ω) as offset or Vdc output. Signal- peak plus offset limited to ±10V (±5V into 50Ω). LO output is ±1V max (±0.5V into 50Ω) as is signal- peak plus offset limit. DC offset plus waveform attenuated proportionately at LO (−20 dB) output.

TTL Pulse Output
TTL pulse (50% duty cycle) at generator frequency. Drives up to 20 TTL loads.

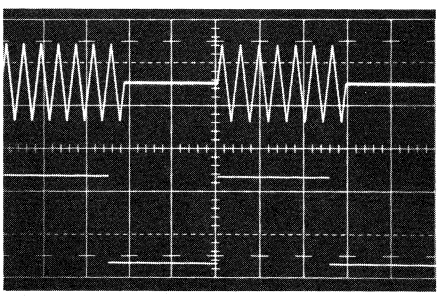
GCV—Generator Controlled Voltage
(188 only.) 0 to 4V open circuit output from 600Ω source impedance. Proportional to frequency of main generator. For use as a horizontal drive signal.

VCG—Voltage Controlled Generator
With external 0 to ±4V signal:
Linear Mode: Up to 1000:1 frequency change.
Log Mode: (188 only.) Up to 10,000:1 change. Upper and lower frequencies limited to maximum and minimum of selected range.
Slew Rate: 2% of range per μs (linear); 0 to 100% of range in 20 ms (logarithmic).
Linearity: ±0.5% thru ×100K range; ±2% on ×1M range.
Input Impedance: 2 kΩ.



VCG Input (lower) and Generator Output

Trigger and Gate
Input: TTL compatible levels.
Pulse Width: 50 ns minimum.
Repetition Rate: 4 MHz maximum.



Trigger Input (lower) and Generator Output

Sweep (188)
Main generator is frequency modulated by internal sweep generator. Main generator frequency repeatedly rises from frequency set by dial and range button to frequency set by sweep stop knob.
Sweep Mode: Linear (3 decades max) or logarithmic (4 decades max).
Sweep Rate: 30 ms to 1 min (nominal) continuously adjustable.
Sweep Width: Up to 1:1000 (linear) or 1:10,000 (logarithmic) continuously adjustable.

Sweep Output (188)
Ramp waveform output with 4V peak into open circuit. For use as a horizontal drive signal.
Source Impedance: 600Ω.

FREQUENCY PRECISION

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 PRECISION

Sine variation (referenced to 1 kHz) with frequency—
On All Ranges Through ×100K: <±0.2 dB.
To 4 MHz: <±1.0 dB.

WAVEFORM CHARACTERISTICS

Sine Distortion
On Ranges—
×1K and ×10K: <0.5%.
×1, ×10, ×100 and ×100K: <1%.
X1M: All harmonics 25 dB below fundamental.

Triangle Linearity
Greater than 99% to 200 kHz.

Square Wave Rise and Fall Time
At HI output, less than 50 ns for 10 Vp-p output into 50Ω termination.

GENERAL

Environment
Specifications apply at 25°C ±5°C. Instrument will operate from 0°C to 50°C ambient temperatures.

Dimensions
28.6 cm (11¼ in.) wide; 8.9 cm (3½ in.) high; 26.7 cm (10½ in.) deep.

Weight
182A: 2.5 kg (5.4 lb) net; 3.6 kg (8 lb) shipping.
188: 2.5 kg (5.4 lb) net; 3.6 kg (8 lb) shipping.

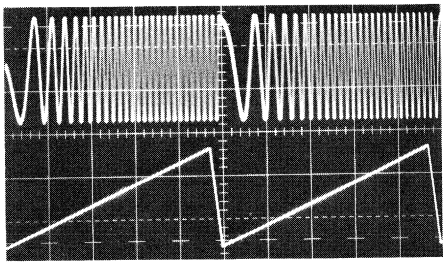
Power
90 to 128V or 198 to 256V (selectable); 48 to 66 Hz; less than 15 VA.

NOTE: All specifications apply for dial between 0.2 to 4.0; amplitude at 10 Vp-p from HI output into 50Ω termination.

FACTORY/FOB

San Diego, CA

5 MHz Sweep Generators



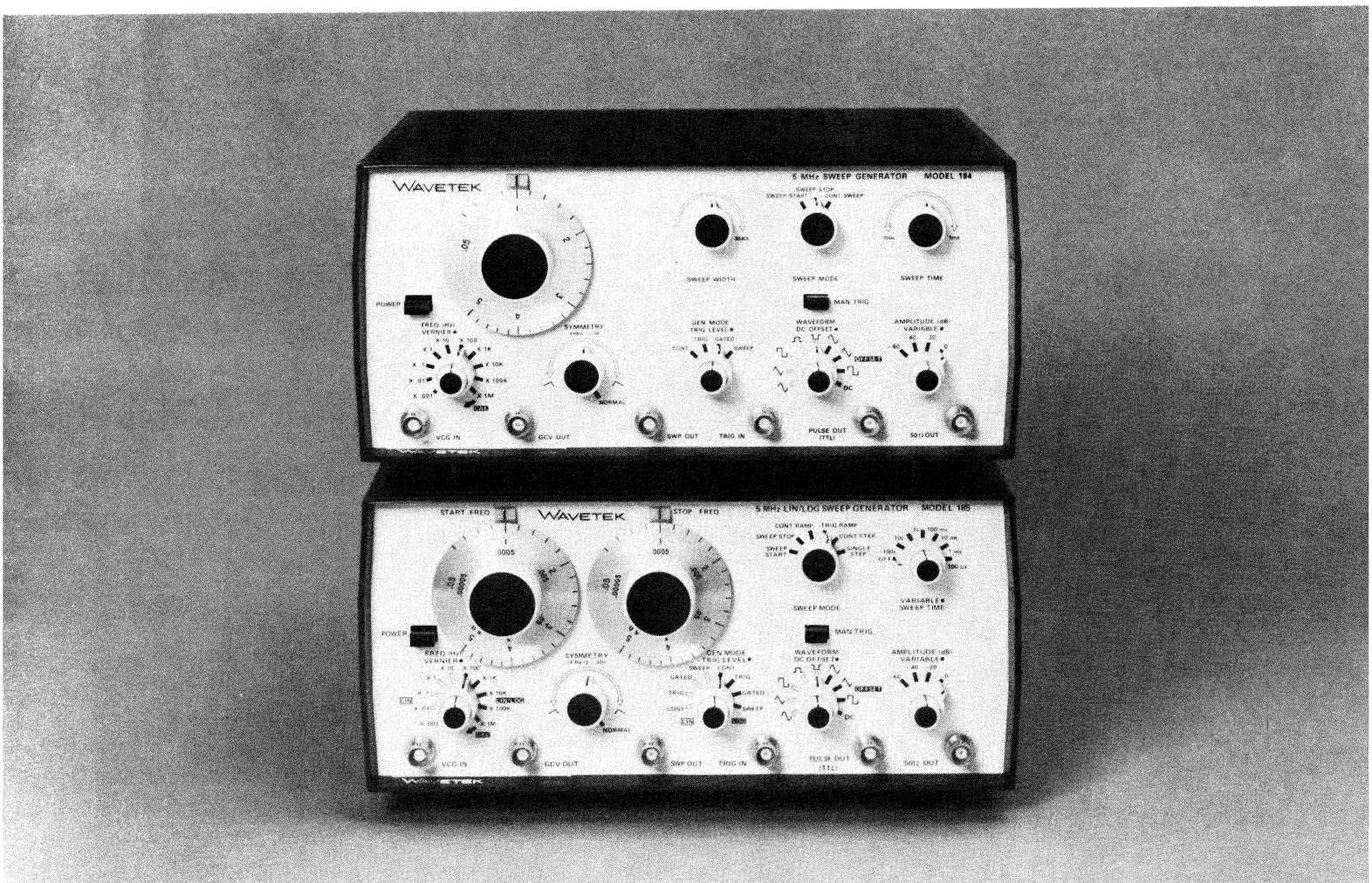
- **0.0001 Hz to 5 MHz Frequency Range**
- **Linear or Logarithmic Sweep (Model 185)**
- **Triggered and Gated Output**
- **20 Volt Peak-to-Peak Output with 80 dB Attenuation Control**

Sweep Features
Models 184 and 185 operate over the broad 0.0001 Hz to 5 MHz frequency range with linear rate sweeps to 1000:1 in 10 ranges. Model 185 has, in addition, logarithmic sweep of 100,000:1 in its upper five ranges. Sweep and end points are easily set by front panel controls. Model 185 end points are set by calibrated dials and sweep may be high-to-low frequencies as well as the conventional low-to-high. Model 185 offers step sweep. Selected sweep range is automatically divided into ten equal frequency steps, which are sequenced automatically or by pushbutton.

Waveforms and Modes
Both models offer sine, triangle, square, positive pulse and negative pulse waveforms with controllable dc offset and continuous waveform symmetry control.

Besides sweep modes, continuous output, triggered single cycles and gated bursts of cycles are available. Triggering can be by front panel pushbutton or external signal.

20 Vp-p Amplitude
Output amplitude is 20 volts peak-to-peak (50Ω source into open circuit) or 10 volts peak-to-peak into 50Ω. You can attenuate the output to 80 dB for signal levels down to 1 mV.



VERSATILITY

Waveforms
Sine ∿, square ⊓, triangle △, positive pulse ⎍, negative pulse ⎎, ramp ◿, and dc.

Operating Modes
Continuous output.
Triggered waveform cycle.
Gated bursts of cycles.
Sweep of recurring low-to-high or (Model 185 only) high-to-low frequency. Range and rate selectable.

Frequency Range
0.0001 Hz to 5 MHz in 10 overlapping linear ranges.
(Model 185 only) 0.005 Hz to 5 MHz in 5 overlapping logarithmic ranges.
Dial and vernier gives 3 decades of frequency per linear range and (Model 185 only) 5 decades per logarithmic range.

Main Output
∿, ⊓, △ selectable and variable to 20 Vp-p max (10 Vp-p into 50Ω). ⎍, ⎎ selectable and variable to ±10V max (±5V into 50Ω). Voltage attenuation 0 to 80 dB: to 60 dB in 20 dB steps plus 20 dB vernier. Output impedance 50Ω.

DC Offset and DC Output
Waveform offset and dc output selectable through 50Ω output. Adjustable between ±10V max (±5V into 50Ω load) as offset or Vdc output. Signal peak plus dc offset limited to ±10V (±5V into 50Ω). DC offset and output are attenuated proportionately by the attenuator.

TTL Pulse Output
TTL pulse at generator frequency; rise and fall time typically 15 ns. Symmetry variable. Drives up to 20 TTL loads.

Model 184 Sweep
Linear (3 decades max) and sweep up.
Sweep Time: 100s to 1 ms; continuously adjustable.
Sweep Width: Up to 1000:1 adjustable on all ranges.
Sweep Start and Stop: Adjustable throughout each of 10 ranges.

Model 185 Sweep
Linear (3 decades max) or logarithmic (5 decades max); sweep up or down; continuous, in series of 10 steps, or triggered for one sweep or one step.
Sweep Start and Stop: Set by calibrated independent controls.
Sweep Time: 100 μs to 100s.

Sweep Output
◿ or (Model 185 only) ⌐ ; +7.5 peak (open circuit) 600Ω source.

GCV—Generator Control Voltage
0 to +5V open circuit output proportional to frequency of main generator; 1 kΩ impedance. For use as a horizontal drive signal.

VCG—Voltage Controlled Generator
Up to 1000:1 (linear) 100,000:1 (log, Model 185 only) frequency change with external 0 to ±5V signal. Upper frequency is limited to maximum of selected range.
Input Impedance: 5 kΩ (Model 184) 10 kΩ (Model 185).
Linear Slew Rate: 2% of range per μs.
Linearity: 0.5% for 0.0001 Hz to 50 kHz.
Logarithmic Slew Rate: (Model 185 only) 0 to 80% of range in 40 μs; 80 to 100% of range in 200 μs.
Logarithmic Response: (Model 185 only) Approximately 1 decade per volt.

Symmetry Control
Symmetry of waveform is continuously adjustable from 1:19 to 19:1 for variable duty cycle pulses and sawtooth ramps.

NOTE: When SYMMETRY control is used, indicated frequency is divided by approximately 10.

Trigger and Gate
Input Range: 1 Vp-p ±10V.
Impedance: 10 kΩ, 33 pF.
Pulse Width: 50 μs min.
Repetition Rate: 5 MHz max.

FREQUENCY PRECISION

Dial Accuracy
±2% of full scale for 0.005 Hz to 5 MHz.
±4% of reading and ±2% of full scale for 0.0005 to 0.005 Hz.

Time Symmetry
±1% for 0.005 Hz to 500 kHz.

AMPLITUDE PRECISION

Amplitude Change With Frequency
Sine variation less than:
±0.1 dB of 0 to 100 kHz.
±0.2 dB for 100 kHz to 1 MHz.
±1.0 dB for 1 to 5 MHz.

Amplitude Symmetry
1% of amplitude range for 0 to 1 MHz.

Step Attenuator Accuracy
±0.3 dB per 20 dB step.

WAVEFORM CHARACTERISTICS

Sine Distortion
Less than:
0.5% for 10 Hz to 50 kHz.
1.0% for 0.005 Hz to 500 kHz.
All harmonics at least 30 dB down for ×1 MHz range.

Triangle Linearity
Greater than 99% for 0.0005 Hz to 100 kHz.

Square Wave Rise and Fall Time
Less than 30 ns terminated into 50Ω load.

GENERAL

Stability
Amplitude, dc offset and frequency in linear mode.
Short Term: ±0.05% for 10 min.
Long Term: ±0.25% for 24 hours.

Environment
Specifications apply at 25°C ±5°C. Instrument will operate from 0°C to +50°C.

Dimensions
28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 27.3 cm (10¾ in.) deep.

Weight
3.9 kg (8.5 lb) net; 5.5 kg (12 lb) shipping.

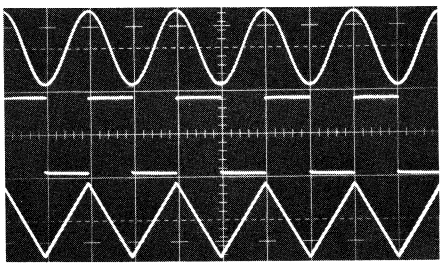
Power
90 to 110V, 105 to 125V, 180 to 220V or 210 to 250V; 50 to 400 Hz; less than 25 VA.

NOTE: Specifications apply from 10 to 100% of a selected frequency range with SYMMETRY control to NORMAL. Symmetry and vernier affect frequency calibration. Maximum possible asymmetry is dependent upon frequency setting.

FACTORY/FOB

San Diego, CA

20 MHz Function Generator



- **0.002 Hz to 20 MHz Frequency Range**
- **Triggered and Gated Modes**
- **30 Volt Peak-to-Peak Output**
- **DC Offset with Calibrated Zero**
- **Symmetry Control**

Frequency Range

Model 190 covers a wide 2 mHz (500 second periods) to 20 MHz frequency span in nine overlapping ranges. Each multiplier setting gives you a full 1000:1 frequency band with calibrated dial and voltage control of frequency throughout.

Triggered and Gated Waveforms

Three generator modes give the Model 190 operating versatility. In continuous mode, the waveform is generated repetitively at the selected frequency. Or, you can select triggered mode and the generator remains quiescent at a dc baseline until your external signal or manual trigger initiates a single waveform cycle. The third mode, gated is similar to triggered except the generator produces a burst of waveform cycles for the duration of the manual or external signal.

High Power Output

The high level output is a full 30 volts peak-to-peak from a 50Ω source (15 Vp-p into 50Ω) with a maximum peak current of 150 milliamperes. This high power output allows you to drive low impedance and capacitive loads without saturating or degenerating the waveform output. Output can also be exactly attenuated down to 80 dB for your precise signal requirement.

Voltage Controlled Generator Frequency

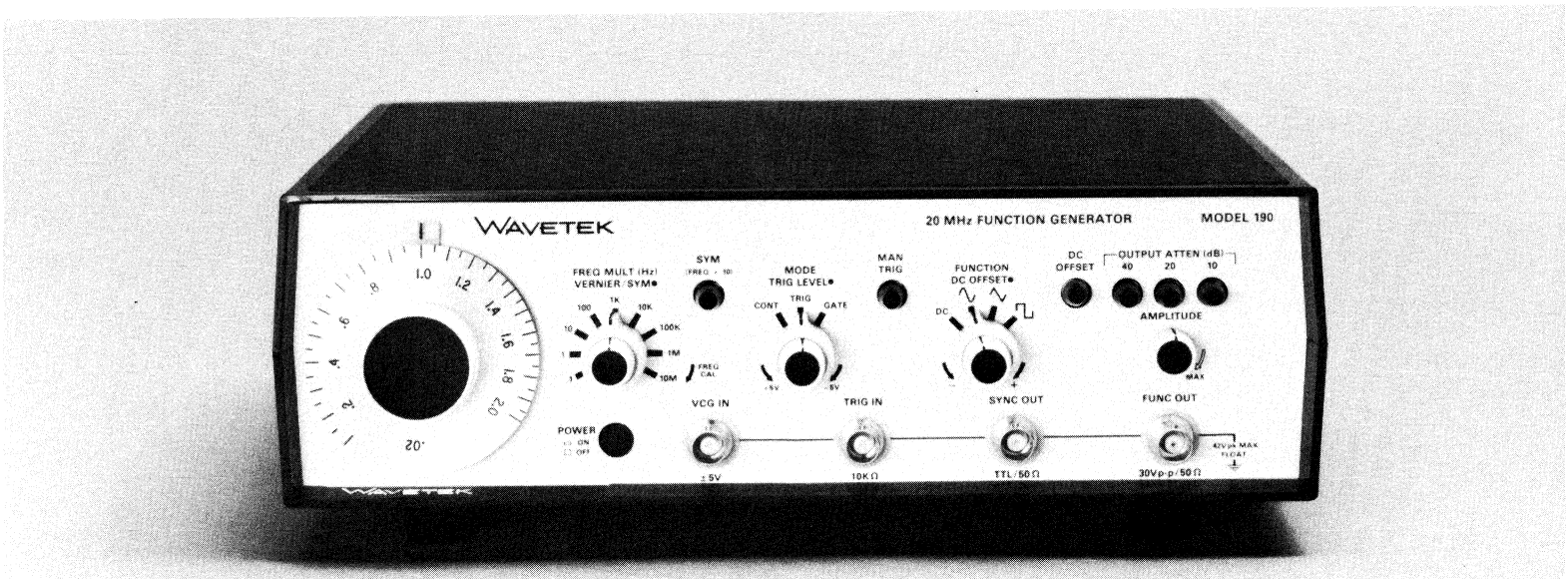
You can externally modulate or sweep the generator frequency in each of its 1000:1 ranges with dc or ac signals. For example, you can sweep the entire 20 Hz to 20 kHz audio band without switching ranges.

DC Offset With Calibrated Zero

Convenient front panel dc offset control lets you raise or lower the output waveform with respect to signal ground. You don't have to use an oscilloscope every time you want a balanced waveform; the 190 gives you a calibrated zero dc offset position.

Variable Symmetry

In addition to the sine, square and triangle waveforms, variable symmetry gives sawtooth ramps, pulses and nonsymmetrical sine waves with symmetry ratios up to 19:1. You can use these waveforms when you need pulses with variable duty cycle or ramps with variable rise/fall ratios.



MODEL 190 FUNCTION GENERATORS

VERSATILITY

Waveforms
Selectable sine ∿ , triangle △ , square ⊓ , and dc with TTL sync.

Symmetry
With SYM on, waveforms may be varied to produce sawtooth ◿ and variable duty cycle pulse ⊓ from 1:19 to 19:1.

When SYMMETRY control is used, indicated frequency is divided by approximately 10.

Operational Modes
Continuous: Generator oscillates continuously at selected frequency.
Triggered: Generator is quiescent until triggered by external signal or manual trigger, then generates one cycle at selected frequency.
Gated: As triggered mode, except generator oscillates for the duration of gate signal plus time to complete the last cycle.

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

Function Output
∿ , ⊓ , △ selectable and variable to 30 Vp-p (15 Vp-p into 50Ω). 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. 50Ω source impedance.

DC Output and DC Offset
Selectable through function output BNC. Controlled by front panel control with separate on-off switch. Adjustable between ±15 Vdc (±7.5 Vdc into 50Ω) with 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.

Sync Output
A TTL level pulse when terminated with 50Ω. Duty cycle varies with symmetry. 50Ω source impedance.

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.
Slew Rate: 2% of range per μs.
Linearity: ±0.5% through ×100K range. ±5% on ×1M and ×10M ranges.
Impedance: 10 kΩ.

Trigger (and Gate) Input
Input Range: 1 Vp-p to ±10V.
Trigger Level Adj: −5V to +5V.
Impedance: 1.5 kΩ shunted by 1.5 pF.
Pulse Width: 25 ns min.
Repetition Rate:

Input	Max Rep Rate
±1V	1 MHz
±2.5V	10 MHz

FREQUENCY PRECISION

Dial Accuracy
×0.1 Hz to ×1 MHz Range: ±3% of full scale.
×10M Range: ±5% of full scale.

AMPLITUDE PRECISION

Amplitude Change with Frequency
Sine variation with frequency:
All Ranges Through ×100K: <±0.2 dB.
×1M Range: <±0.5 dB.
×10M Range: <±1.5 dB.

Step Attenuator Accuracy
10, 20 and 40 dB Attenuator Setting: ±0.3 dB.
30, 50 and 60 dB Attenuator Setting: ±0.6 dB.
70 dB Attenuator Setting: ±0.9 dB.

WAVEFORM CHARACTERISTICS

Sine Distortion
×1K and ×10K Ranges: <0.5%.
×0.1 to ×100, and ×100K Ranges: <1.0%.
×1M Range: All harmonics 30 dB below fundamental.
×10M 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%.

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 25°C ±5°C. Instrument operates from 0°C to +50°C.

Dimensions
28.6 cm (11¼ in.) wide; 8.9 cm (3½ in.) high; 28.6 cm (11¼ in.) deep.

Weight
3.5 kg (7.7 lb) net; 4.5 kg (10 lb) shipping.

Power
100/120/220/240V (+5%, −10%), 48 Hz to 66 Hz, 70 VA.

NOTE All specifications apply from 0.1 to 2.0 on frequency dial, when FUNC OUT is maximum and 50Ω terminated, and with SYM control OFF.

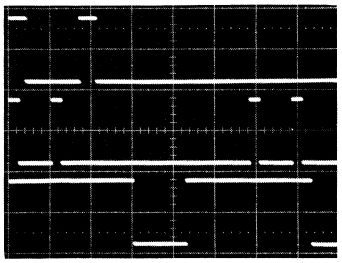
SYMMETRY and VERNIER controls affect frequency calibration. Maximum possible asymmetry is a function of frequency setting.

When SYMMETRY control is used, indicated frequency is divided by approximately 10.

FACTORY/FOB

San Diego, CA

20 MHz Pulse/Function Generator



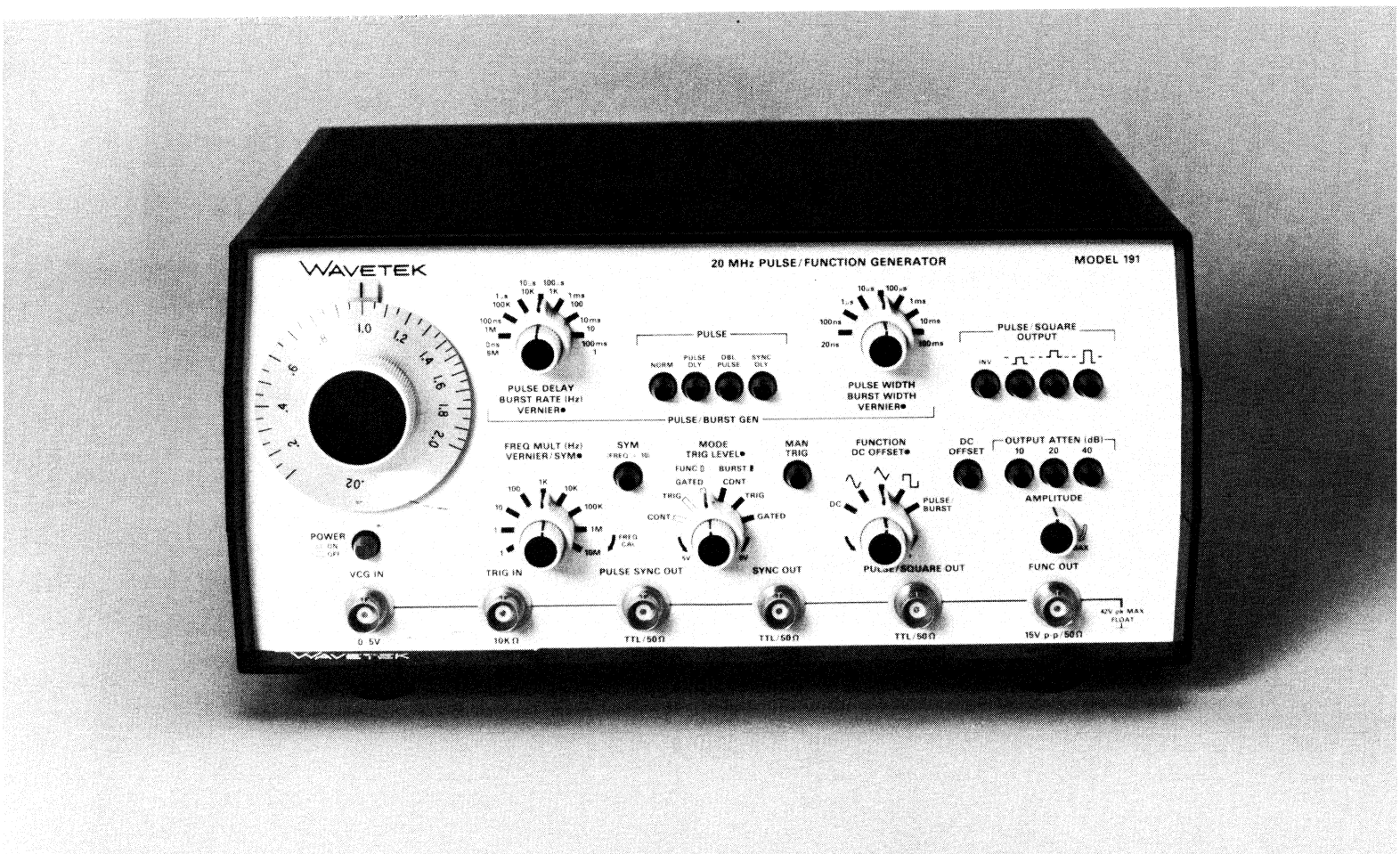
- **0.002 Hz to 20 MHz Frequency Range**
- **Versatile Pulse and Burst Modes**
- **Full Function Generator Performance**
- **Triggered and Gated Bursts with Rate and Width Control**
- **Full 30 Volts Peak-to-Peak Output**

Burst and Pulse Control
In one instrument, Model 191 gives you a function generator with complete burst control—and a pulse generator. A 0.002 to 20 MHz frequency range main generator with a built-in combination burst/pulse generator gives you more than the usual pulse/function generator.

Burst Versatility
A burst of any number of waveforms can now be thought of as a waveform itself. The burst can be triggered, it can be gated, or it can run at a 1 Hz to 5 MHz rate continuously. Remember, internally, the burst itself can be any waveform running at any rate.

Pulse Format
A wide range of pulse formats allow many pulse timing and amplitude designs for your testing needs. For example, delays of either the pulse or its sync signal of up to 100 milliseconds; double pulse separation to 100 milliseconds; fixed baselines at pulse upper level, midpoint or lower level for amplitude control to 30 Vp-p; Widths 20 ns to 100 ms and continuous, triggered and gated modes.

These capabilities make the 191 an extremely versatile instrument for engineering, manufacturing and laboratory applications.



MAIN GENERATOR

Waveforms
Selectable sine, triangle, square, pulses, double pulses and dc.

Symmetry
With SYM on, waveforms may be varied to produce sawtooth and variable duty cycle pulse from 1:19 to 19:1.

Operational Modes

Function

Continuous: Generator oscillates continuously at selected frequency.

Triggered: Generator is triggered by external signal or manual trigger, then generates one cycle.

Gated: As triggered mode, except generator oscillates for duration of gate signal plus time to complete the last cycle.

Burst
Internal burst generator gates main generator and operates in continuous, triggered and gated modes.

Burst Rate: 1 Hz to 5 MHz in 7 ranges.

Burst Width: 20 ns to 100 ms in 7 ranges.

Frequency Range
0.002 Hz to 20 MHz in 9 overlapping decade ranges with 1% vernier.

Function Output
, , and pulse selectable. Amplitude variable to 30 Vp-p (15 Vp-p into 50Ω). Pulse and : baseline selectable (, ,), amplitude variable from baseline, and can be inverted. , can be varied to 15 Vp-p (7.5 Vp-p into 50Ω). 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. 50Ω source impedance.

DC Output and DC Offset
Adjustable between ±15 Vdc (±7.5 Vdc into 50Ω) with 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.

Sync Output
A TTL level pulse when terminated with 50Ω. Duty cycle varies with symmetry control. 50Ω source impedance.

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.

Slew Rate: 2% of range per μs.

Linearity: ±0.5% thru ×100K range. ±5% on ×1M and ×10M ranges.

Impedance: 10 kΩ.

Trigger (and Gate) Input

Input Range: 1 Vp-p to ±10V.

Trigger Level Adj: −5V to +5V.

Impedance: 1.5 kΩ shunted by 1.5 pF.

Pulse Width: 25 ns minimum

Repetition Rate:

Input	Max Rep Rate
±1V	1 MHz
±2.5V	10 MHz

PULSE GENERATOR

Pulse Modes

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.

Sync Delay: Pulse sync output delayed with respect to pulse output.

Function modes of Continuous, Triggered and Gated, but not Burst, also applicable.

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.
50% for pulse widths of 20 to 100 ns.

Pulse/Burst Sync Output
TTL level pulse when terminated with 50Ω. Reference for pulses and bursts at function output BNC and TTL pulse BNC.
In pulse function mode (normal pulse) and burst mode, sync output is coincident with leading edge of pulse/burst output and has width of at least 20% to 60% of minimum selected pulse/burst width except on the 20 to 100 ns range, which will have a sync pulse width of 10 ns to 30 ns.

Also see Pulse Modes.

FREQUENCY PRECISION

Dial Accuracy
±3% of full scale from ×0.1 Hz to ×1 MHz.
±5% of full scale on ×10M range.

AMPLITUDE PRECISION

Amplitude Change with Frequency
Sine variation with frequency:
<±0.2 dB on all ranges through ×100K.
<±0.5 dB on ×1M range.
<±1.0 dB on ×10M range.

Step Attenuator Accuracy
±0.3 dB with 10, 20 and 40 dB.
±0.6 dB with 30, 50 and 60 dB.
±0.9 dB with 70 dB setting.

WAVEFORM CHARACTERISTICS

Sine Distortion
<0.5% on ×1K and ×10K Ranges.
<1.0% on ×0.1 to ×100, and ×100K ranges.

All harmonics 30 dB below fundamental on ×1M range, and 25 dB below fundamental on ×10M 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).

Time Symmetry
Square wave variation from 0.1 to 2 on dial:
<1% to 200 kHz.
<10% to 20 MHz.

Triangle Linearity
>99% for 0.002 Hz to 200 kHz.

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 25°C ±5°.
Instrument operates 0° to +50°C.

Dimensions
28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 28.6 cm (11¼ 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, ≤50 VA.

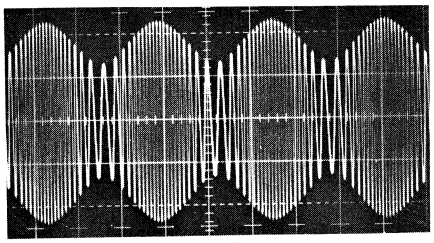
NOTE: All specifications apply from 0.1 to 2.0 on frequency dial, when FUNC OUT amplitude is maximum and 50Ω terminated, and with SYM control OFF.

When SYM control is used, indicated frequency is divided by approximately 10.

FACTORY/FOB

San Diego, CA

20 MHz Sweep/Modulation Generator



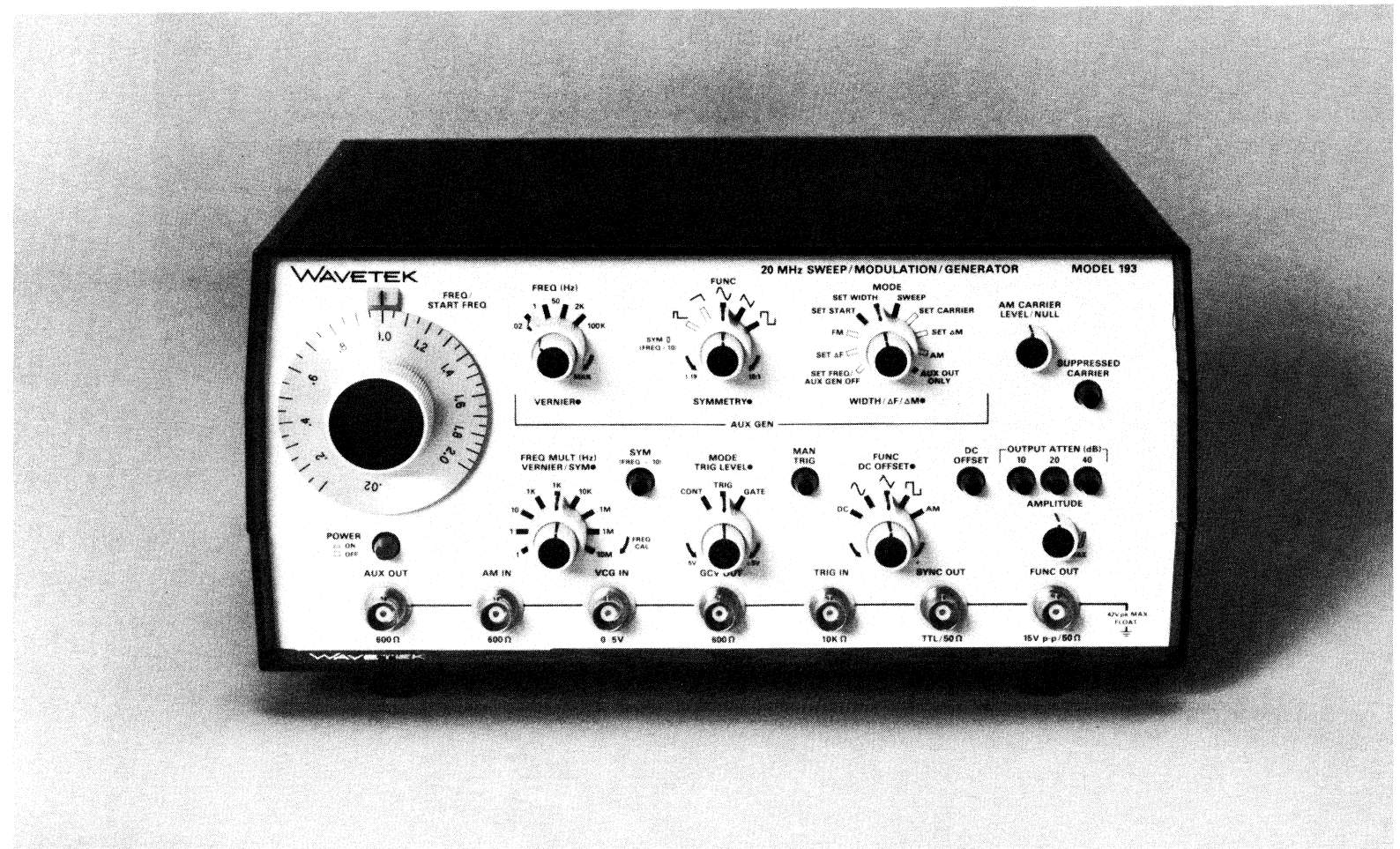
- **0.002 Hz to 20 MHz Frequency Range**
- **Independent Auxiliary Function Generator for AM, FM and Sweep Operation**
- **Static Setting of Modulation Parameters**
- **30 Volt Peak-to-Peak Output**

Sweep/Modulation
Model 193, a full 0.002 Hz to 20 MHz Generator, gives you sweep, frequency modulation and suppressed carrier modulation — all with precision waveforms from two independent function generators. The two generators each have sine, triangle and square waveforms with symmetry control. The main generator can be triggered and gated for single cycle or bursts of output.

Convenient Setups
Each modulation parameter has a static setup feature to allow its exact selection. Independently set these parameters: sweep start and width, AM carrier level and modulation level, suppressed carrier null, and FM center frequency deviation.

Auxiliary Generator
The auxiliary generator, in addition to being an internal modulation generator, can be independently used with its own ouput. This generator has its own waveforms, with symmetry control, and can be frequency modulated by an external signal. As an independent generator, it can be used to externally AM or FM the main generator in modes not available internally; for example, frequency shift keying.

30V Peak-to-Peak Output
The output amplifier provides up to 30V peak-to-peak amplitude from a 50Ω source. Zero to 80 dB attenuation lets you select signals down to 1.5 mV.



MODEL 193 FUNCTION GENERATORS

MAIN GENERATOR

Waveforms
Selectable sine ∿ , triangle ∿ , square ⊓ , AM sine ◇◇ and dc.

Symmetry
Symmetry control produces sawtooth ◿ and variable duty cycle pulse ⊓ from 1:19 to 19:1.*

Operational Modes
Continuous, triggered and gated.

Frequency Range
0.002 Hz to 20 MHz.

Function Output
Waveforms variable to 30 Vp-p (15 Vp-p into 50Ω). Waveforms may be attenuated continuously to 80 dB. 50Ω source impedance.

DC Output and DC Offset
Adjustable between ±15 Vdc (±7.5 Vdc into 50 Ω) with signal peak plus dc offset limited to ±15 Vdc (±7.5 Vdc into 50Ω). DC offset and waveform attenuated proportionately 10 dB/step to 70 dB.

Func Sync Output
TTL level pulse into 50Ω. Duty cycle varies with SYM control. 50Ω source impedance.

GCV Output
0 to +5V open circuit voltage level proportional to main generator frequency. 600Ω source impedance.

AM—Amplitude Modulation
External signal at AM IN (or external plus AUX GEN signal if AUX GEN AM selected) amplitude modulates main generator sine in selectable 0 to 100% AM or suppressed carrier modes.
AM Input: 5 Vp-p gives 100% modulation; 10 Vp-p gives suppressed carrier operation. 600Ω input impedance.
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.

VCG—Voltage Controlled Generator
Up to 1000:1 frequency change with external 0 to ±5V signal. Upper frequency limited to max. of range.
Slew Rate: 2% of range per μs.
Linearity: ±0.5% through ×100K range; ±5% on ×1M and ×10M.
Impedance: 10 kΩ.

Trigger Input
Input Range: 1 Vp-p to ±10V.
Trigger Level Adj: −5V to +5V.
Impedance: 1.5 kΩ shunted by 1.5 pF.
Pulse Width: 25 ns minimum.
Repetition Rate:

Input	Max Rep Rate
±1V	1 MHz
±2.5V	10 MHz

FREQUENCY PRECISION

Dial Accuracy
×0.1 Hz to ×1 MHz: ±3% of full scale.
×10M Range: ±5% of full scale.

AMPLITUDE PRECISION

Sine Frequency Response
All Ranges through ×100K: <±0.2 dB.
×1M Range: <±0.5 dB.
×10M Range: <±1.5 dB.
Step Attenuator Accuracy
10, 20 and 40 dB Setting: ±0.3 dB.
30, 50 and 60 dB Setting: ±0.6 dB.
70 dB Setting: ±0.9 dB.

WAVEFORM CHARACTERISTICS

Sine Distortion
×1K and ×10K Ranges: <0.5%.
×0.1 and ×100 Ranges: <1.0%.
×100K, ×1M Range: All harmonics 30 dB below fundamental.
×10M 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%.

AUXILIARY GENERATOR

Waveforms
Selectable ∿ , ∿ , ⊓ , ◿ and ⊓. Symmetry of ◿ and ⊓ adjustable 1:19 thru 19:1.*
Frequency Range
0.1 Hz to 100 kHz in 4 ranges.*
Auxiliary Output
Waveforms selectable and variable to 10 Vp-p (5 Vp-p into 600Ω).
Auxiliary Sync Output
Rear panel BNC. TTL level pulse coincident with AUX GEN output. Duty cycle varies with symmetry control.
AUX VCG Input
Rear Panel BNC. Up to 33:1 frequency change with external ±5V signal. Upper frequency limited to maximum of selected range. 11 kΩ input impedance.

MODES OF OPERATION

Internal auxiliary generator used as the modulation source.
FM
Two setup and one operate mode.
Set-Freq/Aux-Gen-Off: Disables auxiliary generator for main generator adjustment.
Set ΔF: Allows vernier setup of peak deviation. Vernier range is up to ±10% of main generator range.
FM: Operate mode.
Sweep
Two setup and one operate mode.
Set Start: Allows setup of main generator start frequency.
Set Width: Allows vernier setup of main generator stop frequency.
Sweep: Operate mode.
AM
Two setup and one operate mode for double sideband or suppressed carrier operation.
Set Carrier: Allows setup of carrier amplitude.
Set ΔM: Allows the setup of the modulation level.
AM: Operate mode. 0 to 100% AM or suppressed carrier modulation of main generator by auxiliary generator plus external signal if present at AM IN.
Aux Out Only: Disconnects the modulator for independent operaton of auxiliary generator.

GENERAL

Stability
Amplitude, frequency and dc offset at FUNC output after 2 hour warm-up:
±0.05% for 10 minutes.
±0.25% for 24 hours.
Environment
Specifications apply at 25°C ±5°C.
Operates 0°C to +50°C.
Dimensions
28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 28.6 cm (11¼ in.) deep.
Weight
4.6 kg (10 lb) net; 5.9 kg (13 lb) shipping.
Power
100/120/220/240V (+5%, −10%), 48 to 66 Hz, ≤70 VA.

NOTE: All Specifications apply from 0.1 to 2.0 on frequency dial, when FUNC OUT amplitude is max and 50Ω terminated, and with SYM control OFF.

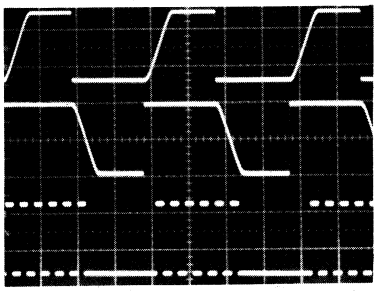
SYMMETRY and VERNIER controls affect frequency calibration. Maximum possible asymmetry is a function of frequency setting.

*In ◺ and ⊓ modes, indicated frequency is divided by approximately 10.

FACTORY/FOB

San Diego, CA

50 MHz Pulse Generator



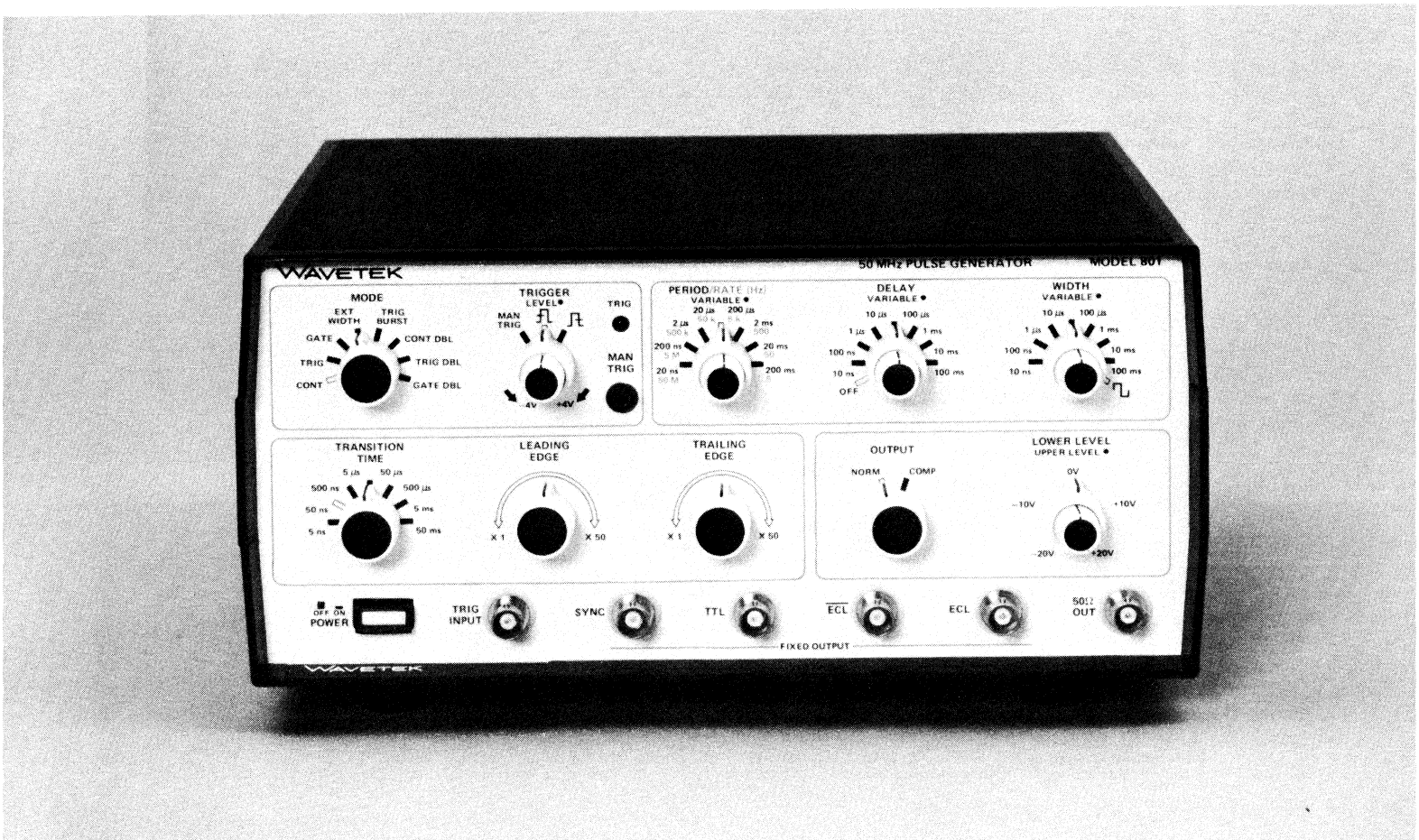
- **5 Hz to 50 MHz Frequency Range**
- **Variable Rise and Fall Times**
- **Full 20 Volt Output**
- **Single and Double Pulses**
- **Pulse Burst Output**

Multiple Outputs
The output circuits give you a variable amplitude pulse and, simultaneously, ECL, $\overline{\text{ECL}}$, TTL and sync pulses. 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. All outputs, the four fixed and one variable can be used simultaneously.

Triggering
Operating modes include continuous, triggered, gated, burst and external width. The external width mode allows you to reconstruct a noisy external pulse. Triggering is by front panel switch or an external signal. A front panel LED indicates trigger acceptance so you will know when the generator is receiving a valid trigger input. You can trigger and gate on the rising or falling edge of the trigger signal and adjust the acceptable trigger signal level.

Variable Rise and Fall
The rise and fall transition times of the pulse can be independently adjusted. The range of control is from 7 ns to 250 ms. Independent width and rate controls ensure that the 801 can generate the pulse that you need for your testing requirements.

Pulse Burst Output
The pulse burst capability of the 801 lets you generate variable length pulses. In this mode, an external trigger signal will start the output of the 801. The delay control lets you easily and accurately adjust the number of pulses that the generator will produce.



VERSATILITY

Five Simultaneous Pulse Outputs: Fixed level ECL, $\overline{\text{ECL}}$, TTL and sync pulses and a pulse with variable amplitude and variable rise/fall times. 5 Hz to 50 MHz frequency range (200 ms to 20 ns periods).

Operational Modes

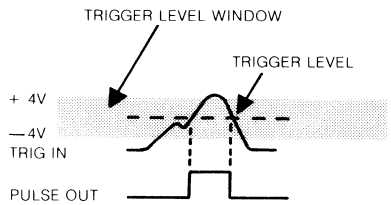
Continuous: Generator oscillates continuously at selected frequency.

Triggered: Generator quiescent until triggered by external signal or manually, then generates one pulse.

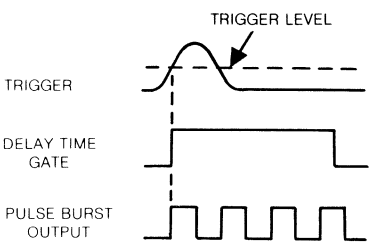
Gated: As triggered mode, except generator oscillates for the duration of the external signal.

Double Pulse: Continuous, trigger and gate as above, except two pulses for each period. Space between pulses of double pulse controlled by delay control. Double pulse at all outputs except sync.

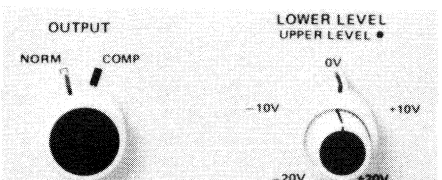
External Width: External signal at trigger input and trigger level control determine output pulse width and period as shown.



Trigger Burst: External trigger starts internal gate (delay time) for pulse burst as shown.



PULSE OUTPUTS



Pulse Controls

Variable Amplitude Pulse

Upper and lower pulse levels are independently adjustable.

Source Impedance: 50Ω.

Into Open Circuit:

Pulse Dynamic Range: ± 20V.
Max Pulse: 20 Vp-p.
Min Pulse: 1 Vp-p.

Into 50Ω Termination:

Pulse Dynamic Range: ± 10V
Max Pulse: 10 Vp-p.
Min Pulse: 0.5 Vp-p.

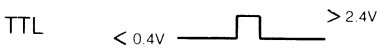
Overshoot and Ringing:

< ± (5% of amplitude setting + 100 mV) into 50Ω load.

Preshoot: < ± (5% of amplitude setting + 100 mV) into 50Ω load.

Fixed TTL Pulses

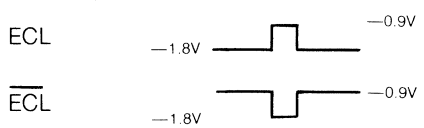
Pulse Levels for 50Ω Loading:



TTL Transition Time: <10 ns.

Fixed ECL, ECL Pulses

Pulse Levels with 50Ω Termination into — 2V:



ECL, $\overline{\text{ECL}}$ Transition Time: <6 ns.

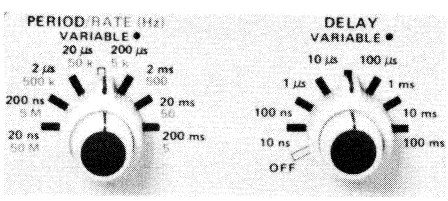
Sync Pulse

Sync pulse is 0 to at least + 1V from a 50Ω source.

Normal/Complement Control

Normal pulse or its complement is selected. The normally quiescent and active levels are reversed in complement format. This control affects all outputs except sync pulse.

TIME DOMAIN



Period and Delay Controls

Period Range: <20 ns to >200 ms in 7 overlapping ranges.

Period Jitter: <0.1% plus 50 ps.

Width

Width Range: <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. Range switch also has a square wave detent ( ).

Duty Cycle: 50 ± 4% to 2µs period changing to 50 ± 15% at 20 ns period.

Width Jitter: <0.1% plus 50 ps.

Sync Pulse Duty Cycle: 50 ± 4% of pulse period to 2µs period. Changes to 50% ± 15% at 20 ns, except in trigger and external width modes, where it is determined by the trigger signal.

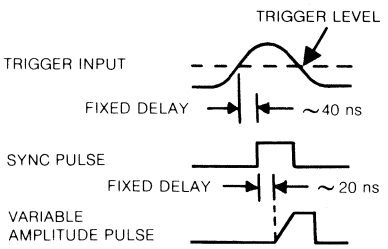
Delay

Pulse occurrence can be delayed from approximately 20 ns to 100 ms with respect to the sync pulse.

Max Duty Cycle: 70% for periods down to 200 ns, decreasing to 30% for 20 ns periods.

Delay Jitter: <0.1% plus 50 ps.

Fixed Delay:



Transition Time

For variable amplitude pulse only. Independently adustable leading and trailing edges from <7 ns (5 ns typical) to 250 ms in 7 overlapping decade ranges (measured from 10 to 90% points). Verniers give 50:1 adjustment on all ranges except 5 ns, which gives 25:1.

Linearity: ± 5% for transition >10 ns, measured between 10 and 90% points on pulse.

INPUT CHARACTERISTICS

External Trigger

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.

Input Impedance: 1 kΩ in parallel with 22 pF.

Triggering is selected to occur at either rising or falling edge of trigger signal; triggering level is adjustable to be between ± 4V. An LED lights for approximately 100 ms for each external and manual trigger occurrence accepted.

GENERAL

Environment

Specifications apply at 25°C ± 5°C after 1 hour warm-up. Instrument will operate from 0°C to 50°C.

Dimensions

28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 29 cm (11¼ in.) deep.

Weight

5.4 kg (12 lb) net; 6.8 kg (15 lb) shipping.

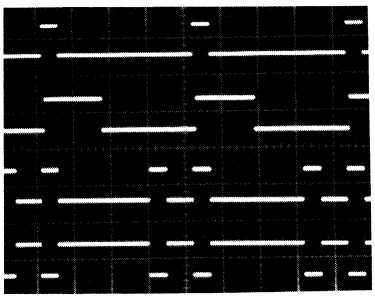
Power

90 to 130V or 180 to 250V; 50 to 400 Hz; 60 watts nominal.

FACTORY/FOB

San Diego, CA

50 MHz Pulse Generator



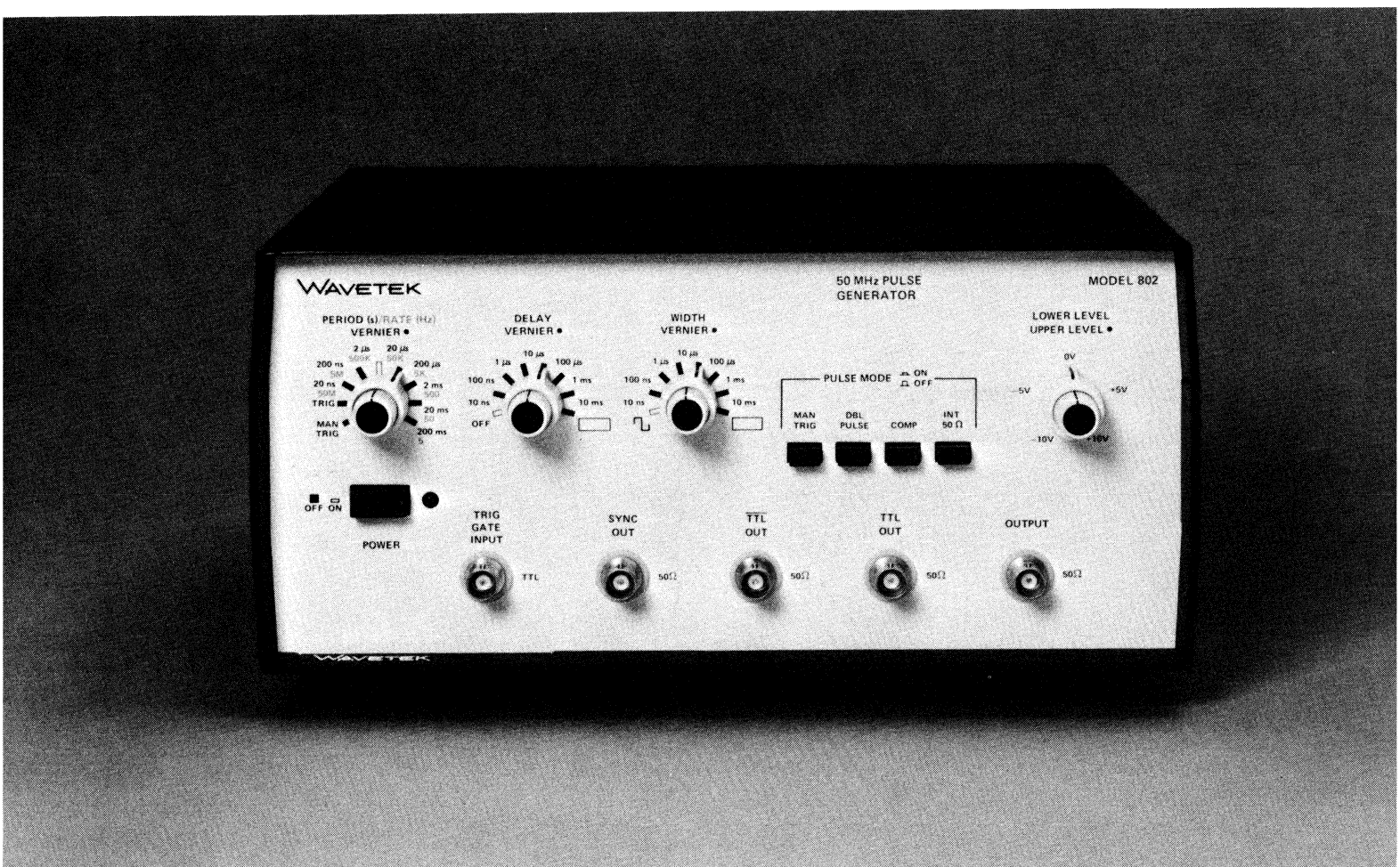
- **5 Hz to 50 MHz Repetition Range**
- **Variable Width and Delay**
- **Full 10 Volt Output**
- **Four Simultaneous Outputs**
- **Five Nanoseconds Rise/Fall Times**

Adjustable Upper and Lower Levels
You can adjust the pulse upper and lower levels independently and directly. Amplitude and dc offset do not interact. This feature frees you from tedious readjustment and tuning when you are setting up a given pulse.

Selectable Source Impedance
For optimum loading, an internal 50 ohm termination is selectable at the 802 output. Placement of the 50 ohm termination at the source, at the load, or both gives you additional versatility in minimizing aberrations due to reflections.

Multiple Outputs
In addition to the variable ± 10V output, the Model 802 gives you fixed TTL and $\overline{\text{TTL}}$ outputs. You can use these convenient fixed outputs with your most commonly used logic, TTL, and never adjust amplitude, or you can have simultaneous outputs at fixed and variable levels for further versatility and performance

Independent Rate, Width and Delay Control
Repetition rate, width and delay can all be independently adjustable. Delay and width controls each have a blank detent for your custom range. This allows you to select your most often required pulse values quickly and repeatably. You can use the Model 802 in the continuous, trigger, gate and external width modes with normal delayed or double pulse outputs, for further operating versatility and performance.



VERSATILITY

Four Simultaneous Pulse Outputs

Fixed TTL level sync, TTL and $\overline{\text{TTL}}$ outputs and variable amplitude output pulses are available over a 5 Hz (200 ms) to 50 MHz (20 ns) frequency range.

For optimum pulse characteristics from the variable amplitude pulse output, an internal 50Ω load can be selected via a front panel control.

Operational Modes

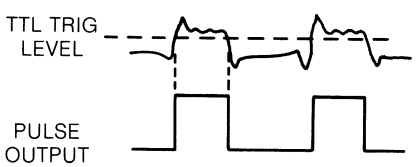
Continuous: Generator oscillates continuously at selected frequency.

Triggered: Generator quiescent until triggered by external TTL pulse or front panel control, then generates one pulse.

Gated: Generator oscillates at the period rate selected by the front panel control when gate input is high. Generator quiescent when input is low. First cycle is synchronous with rising edge of gating signal.

Double Pulse: Continuous, triggered and gated, as above, except two pulses for each period. Time to second pulse is controlled by delay control. Double pulse at all outputs except sync.

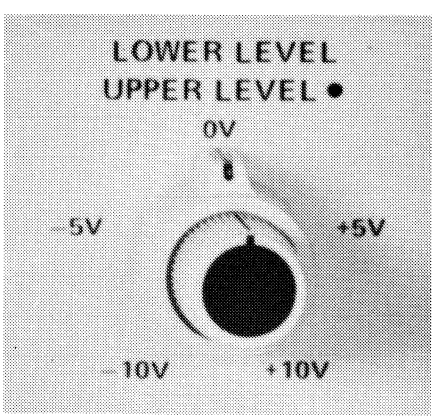
External Width: External signal at trigger input determines output pulse width and period as shown.



PULSE OUTPUTS

Variable Amplitude Pulse

Upper and lower pulse levels are independently adjustable. Pulse dynamic range is ±10V when load is 50Ω terminated and source is not (internal 50Ω off) or vice versa. Maximum pulse amplitude is 10V; minimum is 1V.



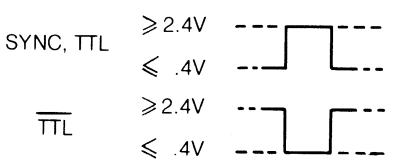
Level Controls

Dynamic range and pulse amplitude are decreased by a factor of 2 when source and load are 50Ω terminated. Overshoot and ringing are less than (±5% of amplitude setting + 100 mV) when terminated into 50Ω at both load and source. Transition times are less than 5 ns.

SOURCE	LOAD	DYNAMIC RANGE	AMPLITUDE MAXIMUM	AMPLITUDE MINIMUM
50Ω	50Ω	+5V	5V	.5V
		−5V		
1 kΩ OR ≥1 kΩ	50Ω	+10V	10V	1V
50Ω		−10V		

Sync TTL and $\overline{\text{TTL}}$ Pulses

TTL, $\overline{\text{TTL}}$ pulse levels into 50Ω termination; sync pulse level from 50Ω source.



Transition times less than 7 ns into 50Ω termination.

Normal/Complement Control

Normal pulse or its complement is selected. The normally quiescent and active levels are reversed in complement format. This control affects all outputs except sync pulse.

TIME DOMAIN

Period

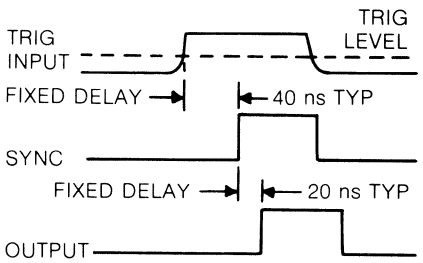
Period range is from less than 20 ns to greater than 200 ms in seven overlapping ranges. Period jitter is less than ±0.1% plus 50 picoseconds.

Width

Width range is from less than 10 ns to 10 ms in six overlapping ranges. Maximum duty cycle is 70% for periods to 200 ns, decreasing to 50% for 20 ns periods. Width selector switch also has a square detent and a customer-specified dentent.* ⊓ duty cycle is 50 ±4% to 2 μs period, changing to 50 ±15% at 20 ns period. Width jitter is less than ±0.1% plus 50 picoseconds. Sync pulse duty cycle is 50 ±4% of pulse period to 2 μs period, changing to 50 ±15% at 20 ns period, except in trigger and external width modes, in which case it is determined by the trigger signal.

Delay

Pulse occurrence can be delayed from less than 10 ns to 10 ms with respect to the sync pulse (not including fixed delay). Delay selector switch also has a customer specified detent.* Maximum delay duty cycle is 70% for periods to 200 ns, decreasing to 30% for 20 ns periods. Delay jitter is less than ±0.1% plus 50 picoseconds. Fixed delay is as shown.



INPUT CHARACTERISTICS

External Trigger

The circuit receiving the external trigger is TTL compatible. Triggering level is fixed at approximately 1.4V. Input impedance is greater than 500Ω shunted by approximately 33 pF. Triggering and gating occur on the rising edge of the input signal.

GENERAL

Environmental

Specifications apply at 25°C ±5°C after 30 minutes warm-up. Instrument will operate from 0°C to 50°C.

Dimensions

28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 28.6 cm (11¼ in.) deep.

Weight

4.0 kg (8.9 lb) net; 5.4 kg (12 lb) shipping.

Power

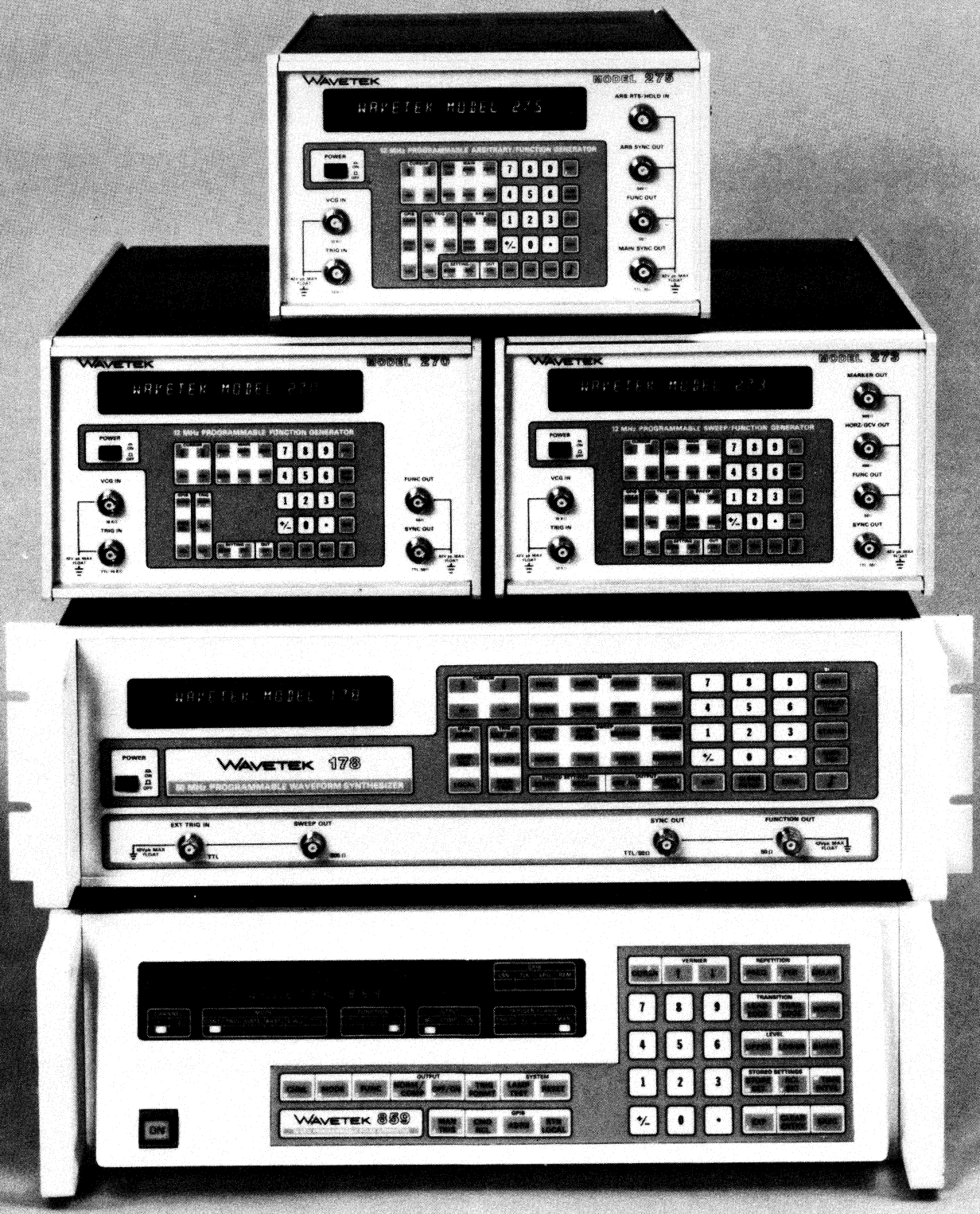
108 to 132V or 216 to 250V; 50 to 400 Hz; 40 VA nominal.

*Customer-installed capacitor determines detent range.

FACTORY/FOB

San Diego, CA

Programmable Function Generators



Programmables
Wavetek is particularly proud of its fine programmable instruments. For better than 20 years, Wavetek has been providing a wide range of programmable function generators for stimulus applications, and, as a result, has developed superior products for both remote and local control.

The basic role of programmability is to permit remote access to an instrument's control circuits without the need for direct operator intervention. Wavetek's well designed programmable interface starts deep within the instrument's control structure, including the interface between the front panel and the generator circuits. The result of thorough designing is not only a highly efficient communications link *among instruments* but an extremely usable *operator's instrument* as well. The Wavetek programmables listed on the next several pages are the positive result of many generations of these analog and digital interface implementations.

Early generations of programming interfaces were virtually custom techniques for each computer/instrument application. This involved various BCD, binary, serial and analog signal combinations with special hardware and software manipulations for computer/instrument compatability. The resulting heavy engineering and time investments restricted earlier automated systems.

A team effort from several electronics customers and manufacturers including Wavetek, contributed to the creation of the *General Purpose Interface Bus* standard. The GPIB was adopted as the IEEE 488 standard in 1975, and was revised with minor technical interpretation improvements in 1978 and 1980. The American National Standards Institute publishes the GPIB as ANSI Standard MC 1.1 and the International Electrotechnical Commission documents the GPIB as IEC 625.1, which is identical to the IEEE 488 standard with a minor change only. As a user, you should consider these standards to be identical.

The universal acceptace of the GPIB has overcome the heavy mechanical, electrical, timing, and software burdens previously associated with programmables. This has spurred the rapid growth of new programmable instruments, a wider variety of venders, low cost interface chips and software, and an appealing invitation for customer users of instrumentation to "get on the (GPIB) bus."

Some manufacturers have coined their own trade names for the GPIB. Wavetek does not - the beauty of the GPIB is its universatility, not its applicability to a particular manufacturer's products. In all cases, a bus can be identified as GPIB by its adherence to any of the three standards mentioned above.

All Wavetek programmable function generators in this catalog that are compatible with the General Purpose Interface Bus (GPIB) are flagged GPIB.

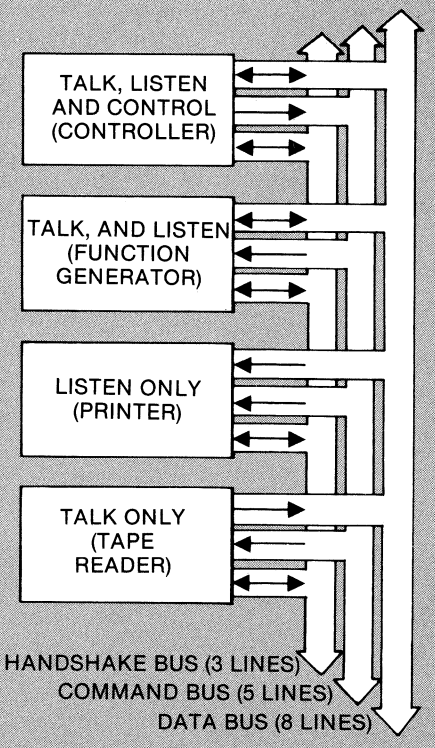
Each instrument on the GPIB can be uniquely addressed or group addressed for commands and queries. Communications over the bus can be keyboard controlled by an operator or completely automated with a controller that reads punched cards, magnetic tapes, memory stored routines, etc. The flexibility of the GPIB makes it ideally suited for automatic test systems. Further, the system designer has a great variety of bus compatible instruments manufactured by leading electronic firms from which to choose.

GPIB System
A typical GPIB system might include a controller, listener devices, talker devices and devices which can both listen and talk. Wavetek Models 172B, 175, 178, 859 and Series 270 have capabilities to listen and talk.

The actual interface circuitry enabling an instrument to operate on the GPIB is contained within that instrument. The interconnecting bus is entirely passive. Interface circuitry and external bus together make up the GPIB system.

Instrument with GPIB Cable

The external bus contains 16 lines which are functionally grouped into 3 sub-buses. The *data bus* consists of 8 lines which are used to transfer ASCII coded instructions from the controller to all devices, and to transmit data from the talker to listeners. The 3 line *handshake bus* synchronizes the transfer of data. The *command bus* is principally used by the controller to manage bus transactions.



Typical GPIB System

Programming
The typical program parameters for Wavetek programmables are frequency, amplitude and offset voltage, function (waveform), mode and output on/off selection. The architecture of the command is an alphabetic character followed by a numeric value. For example, F1.2345E06 or F1234500 will adjust the frequency to 1,234,500 Hz. Both *strings* will be accepted by instruments with an internal microprocessor. In fact, the microprocessor will eliminate leading zeros or blanks and round or truncate the data as required. Instruments without microprocessors require scientific notation format such as the first example string.

The alpha prefix, "F" in the example, directs the numeric data that follows the "F" to a particular circuit where it is stored, and when executed, changes generator frequency. The numerics of some other alphas are read as codes rather than values; e.g., the string "B1" directs the numeric data to the operating mode circuit where the "1" is interpreted as trigger mode.

Because of the open format employed, a terminator is necessary to tell the instrument that programming of a parameter is completed before it is stored as the final data; the next alpha prefix character or the execute character is the terminator of the numeric data which preceded it. Typically, once a parameter value is routed to the correct circuit and interpreted, it is stored and awaits the execute command which will cause the value to alter the instrument output. The entire setup for a generator may be programmed and no change will be made to the generator output until the execute command is given.

In some cases, it is possible to program conflicting values for two parameters, such as amplitude and offset. Their values may be acceptable individually but together they may exceed the output capability of the instrument. Wavetek instruments with internal microprocessors evaluate conflicting values at execute time. Where improper operation would result, the new programming is not used by the generator, and, for both the display and bus, error messages are initiated.

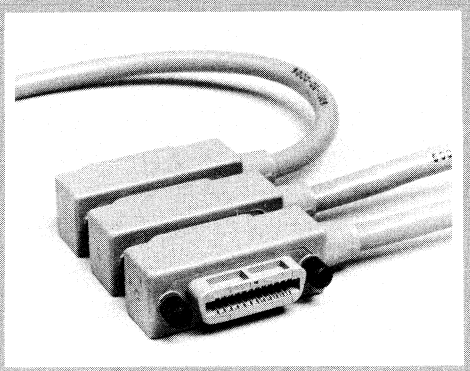
Where listener-only generators are not adequate, Wavetek supplies listen plus microprocessor controlled talk capability for indication of programming errors and generator status. Talking on the GPIB is provided through *serial poll* capability. After the generator indicates that it wishes to transmit information, the controller will serially poll the instruments to detect the one that wishes to talk, then enable it to talk. The talk messages are a set of codes and data interpreted by the controller. The transmission may be an evaluation of instrument compliance to programmed instruction; it may be its phase lock status or the parroting of the received data string to verify proper GPIB operation. This information formatted for the operator is also available through the instrument display panel.

GPIB System Throughput
Most Wavetek instruments accept data over the GPIB at very high rates. They handshake command instructions at 2 microseconds per character (byte) and can be expected to handshake through an entire command sequence in just 10 microseconds. Data rate is 220 microseconds per character. GPIB data are accepted at maximum possible speed and are held in temporary storage until there is a break in GPIB activity. The stored characters must then be acted upon by the instrument's firmware (identify parameter, format value, check for errors, direct to analog circuits and execute) before the output circuits reflect the programming change. This is the system throughput and it requires a specific amount of time for each programmed parameter involved in the transaction. Timing charts for all programmable parameters are included with the detail specifications of each model as an aid to programming with the GPIB.

Microprocessor Control
The newest Wavetek programmables have a microprocessor-based design of their digital control and interface circuits. The microprocessor allows more sophisticated instruments with greater flexibility and simplified operator controls and programming. Most obvious indication of the microprocessor is the amount of useful information on the front panel display and the interaction between the display and manual programmer. Bus programming is also greatly simplified, as values are accepted in any format. Parameters may be entered in any order, because cross-checking for errors is not done until the group execute. The microprocessor design also gives the generator GPIB talker capability for interaction with the controller.

Even without the aforementioned features, microprocessor-based design is advantageous in complex instruments. It handles algebraic and logical manipulations of data with an overall reduction in hardware over older design methods. The more complex the instrument, the greater the cost-saving potential. There are also hidden advantages, such as automatic diagnostic testing at turn-on, which contribute to overall reliability.

GPIB Cables GPIB
For instruments with GPIB capability, Wavetek furnishes interface cabling with connectors for chain or branching attachment of instruments and controllers. The cables come in one and two meter lengths.



GPIB Cables

FACTORY/FOB

San Diego, CA

GPIB Support

Whether you currently employ the GPIB or are presently considering it, Wavetek's Sales, Service and Engineering groups are available to advise you on the GPIB as well as on our programmables. Available literature includes *Introduction to the GPIB, Programming Techniques.* Introduction manuals for individual programmable instruments are also available.

PROGRAMMABLE SELECTION GUIDE

MODELS	172B	175	178	270	271	273	275	278	859
Low Frequency (Hz)	0.1m	3.9μ	1μ	0.01	0.01	0.01	0.01	0.01	0.5
High Frequency (MHz)	13	*	50	12	12	12	12	12	12
AM/FM/ΦM	FM		AM/ΦM	FM	FM	FM	FM	FM	
Maximum Voltage Output (Peak-to-Peak)	30	20	20	20	20	20	20	20	20
Triggered and Gated	•	•	•	•	•	•	•	•	•
Stored Settings	•		•	•	•	•	•	•	•
Variable Phase Control			•						
Manual Control	Optional	•	•	•	•	•	•	•	•
Symmetry Control	•	•							
Arbitrary Waveforms		•					•		
Pulse			•		•				•
Synthesizer	Optional		•					•	
Burst			•	Optional	•	•	•	•	
Sweep			•			•			
Internal Trigger			•			•	•	•	
Programmable Digits of Resolution									
Frequency	5½o	4	8	3	3	3	3	5	3
Amplitude	3½	3	3½	3	3	3	3	3	3
Phase			4						
DC Voltage/Offset	3	3	3	3	3	3	3	3	3
Programming									
MATE Interface			Optional						Optional
IEEE 488-1978	•	•	•	•	•	•	•	•	•
Automatic Calibration and Performance Verification Aid				•	•	•	•	•	•
Output Protection				•	•	•	•	•	
Featured on Catalog Page	**	**	106	110	112	114	118	122	124

*See Specifications.
**Consult Wavetek representative or factory for details.

Programmable Waveform Synthesizer

- **1 μHz to 50 MHz Frequency Range**
- **Synthesized 8 Digit Accuracy**
- **Trigger, Gate, Burst, Lin/Log Sweep**
- **20 Volts Peak-to-Peak Output into 50Ω**
- **Sine, Triangle, Square, Ramps, and DC**
- **NEW Optional MATE Interface**

High Performance Generator
Model 178 Waveform Synthesizer, a bench top or ATE programmable instrument, combines the precision of an 8 digit, 50 MHz synthesizer with the versatility of a function and sweep generator. In addition to sine and square wave to 50 MHz, Model 178 includes the useful triangle, ramps and haverwaves.

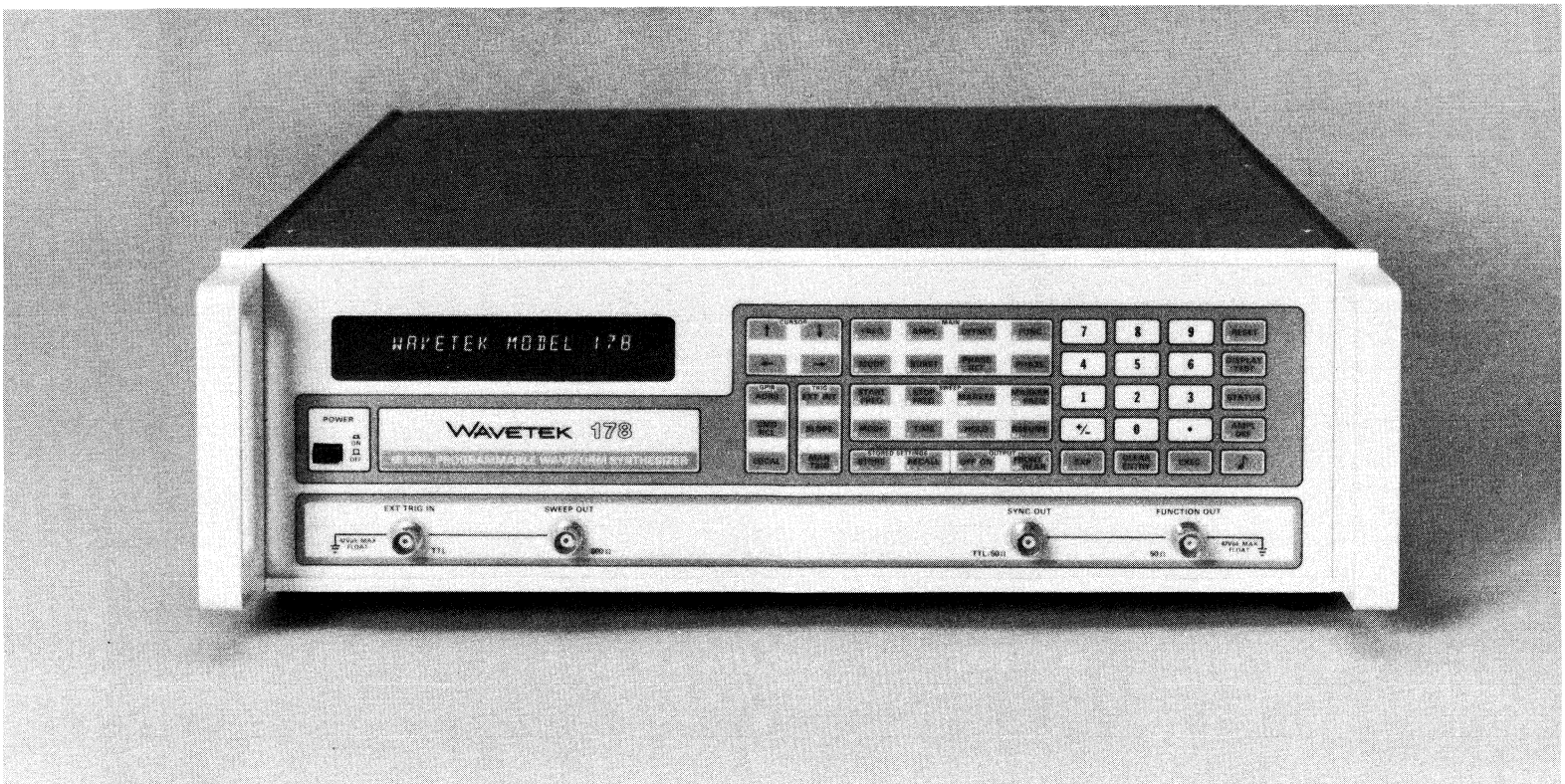
Innovative design gives synthesized triggering, gating, frequency sweep, burst counts and combinations of these modes for application flexibility. The output drives your 50Ω load to a full 20 volts peak-to-peak. The microprocessor design lets you program the level in convenient terms of Vrms, Vp-p or dBm.

Careful software design has resulted in a flexible, easy to program format. You may implement a change of only one instruction or completely change all settings in a few milliseconds.

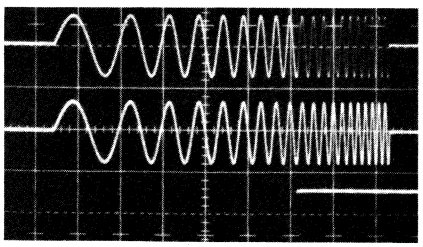
Additional features include amplitude and phase modulation, stored settings, variable waveform phase and programmable frequency markers.

Main Generator
Fifty megahertz synthesized performance to 8 digit resolution places your output precisely where you want it—and with a spectrally pure and accurate signal. Stimulus diversity includes the function generator waveforms of sine and square waves (less than 8 ns rise/fall) to 50 MHz, triangles to 500 kHz and ramps to 20 kHz. Useful haverwaves, based on sine or triangle waveforms, extend precision performance to include low frequency medical and mechanical stimulations.

Sweep Generator
Choose from linear or true log frequency sweeps, up or down and at virtually any sweep times. The sweeper may be operated by itself or combined with the main generator to provide continuous, triggered, gated, hold at start or stop, and even burst counted sweeps. Ten preset markers, available one at a time, flag critical sweep frequencies and provide start or stop triggers. Sweep is synthesized at all frequencies and



remains phase continuous even if the sweep is interrupted with a hold and later resumed.



Sweep with Marked Frequency, Sweep without Marker, and Marker Pulse

Pulse
The 178 is a versatile pulse generator with precision pulses, available to a full ± 10 volt swing. Independent width and rate controls remain fully synthesized even in triggered, gated and burst operation.

Precision Output
Now you can drive your 50Ω load from as low as 1 millivolt to a full 20 volts peak-to-peak (flat even to 50 MHz), without the need for additional amplifiers. All waveforms may be combined with dc offset to the full ± 10V output window. Three digit amplitude and offset controls provide top performance in repeatability, accuracy and wideband flatness. Output is conveniently available either front or rear (selectable) and safely defaults to a 1 Vp-p level upon power-up and reset.

GPIB Compatibility
All of the 178's useful features may be programmed via the IEEE 488-1978 standard General Purpose Interface Bus (GPIB) system. Programming is just as easy as the GPIB as it is from the front panel. Any one parameter may be changed individually or several instructions may be entered for a simultaneous output change. Extremely high speed GPIB response and fast settling ensures fast ATE test times and greater production throughputs. For convenience, the GPIB coding string of recent manual and remote programming is displayed at a push of a button or placed on the bus in talker mode. Other GPIB features include expanded terminator characters, SRQ messages, error listings and sweep hold flags.

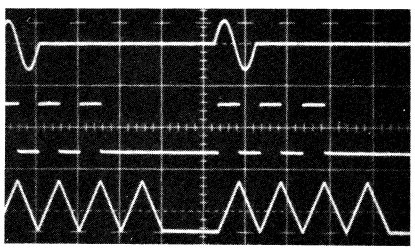
Programming String Display

Stored Settings
Time saving internal registers permit recall of complete instrument setups within milliseconds. Each setup may be loaded into any of the five storage areas of dynamic memory for later recall. Storage may be optionally expanded to forty additional registers with battery backup. Single commands permit rapid sequencing through all stored settings. Fast recall of stored settings is particularly well suited for repetitive testing both on the bench with front panel controls and also via the GPIB.

Amplitude Conversion
Enter and display amplitude entires in convenient volts peak-to-peak, volts rms or in dBm—all into 50Ω. The 178 performs these conversions automatically on any waveform.

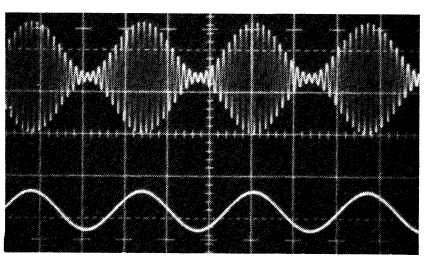
Variphase Synchronization
Incrementally shift the 178's main output in phase steps as fine as 0.01°. Locking the 178 synthesizer with another generator or external clock expands our stimulus capability to high resolution servo positioning and phase coherency.

Innovative Trigger
Trigger, gate and burst count (to 2^{16}) the 178's synthesizer up to 200 kHz rate. Full synthesizer performance guaranteed on all your stimulus applications.



Synthesizers Output in Triggered Burst Mode

Amplitude Modulation
In addition to all these features, the 178 may be externally phase modulated at any time or externally amplitude modulated up to 200 percent.



Sine Wave Amplitude Modulation

NEW Optional MATE Interface

Model 178 is available with a factory-installed MATE interface per USAF Standard 2806763 (Option 010). The MATE interface consists of both hardware and software. The software accepts GPIB commands in Control Interface Intermediate Language (CIIL) as well as the "native" Model 178 language. The hardware includes expanded memory to support the additional software, shallower handles to allow the instrument to be mounted in a rack equipped with a front door, and a status monitor interface to report catastrophic failures to the control computer in real-time. The status monitor interface is independent of the GPIB.

VERSATILITY

Waveforms
Sine ∿, square ⊓, triangle △, ramps ◿, ◺, haversine ∧, ∨, havertriangles ∧, ∨, AM (sine) ◈, and DC.

Operational Modes
NOTE: All modes are synthesized.
Continuous: Generator runs continuously.
Triggered: Generator is quiescent until triggered by an external signal, internal sweep signal, GPIB or manual trigger, then generates one cycle at selected frequency.
Gated: As triggered mode, except generator oscillates for the duration of the gate signal plus the remainder of the waveform in progress.
Triggered Haverwave: As triggered mode, except output is a sine or triangle waveform starting at −90° (or +90°).
Gated Haverwave: As gated mode, except output is a sine or triangle waveform starting at −90° (or +90°).
Triggered Burst: As triggered mode, except the number of cycles output for each trigger input is selected from 1 to 65,536 (2^{16}) counts.
Triggered Haverwave Burst: As triggered burst, except output is a sine or triangle waveform starting at −90° (or +90°).
NOTE: See Frequency Range Section for frequency capability in each mode.

Frequency Sweep: Output frequency can be swept by internal sweep generator. (See Sweep Generator for sweep modes.)

Frequency Range
Low end for all waveforms is 1 μHz.
Continuous Mode:
∿, ⊓, ◈ to 50 MHz.
∿ to 500 kHz.
◿, ◺ to 20 kHz.
All Triggered Gated and Burst Modes:
∿, ⊓, △, ◈ to 200 kHz.
◿, ◺ to 20 kHz.
Frequency Sweep: (See Sweep Generator).

Main Output
All waveforms are available 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 a voltage less than ±5V peak is selected. Output available on front or rear (selectable) BNC.
Phase Offset: Output phase may be changed to any angle in 0.01° resolution steps to 500 kHz and 0.1° (or better) resolution steps above 500 kHz.

Amplitude Conversion
Permits entry and display of amplitude for all waveforms in units of Vrms, Vp-p and dBm, all into 50Ω load.

DC Offset and DC Voltage Output
0 to ±10 Vdc into 50Ω. Output voltage is double into open circuit when voltage less than ±5 Vdc is selected. DC offset is attenuated by the amplitude range attenuator.

Auxiliary Outputs
TTL and TTL Sync Outputs: At generator frequency, 50Ω source impedance, 50% duty cycle. Less than 5 ns transition time.
Sweep Ramp Output: (See Sweep Generator).
Reference Output: 10 MHz, 1 Vp-p sine, 50Ω source impedance.
Frequency Marker Output: (See Sweep Generator).

Inputs
Trigger Input: A TTL level transition can trigger or gate both main generator and internal sweep generator. Triggering slope up (⤴) or down (⤵) is selectable.
Reference Input: 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. External clock may be 1, 2, 3, . . . 9 or 10 MHz. A message "REFERENCE NOT LOCKED" is displayed if external reference is present but internal reference is not synchronized to it. Input impedance is 1 kΩ.
Amplitude Modulation Input: Rates from DC to 10 MHz minimum. Input impedance is 600Ω. 5 Vp-p input gives 100% modulation. Main output halved with no modulation. 200% modulation permitted. 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.

Data Entry
Front panel keyboard with display and GPIB programming.

MAIN GENERATOR

FREQUENCY RESOLUTION

8 digits or 1 μHz.

FREQUENCY PRECISION

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

Stability
Long Term: $\pm 1 \times 10^{-6}$ of frequency per month.
Temperature: 1.2×10^{-7} per °C.

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

Spurious
−60 dBc or 30 μV whichever is greater, 1 μHz to 500 kHz.
−50 dBc or 30 μV whichever is greater, 500 kHz to 50 MHz.

AMPLITUDE PRECISION

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

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

Resolution: 3 digit, less than or equal to 10.0 Vp-p. 4 digit (20 mV), greater than 10Vp-p.
DC Offset: ±1% of setting ±40 mV (worst case).
NOTE: Amplitude and dc offset share the output attenuator.

Frequency Response
Specified relative to 1 kHz sine wave.

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

NOTE: ⊓, ∿ add 1% to above ◿, ◺ add 5%.

Amplitude and Offset Stability
Measured at room temperature.
Short Term: 0.1% for 10 min.
Long Term: 0.5% for 6 months.

WAVEFORM CHARACTERISTICS

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

Square Wave Rise and Fall Time
Less than 8 ns, 1.01 to 10.00 Vp-p.
Less than 10 ns, greater than 10 Vp-p.

SWEEP GENERATOR

Sweep generator is fully synthesized and may be used independently or for frequency sweeping and triggering the main generator. Frequency sweep may be selected linear or logarithmic, and up or down. Sweep may be triggered, gated, burst, interrupted with hold, and continued with resume.

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.

SWEEP CHARACTERISTICS

Sweep Time
0.01 to 600.00s, 0.01s resolution.

Sweep Output
0 to +5V ramp synthesized to 2000 steps per sweep. 600Ω output impedance.

Frequency Marker Output
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.

Maximum Sweep Range
Low Band: 1 μHz to 500 kHz.
High Band: 5 kHz 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 per 1s of sweep time.
High Band: 2 Hz per 1s of sweep time.

Sweep Resolution
Frequency Resolution including Start, Stop, Hold, Markers: 8 digits or 1 μHz.
Frequency Update: Every 5 μs (lin and log).
Log Slope Update: Every 2 ms.

PULSE

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 μsec to 600s (10 min.);
4 digit resoution (sweep time control);
Less than 1% jitter.

Width
5 μs to 500,000s (5 days); 8 digit resolution (frequency control);
Less than 0.05% jitter.

NOTE: Width usable to 1 μs.

GENERAL

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

GPIB Programming
Standard Purpose Interface Bus (GPIB) programming per IEEE Standard 488-1978. Interface is optically isolated from signal ground. Interface includes Listener (AH1 and L4), Talker (SH1 and T6), SRQ (SR1), Local Lockout (RL1), Device Clear (DC1), and Group Execute Trigger (DT1) Capabilities and Open Collector Logic (E1).

Parameter	Time
Command Handshake	15 μs
Data Handshake	65 μs
Frequency	11 ms
Amplitude	14 ms
DC Offset	14 ms
Mode	4 ms
Function	5 ms
Output	4 ms
Execute	8 ms

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

Dimensions
44.5 cm (17.5 in.) wide; 13.3 cm (5¼ 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; less than 180 watts.

OPTIONS

001: Additional Stored Settings
Provides nonvolatile memory for up to 40 additional stored settings. Memory is battery backed up (internall recharged) for 60 day (minimum) retention of 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: $\pm 5 \times 10^{-8}$.
Aging Rate: 5×10^{-9}/day (average), $<4 \times 10^{-8}$/week.

010: MATE Interface
Factory installed MATE interface per USAF Standard 2806763.

FACTORY/FOB

San Diego, CA

12 MHz Function Generator

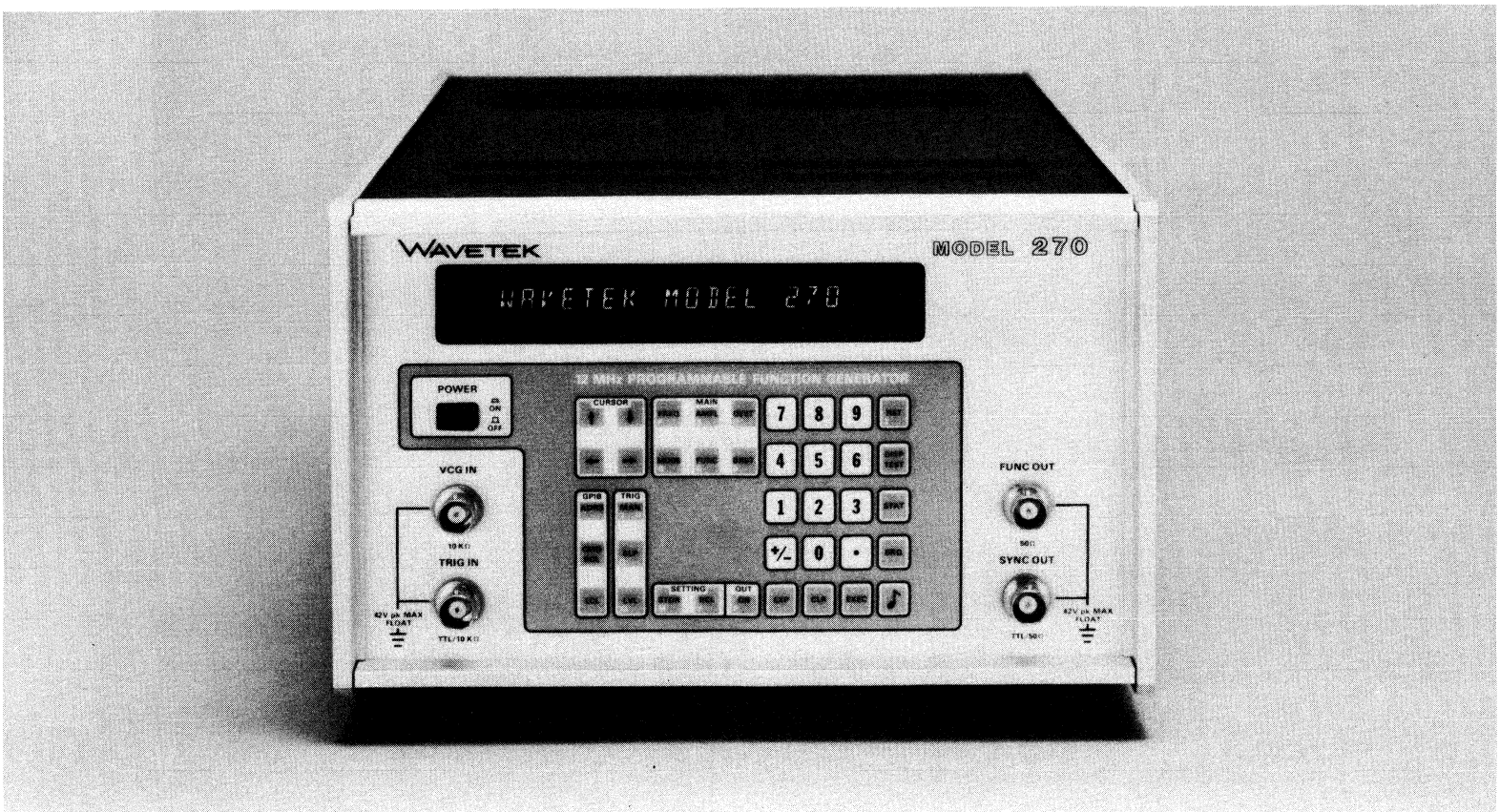
- **Half-Rack Width Package**
- **0.01 Hz to 12 MHz Frequency Range**
- **GPIB (IEEE 488) Standard**
- **200V Output Protection**
- **200 Stored Settings Standard**

Compact and Versatile
Model 270 Programmable Function Generator is a light-weight, half-rack instrument for bench or ATE use. The 270 can generate precise sine, triangle, square, and external width controlled waveforms from 0.01 to 10 Vp-p, and dc offsets within a − 5V to + 5V range into 50Ω. Waveforms can be continuous, gated or triggered.

Easy to Program
The GPIB entry sequence is identical to front panel entry and the ASCII character, for GPIB programming, appears with each key on the front panel. This makes it easy to transfer a manual setup to a controller program and vice versa. To help the operator even more, "command recall" can display up to 40 previous characters entered either at the front panel or by GPIB. The 270 also features free-format numeric entry, parameter independence until a final execute command, and front panel GPIB address selection (which can, however, be locked out for security).

Protected Outputs
All 270 outputs are protected against short circuits and excessive voltages between ± 15V. The main output is further protected against voltage inputs of up to 140 Vac or ± 200 Vdc. If a voltage greater than ± 15V is applied to the main output, the 270 generates an audible alarm, a front panel error message, and a GPIG service request. Inputs are protected from voltages up to ± 50V.

Stored Settings
The 270 can store up to 200 complete operational settings in memory for fast recall. Battery backup is standard. In addition, stored setting 0 recalls the last executed setup of the instrument, even after the instrument has been turned off. A warning message will be displayed when the long-life, non- rechargeable battery needs to be replaced.



MODEL 270 PROGRAMMABLE FUNCTION GENERATORS

VERSATILITY

Waveforms
Programmable sine ∿, triangle ∿, square ⊓, square complement ⊔, external width or dc.

Operational Modes

Continuous: Output continuous at programmed frequency.

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

Gated: As triggered mode except output oscillates for the duration of the gate signal. The last cycle started is completed.

Frequency Range
10 mHz to 12 MHz.

Outputs

Function Output: Waveforms from 0.01 to 10 Vp-p into 50Ω (0.02 to 20 Vp-p into ≥50 kΩ). DC or offset programmable from −5V to +5V into 50Ω (−10V to +10V into ≥50 kΩ).

Programmable Control Provides:
Output On (50Ω source impedance);
Output Off, High Z (>500kΩ);
Output Off, Low Z (approx 50Ω termination).
Absolute peak amplitude plus offset may not exceed 5V into 50Ω (10V into ≥50 kΩ).
Source Impedance: 50Ω.
Protection: Output protected to 140 Vac or ±200 Vdc without replacement of internal fuse.

Sync Output: TTL level square wave into 50Ω at programmed frequency.
TTL Compatible: ≤0.4V to ≥2.4V into 50Ω, ≤0.8V to ≥4.8V into ≥50 kΩ.
Source Impedance: 50Ω.
Timing: Concurrent with main output in square; lags sine and triangle by 90°.
Over/Undershoot: <10% into 50Ω.
Protection: Output protected against ±15V input minimum.

Inputs

VCG In: 0.01 to 12V into 10 kΩ, for up to 1200:1 frequency change. 10V gives range max. 12V gives 20% overrange. Slew Rate: 1V/μs.

Trig In: Level programmable: −10 to +10V, 20 mV resolution, ±500 mV accuracy. Programmable to trigger on − or + signal slope.
Impedance: 10 kΩ.
Maximum Rate: 12 MHz (24 MHz for External Width).
Minimum Width: 20 ns.
Minimum Amplitude: 500 mVp-p to 1 MHz, 1 Vp-p to 24 MHz.

Protection: Inputs protected against ±50V input minimum.

PRECISION

Frequency
Resolution: 3 digits.
Accuracy: ±2%.
Repeatability: ±1% for 24 hr.
Jitter: ≤0.1% ±100 ps.

Amplitude
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: ±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.
Repeatability (24 hr): ±1% ±10 mV.
Flatness: 0.1 dB to 100 kHz, 1.5 dB to 12 MHz for output at 5 Vp-p.

Offset
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.
Repeatability (24 hr): ±1% ±20 mV.

Waveform Quality
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.

GENERAL

GPIB Programming
IEEE 488-1978 compatible. Non-isolated. Double buffered.
Address: 0-30, keyboard or internal switch selectable. Internal switch can lock out keyboard selection. Power-up address is internal setting.
Subsets: SH1 Complete source handshake, AH1 Complete acceptor handshake, T6 Basic talker, TE0 No extended talker, L4 Basic listener, SR1 Complete service request (software selectable), RL1 Remote/local and local lockout, PP0 No parallel poll capability, DC1 Complete device clear/selective device clear, C0 No controller capability, E2 Tri-state drivers.

Interface Timing

Parameter	Time
Frequency	11 ms
Amplitude	14 ms
Offset	14 ms
Mode	4 ms
Waveform	5 ms
Execute	8 ms
Other	4 ms

Stored Settings
Nonvolatile memory for 200 stored settings. Battery back-up with minimum 6 mo. retention (typ. 5 yr.), battery check and status display.

Environmental
Temperature Range: 25°C ± 10°C for spec operation, operates 0°C to 50°C, −50°C 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 and 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; 6.8 kg (15 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.

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

12 MHz Pulse/Function Generator

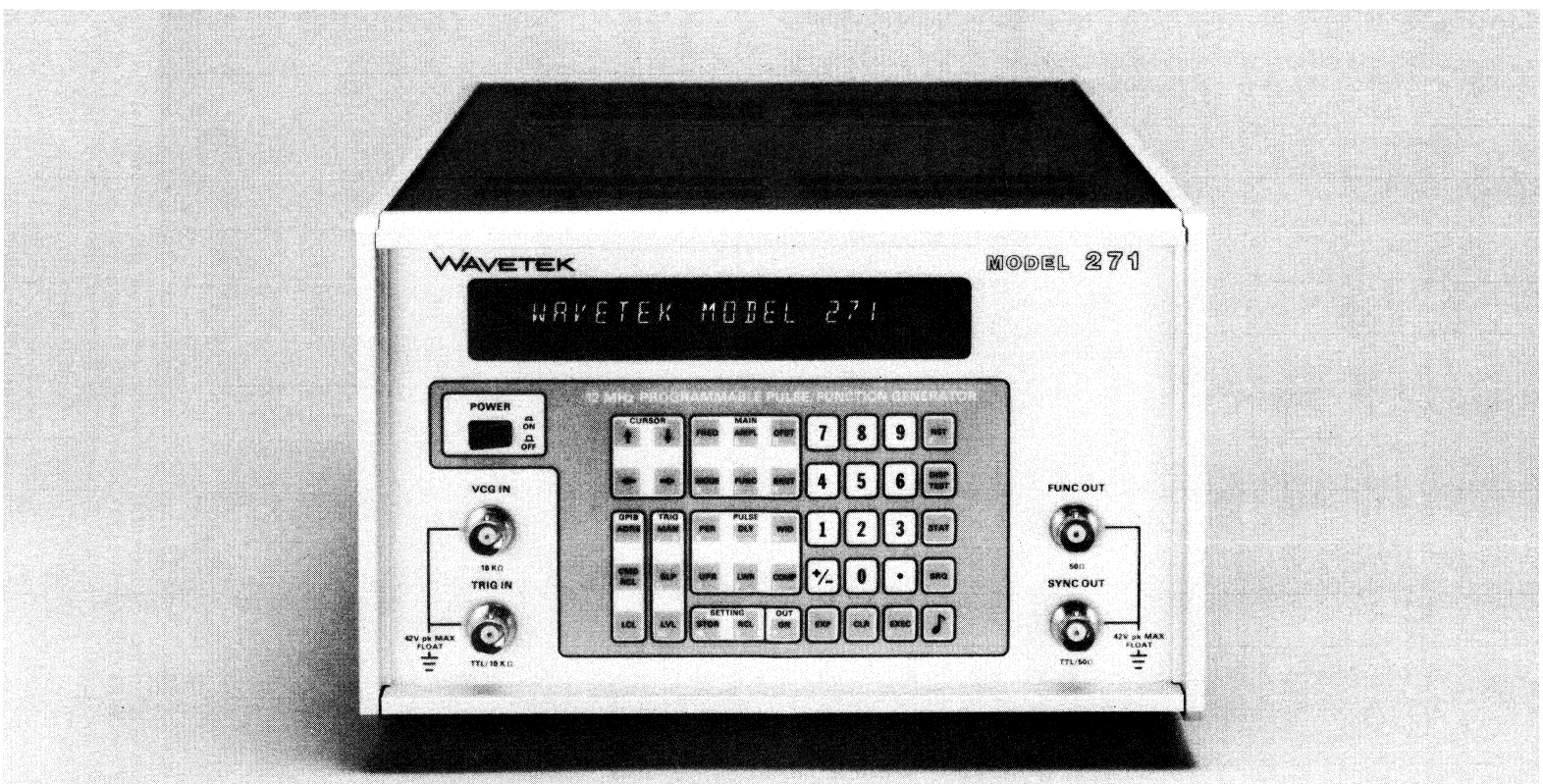
- **0.01 Hz to 12 MHz Frequency Range**
- **Pulse Delay, Width and Complement**
- **1 to 1,048,200 Burst Count**
- **GPIB (IEEE 488) Standard**
- **200V Output Protection**

Compact and Versatile
Model 271 Programmable Pulse/Function Generator is a light-weight, half-rack instrument for bench or ATE use. The 271 can generate precise sine, triangle, square, pulse, and external width controlled waveforms from 0.01 to 10 Vp-p, and dc offsets within a −5V to +5V range into 50Ω. Waveforms can be continuous, gated or triggered.

True Pulse Capability
The 271's pulse capability provides variable pulse delay from 80 ns to 0.1 sec, variable pulse width from 40 ns to 0.1 sec, and double pulse. All pulse functions may be complemented. For added convenience, period may be programmed rather than frequency, and upper and lower level rather than amplitude.

Ease of Programming
The GPIB entry sequence is identical to front panel entry and the ASCII character, for GPIB programming, appears with each key on the front panel. This makes it easy to transfer a manual setup to a controller program and vice versa. To help the operator even more, "command recall" can display up to 40 previous characters entered either at the front panel or by GPIB. The 271 also features free-format numeric entry, parameter independence until a final execute command, and front panel GPIB address selection (which can, however, be locked out for security).

Protected Outputs
All 271 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. If a voltage greater than ±15V is applied to the main output, the 271 generates an audible alarm, a front panel error message, and a GPIB service request. Inputs are protected against voltages up to ±50V.



MODEL 271 PROGRAMMABLE FUNCTION GENERATORS

VERSATILITY

Waveforms

Programmable sine ∿, triangle ∿, square ⊓, square complement ⊓, external width pulse ⊓, double pulse ⊓⊓ or dc.

Operational Modes

Continuous: Output continuous.

Triggered: One cycle at programmed frequency when triggered by an external signal, GPIB or manually.

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

Burst: As Triggered except output oscillates for the number of cycles programmed into burst counter (1-1,048,200; burst rate 12 MHz max).

Frequency Range

10 mHz to 12 MHz.

Outputs

Function Output: Waveforms from 0.01 to 10 Vp-p into 50Ω (0.02 to 20 Vp-p into ≥50 kΩ). 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).

Programming: May be Vp-p and offset or upper and lower levels: lower from −5 to +4.99V into 50Ω, upper from −4.99 to +5V. Upper must be greater than lower.

Programmable Control Provides:
Output On (50Ω source impedance);
Output Off, High Z (>500kΩ);
Output Off, Low Z (approx 50Ω termination).

Source Impedance: 50Ω.

Protection: Output protected to 140 Vac or ±200 Vdc without replacement of internal fuse.

Sync Output: TTL level square wave: ≤0.4V to ≥2.4V into 50Ω, ≤0.8V to ≥4.8V into ≥50 kΩ.

Source Impedance: 50Ω.

Timing: Concurrent with main output in square; lags sine and triangle by 90°.

Protection: Output protected against ±15V input minimum.

Inputs

VCG In: 0.01 to 12V into 10 kΩ, for up to 1200:1 frequency change. 10V gives range max, 12V gives 20% overrange. Slew Rate: 1V/μs.

Trig In: Level programmable: −10 to +10V, 20 mV resolution, ±500 mV accuracy. Programmable to trigger on − or + signal slope.

Impedance: 10 kΩ.

Maximum Rate: 12 MHz (15 MHz in External Width).

Minimum Width: 20 ns.

Minimum Amplitude: 500 mVp-p to 1 MHz, 1 Vp-p to 24 MHz.

Protection: Inputs protected against ±50V input minimum.

Pulse

Delay: 80 ns to 0.1 sec. Measured from 1.25V point of leading edge of sync (into 50Ω load) to leading corner of main output pulse. (In double pulse, to second pulse of pulse pair.)

Width: 40 ns to 0.1 sec. Measured from 50% of leading edge to 50% of trailing edge.

Delay/Width Duty Cycle:
50% when delay/width <500 ns.
80% when delay/width ≥500 ns.

Normal/Complementary: All pulses may be complemented. Sine, triangle and square outputs cannot be complemented.

PRECISION

Frequency

Resolution: 3 digits.
Accuracy: ±2%.
Repeatability (24 hr): ±1%.
Jitter: ≤0.1% ±100 ps.

Amplitude

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: ±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.
Repeatability (24 hr): ±1% ±10 mV.
Flatness: 0.1 dB to 100 kHz, 1.5 dB to 12 MHz for output at 5 Vp-p.

Offset

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.
Repeatability (24 hr): ±1% ±20 mV.

Pulse Delay and Width

Resolution: 3 digits.
Accuracy: ±3% of programmed value ±10 ns.
Repeatability (24 hr): ±1% ±3 ns.

Waveform Quality

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.

GENERAL

Stored Settings

Nonvolatile memory for 150 stored settings. Battery back-up with minimum 6 mo. retention (typ. 5 yr.), battery check and status display.

GPIB Programming

IEEE 488-1978 compatible. Non-isolated. Double buffered.

Address: 0-30, keyboard or internal switch selectable. Internal switch can lockout keyboard selection. Power-up address is internal setting.

Subsets: SH1 Complete source handshake, AH1 Complete acceptor handshake, T6 Basic talker, TE0 No extended talker, L4 Basic listener, SR1 Complete service request (software selectable), RL1 Remote/local and local lockout, PP0 No parallel poll capability, DC1 Complete device clear/selective device clear, C0 No controller capability, E2 Tri-state drivers.

Interface Timing

Parameter	Time
Frequency	11 ms
Amplitude	14 ms
Offset	14 ms
Mode	4 ms
Waveform	5 ms
Execute	8 ms
Other	4 ms

Environment

Temperature Range: 25°C ± 10°C for spec operation, operates 0°C to 50°C; −50°C 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 and 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; 7.3 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

BNCs relocated to rear panel.

FACTORY/FOB

San Diego, CA

12 MHz Sweep/Function Generator

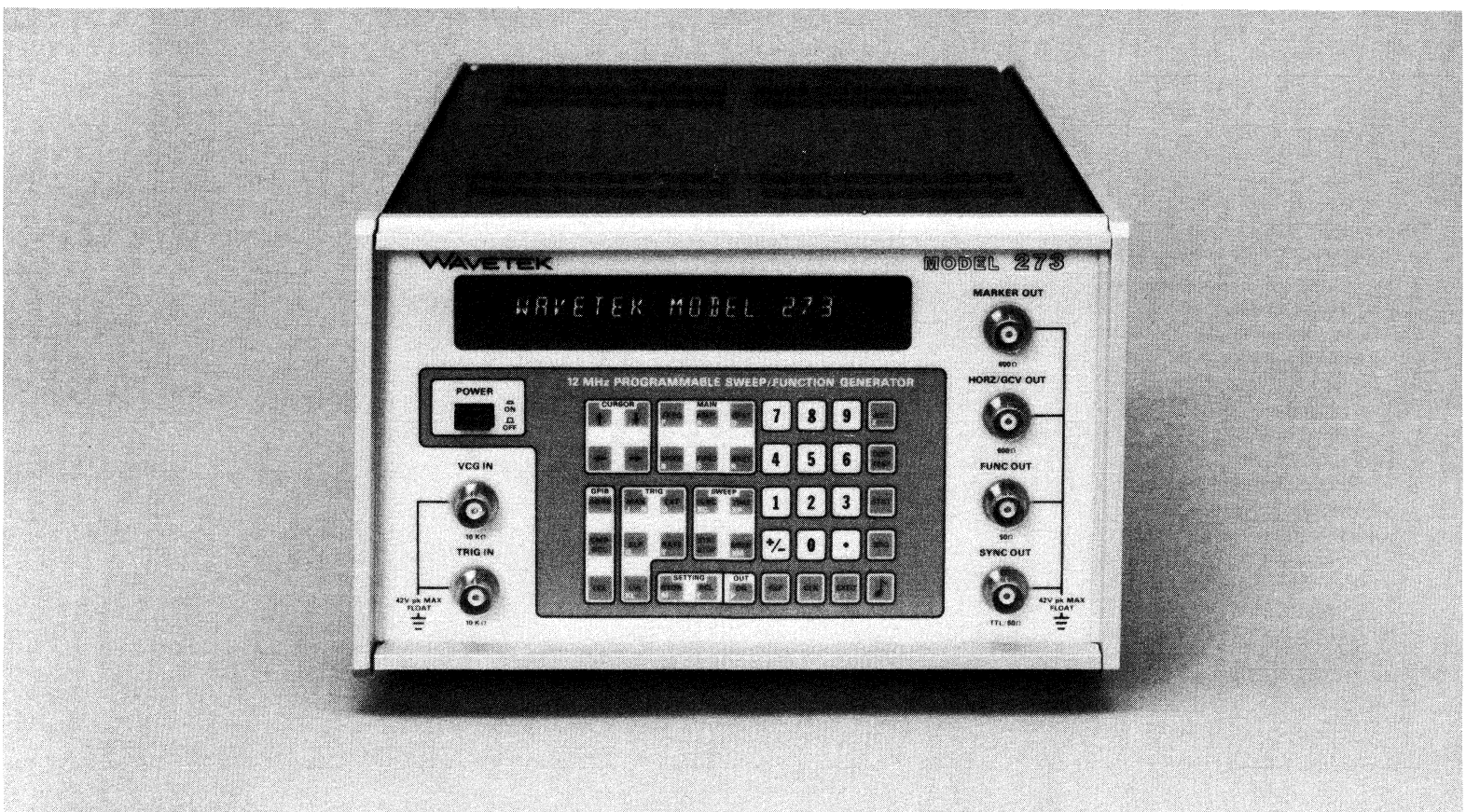
- **User Definable Sweep Shape**
- **Six Standard Sweep Shapes**
- **Twelve Sweep Modes**
- **Three Frequency Markers**
- **GPIB (IEEE-488) Standard**

Compact and Versatile
Model 273 Programmable Sweep/Function Generator is a light-weight, half-rack instrument for bench or ATE use. The 273 can generate precise sine, triangle and square 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; all waveforms may be swept.

Exceptional Sweep Capability
Up to 1200:1 sweep range, 12 sweep modes and 6 standard sweep shapes (plus your own GPIB programmable sweep shape) provide exceptional sweep capabilities in a programmable function generator. Three simultaneous, active markers are available with polarity selection. Sweep start and stop frequencies are easily programmed with a front panel key or GPIB.

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. This makes it easy to transfer a manual setup to a controller program or vice versa. To help the operator even more, "command recall" can display up to 40 previous characters entered either at the front panel or via the GPIB. The 273 also features free-format numeric entry, parameter independence until a final execute command, and front panel GPIB address selection (which can, however, be locked out for security).

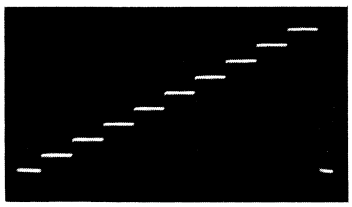
Protected Outputs
All 273 outputs are protected against short circuits and excessive voltages between ±15V. The main output is further protected against voltage inputs of up to 140 Vac or ±200 Vdc. If a voltage greater than ±15V is applied to the main output, the 273 generates an audible alarm, a front panel error message, and a GPIB service request.



MODEL 273 PROGRAMMABLE FUNCTION GENERATORS

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.

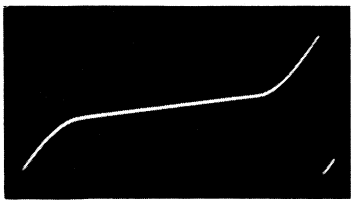


Example of "User Defined" Sweep

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 mid-frequency point for higher resolution when sweeping high-Q circuits.

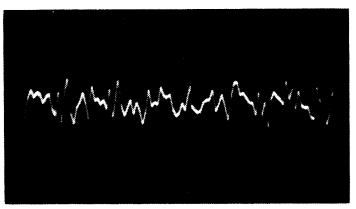


Filter Sweep Function

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

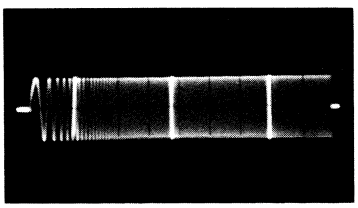
Applications: Jitter testing is greatly simplified when using this mode. The built-in pseudo-random noise pattern allows you to test for FM noise rejection and jitter susceptibility.

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 convenient 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 −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.

OPERATIONAL MODES

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.

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

Burst: As triggered mode for programmed number of cycles.
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.

Value: Frequency value is keyboard or GPIB programmable with automatic range selection.

VCG (Voltage Controlled Generator): AC or dc input controls frequency. +0.01 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 1V/μs.

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: ±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 1 mV when absolute peak amplitude plus offset ≤0.5V.

Accuracy: ±40 mV in dc function.

Repeatability (24 hr): ±20 mV.

OUTPUTS

Function Output: Source of primary waveforms.

Programmable Control Provides:
Output On, (50Ω source impedance);
Output Off, High Z (>500 kΩ);
Output Off, Low Z (approximately 50Ω termination).

Source Impedance: 50Ω.

Protection: Output protected to 140 Vac or 200 Vdc without internal damage.

Sync Output: Sync signal is at programmed frequency and TTL level.

Level: ≤0.4V to ≥2.4V into 50Ω, ≤0.8V to ≥4.8V into ≥50 kΩ.
Source Impedance: 50Ω.
Timing: Concurrent with function output in square; lags sine and triangle by 90°.
Over/Undershoot: <10% into 50Ω.
Protection: Output protected from short circuit to any voltage between ±15 Vdc input minimum.

INPUTS

External Trigger: 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 1 MHz, 1 Vp-p to 15 MHz.
VCG In: Voltage control of generator frequency. See frequency.
Range: 0.01 to 12V.
Impedance: 10 kΩ.
Protection: Inputs protected to ±50V.

INTERNAL TRIGGER

Range: 0.0025 Hz to 2.5 MHz.
Resolution: 4 digits.
Accuracy: 0.2%.

SWEEP MODES

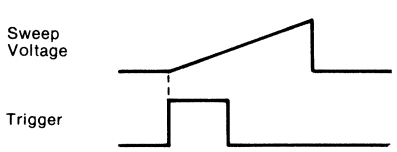
Continuous Sweep and Reset

Main generator sweeps from start frequency to stop frequency, resets to start frequency and continues.

Continuous Sweep and Reverse

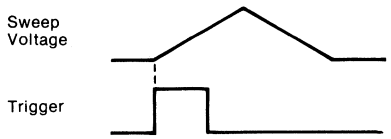
Main generator sweeps from start frequency to stop frequency, reverse sweeps to start frequency and continues.

Triggered Sweep and Reset



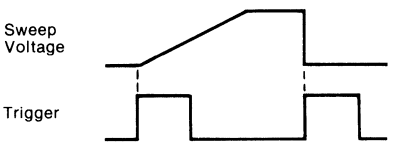
When triggered, main generator sweeps from start frequency to stop frequency and resets to start frequency until next trigger.

Triggered Sweep and Reverse



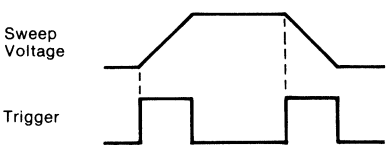
When triggered, main generator sweeps from start frequency to stop frequency, reverse sweeps to start frequency and remains until next trigger.

Triggered Sweep and Hold with Triggered Reset



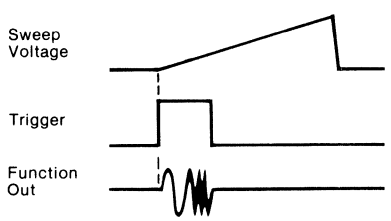
When triggered, main generator sweeps from start frequency to stop frequency until next trigger. When triggered again, resets to start frequency and remains.

Triggered Sweep and Hold with Triggered Reverse



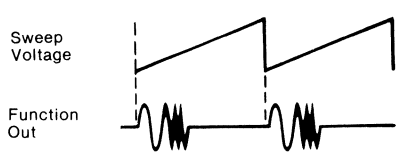
When triggered, main generator sweeps from start frequency to stop frequency. When triggered again, main generator reverse sweeps to start frequency.

Triggered Sweep and Reset with Burst



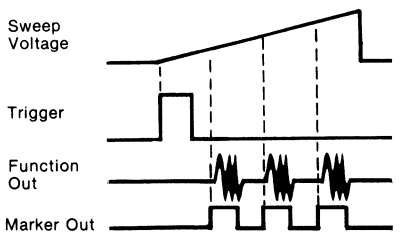
Main generator quiescent until triggered. When triggered, sweep and programmed burst counter run simultaneously for programmed number of waveform cycles. Output quiescent upon completion of cycle count.

Continuous Sweep and Reset with Burst



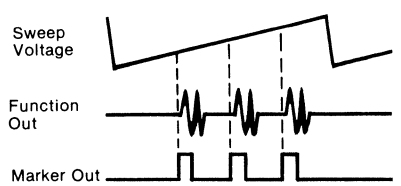
Main generator sweeps from start frequency to stop frequency, resets to start and continues. Start of sweep triggers burst counter. Main generator output is quiescent until triggered by the start of sweep, and returns to quiescent state after completion of programmed number of cycles.

Triggered Sweep and Reset with Burst on Markers



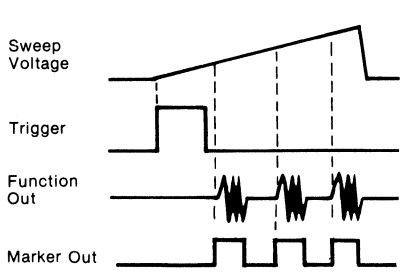
When triggered, main generator sweeps from start frequency to stop frequency , resets and is held until next trigger. Main generator output is quiescent until triggered by markers and returns to a quiescent state after completion of the programmed number of cycles.

Continuous Sweep and Reset with Burst on Markers



Main generator sweeps from start frequency to stop frequency, resets to start frequency and continues. Burst counter is triggered by markers. Main generator output is quiescent until triggered by markers and returns to a quiescent state after completion of programmed number of cycles.

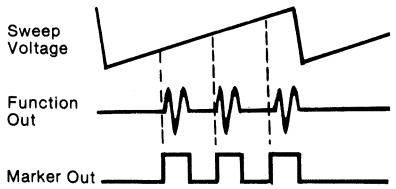
Triggered Sweep and Reset with Gate on Markers



When triggered, main generator sweeps from start frequency to stop frequency, resets to start frequency and is held until next trigger. Main generator output is quiescent until gated on by markers going high, and returns to a quiescent state when markers are low.

MODEL 273 PROGRAMMABLE FUNCTION GENERATORS

Continuous Sweep and Reset with Gate on Markers



Main generator sweeps from start frequency to stop frequency, resets to start frequency and continues. Main generator output is quiescent state when markers are low.

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 Ranges

10 mHz	—	12 Hz
100 mHz	—	120 Hz
1 Hz	—	1.2 kHz
10 Hz	—	12 kHz
100 Hz	—	120 kHz
1 kHz	—	1.2 MHz
1 kHz	—	12 MHz

SWEEP OUTPUTS

Marker Output: Three independent, simultaneously active markers. 0 to 5V into 600Ω. Programmable polarity control: RCL 4000 EXEC initiates positive marker, RCL 4001 EXEC initiates negative marker.

Horizontal Output: 0 to + 5V ± 5%. 250 point synthesized ramp. 600Ω source impedance. RCL 3000 EXEC initiates Horizontal Out.

GCV Output: 0 to + 6V ± 10%. 1000 point synthesized GCV the same wave shape as that sweeping the main generator. Source impedance: 600Ω. RCL 3001 EXEC initiates GCV. GCV output voltage level is proportional to main generator frequency.

Protection: Output protected against ± 15V input minimum.

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 midfrequency point.

Filter: Sweep rate slows towards midfrequency point allowing higher resolution.

User Defined: User programmable variation of frequency between start and stop during active sweep. Unique user defined sweep function is stored in non-volatile memory.

GPIB PROGRAMMING

IEEE 488-1978 compatible. Non-isolated. Double buffered.

Address: 0—30, keyboard or internal switch selectable. Internal switch can lock out keyboard selection. Power-up address is internal setting.

Subsets: SH1, AH1, T6, TE0, L4, SR1, RL1, PP0, DC1, C0, E2.

Interface Timing:

Frequency	16 ms
Amplitude	13 ms
Offset	14 ms
Mode	6 ms
Function	5 ms
INT/EXT	5 ms
Execute	20 to 500 ms
Store	11 ms
Output	10 ms
Slope	5 ms
Burst Count	10 ms
Rate	35 ms
Recall	185 ms
Reset	185 ms

GENERAL

Stored Setting: Non-volatile memory will store 25 settings.

Environment:

Temperature Range: 25°C ± 10°C for specified operation; operates 0°C to 50°C; − 50°C 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 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 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. 5¼ 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. 5¼ inches high.

FACTORY/FOB

San Diego, CA

12 MHz Arbitrary/ Function Generator

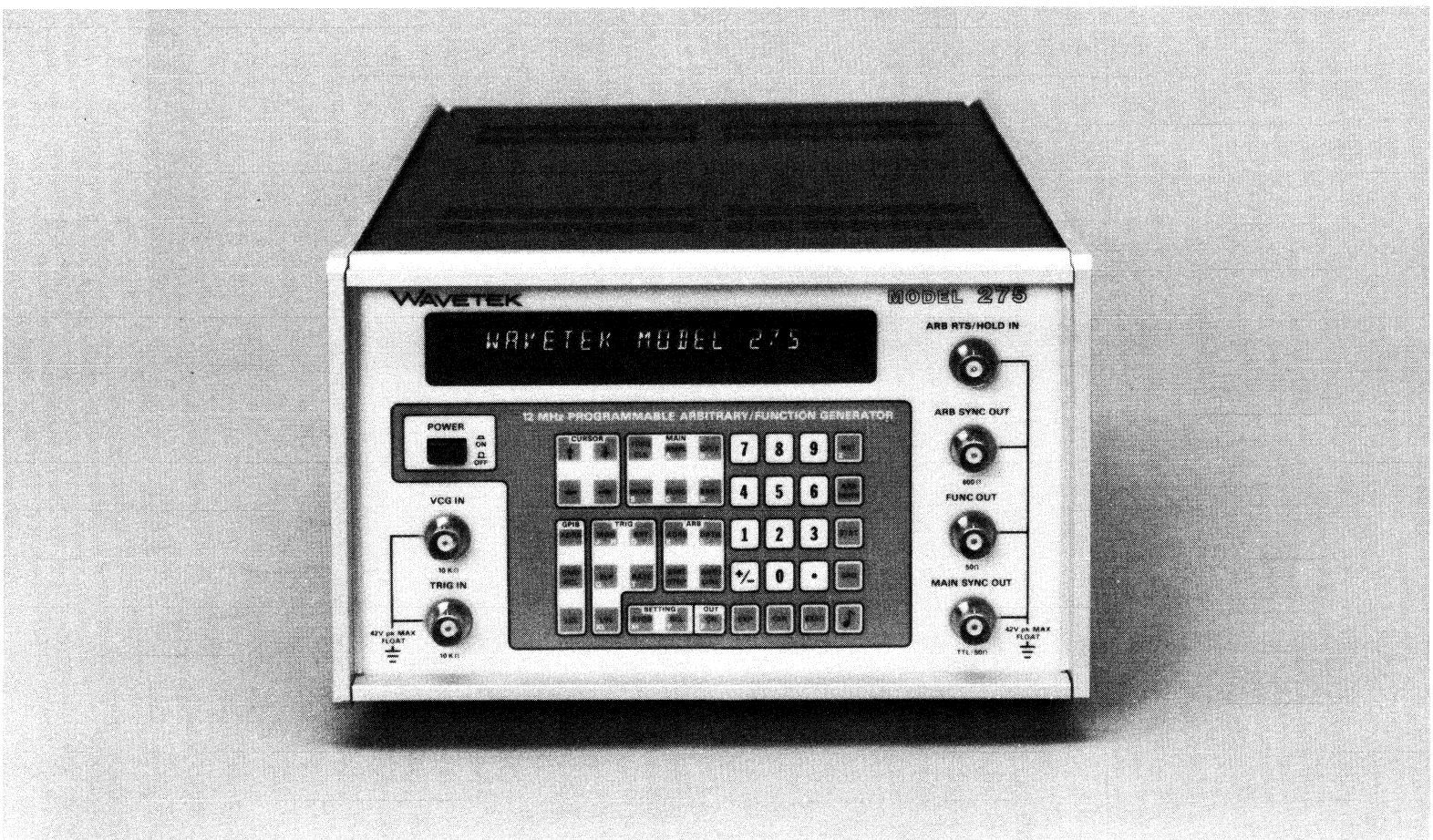
- **User Defined Wave Shapes**
- **12 Bit Amplitude Resolution**
- **Up to 8K Horizontal Points**
- **267 ns to 267s Clock Speed**
- **GPIB (IEEE-488) Standard**

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 and 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, and the internal microprocessor will automatically compute and store the data values for the remainder of the line segment.

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. 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. This makes it easy to transfer a manual setup to a controller program or vice versa. To help the operator even more, "command recall" can display up to 40 previous

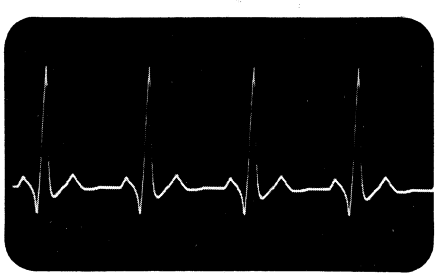


characters entered either at the front panel or by the GPIB. The 275 also features free-format numeric entry, parameter independence until a final execute command, and front panel GPIB address selection (which can, however, be locked out for security).

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. If a voltage greater than ± 15V is applied to the main output, the 275 generates an audible alarm, a front panel error message, and a GPIB service request.

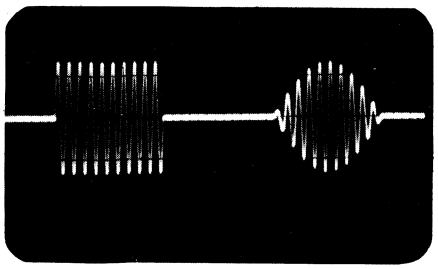
ARB Applications

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



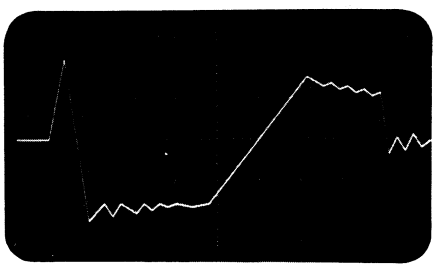
Heartbeat Simulation

Doppler. Doppler applications include underwater 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.



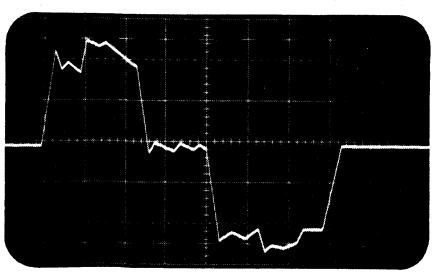
Simulated Doppler Signals

Material Testing. Material testing is a traditional application for ARB geneators. Ramp-to-start, hold-on-trigger, panel lockout, and ARB monitor features make the 275 more useful than previous ARB's for this application.



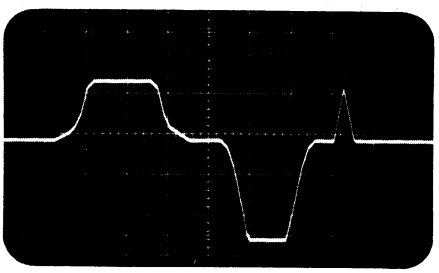
Typical Material Testing Waveform

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 (FUNCTIONS)

Programmable sine ∿, triangle △, square ⊓, square comp, dc, external width, arbitrary and filtered arbitrary.

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.

OPERATIONAL MODES (FOR ALL FUNCTIONS INCLUDING ARB)

Continuous
Output continuous at programmed frequency.

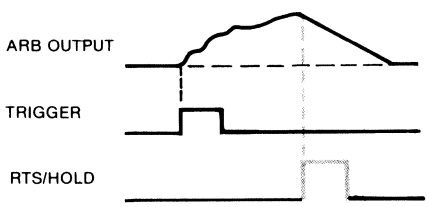
Triggered
Output quiescent until triggered by internal or external signal, GPIB trigger or manual trigger, then generates one cycle at programmed frequency or clock rate.

Gated
As triggered mode except output is continuous for the duration of the gate signal. The last cycle started is completed.

Burst
As triggered mode for programmed number of cycles.
Count Range: 1 to 1,048,200.
Burst Rate: 12 MHz maximum.

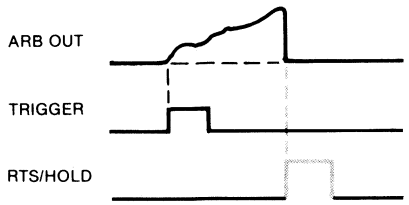
OPERATIONAL MODES (ARB ONLY)

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.



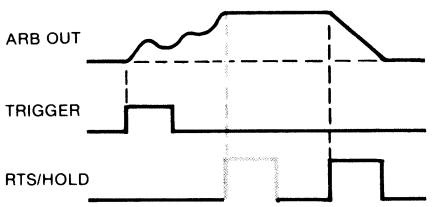
Triggered ARB with Ramp-to-Start

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.



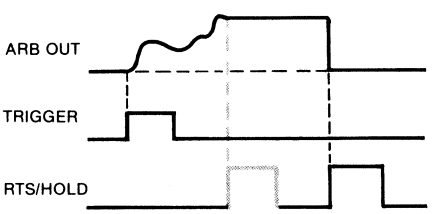
Triggered ARB with Reset

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

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.

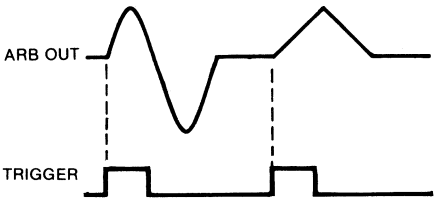


Triggered ARB with Hold and Triggered Reset

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

FREQUENCY

Range
10 mHz to 12 MHz for sine, triangle, square, square complement. >15 MHz for external width. ARB range dependent upon clock rate and block size. Clock rate 267 ns to 267s.

Block Size
2 to 2048 points (to 8192 points optional).

Resolution
3 digits.

Accuracy
±2% for non-ARB modes.
±0.2% for ARB modes.

Repeatability (24 hr)
±1% for non-ARB modes, 0.01% for ARB modes.

Jitter
≤0.1% ±100 ps.

Control
Frequency may be controlled by programmed value or external VCG input.
Value: Frequency value is keyboard or GPIB programmable with automatic range selection.
VCG (Voltage Controlled Generator): AC or dc input controls frequency. +0.01 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 1V/μs.

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
±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 1 mV when absolute peak amplitude plus offset ≤0.5V.

Accuracy
±40 mV in dc function.

Repeatability (24 hr)
±20 mV.

OUTPUTS

Function Output
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 Output
Sync signal is at programmed frequency and TTL level.
Level: ≤0.4V to ≥2.4V into 50Ω, ≤0.8V to ≥4.8V into ≥50 kΩ.
Source Impedance: 50Ω.
Timing: Concurrent with function output in square; lags sine and triangle by 90°.
Over/Undershoot: <10% into 50Ω.
Protection: Output protected from short circuit to any voltage between ±15 Vdc input minimum.

ARB Sync Output
0 to +5V into 600Ω, programmable phase control. RCL 4000 initiates positive ARB sync; RCL 4001 initiates negative ARB sync.
Source Impedance: 600Ω.
Protection: Output protected from short circuit to voltage between ±15V.

INPUTS

External Trigger
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: 20 ns.
Minimum Amplitude: 500 mVp-p to 1 MHz, 1 Vp-p to 15 MHz.
Protection: Input protected to ±50V.

VCG In
Voltage control of generator frequency. See frequency.
Range: 0.01 to 12V.
Impedance: 10 kΩ.
Protection: Input protected to ±50V.

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.
Protection: Input protected from short circuit to any voltage between ±15V.

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: 2%.

ARB CHARACTERISTICS

Horizontal Resolution
2048 points standard; 8192 optional.

Vertical Resolution
12 bits (−2048 to +2047).

Auto-line
Draws straight line between two data points.

Programmable Filter (ARB Waveforms)
Non-filtered ARB Waveform: Settling time <1.5μs.
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 3 Digit ARB Clock
Period Ranges from 267s to 267 ns with 0.2% accuracy.

GPIB PROGRAMMING

IEEE 488-1978 compatible. Non-isolated. Double buffered.

Address
0−30, keyboard or internal switch selectable. Internal switch can lock out keyboard selection. Power-up address is internal setting.

Subsets
SH1, AH1, T6, TE0, L4, SR1, RL1, PP0, DC1, C0, E2.

Interface Timing

Frequency	16 ms
Amplitude	13 ms
Offset	14 ms
Mode	6 ms
Function	5 ms
Int/Ext	5 ms
Execute	20 ms to 4 sec

Interface Timing (Cont.)

Store	11 ms
Output	10 ms
Slope	5 ms
Burst Count	10 ms
Rate	35 ms
Recall	185 ms
Reset	185 ms
Start	20 ms
Stop	20 ms
GET Mode	5 ms to 4 sec
Adrs	10 ms
Data	15 ms
Auto-line	20 ms to 2 sec

GENERAL

Stored Settings
Nonvolatile memory stores 75 settings.

Environment
Temperature Range: 20°C ± 10°C for specified operation, operates 0°C to 50°C, −50°C 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 Vrms; 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
Allows any 270 series instrument to be right or left mounted in a standard 19 inch rack. 5¼ inches high.

Style 13: Dual Rack Adapter Kit
Allows any two 270 series instruments to be mounted side-by-side in a standard 19 inch rack. 5¼ inches high.

FACTORY/FOB

San Diego, CA

12 MHz Synthesized Function Generator

- **0.01 Hz to 12 MHz Frequency Range**
- **0.0005% Synthesized Accuracy**
- **Pulse Capability**
- **GPIB (IEEE 488) Standard**
- **200V Output Protection**

Compact and Versatile
Model 278 Programmable Synthesized Function Generator is a light-weight, half-rack instrument for bench or ATE use. The 278 can generate precise sine, triangle, square, pulse, and external width controlled waveforms from 0.01 to 10 Vp-p, and dc offsets within a −5 to +5V range into 50Ω. Waveforms can be continuous, gated, or triggered.

Synthesized Accuracy
The 278's synthesized mode has 5 digit frequency resoution with 0.0005% accuracy, or it can be locked to an external 10 MHz frequency standard for even greater accuracy and stability. Other 278 features include phase locking to an external frequency and use of the synthesizer circuit as a highly accurate internal trigger.

Programmable Pulse Widths
The 278 can function as a pulse generator with pulse widths programmable from 45 ns to 500 ms with 2 digits of resolution. To make its use as a pulse generator more versatile, the 278 can also program upper and lower levels rather than amplitude and offset, and periods from 90 ns to 1 sec with 3 digits of resolution.

Ease of Programming
The GPIB entry sequence is identical to front panel entry and the ASCII character for GPIB programming appears with each key on the front-panel. This makes it easy to transfer a manual setup to a controller program or vice versa. To help the operator even more, "command recall" can display up to 40 previous characters entered either at the front panel or by GPIB. The 278 also features free-format numeric entry, parameter independence until a final execute command, and front panel GPIB address selection (which can, however, be locked out for security).

Protected Outputs
All 278 outputs are protected against short circuits and excessive voltages between ±15V. The main output is further protected against voltage inputs of up to 140 Vac or ±200 Vdc. If a voltage greater than ±15V is applied to the main output, the 278 generates a audible alarm, a front panel error message, and a GPIB service request. Inputs are protected from voltages up to ±50V.

MODEL 278 PROGRAMMABLE FUNCTION GENERATORS

VERSATILITY

Waveforms
Programmable sine ∿, triangle △, square ⊓, square complement ⊓, pulse ⊓, pulse complement ⊓, external width, or dc.

Operational Modes
Continuous: Nonsynthesized.
Triggered: One cycle triggered by external signal, GPIB, manual, or internal 1 Hz to 12 MHz rate (to 24 MHz in external width).
Gated: As Triggered except output continuous for duration of gate signal. Internal gate signal produces 50% duty cycle gate.
Burst: As Triggered for programmed number of cycles (1 - 1,048,200).
Synthesizer: As Continuous with increased freq accuracy and stability.
External Reference: As Synth plus locked to external 10 MHz ref.
External Phase Lock: As Continuous with output signal locked to external 10 Hz to 12 MHz signal.

Frequency Range
10 mHz to 12 MHz except 10 Hz minimum in Synth, Ext Ref and Ext Lock modes.

Outputs
Function Output: Waveforms from 0.01 to 10 Vp-p into 50Ω (0.02 to 20 Vp-p into ≥50 kΩ). DC or offset 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).
Source Impedance: 50Ω
Programmable Control Provides:
Output On, (50Ω source impedance);
Ouput Off, High Z (>500kΩ)
Output Off, Low Z (approx 50Ω termination).
Sync Output: TTL level square wave into 50Ω. 50Ω source impedance. Concurrent with main output in square; lags sine and triangle by 90°.
Over/Undershoot: <10% into 50Ω.
Ref Out: TTL level pulse. Frequency of internal trigger when in Trig, Gate, Burst or Pulse modes; 10 MHz in Ext Ref or Synth modes.
Protection: Sync and Ref outputs protected against ±15V input minimum. Function output protected to 140 Vac or ±200 Vdc without replacement of internal fuse.

Inputs
VCG In: 0.01 to 12V into 10 kΩ for up to 1200:1 frequency change. 10V gives range max. 12V gives 20% over range. Slew Rate: 1V/μs.
Trig In: Level programmable: −10 to +10V, 20 mV resolution, ±500 mV accuracy. Programmable to trigger on + or − signal slope.
Max Rate: 12 MHz (15 MHz in external width). Min Width: 20 ns. Min. Ampl: 500 mVp-p to 1 MHz, 1 Vp-p to 24 MHz. Impedance: 10 kΩ.
Ref In: TTL or 1 Vp-p min (select TTL or zero crossing). 10 MHz for Ext Ref mode; 10 Hz to 12 MHz for Phase Lock mode (capture and lock range >5% of programmed frequency).
Protection: Inputs protected against ±50V input minimum.

PRECISION

Frequency
Resolution: Synth and Ext Ref Modes: 5 digits.
All Other Modes: 3 digits.
Accuracy: Synthesizer Mode: 5 ppm ±1 mHz.
Ext Ref and Lock Modes: Accuracy of external ref signal ±1 mHz.
All Other Modes: ±2%.
Noise Floor: >−50 dBc.
Spurious: >−45 dBc.

Amplitude
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: ±2% of programmed value and: ±5 mV to 0.1 for 1V (pk ampl + ofst <0.5V), ±20 mV for 1.01 to 10V, ±50 mV for all other.
Repeatability (24 hr): ±1% ±10 mV.
Flatness: 0.1 dB to 100 kHz, 1.5 dB to 12 MHz for output at 5 Vp-p.

Offset
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 (24 hr): ±1% ±20 mV.

Waveform Quality
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% ±5 ns.
Square Transition Time: <15 ns.
Square Over/Undershoot: <5% of pk-pk amplitude ±20 mV.
Triangle Linearity: 99% to 100 kHz.

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

Pulse Period
Resolution: 3 digits.
Accuracy: 0.1%.
Range: 90 ns to 1 sec.

Pulse Width
Duty Cycle: ≤50%.
Resolution: 2 digits.
Accuracy: 3% from 500 ns to 500 ms, 5% from 45 ns to 490 ns.
Range: 45 ns to 500 ms.

GENERAL

Stored Settings
Nonvolatile memory for 100 stored settings. Battery back-up with minimum 6 mo. retention (typ. 5 yr.), battery check and status display.

GPIB Programming
IEEE 488-1978 compatible. Non-isolated. Double buffered.
Address: 0-30 keyboard or internal switch selectable. Internal switch can lockout keyboard selection. Power-up address is internal setting.
Subsets: SH1, TE0, RL1, AH1, L4, PP0, C0, T6, SR1, DC1 and E2.

Interface Timing

Parameter	Time
Frequency	11 ms
Amplitude	14 ms
Offset	14 ms
Mode	4 ms
Waveform	5 ms
Execute	8 ms
Other	4 ms

Environment
Temperature Range: 25°C ± 10°C for spec operation, operates 0°C to 50°C, −50°C to +75°C for storage.
Warm-up Time: 20 minutes for specified operation.
Altitude: Operates 0 to 10,000 ft, 0 to 40,000 ft for storage.
Relative Humidity: 95% at 25°C and 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 (12.9 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; <50 watts.

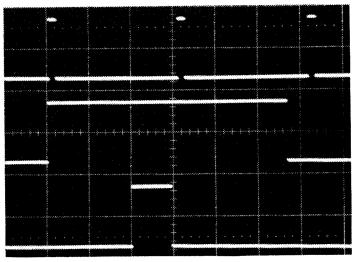
OPTIONS

002: Rear Panel Connectors
BNCs relocated to rear panel.

FACTORY/FOB

San Diego, CA

50 MHz Pulse Generator



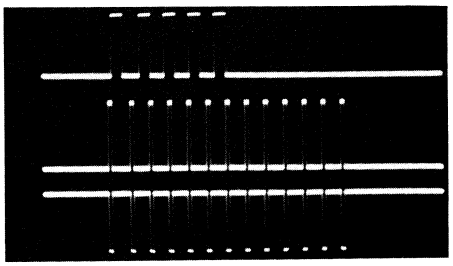
- **0.5 Hz to 50 MHz Frequency Range**
- **Full 20 Volt Output**
- **Variable Transition Times**
- **Second Channel Output Option**
- **GPIB and Stored Settings**

Wide Frequency Range
Model 859 provides 0.5 Hz (2s periods) to 50 MHz (0.02 μs periods), in a 5¼ inch high, rack mountable instrument that is fully programmable for systems applications.

Pulse Capabilities
Pulse widths can vary from 10 nanoseconds to 1 second, delays to 1 second, transition times from 5 nanoseconds to 25 milliseconds, and output levels up to 20 volts. All pulse parameters have a resolution of 3 digits. 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.

Mode Versatility
Operating modes include continuous, triggered, gated burst (1 to 10,000 pulse periods), external width mode to reconstruct or shape an external signal, and unique time interval mode for extremely long pulses.

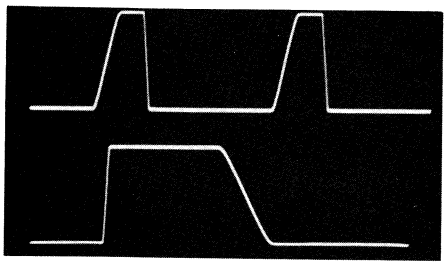
Trigger status is always shown. Front panel annunciators give positive indication of the selection of manual triggering (pushbutton or GPIB), external rising or falling edge triggering and of trigger presence.



Pulse Burst

Second Channel Option
Second channel output is available for dual pulse applications. Second

channel delay, width, function, transition times, output levels and complement parameters are fully indeendent of the first channel parameters. The two channels have common repetition rate and mode.



Double and Single Pulse

GPIB Programmable
Model 859 is fully compatible with the IEEE Standard 488-1978 for your General Purpose Interface Bus (GPIB) system. All parameters can be readily bus or manually programmed using the same simple prefix/ value notation. You are not tied to a rigid format. Any combination of numerals, floating decimal points and exponents that can express values will be correctly interpreted. 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.

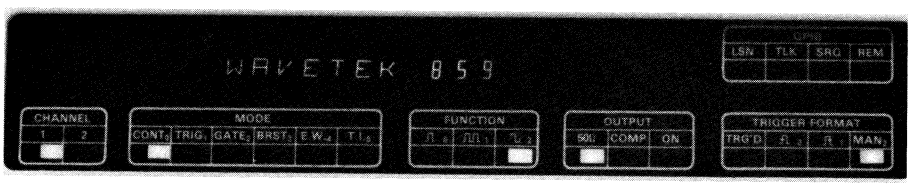
Parameter Independence
You can vary a pulse parameter with full assurance that the other parameters remain exactly as programmed. We did not redefine the parameters in order to make them independently adjustable. For example pulse width is still measured at the 50% point (not leading edge to trailing edge start) and, yes, it remains constant as the transition times are varied, or pulse height, or frequency, or any other programming parameter. 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.

False Errors Eliminated
When programming a new setup, error checking is delayed until the entire set of new parameters has been entered and executed. You do not have to concern yourself with the order in which you program a setup to avoid tedious false errors.

Stored Settings
Operation is further simplified through stored settings and vernier features standard in the Model 859. You can store and recall up to 25 complete setups in battery-backed RAM which can eliminate the need for a controller in repetitive tests.

Rapid Incrementing
Vernier controls increment or decrement a single parameter value at a rate determined by positioning the front panel cursor to the digit to be modified. Vernier control eliminates repetitive rekeying of values when you are determining exact limitations of a device under test.

Front Panel
Using the front panel keyboard and display is quite straight forward and makes pulse design and programming easily understood. The internal microprocessor "converses" with the operator via the front panel informing him of what is possible to program, what was programmed and when an error is made. The front panel display shows the parameter being programmed and its value. Adjacent to the parameter display, annunciators give the status of the 859's operating conditions. The 859 front panel lets you know what's happening.



Display and Annunciators

NEW Optional MATE Interface

Model 859 is available with a factory-installed MATE interface per USAF Standard 2806763 (Option 010). The MATE interface consists of both hardware and software. The software accepts IEEE 488-1978 interface bus (GPIB) commands in Control Interface Intermediate Language (CIIL) as well as the "native" Model 859 language. The hardware includes expanded memory to support the additional software, shallower handles to allow the instrument to be mounted in a rack equipped with a front door, and a status monitor interface to report catastrophic failures to the control computer in real-time. The status monitor interface is independent of the GPIB.

VERSATILITY

Pulse Outputs

Four pulse outputs:
Variable main channel pulse;
A 2nd channel variable pulse (optional);
TTL compatible fixed sync pulse at lowest frequency in generation system;
Fixed symmetrical (approximately 50% duty cycle) clock output which follows repetition rate generator.

Pulse 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 symmetrical (50% duty cycle) up to 50 MHz repetition rate with variable transition times to 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.

Operational Modes

Continuous: Output continuous at programmed frequency.
Triggered: Output quiescent until triggered for one pulse (or double pulse).
Gated: As triggered mode, except repetition rate generator is enabled for duration of input trigger. Last pulse period started is completed. Maximum gate rate is 25 MHz.
Burst: As triggered mode, except repetition rate generator is enabled for 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.

PULSE OUTPUTS

Main Output

Upper and lower pulse levels of both main output channels (2nd channel optional) are independently programmable. High impedance or 50Ω source impedance is automatically selected. If upper level, lower level or peak-to-peak amplitude absolute value is >10V, 50Ω internal source is changed to high impedance. The values in table 1 are for a 50Ω load impedance. Pulses of either output channel may be normal or complement. In complement, upper and lower levels are interchanged. Transition times remain as programmed.

Sync Output

A pulse of approximately −0.6 to 3V from 50Ω source at lowest frequency in generator system.

Clock Output

A pulse of approximately −0.6 to 3V from 50Ω source, 50% duty cycle and with programmed repetition rate in continuous, gate and burst modes. Repetition rate in time interval mode determined by microprocessor.

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% ±1 ns.
Repeatability: 2% ±1 ns.
Jitter: ±0.1% ±50 ps.

Width

Width control affects pulses of the main channels.
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.
Jitter:
±0.1% ±50 ps width <1 μs;
±0.05% width 1 to 10 μs;
±0.005% width >10 μs.
Duty Cycle: 90% limited by 10 ns minimum off time.

Delay

Delay control affects pulses of the main channels.
Range: 0 ns to 999 ms.
Resolution: 1 ns from 0 ns to 19.999 μs; 3 digits of programmed value from 20 μs to 999 ms.
Accuracy: ±1% ±2 ns.
Repeatability: ±1% ±1 ns.
Jitter:
±0.1% ±50 ps delay <1 μs;
±0.05% delay 1 to 10 μs;
±0.005% delay >10 μs.
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.

Transition Time

For pulses of either main channel, leading and trailing edge transition times independently adjustable from 5 ns to 25 ms (10% to 90% points of programmed amplitude).

Table 1

Characteristics	Hi Impedance Source	50Ω Source
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% program value ±1% ampl ±100 mV	2% program value ±1% ampl ±50 mV
Repeatability	Highly dependent upon cable length and load impedance	±1% ampl ±50 mV
Preshoot		±3% ampl ±10 mV
Overshoot & Ringing		±3% ampl ±10 mV

Range: Variable to 50:1. Leading and trailing edge times must be in the same range.
5 to 100 ns;
50 ns to 2.50 μs;
500 ns to 25 μs;
5 to 250 μs;
50 μs to 2.5 ms;
500 μs to 25 ms.

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.
Repeatability: ±1% ±1 ns.
Linearity: ±3% for transitions >50 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.

INPUT CHARACTERISTICS

External Trigger
Arbitrary trigger signals accepted. Rising or falling edge triggering selectable.
Trigger Point: −5 to +5V, adjustable at rear panel.
Impedance: Approximately 1 kΩ paralleled by 22 pf.
Width: 10 ns minimum.
Amplitude: 700 mV minimum.
Repetition Rate:
50 MHz maximum.

Manual Trigger
Front panel key. In gate and external width modes, output active while key depressed.

GPIB Trigger
ASCII "J". In gate and external width modes, "H" signals and of active interval.

GPIB
IEEE 488-1978 compatible for direct connection to GPIB. Optical isolation.
Capabilities:
Listener: AH1 and L4;
Talker: SH1 and T6;
Service Request: SR1;
Remote Local: RL1;
Device Clear: DC1;
Device Trigger: DT1.

Parameter	Typical Programming Time
Command Handshake	2 μs
Data Handshake	220 μs
Frequency	15 ms
Period	20 ms
Upper Level	20 ms
Lower Level	20 ms
Delay	15 ms
Width	18 ms
Leading Edge	35 ms
Trailing Edge	35 ms
Time Interval	10 ms
Mode	10 ms
Function	5 ms
Channel	7 ms
Trigger Format	5 ms
Normal/Complement	5 ms
Output ON/OFF	5 ms
Burst Number	8 ms
Trigger	3 ms
Store Settings	20 ms
Recall Setting	8 ms*
Next Setting	5 ms*
Previous Setting	5 ms*
Execute	20 ms*
GET	2 ms

*2.5 ms when via GET.

Measurements made with HP9825 controller. Times will vary with different controllers. Data rate will follow slowest listener on bus.

GENERAL

Features
Trigger Indicator: Indicates when generator is properly triggered or a burst or time interval is in progress.
Error Detection: Microprocessor detected errors are displayed.
Vernier: Key controlled step or continuous incrementing of any pulse parameter. Cursor selects digit to be updated. Automatic over and under flow.
Nonvolatile Stored Settings: 25 complete front panel setups can be stored and recalled from internal memory. 30 day back-up time.
Reset: Generator is returned to standard setup for confidence check.
Command Recall: Key controlled display of last 36 characters sent via GPIB interface or keyboard.
Return to Local: Key controlled return from GPIB to front panel operation.
Manual Trigger: Key controlled trigger for trigger, gate burst, external width and time interval modes.

Environment
Specifications apply for 25 ±5°C after 30 minute warm-up. Instrument will operate from 0 to 50°C, 0 to 10,000 feet altitude at 25°C and 0 to 95% relative humidity at 25°C.

Dimensions
Fits standard 48.3 cm (19 in.) rack. Dimensions behind front panel are 43.2 cm (17 in.) wide; 13.3 cm (5¼ 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.

OPTION

001: Additional Channel
Second channel of delay, width, transition times and output levels. Channels share operating mode and internal clock period only. All other functions and parameters are independent.

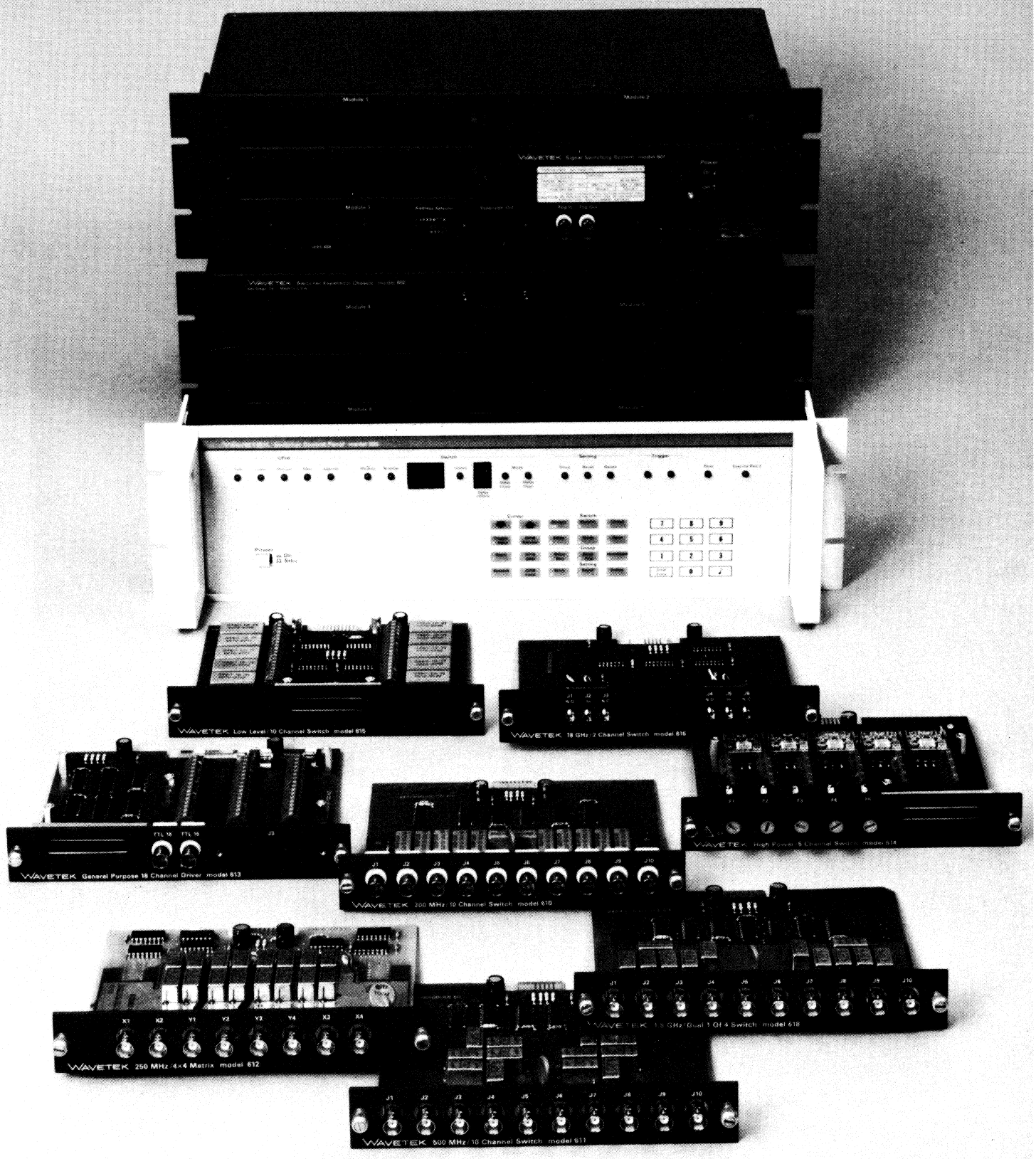
010: MATE Interface
Factory installed MATE interface per USAF Standard 2806763.

NOTE: Specifications apply with transition time set to minimum and the 50Ω source driving a 50Ω load.

FACTORY/FOB

San Diego, CA

Programmable Signal Switchers



Signal Switchers
Wavetek's versatile family of signal switching systems covers a wide range of ATE and R&D applications. The family of signal switchers consists of two basic model concepts: The highly modular, bench or ATE System 600 and the low cost Model 604 bench-top switcher.

System 600
The versatile System 600 consists of:

Model 601 Chassis with up to three plug-in switch modules.

And optional:

Model 602 Expansion Chassis with up to four switch modules,
Model 603 Front Panel, and
Models 610 through 620 Switch Modules.

The 601 main chassis along with the 602 expansion chassis offer full GPIB (IEEE-488) control for as many as seven plug-in modules. The 603 front panel can be added for manual control in addition to the existing GPIB interface.

Model 604
For R&D applications and small ATE systems, our low cost Model 604 offers self-contained signal switching capabilities. The 604 has front panel controls and the GPIB interface. It handles up to eight channels of switching in two groups of four, each group having a common connector for input or output.

Switching Flexibility
The 604 offers fixed contact ratings and frequency range. If you require more versatility, the plug-in switch modules for the System 600 offer virtually every contact type and rating you may require. The low cost Model 610 switch module basically covers the same 200 MHz frequency range that the Model 604 switcher offers. Other plug-in modules include a variety of frequency ranges and contact types including a 250 MHz matrix module, high power switching up to 500 VA, low level switching with $\leq 1\ \mu V$ thermal offset, modules ranging up to 26.5 GHz in frequency and a programmable attenuator module. In addition to these analog signal switching modules, a general purpose I/O module with 16 channels of TTL and relay drivers is available as well as a prototype (breadboard) module which has 16 channel drive capability and ample room to mount your own relays and other components.

The most important switch module specifications are listed in the selection guide overleaf. More details are on pages referenced in the guide.

Standard Control Features
Both the System 600 and Model 604 have GPIB (IEEE-488) interface for full control of switching functions. System 600 can store complete instrument setups including all switching parameters such as Make-Before-Break (MBB) or Break-Before-Make (BBM), and switching delay times from 0 to 175 ms in 25 ms steps at either switch closure or opening. All these parameters for every switch in a system (up to 112) can be stored or recalled by just a few key strokes or by a simple GPIB command. Also, since the main chassis, Model 601, has a trigger input and trigger output, System 600 can step through as many as 50 stored settings without computer control.

GPIB Control
For ease of program development, each syntax control character is printed on the applicable front panel key.

The GPIB interface is implemented in a very flexible way. When using the GPIB interface you can control every switch in the system by sending just one string variable. Furthermore, you may increment or decrement a stored setting with a simple command or store/recall a specific setting. It also has various talker modes that let you verify switch status, perform a serial poll, verify the software version in use and the module number in a specified plug-in slot. You may bit-mask the condition under which an SRQ is generated and you may read the programming error register. System 601 has a software checking routine that verifies all commands you send, and if you try to program nonexisting switches or violate other parameters, the error type and quantity are stored in the error register. Thus the GPIB interface is both flexible and easy to use. Note that System 600 is a full talker/listener and the Model 604 is a listener only.

Easy Expansion
Although the Model 604 firmware was derived from the System 600, it differs in a few areas because the 604 has fixed time delays in MBB and BBM modes rather than the programmable delay the 600 offers. Also the 604 has no stored settings thus no need for a trigger input/output. Yet any program developed with the 604 in an R&D environment can easily be transferred into a 600 compatible version; thus making the transition from your test lab to the production floor a very easy one.

Superior Mechanical Design
Another important aspect of the 600 family is its mechanical flexibility. The 601/602 chassis combination for example can be mounted behind each other in just 5 ¼ inch of 19 inch rack space. The 603 front panel can be mounted independently or it can be nested into the 601 main chassis. Moreover, the chassis can be mounted with connectors facing toward the front as well as facing towards the back of a rack. The smaller 604 can also be rack mounted as well as used as a bench-top unit. Hence the 600 family provides an optimum solution, using as little as possible front panel space thereby satisfying mechanical as well as electrical engineering aspects.

SIGNAL SWITCHING SYSTEM SELECTION GUIDE

Model	Function	Max Frequency	No of Switches	Contact Type/Rating	Catalog Page
Model 600 Signal Switching System					
601 **Opt 001**	Main Chassis Memory Expansion	N/A N/A	N/A* N/A	N/A N/A	132
602 **Opt 002**	Expansion Chassis (with 1 ft cable) 601/602 Interconnect Cable, 5 ft	N/A N/A	N/A** N/A	N/A N/A	132
603 **—**	Control Panel Extender Cable	N/A N/A	N/A N/A	N/A N/A	134
Model 604 200-MHz Programmable Signal Switcher					
604	Self-contained A-Band RF Small Systems Switching	200 MHz	10	200V, 0.5A, 10W	131
Plug-in Modules (610-620) for 601 and 602 Chassis					
610	A-Band RF Switching	200 MHz	10	200V, 0.5A, 10W	134
611	B-Band RF Switching	500 MHz	10	100V, 2A, 60W	135
612	Matrix/RF Switching	250 MHz	16 (4 × 4)	100V, 2A, 60W	135
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	136
614	High Power Switching	N/A	5	250 VAC, 5A, Max 500 VA	136
615	Low Level Switching	≤1 MHz	10	100V, 200 mA, Max 5W, <0.2Ω, <1 μV	137
616	J-Band Microwave Switching	18 GHz	2	70V, 1.4A (N.S.)	137
617	Attenuation (0 to 85 dB, 1 dB steps, 2 sections)	250 MHz	2 Sections	20V, 2A, 5W Continuous Power	138
618	D-Band RF Switching	1.5 GHz	10	100V, 2A, 60W	138
619	Breadboard/Customer Defined	Customer defined	16 Channels	1 LS TTL per each of 16 lines	139
620	K-Band Microwave Switching	26.5 GHz	2	Max 250 W @ 100 MHz; derates to 15 W @ 26.5 GHz	139

*Main Chassis acepts 3 plug-in switch modules.
**Expansion Chassis accepts 4 plug-in switch modules.

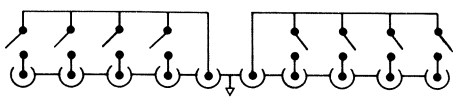
200 MHz Programmable Signal Switcher

Model 604, a dc to 200 MHz Programmable Signal Switcher, contains two four-channel switch groups in a star configuration. Switch selection, operation and modes are controlled by front panel or GPIB.

SPECIFICATIONS

SWITCHES

Number of Switches
8 in 2 groups.



Insertion Loss
≤0.5 dB @ 100 MHz.
≤1 dB @ 200 MHz.

Crosstalk
Any channel to any channel, all switches open:
≤ – 70 dB to 10 MHz
≤ – 50 dB to 100 MHz
≤ – 40 dB to 200 MHz.

Isolation
One signal path, input to output, one switch open:
≤ – 55 dB to 10 MHz
≤ – 35 dB to 100 MHz
≤ – 30 dB to 200 MHz

Risetime
≤2 ns.

Maximum V/A/W
200 V, 0.5 A, 10 W.

Switch Contact Resistance
≤0.25 Ω per switch.

VSWR (Typical)
≤1.03 @ 10 MHz,
≤1.15 @ 100 MHz,
≤1.51 @ 200 MHz.

Switching Time
≤1 ms.

I/O Connections
10 BNC female connectors.

PROGRAMMING

Local and GPIB Parameters
Multiple/Single: Multiple mode allows any combination of switches to be closed. Single mode allows only one switch of each group to be closed.
Make 1st/Break 1st: Make 1st is Make-Before-Break mode. Break 1st is Break-Before-Make mode.
Open/Close: Open or close designated switch.
Remote/Local: GPIB or front panel control selection. Remote LED lights when the 604 is under GPIB control.

GPIB Only Parameters
Execute: Transfers the program to the switches.
Reset: Returns the 604 to its power-on conditions.

GPIB
IEEE 488-1978 compatible, non-isolated, double buffered, listen only.
Address: 0 to 30; externally switch selectable.
Subsets: AH1, DC1, DT1, L3, RL1.
Timing: All parameters ≤25ms.

GENERAL

Environment
Temperature Range: 0 to 50°C.
Warm-up Time: 0 hours.
Altitude: Up to 10,000 ft for operation; up to 40,000 ft for storage.
Relative Humidity: 90% noncondensing.

Dimensions
21.6 cm (8½ in.) wide, 8.9 cm (3½ in.) high, 27.9 cm (11 in.) deep.

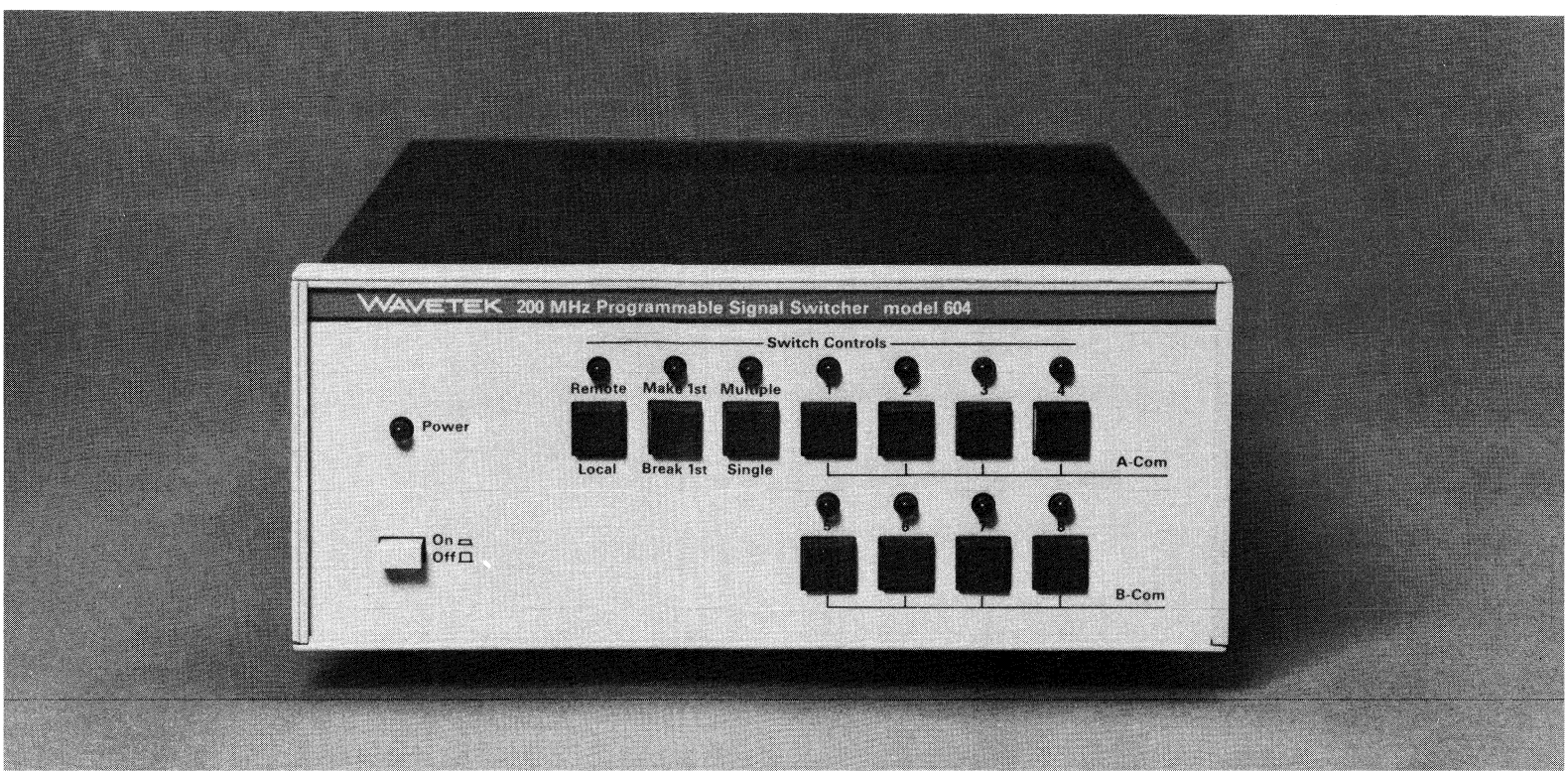
Weight
2.3 kg (5 lb) net; 3.6 kg (8 lb) shipping.

Mounting
Shelf, bench, or in a "half 19-inch" rack mount adapter.

Power
90 to 260 Vac, 48 to 66 Hz, 1 phase, ≤10 W.

FACTORY/FOB

San Diego, CA



System Chassis and Expansion Chassis

- **Low Cost, High Performance**
- **Small Size, Bench or Rack**
- **Wide Variety of Switch Modules**
- **Maximum Configuration Flexibility**
- **GPIB and Stored Settings Standard**

Model 601
Model 601, the main chassis for the 600 Signal Switching System, houses the GPIB interface, stored setting memory, power supply and up to three switch modules. The Model 601 supplies all the power and controls for the optional Models 602 (Expansion Chassis) and 603 (Control Panel).

Model 602
Model 602, Expansion Chassis, provides room for four additional switch modules. The Model 602 receives all its power and commands from the Model 601.

Mounting
Both chassis measure only 8 inches deep and can be mounted at the rear of a rack, switch modules facing rearward. If the manual control panel (Model 603) is not required (GPIB operation only), no front-of-rack space is used up. Both chassis are convenient depth for bench or shelf usage.

Modules
A variety of switch modules provide flexibility and performance at a low cost. Applications from DC to 26 GHz as well as low level (<1μV), high voltage, and power switching are covered. For module specifications, see pages 134 through 139.

MODELS 601 & 602 PROGRAMMABLE SIGNAL SWITCHERS

MODEL 601 CHASSIS

Switch Module Slots
3. Numbered 1 thru 3.

Programming
Control of Model 601 and switch modules is via the GPIB or Model 603 control panel.
Program parameters are:
Module Number: Selects one of the up to seven modules in a Model 600 system.
Switch Number: Selects a switch within a module.
Open/Close: Opens or closes a switch.
Delay Mode: Specifies the actuation mode of each individual relay. Actuation modes are: open and close immediately; delay on open; delay on close; delay on both.
Delay Time: The actuation delay as it applies to the delay mode. The delay of each individual switch can be set from 0 to 175 ms in eight steps.
Group Break Before Make: Programs all switches in one module to operate as break-before-make.
Group Make Before Break: Programs all switches in one module to operate as make-before-break.
Group Immediate: Programs all switches in one module for immediate make and break operation.
Trigger Slope: Configures trigger circuit to respond to input of + slope or − slope, or not to respond to input.
Execute: Transfers all switch programs to the module circuits.
Reset: Returns Model 601 and all modules to the power-on condition.

Stored Settings
A stored setting holds the configuration of every switch in the system (including expansion chassis). 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). Model 601 has 10 settings standard with an additional 40 (50 total) available optionally.

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 less than 25 ms.

External Trigger Input
Switch closure or TTL level change causes one increment of stored setting. >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
4. Numbered 4 through 7.

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
(Each Model)
Width: 43.2 cm (17 in.).
Height: 13.3 cm (5¼ in.).
Depth: 20.3 cm (8 in.).

Weight
Model 601: 5.2 kg (11½ lb) net; 6.8 kg (15 lb) shipping.
Model 602: 3.8 kg (8½ lb) net; 5.9 kg (13 lb) shipping.

Mounting
Models 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 40 W.

Power Distribution
The following power is available for modules:
Model 601: 10 W @ 12V, 1.5 W @ 5V.
Model 602: 12 W @ 12V, 1.5 W @ 5V.
The total number of switches turned on must not exceed this power. (See individual module specifications.)

OPTION

001: Additional Stored Settings 40 additional stored settings for Model 601 (total of 50).

ACCESSORIES

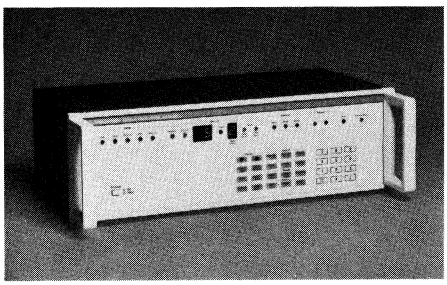
Extender Cable
Front panel to chassis, 5 ft extender cable for remote operation.

FACTORY/FOB

San Diego, CA

Switching System Control Panel

- **Versatile Mounting**
- **Manual Switcher Control**



Model 603 provides manual control and status display of all switch parameters and stored settings, GPIB status information and error indications for the Model 600 Signal Switching System. Control panel can be mounted at the front of the rack with a cable to the Model 601 chassis mounted at the rear of the rack. The panel also can be nested into the 601 for rack or bench use.

SPECIFICATIONS

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.
Miscellaneous: 0-9 keypad, clear entry, reset, execute.
Environment
(See Chassis.)
Dimensions
Width: 43.8 cm (17¼ in.).
Height: 13.3 cm (5¼ in.).
Depth: 4.4 cm (1¾ in.) excluding handles.
Weight
1.6 kg (3½ lb) net; 3.2 kg (7 lb) shipping.
Power Required
From Model 601, Chassis.

ACCESSORIES

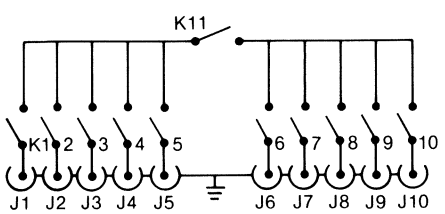
Extender Cable
Front panel-to-chassis, 5 ft extender cable for remote operation.

FACTORY/FOB

San Diego, CA

200 MHz, 10 Channel Module

- **200 MHz Bandwidth**
- **Versatile Configuration**



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.

SPECIFICATIONS

Insertion Loss: ≤0.5 dB @ 100 MHz.
Bandwidth: ≥200 MHz @ −3 dB.
Cross Talk: Any channel to any channel; all switches open:

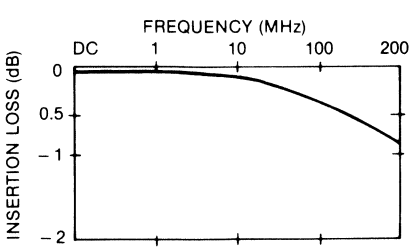
10 MHz	100 MHz	200 MHz
≤ −75 dB	≤ −55 dB	≤ −50 dB

Isolation: One signal path, input to output; one switch open:

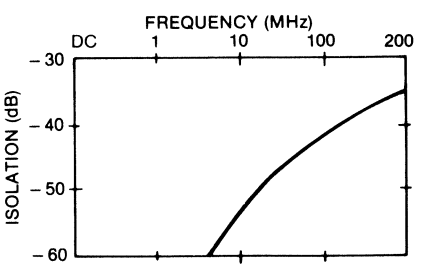
10 MHz	100 MHz	200 MHz
≤ −55 dB	≤ −40 dB	≤ −35 dB

Risetime: ≤2.0 ns.
Max V/A/W: 200V, 0.5A 10W.
Contact Resistance: ≤0.15Ω/switch.
VSWR (Typical): ≤1.1:1 @ 25 MHz, ≤1.2:1 @ 95 MHz.
Switching Time: ≤2 ms.
I/O Connections: 10 BNC, female.
Power Consumption:
1.0 W max @ 12V;
0.1 W per switch.

Typical Insertion Loss:



Typical Isolation:

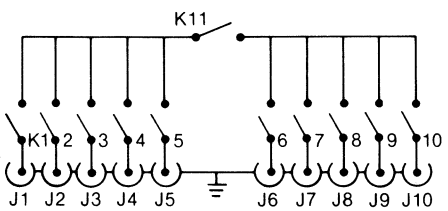


FACTORY/FOB

San Diego, CA

500 MHz, 10 Channel Module

- **500 MHz Bandwidth**
- **Versatile Configuration**



Model 611, a 500 MHz RF module, gives maximum connection flexibility by providing two sets of five relays in a modified star configuration.

SPECIFICATIONS

Insertion Loss: ⩽0.5 dB @ 100 MHz.
Bandwidth: ⩾500 MHz @ −3 dB.
Rise Time: ⩽1.0 ns.
Cross Talk: Any channel to any channel; all switches open:

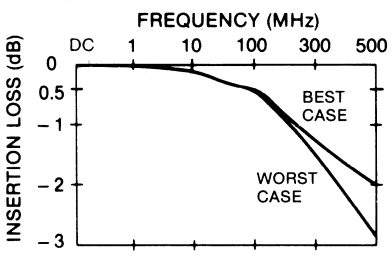
10 MHz	100 MHz	500 MHz
⩽ −100 dB	⩽ −90 dB	⩽ −60 dB

Isolation: One signal path, input to output; one switch open:

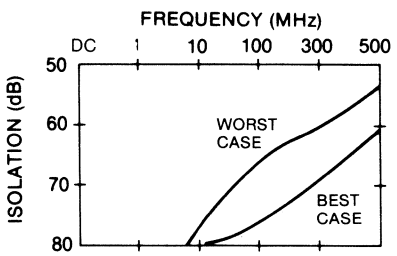
10 MHz	100 MHz	500 MHz
⩽ −70 dB	⩽ −60 dB	⩽ −50 dB

Max V/A/W: 100V, 2A 60W.
Contact Resistance: ⩽0.10Ω/switch.
VSWR (Typical): ⩽1.1:1 @ 25 MHz, ⩽1.2:1 @ 95 MHz.
Switching Time: ⩽10 ms.
I/O Connections: 10 BNC, female.
Power Consumption: 3.3 W max @ 12V; 0.3 W per switch.

Typical Insertion Loss:



Typical Isolation:

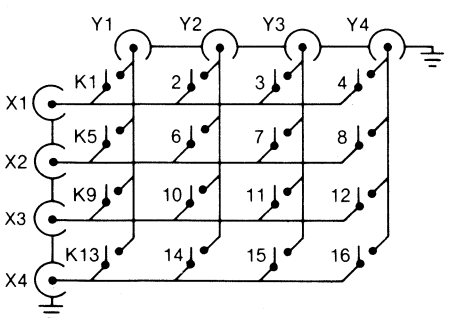


FACTORY/FOB

San Diego, CA

250 MHz Matrix Module

- **4 × 4 Matrix**
- **250 MHz Bandwidth**



Model 612, a 250 MHz RF module, gives the ultimate in switching flexibility. The module is a 4 × 4 matrix allowing any port to be connected to any other port independently or all together and at the same time.

SPECIFICATIONS

Insertion Loss: ⩽0.75 dB @ 100 MHz.
Bandwidth: ⩾250 MHz @ −3 dB.
Rise Time: ⩽2.0 ns.
Cross Talk: Any channel to any channel; all switches open:

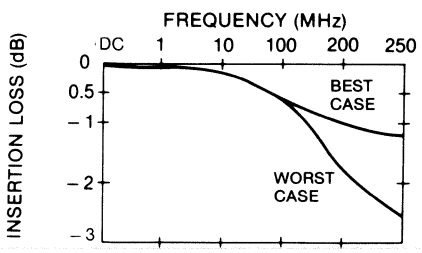
10 MHz	100 MHz	250 MHz
⩽ −75 dB	⩽ −70 dB	⩽ −60 dB

Isolation: One signal path, input to output; one switch open:

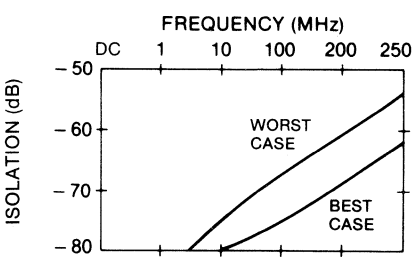
10 MHz	100 MHz	250 MHz
⩽ −70 dB	⩽ −60 dB	⩽ −50 dB

Max V/A/W: 100V, 2A, 60W.
Contact Resistance: ⩽0.15Ω/switch.
VSWR (Typical): ⩽1.1:1 @ 10 MHz, ⩽1.35:1 @ 50 MHz.
Switching Time: ⩽10 ms.
I/O Connections: 8 BNC, female.
Power Consumption: 4.5 W max @ 12V; 0.3 W per switch.

Typical Insertion Loss:



Typical Isolation:

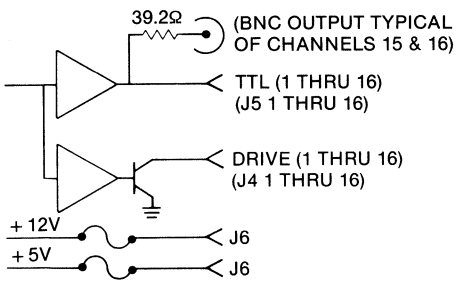


FACTORY/FOB

San Diego, CA

General Purpose 16 Channel Driver Module

- **Drives External Devices**
- **Up to 16 Channels**



Model 613, a general purpose driver module, can drive devices external to the module, such as your own microwave switches, which may require a +12V level, or other devices that require a TTL signal or combination of TTL signals. It provides 16 channels of both TTL level drive and parallel 12V, 300mA open collector drive. To conveniently trigger external devices, two channels have additional BNC outputs. A fused +12V and +5V supply is available.

SPECIFICATIONS

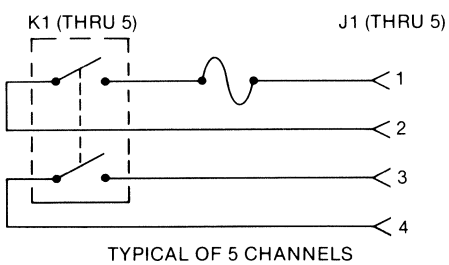
I/O Connections: 50 pin subminiature "D" connector and 48 screw terminals.
TTL Output: +20/−10 mA maximum per channel.
Max Collector Voltage: +40 Vdc.
Max Collector Current: 200 mA.
+5V Supply: 100 mA maximum load.
+12V Supply: 300 mA maximum load.
Output Power Available:
3.6 W max @ 12V;
1.0 W max @ 5V.

FACTORY/FOB

San Diego, CA

High Power Module

- **Five Channels**
- **Fuse Protected**



TYPICAL OF 5 CHANNELS

Model 614 is a module that switches high voltages and currents. It can be used to switch line voltages and power supplies. One side of the double pole relays is fused. The fuse holders are conveniently located on the outside of the module. Also, insulating covers shield top and bottom of module to protect user from external high voltage.

SPECIFICATIONS

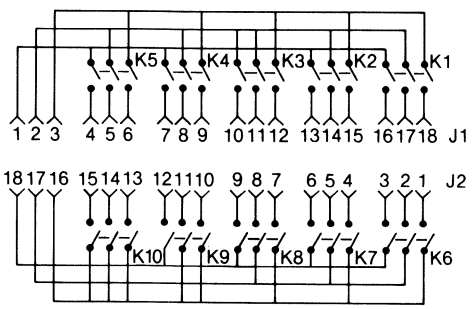
Contact Rating:
5A @ 30 Vdc,
3A @ 125 Vac,
2A @ 250 Vac.
Contact Resistance: ≤0.07Ω per contact.
Switching Time: ≤20 ms.
I/O Connections: 20 screw terminals.
Standard Fuse: 5A, fast blow.
Power Consumption:
1.8 W max @ 12V;
0.36 W per switch.

FACTORY/FOB

San Diego, CA

Low Level 10 Channel Module

- **Very Low Level Switching**
- **No Thermal EMF**



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.

SPECIFICATIONS

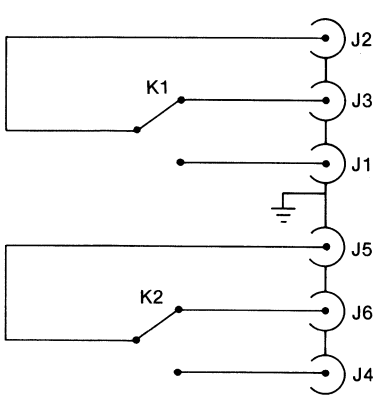
Signal Level: 100V, 200 mA, 5W.
Contact Resistance: <0.2Ω per contact.
Insulation Resistance: $>10^{12}\Omega$, <5pF.
Contact Potential: <1μV after 20 min warm-up (output to copper leads).
Switching Time: ≤2 ms.
I/O Connections: 36 screw terminals.
Power Consumption:
0.8 W max @ 12V;
0.08 W per switch.

FACTORY/FOB

San Diego, CA

DC to 18 GHz Microwave Switch Module

- **18 GHz Bandwidth**
- **Two Channels**

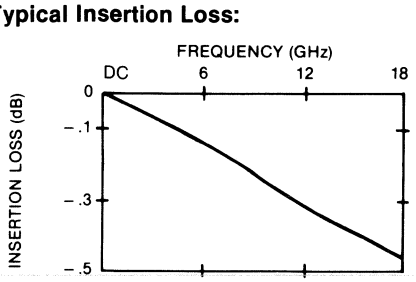


Model 616, a dc to 18 GHz microwave switch module, provides the ultimate in RF switching quality. This module provides two channels of SPDT switching with 18 GHz bandwidth.

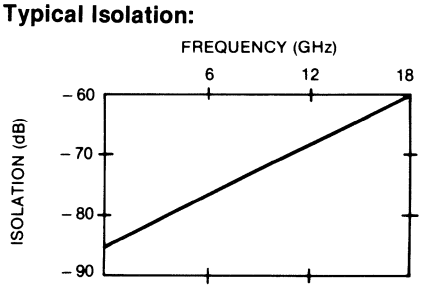
SPECIFICATIONS

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:
4.5 W max @ 12V;
2.25 W per switch.

Typical Insertion Loss:



Typical Isolation:

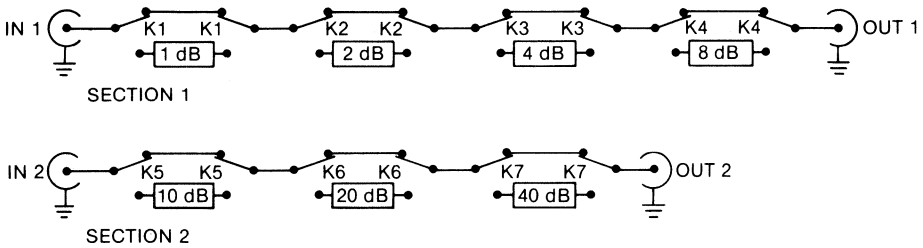


FACTORY/FOB

San Diego, CA

250 MHz Attenuator Module

- **Up to 85 dB Attenuation**
- **Two Separate Sections**



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.

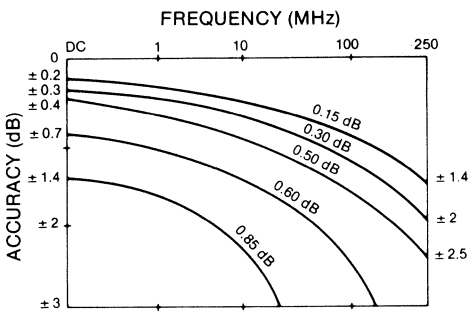
SPECIFICATIONS

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):

	Attenuation Range (dB)				
Frequency (MHz)	**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	—	—

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:
2.3 W max at 12V; 0.3 W per switch.
Typical Accuracy:

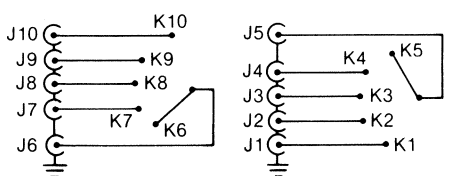


FACTORY/FOB

San Diego, CA

1.5 GHz, Dual 1 of 4 Module

- **1.5 GHz Bandwidth**
- **Two Channels**



Model 618, a 1.5 GHz module, offers outstanding 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.

SPECIFICATIONS

Insertion Loss: ⩽0.5 dB @ 100 MHz.
Bandwidth: ⩾1.5 GHz @ – 3 dB.
Rise Time: ⩽0.5 ns.
Cross Talk: Any channel to any channel; all switches open:

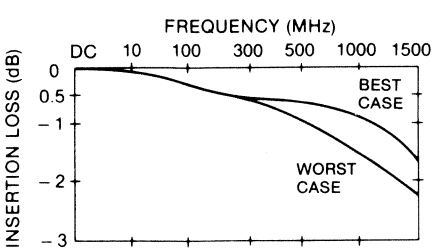
10 MHz	**100 MHz**	**1.5 GHz**
⩽ – 100 dB	⩽ – 95 dB	⩽ – 40 dB

Isolation: One signal path, input to output; one switch open:

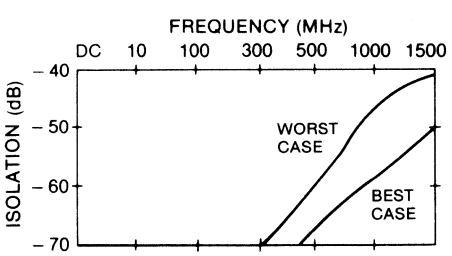
10 MHz	**100 MHz**	**1.5 GHz**
⩽ – 100 dB	⩽ – 90 dB	⩽ – 40 dB

VSWR (Typical): ⩽1.1:1 @ 200 MHz, ⩽1.25:1 @ 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:
3.3 W max @ 12V; 0.3 W per switch.

Typical Insertion Loss:



Typical Isolation:

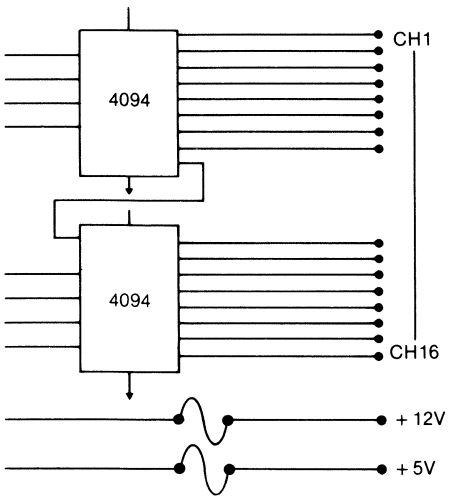


FACTORY/FOB

San Diego, CA

Universal Breadboard Module

- **Custom Switch Module**
- **16 Channels**



Model 619, a breadboard module with all driver circuitry, breadboard space, and I/O terminals, gives you the option of building a custom switching module. The breadboard space, a 7 by 2.7 inch area with 0.1 inch universal hole pattern, provides an area for mounting many standard relays, IC's and components. You can program this "custom" module by addressing the 16 logic lines, just as you would address any switch on other modules. A "close" command causes the channel output to go high and an "open" command results in a low output.

SPECIFICATIONS

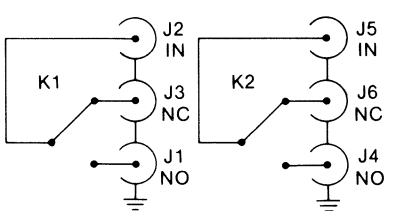
I/O Connections: Two terminal blocks with 12 screw connections each.
Driver Outputs: 16 channel low power (one LS TTL load per channel).
Supply Voltage: 300 mA max. at + 12 V; 100 mA max at + 5V.
Breadboard Space: 7 by 2.7 in.
Hole Pattern: 0.1 in. matrix (66 by 29 holes).
Hole Size: 0.046 in.
Maximum Allowable Component Height:
Above board surface: 0.7 in.
Below board surface: 0.15 in.
Maximum Allowable External Supply: 42 V, 1 A, 5 W.

FACTORY/FOB

San Diego, CA

DC to 26.5 GHz Microwave Switch Module

- **26.5 GHz Bandwidth**
- **Two Channels**

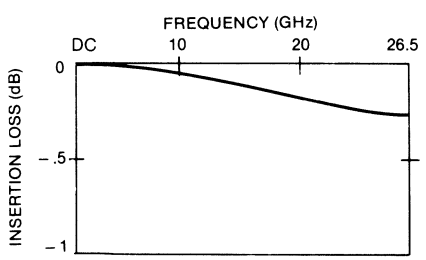


Model 620, a DC to 26.5 GHz microwave switch module, provides the maximum bandwidth available in a standard programmable plug-in. This module provides two channels of single-pole, double-throw, break-before-make switching with excellent power rating and 26.5 GHz bandwidth.

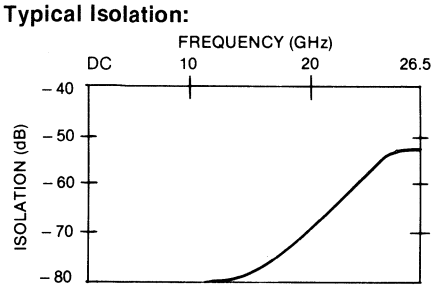
SPECIFICATIONS

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:

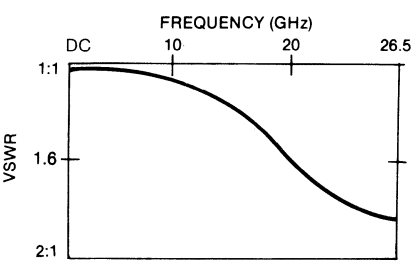


Typical Isolation:



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.

Typical VSWR:



FACTORY/FOB

San Diego, CA

Instrumentation Controller

MODEL 6000 INSTRUMENTATION CONTROLLER

- **16-bit CPU 68000 For High Speed Data Processing**
- **Multi-tasking And Real-Time Processing**
- **Enhanced BASIC With Structured Programming**
- **High Resolution CRT With Full Dot Graphics**
- **Additional Slots For System Expansion (Memory And I/O Cards)**

Introduction
Over the past few decades, instrumentation has developed from totally manually operated instruments to more sophisticated instruments capable of remote control. This control took a giant step forward in 1975 when IEEE adopted their 488 standard which defined a standard mechanical and electrical interface by which instruments could be controlled. It also defined functionally how to send data down a bus structure to address the instruments, receive data back, trigger the instruments, and more. Wavetek, along with other instrumentation companies, participated in the development and the adoption of this standard and, in fact, Wavetek was one of the first companies to bring out a product, the Model 159 in 1975, that adopted this standard. Since then, Wavetek has developed a whole generation of products, based on this IEEE 488 standard. In 1983 we made the next step, the introduction of our first instrumentation controller, the Wavetek Model 6000.

EVERY IMPORTANT FEATURE REQUIRED OF AN INSTRUMENTATION CONTROLLER EMBODIED IN ONE OUTSTANDING PRODUCT

Designed to Think Like a Test Engineer
Engineers have been forced to choose between computers that were flexible and powerful but not designed for instrumentation control, or special purpose controllers with limited memory and speed. Model 6000 has the best of both.

It can contain up to 1.8 megabytes of user memory and operate in a multi-tasking, parallel processing environment. A special version of enhanced BASIC has been created that simplifies programming and merges separate programs written by different people.

Special attention has been given to the need for high speed data acquisition. The Model 6000 provides Direct Memory Access (DMA) as a standard capability, giving it a maximum data transfer rate of 200 Kbytes per second on GPIB interface. Additional optional I/O channels are serial (RS232 or TTY), GPIB, parallel, or a multi-channel analog to digital converter.

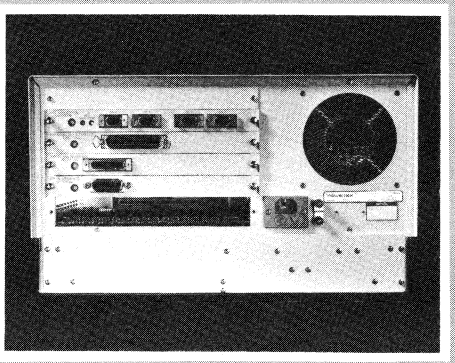
Multi-tasking
Modern computer processing speed far exceeds the measurement speed of the average instrument. A computer dedicated to instrument control addresses instruments and then waits a period of time, receives a little data and then waits another period of time, and so on. The declining cost of computers and rising cost of labor still makes this cost effective.

In many cases it is desirable to run an analysis program on the data taken, run a peripheral process such as an oven that is cycling the unit under test, and consolidate data taken previously. If each of these tasks is performed in a serial manner the tester is not as efficient as possible and the overall testing takes longer. It becomes increasingly desirable to be able to run tasks in parallel. Larger, more sophisticated minicomputers have been able to run tasks in parallel, but until now desktop computers have not had this capability.

With the Wavetek 6000, multi-tasking in a desktop has become a reality. Up to eight separate programs can be run at one time allowing you to address and control instrumentation, receive real time data, and still process data already stored. This new capability allows you to multiply the usefulness of your instrumentation controller without multiplying its cost.

Microprocessor
The heart of the Model 6000 is a Motorola 68000, a state of the art 16/32-bit microprocessor, that allows us to put minicomputer speed and flexibility into a desktop unit. Its multiple registers and stacks, large addressing range, memory management, and powerful multilevel vectored interrupts make possible the multi-tasking of up to 8 separate programs for high utilization of CPU and shorter overall test time. It also allows the use of an enhanced version of BASIC developed specifically for instrumentation control. This version accommodates multi-tasking and has expanded program flow statements that facilitate structured programming and powerful I/O.

Versatile Rear Panel
The back panel has seven slots for I/O cards and memory expansion. Since the Model 6000 comes with a GPIB card and one memory card already installed, five slots are available to the user, with the lower slot dedicated to memory expansion.



Rear Panel

ANSI Extended BASIC

The ANSI extended BASIC conforms with the American National Standards Institute (ANSI) proposed as an international BASIC standard. Top-of-the-line software technology has developed a real-time BASIC language with further enhanced input/output control and GPIB control statements, allowing easy programming, powerful functions, and advanced programming. The ANSI extended BASIC offers various functions including:

- Structured programming statements
- Parallel processing
- Exception handling
- Subprogram statements
- File processing
- Extended function definitions
- Graphics statements
- I/O control statements
- GPIB control statements
- Matrix operations

Parallel Processing Function

The parallel processing function implements execution of more than one program according to predetermined priorities. For example, when the quick response to an external event is needed during printout or data processing, a higher priority can be assigned in advance to interrupt the operation. The parallel processing function allows programming work to be divided, thus saving time in program development and maintenance.

Three Stage Error Checking

When a program is entered, it is checked from three standpoints: syntax check during line editing, structure check at the completion of editing, and run-time check. If any error is found, the corresponding error message is displayed on the system message area.

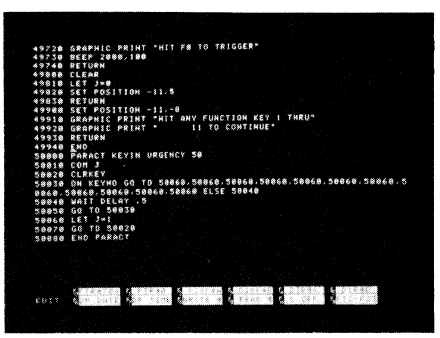
Keyboards

Model 6000 comes standard with a full ASCII detachable keyboard equipped with 12 special function keys, multiple editing keys, and a full numeric keypad. As an option we supply a simplified operator keyboard that mounts directly below the CRT on the front panel, supplying numeric keys and the 12 special function keys. The detachable keyboard can be plugged in while the operator keyboard is in place to give full programming control and then removed to provide simplified operation and avoid operator confusion.

Operator Keyboard

CRT Display

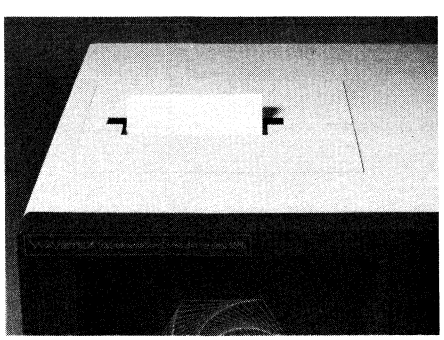
The CRT display screen is divided into sections for general information (user messages, key inputs, system messages, and functional key labels) allowing conversational interaction between the operator and the controller. The editor automatically provides line numbers and allows complete screen editing. The scroll buffer offers three screens, enabling high-speed scrolling.



CRT Display Screen

Optional Built-in Printer

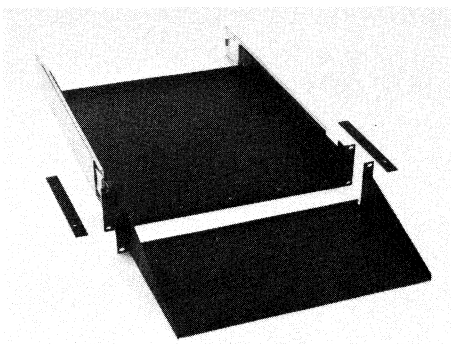
This thermal printer has the capability to print 35 characters per line at a rate of 1.5 lines per second. It can make hardcopies of programs, data, graphs, and characters from the CRT display. Because of its compactness, the printer is ideal for data output.



Built-in Printer

Rack Mount Kit

Model 6000 was designed as an instrumentation controller and will often be used in conjunction with racked equipment using a standard 19 in. rack. We have provided an adapter kit which allows the Model 6000 to be mounted on a tray with rack slides that bolt securely into the rack.



Rack Mount Parts

Documentation

Computer documentation is a difficult task at best and one that is most often done poorly. A computer is a very complex instrument particularly in the instrumentation and desktop computer world. Here the user is not a computer scientist, but a test engineer using the controller as a tool.

Model 6000 Manuals

Wavetek has spent a great deal of time to provide an outstanding documentation package.

We start with the *Introduction Manual* which describes the instrument physically and how to get started with programming. We provide 72 sample

programs that show by example how various tasks are performed on the Model 6000.

Second is the *BASIC Language Reference Manual* which contains a detailed description (plus a 'railroad' diagram) of each function, statement and command in the Model 6000 BASIC. Examples are shown, and remarks provide information about statement interactions, restrictions, or limitations relating to each function, statement, and command.

Third is the *Interfacing Manuals* for each of the I/O cards which include electrical/mechanical characteristics of the card as well as the language statements and how they operate specifically with that card.

A *Quick Reference Manual* is also available. It is an easy to use guide, in pocket form, that allows the programmer to quickly refer to the Model 6000 statements.

Model 6000 manuals offered are:
- Master Manual Package
- Introduction Manual
- BASIC Language Reference Manual
- BASIC Quick Reference Guide
- GPIB Operation Manual
- Parallel Operation Manual
- Serial Operation Manual
- A-to-D Operation Manual

Software
Besides the Extended BASIC, that is standard with the Model 6000, Wavetek offers Assembly Language and UCSD Pascal. Pascal has been enhanced to provide many of the IO enhancements available in BASIC. Because Pascal is a compiled language, it will run faster than BASIC. Assembly, of course, will be the fastest of all.

Model 6020 Assembly Language System
- Includes Text Editor, Macro-assembler, and Linkage Editor
- Full Scale 68000 Software Development Utility
- Can Be Incorporated Into Main BASIC Program

Model 6020 optional Assembler Language System consists of a text editor, macroassembler, and linking editor. It is a full-scale 68000 software development utility capable of being incorporated within the main BASIC program. When the BASIC language speed is not sufficient for certain applications, those sections can be written in assembly language and called from the BASIC program.

Assembler Functions are:

CALLB	LOADB
POKE	PEEK
POKEL	PEEKL
POKEW	PEEKW
VARADD	

Model 6021 PASCAL Language System
- Includes File Manager, Editor, Compiler, Macroassembler, Linker, Debugger and I/O Library
- Supports Complete UCSD p-System
- Supports All Model 6000 I/O Cards Directly From PASCAL

Model 6021 Pascal Language System is a complete UCSD p-System software development system. The option offers an integrated operating system and includes enhancement for all I/O cards offered on the Model 6000 Instrument Controller.

Translators
Many existing programs are written on older BASIC language computers. Some of the most popular are the HP85, HP9835, and HP9845 BASIC. We have written a translator for the HP85 to Model 6000 and for the HP9835/HP9845 to Model 6000. We have also written a translator for the HP9826/9836 to Model 6000. For those applications where a modern controller is being used and you want to take advantage of our multi-tasking capability, the programs must be written on the Model 6000.

Translators are:
- Model 6030, HP85 BASIC to 6000 BASIC
- Model 6035, HP9835/45 BASIC to 6000 BASIC
- Model 6036, HP9826/36 BASIC to 6000 BASIC

Applications Software
Model 6040 thru 6043 Applications Software are textbook solutions to common problems. They are programs written for the Model 6000 enabling it to solve common problems requiring these routes.

Model 6040 Math Library:
- Complex Numbers
- Determinant Calculation
- Inverse Matrix
- Simultaneous Primary Equations
- Various Random Number Generations
- Quadratic and Cubic Equations
- Nth Order Algebraic Equations

Model 6041 Statistics I Library:
- Basic Statistics
- Histograms
- Correlation Coefficients and Regressions

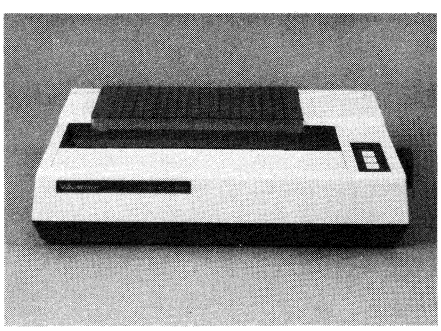
Model 6042 Statistics II Library:
- Analysis of Variance
- Analysis of Covariance

Model 6043 Fast Fourier Transform:
- Both BASIC and Assembly Language
- Fourier Analysis (FFT, IFT, Hamming, and Hanning)

Peripherals

Model 6010 80-Column Printer with GPIB Interface:
- 160 CPS Impact Dot Matrix
- Bit Image Modes, CRT Graphics
- Fanfold, Cut Sheet Or Roll Paper
- Multiple Character Sizes
- Single Keystroke Copies CRT Display

Model 6010 is an OEM version of the popular Epson FX80 with GPIB interface added for compatibility to the Wavetek 6000 Instrumentation Controller. Model 6010 prints a fast 160 cps or, in 'quiet' mode, 80 cps.

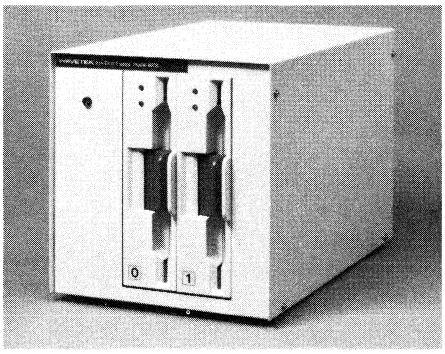


Model 6010 Printer

MODEL 6000 INSTRUMENTATION CONTROLLER

Model 6008 Floppy Disk Drive

- Dual 8-Inch Drives
- 1 Mbyte Per Diskette
- IBM 3740 Compatible
- Same Model 6000 BASIC Commands

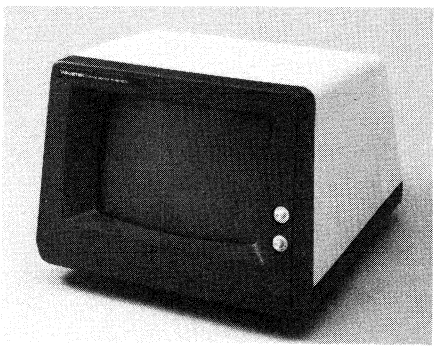


Model 6008 Floppy Disk Drive

Model 6014 External Monitor

- Large 14-Inch Screen
- Functions As Remote CRT
- Switch For Model 6000, Monitor, Or Both

Model 6014 has many applications among which are teaching a large group from one Model 6000 or remote monitoring of the production area. A switch is included to permit use of just the monitor, the monitor and the built-in display of the Model 6000, or just the Model 6000 display.

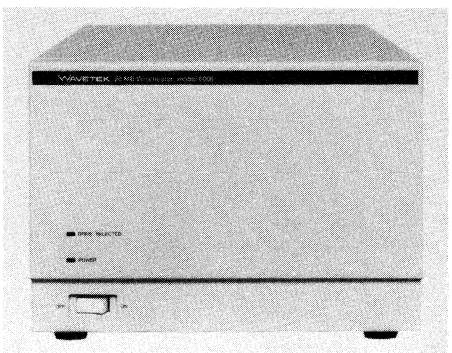


Model 6014 External Monitor

Models 6005 and 6006, 5¼ Inch Winchester Disk Drives

- 10 Mbyte Capacity (6005)
- 20 Mbyte Capacity (6006)
- For use with Model 6000 Instrumentation Controller.

For high speed and large data storage capacity, Wavetek Models 6005 and 6006 hard disks offer the optimum solution. The high speed is achieved through the GPIB interface. Each hard disk has built-in intelligence to allow multiple users and shared access.



Winchester Disk Drive

SOFTWARE SPECIFICATIONS

ANSI Extended BASIC

Standard BASIC Statements
LET, GOSUB, RETURN, IF THEN, GOTO, DEF FN, STOP, FOR NEXT, PRINT

Structured Programming Statements
DO LOOP, IF THEN ELSE, END IF, SELECT CASE, END SELECT

Subprogram Statements
CALL, SUB EXIT, SUB, END SUB

Extended Function Defining Statements
DEF, END DEF, FUNCTION

Multi-tasking Statements
CONNECT EVENT, DISCONNECT EVENT, PARACT, END PARACT, PARSTOP, START, PROCESS EVENT, SIGNAL WAIT EVENT, WAIT PACER, WAIT TIME, WAIT DELAY

File I/O Statements
ASK, CLOSE, DELETE, FORMAT, OPEN, READ @, RESET, SCRATCH, WRITE @

Other Statements
I/O-related
Debugging
Matrix operation

Mathematical Functions
Includes all normal math functions such as hyperbolic function SINH, TANH, etc., and the followng:

ABS, ATN, COS, EXP, INT, etc.

16-bit Binary Operation Functions
ADB, BIC, BIS, COM, EXB, LRO, LSH, RRO, RSH, SWP

Character String Functions
ASC, BSTR$, BTOH$, BTOO$, BVAL, CHR$, DATE$, HSTR$, HTOB$, HVAL, LEN, LWRC$, NOT$, ORD, OSTR$, OTOB$, OVAL, POS, STR$, TIME$, UPRC$, VAL

GPIB Control Statements
COMMAND
DCL (Device Clear)
EOI (End or Identify)
IFC (Interface Clear)
IST (Individual Status)
LCL (Local)
LLO (Local Lockout)
PARITY
PCT (Pass Control)
PPD (Parallel Poll Disable)
PPE (Parallel Poll Enable)
PPL (Parallel Poll)
REN (Remote Enable)
SRQ (Service Request)
STATUS (Serial Poll)
TRG (Group Execute Trigger)

Exception Handling Statements
EXLINE, EXTYPE, ENABLE HANDLER, DISABLE HANDLER, HANDLER, END HANDLER, RESURE, CONTINUE, RETRY, CAUSE

Graphic Functions
SET BOUNDS, ASK BOUNDS, SET LINE STYLE, CLEAR, SET VIEWPORT, ASK VIEWPORT, ASK WINDOWS, SET WINDOWS

HARDWARE SPECIFICATIONS

CRT Monitor
Size: 240 mm (9.5 in.) diagonal.

Floppy Disk Drives
Double sided, double density, 300 Kbytes per drive.
First drive standard, second drive optional.

GPIB
Type: Direct Memory Access (DMA).
Transfer rate: 200 Kbytes/Kbytes.

Parallel I/O
I/O Lines: 16 lines with DMA.
T/R Rates: Up to 200K words.

MODEL 6000 INSTRUMENTATION CONTROLLER

Processor
Type: Motorola MC68000.
Clock Frequency: 8 MHz.
Internal Architecture: 32-bit data/address registers.
Address Range: 16 Mbytes.
Data Bus: 16 bit asynchronous.

Memory
ROM: 16 Kbytes (operating system and BASIC).
RAM: 384 Kbytes with parity, >160 Kbytes available to user.
Expansion: To 1.8 Mbytes (user) in 128 Kbytes or 256 Kbyte increments.

Graphics Display
Controller Chip: NEC 7220.
Resolution: 512 dots horizontal, 348 dots vertical.
Density: 32 dots/cm (81 dots/in.).
Graphic Buffer: 4 graphics planes (32 Kbytes each) 128 Kbytes total (separate from main memory).

Parallel I/O
Bidirectional I/O lines: 16.
Status input lines: 8.
Status output lines: 8.
Additional lines: 1-REQ (input).

Serial I/O
Formats: RS232C or 20 mA current loop.
Baud rate: From 50 to 9600 baud.

A/D Conversion
Card Input: 8 single ended or 4 differential analog channels.
Input Levels: Shielded ± 10V.
Type: High speed successive approximation converter.
Resolution: 12 bits with single channel conversion rate of 30 μs. (200 μs when 4/8-channel scanner is used.)

GENERAL

Environment
Operating Temperature: 10 to 40°C, relative humidity 5 to 95% noncondensing.
Storage: 5 to 45°C.

EMI
FCC class A.

Dimensions
280 mm (11 in.) high; 436 mm (17 in.) wide; 650 mm (26 in.) deep.

Weight
33 kg (72 lb) shipping.

Power
100 to 127V or 200 to 254V; 50 to 60 Hz; less than 200 VA.

OPTIONS

001: 128K Memory Board
001A: 256K Memory Board
002: Operator Keyboard
003: Built-in Thermal Printer
004: Second Built-in Disk Drive
005: External Interrupt Interface
006: Additional GPIB Interface Card
007: Parallel I/O Interface Card
008: Serial I/O Interface Card
009: A/D Conversion Card
010: Software Update Service (1 year)
011: Matrix/Advanced Graphics

ACCESSORIES

GPIB Cable (1 meter)
GPIB Cable (2 meters)
Parallel Interface Cable, One-end
Serial Interface Cable, Modem-end
Serial Interface Cable, Terminal-end
A to D Cable, 1 per Channel
5.25-inch Floppy Disks, Box of 10
Transit Case for Model 6000
Rack Adapter Kit

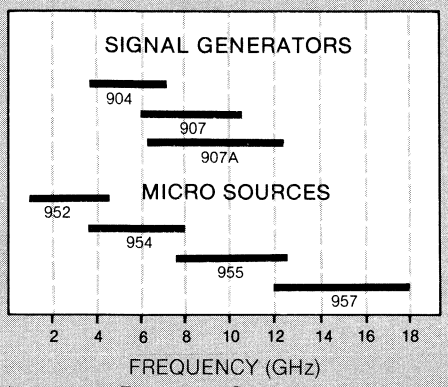
FACTORY/FOB

San Diego, CA

Microwave Signal Generators

Introduction

Wavetek offers two families of solid state microwave signal sources which are based on YIG-tuned oscillator technology: the 900 Series and the 950 Series. The 900 Series of full performance signal generators provides GPIB programmability, a high quality CW signal, full band sweep, over 120 dB of calibrated power control, AM, FM, and pulse modulation. The 950 Series of Micro Sources offers the same high quality CW signal but with fewer features at half the price and one fourth the size of the 900 Series signal generators.



Instrument Frequency Coverage

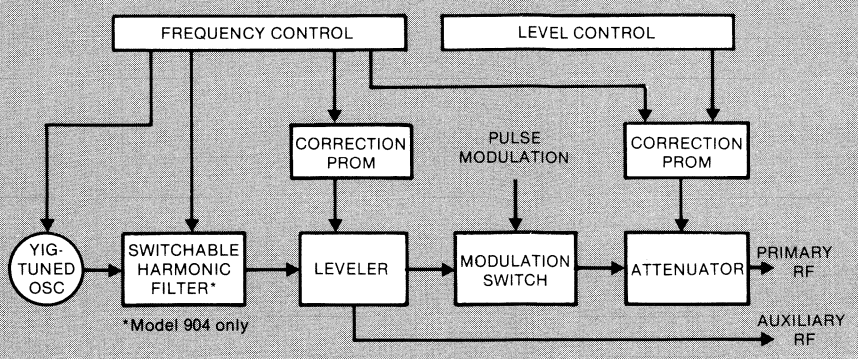
900 Series Signal Generators

Applications — Microwave radar and communication system testing requires clean stimulus signals with accurate power level control. Wavetek's 900 Series provides these capabilities as well as internal/external pulse modulation and FM, and external AM. GPIB control and internal/external sweep are two additional capabilities that have application for component testing and R&D experiments.

Designed for Increased Capability — Each signal generator (and Micro Source) employs an electronically controlled, compact YIG-tuned oscillator as its microwave signal source. These ocillators use bipolar transistors for ranges below 7.6 GHz and GaAs diodes for ranges above 7.0 GHz. They are well known for their low noise and excellent tuning linearity over wide frequency ranges. The solid state PIN diode leveler, pulse modulator and attenuator in each generator are also electronically controlled and highly reliable, allowing the user to operate under extreme environmental conditions or continuous computer cycling.

Electronic control permits the 904 and 907A to provide a number of capabilities not available from manually controlled signal generators. First, the remote (GPIB) option allows computer control over frequency and power, thus enabling tests to be performed more efficiently and thoroughly. Secondly, RF output power accuracy is electronically enhanced using data collected during the generator's calibration and held in its digital memory. The result is state-of-the art accuracy and automatic leveling without the need for a manual or relay actuated mechanical attenuator. Finally, the 904 and 907A provide both internal and external sweep.

Convenience — First-time users of Wavetek's microwave signal generators are often surprised by their convenience. Automatic leveling is a welcomed surprise for those who have been using klystron generators. The single control knob and easy-to-read digital display allow quick, unambiguous power readings. And, the dBref mode allows the operator to zero the display and adjust power from that point quickly and accurately. External analog (and optional GPIB) control over frequency and power, simultaneous AM, FM and pulse modulation, easy phase lock capability, excellent pulse characteristics and many other features make these generators exceptionally convenient and efficient to use.

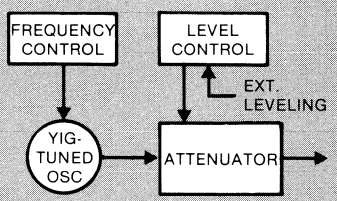


Basic 900 Series Signal Generator

950 Series Micro Sources

Multiple Functions — Wavetek's Micro Sources are small, low cost sources of clean CW signals, but they are also much more. They have internal/external FM and AM, greater than 25 dB of RF power control, capabilities for external leveling, phase locking and remote analog control of both frequency and power level. Other features include full band internal frequency sweep with proportional voltage output, easy-to-use controls and digital frequency readout. All this in approximately the same volume as a sweeper plug-in—no need for a bulky and expensive mainframe.

These features make the Micro Sources ideal in applications where a full sweeper or signal generator is overkill. For production, R&D, field service or educational test applications, these sources provide good performance at considerable price savings.



Basic 950 Series Micro Source

High Performance/Cost Ratio

Wavetek's microwave generators and sources offer the same high performance/cost ratio that Wavetek has been providing from its function generators and other instruments. Each instrument has been engineered to provide exceptional performance for its price. Wavetek's policy of manufacturing nearly all major microwave components also helps to ensure consistent reliability and performance.

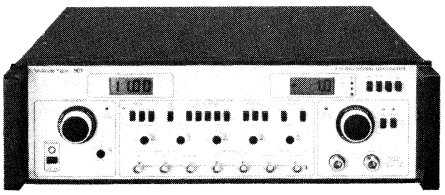
3.7 to 12.4 GHz Signal Generators

- 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 usefullness 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.



Model 907

Model 907 differs from Models 904 and 907A in that it does not provide for internal sweep or optional GPIB control and its colors remain the original Wavetek black and white. The 907 has been assigned National Stock Number 6625-01-091-8459 by the U.S. Air Force.

3.7-7.6 GHz

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 all originate 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.

OUTPUT

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: 3.7 to 7.6 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 (3 kHz peak typical).

Harmonics: <−25 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 <−115 dBm.

Readout: 3½ digit LCD, in units of dBm, dBref, Vrms.

Display Resolution: 0.1 dB.

Amplitude Accuracy:

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.

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.

Sweep Range: 3.7 to 7.6 GHz.

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

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).

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 10 kHz 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°C to +50°C, to 10,000 ft and to 90% rel humidity, non-condensing. Storage: −25°C to +65°C. Designed and type tested to MIL-T-28800 class V.

Dimensions (Max)

43.2 cm (17 in.) wide; 13.3 cm (5¼ in.) high; 49.5 cm (19½ 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; <100 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.

002: High Output Power

+10 dBm maximum calibrated output power.

NOTE: Options require factory installation. Option prices apply to original purchase only. Contact factory for retrofit option prices.

FACTORY/FOB

San Diego, CA

7-11 GHz

VERSATILITY

A cw signal source with AM, FM, pulse modulation and external sweep capabilities. All parameters are independently adjustable.

Pulse and FM modulation signals externally provided or from the internal modulation generator.

Frequency and output level can be externally controlled by analog voltages.

Internal modulator signals available for monitoring and system synchronization.

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 and delay adjustable. External pulse mode triggers on rising or falling edge of input signal. A gate mode allows the external input to control pulse width and repetition rate.

OUTPUT

NOTE: OUTPUT specifications applicable to non-swept modes only.

Frequency

Varied by a 10-turn potentiometer and a 0.1% vernier or by an external 0 to +5V.

Range: 7.0 to 11.0 GHz.

Readout: 3½ digit LCD.

Resolution: 10 MHz.

Accuracy: ±1% of reading.

Stability: Typically <60 ppm/°C; <20 ppm (±10% line variation).

Signal Purity

Residual FM: <15 kHz peak in a post-detection bandwidth of 100 Hz to 10 kHz.

Harmonics: <−30 dBc.

Spurious: <−55 dBc.

Level

Varied by a 10-turn potentiometer or external 0 to +13.6V (−10 dB/V). Output can be switched on and off.

Range (Leveled): 0 to −127 dBm; 0.225V to 0.100 μV (into 50Ω).

Maximum Output: Typically >+3 dBm unleveled.

Readout: 3½ digit LCD, in units of dBm, dBref, Vrms.

Display Resolution: 0.1 dBm.

Amplitude Accuracy:

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.

Level Flatness: (>−10 dBm: ±1.0 dB.

VSWR: <1.5 relative to 50Ω.

Connector: Female type N coax.

Auxiliary Output Power: Typically >−10 dBm CW signal.

Reverse power protection: +30 dBm (both RF outputs).

PULSE MODULATION

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 gate mode.

Delay Range: 3 μs to 1 ms in 2 ranges, relative to normal sync. (Not applicable to gate mode).

Internal Mode: Fixed square wave or variable width pulses; 10 Hz 50 10 kHz in 3 ranges.

External Pulse Mode: Triggers internally generated pulse delay and width from PULSE TRIG input.

External Trigger Input: 1 Vp-p min. trigger, ±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

Max RF Output Deviation: >5 MHz p-p

Internal Sawtooth Modulator: 10 Hz to 10 kHz in 3 ranges.

External Modulation: >1 MHz/V; ±2.5V max; 0 to >10 kHz; 10 kΩ nominal input impedance.

AM-AMPLITUDE MODULATION

Ext. Modulation Frequency Range: 0 to 10 kHz.

Max. Source Level: ±2V peak.

Input Impedance: 10 kΩ nominal.

Sensitivity: 27 dB/V (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

National Stock Number

Equivalent to NSN6625-01-091-8459 with minor differences.

Environment

Specifications apply for 25° ±10°C after 1 hour warm-up. Instrument will operate from 0°C to +50°C, to 10,000 ft altitude and to 90% relative humidity non-condensing. Storage: −25°C to +65°C. Designed and type tested to MIL-T-28800 class V.

Dimensions (Max)

43.2 cm (17 in.) wide; 13.3 cm (5¼ in.) high; 49.5 cm (19.5 in.) deep. Rack adapters supplied for rack mounting.

Weight

19.1 kg (42 lb) net; 22.3 kg (49 lb) shipping.

Power

90 to 105V, 108 to 126V, 198 to 231V; 50 to 400 Hz; 140 VA maximum.

FACTORY/FOB

San Diego, CA

7-12.4 GHz

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.

OUTPUT

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: 7.0 to 12.4 GHz.

Readout: 3½ digit LCD.

Resolution: 10 MHz.

Accuracy: ±1% of reading.

Stability: Typically <60 ppm/°C; <20 ppm (+5%, −10% line variation).

Signal Purity

Residual FM: <15 kHz peak in a post-detection bandwidth of 100 Hz to 10 kHz.

Harmonics: −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; 0.251V to 0.100 μV (into 50Ω).

Range (Unleveled): Typically >+3 to <−115 dBm.

Readout: 3½ digit LCD, calibrated in dBm, dBref, Vrms.

Display Resolution: 0.1 dB.

Amplitude Accuracy:

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.

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.

Sweep Range: 7 to 12.4 GHz.

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

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 aplicable to gated pulse).

Internal Mode: Fixed square wave or variable width pulses; 10 Hz to 10 kHz in 3 ranges.

External Trigger Input: 1 Vrms min, 10 Vrms max trigger; slope and trigger point adjustable; 0 to 10 kHz with full leveling.

Externally Gated Pulse: 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 10 kHz 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 pulse 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 will operate from 0°C to +50°C, to 10,000 ft and to 90% rel humidity non-condensing. Storage: −25°C to +65°C. Designed and type tested to MIL-T-28800 class V.

Dimensions (Max)

43.2 cm (17 in.) wide; 13.3 cm (5¼ in.) high; 49.5 cm (19.5 in.) deep. Adapters supplied for rack mounting.

Weight

19.1 kg (42 lb) net; 22.7 kg (50 lb) shipping.

Power

100V, 120V, 220V, 240 (+5%, −10%); 48 to 66 Hz; 130 VA max.

OPTION

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.

FACTORY/FOB

San Diego, CA

NEW

1 to 18 GHz Micro Sources

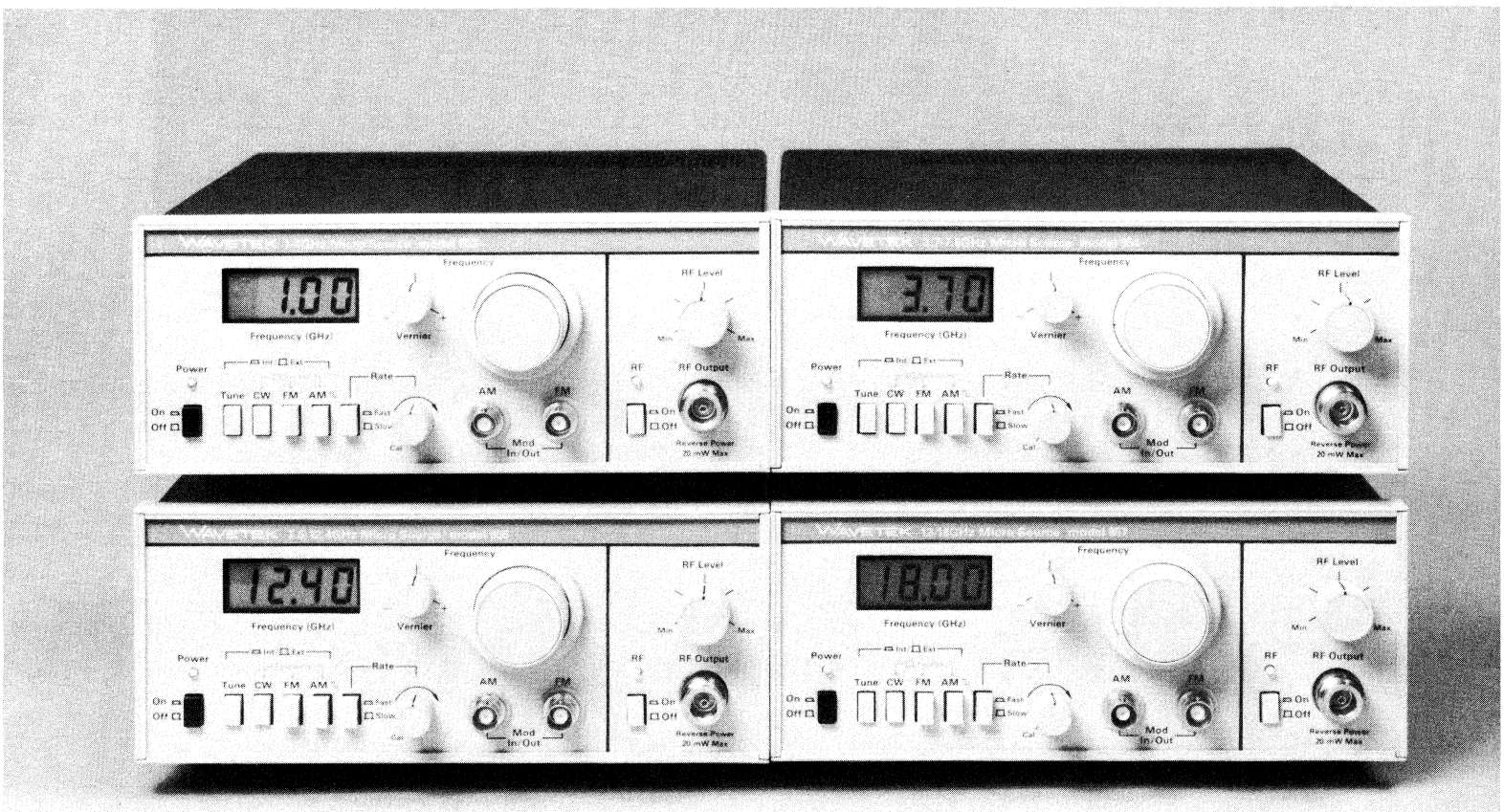
- **1 to 18 GHz From 4 Models**
- **CW, AM, FM and Internal Sweep**
- **+10 dBm Typical Output Power**
- **External Leveling Capability**
- **Compact, Portable and Exceptional Value**

Versatile Performance
The Wavetek Model 950 Micro Sources are exceptional values 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

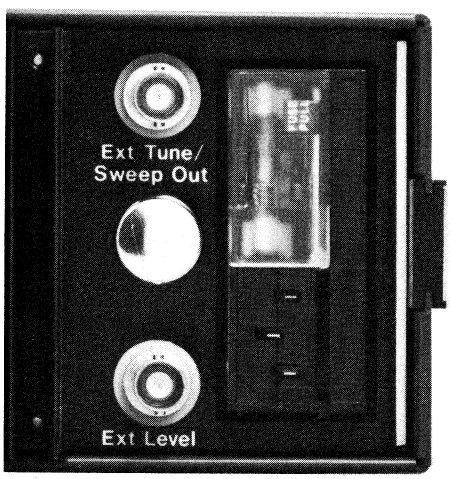
Each Micro Source uses a YIG tuned oscillator to generate low noise, stable CW signals. Maximum output power is typically greater than +10 dBm, with over 25 dB of power control range. In addition to CW, each source provides internal AM, FM and frequency sweep. For greater versatility, both frequency and power level are externally controllable, and all units permit convenient external power leveling and phase locking.

Reliability and Value
The Micro Source Series will give long service in the field or in the lab. The solid-state YIG tuned oscillator and rugged aluminum chassis ensure an exceptionally durable and reliable instrument. And, the clean open interior design results in easy maintenance and low life-cycle costs. Each Micro Source is priced approximately equal to a sweeper plug-in (without the mainframe) for superb value.



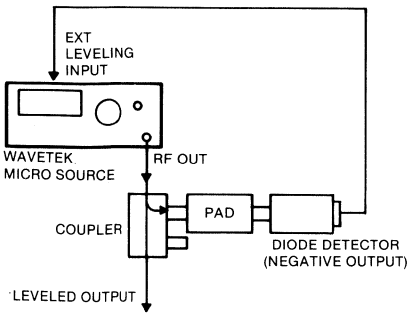
Frequency Control

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 50 Hz, 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

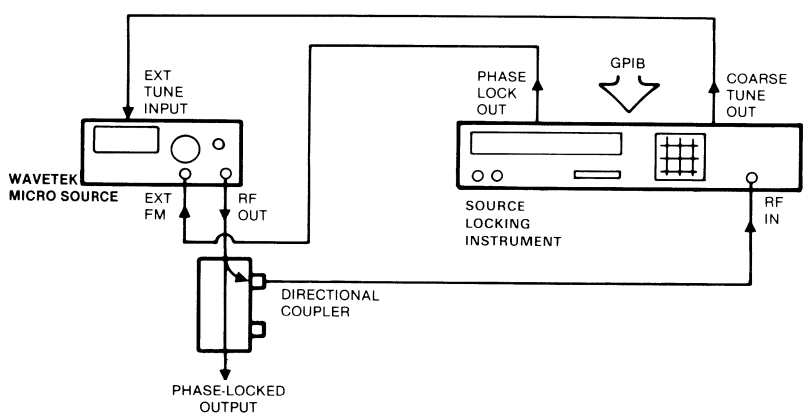
Each Micro Source internally generates both AM (square wave) and FM over a wide range of rates. In conjunction with the Fast/Slow pushbutton, the front panel Rate knob adjusts modulation rates over the 10 to 500 Hz and 100 to 5000 Hz ranges. A CAL detent position also permits quick selection of the commonly used 1 kHz rate. (This knob and pushbutton also control the internal frequency sweep, with rates of 0.1 to 5 Hz and 1 to 50 Hz for the respective Slow and Fast settings.)

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 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. And, with one commonly available source locking counter, phase locked frequency control via GPIB is easily provided over the full frequency range.

Additional Features

Numerous additional features provide increased performance and utility to the user. For instance, during external frequency control, the front panel Fast/Slow button Slow position minimizes residual FM for single frequency operation while the Fast position permits rapid sweep. Only two screws must be removed to lift top or bottom cover and expose all internal components. Also, clever designs provide quick warm-up and good thermal stability.



Phase Locked Operation Under GPIB Control of Frequency

	All Models	Model 952	954	955	957
FREQUENCY					
Range (GHz)		1.0-4.0	3.7-7.6	7.5-12.4	12.0-18.0
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
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		+10 dBm	+7 dBm	+7 dBm	+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				
SIGNAL PURITY					
Residual FM, Peak (Note 5)					
Guaranteed		8 kHz	15 kHz	15 kHz	15 kHz
Typical		4 kHz	6 kHz	6 kHz	6 kHz
Spurious	−55 dBc				
Harmonics					
Maximum (Note 6)		−12 dBc[6]	−12 dBc	−20 dBc	−20 dBc
Typical		−15 dBc	−15 dBc	−30 dBc	−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).

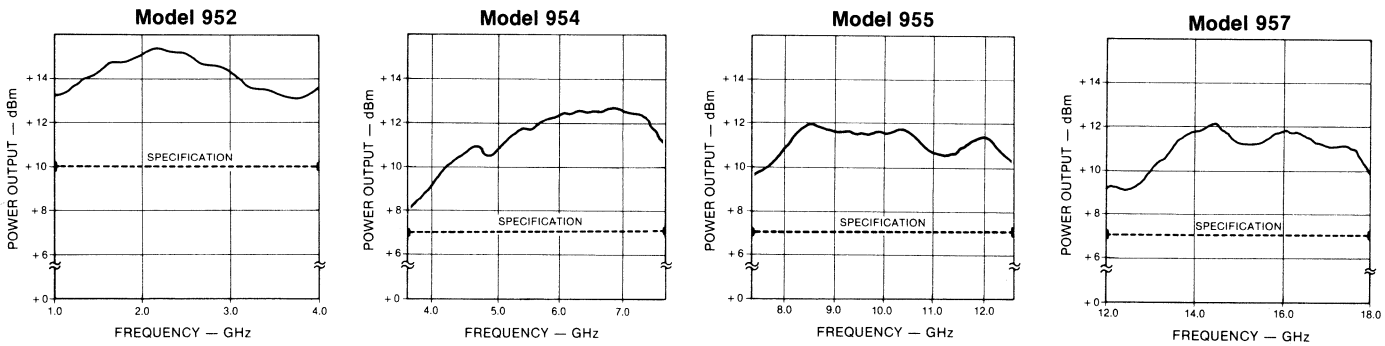
FM

Internal (Sawtooth)	±5 MHz minimum, 10 Hz to 5 kHz adjustable rate.
External	±5 MHz minimum deviation for ±4V input, 50 kHz nominal 3 dB bandwidth, DC coupled.
Monitor Output	5V peak-peak nominal (during internal modulation only).

GENERAL

Connectors	
RF Output	Precision Type N
AC Power	CEE 22 Type VI
Other	BNC
Temperature	
Operating	0°C to +50°C
Non-operating	−40°C to +75°C
Humidity	0 to 95% non-condensing
Dimensions	21.6 cm (8½ in.) wide, 9.8 cm (3½ in.) high, 29.9 cm (11¾ in.) deep.
Weight	5.4 kg (12 lb), approximately
Power	90-126V or 198-252V; 50-400 Hz (50-60 Hz for Model 954); 40VA maximum.

TYPICAL POWER OUTPUT



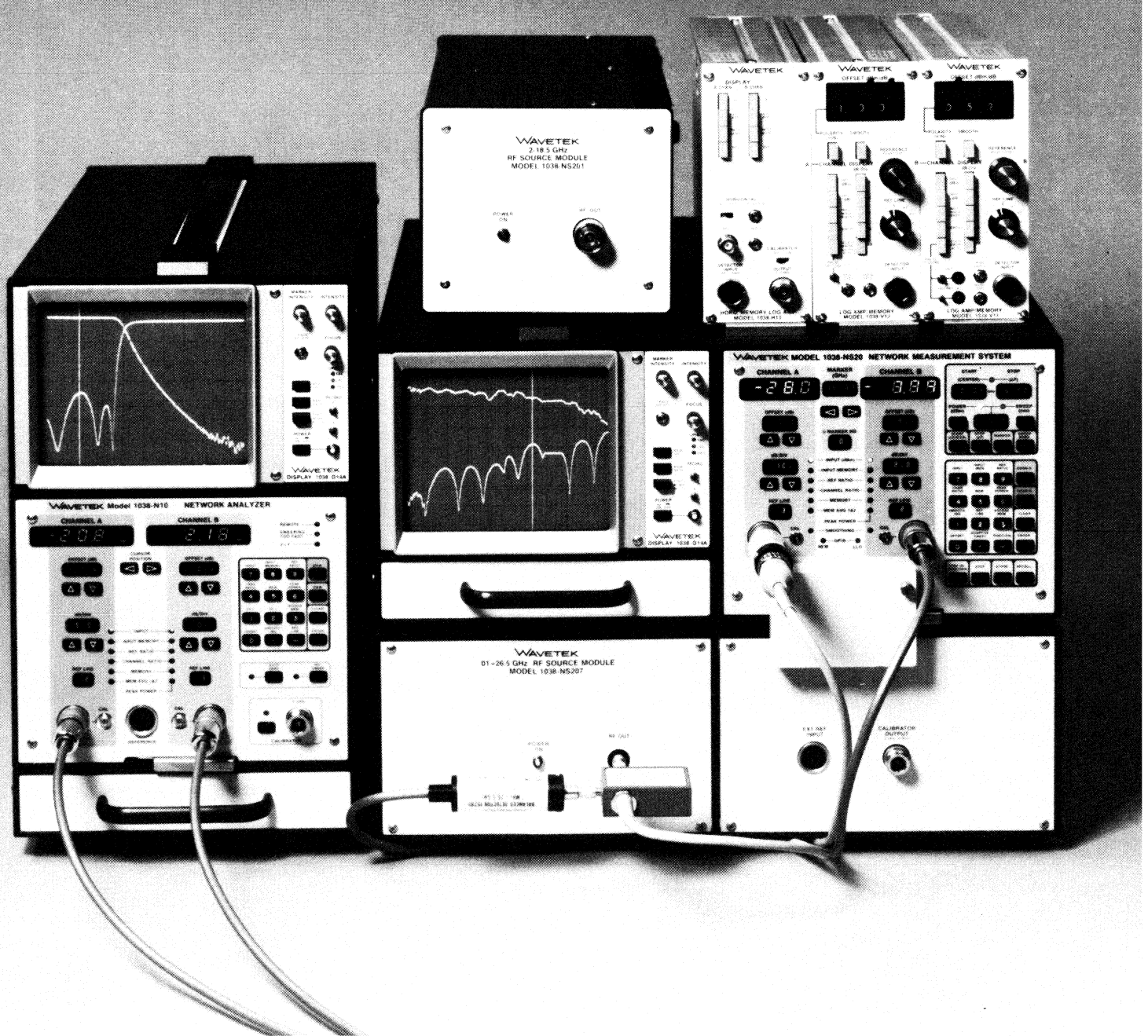
Notes:

1. All specifications apply after 1 hr warm-up and at 25°C ±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 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. 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

San Diego, CA

Microwave Scalar Measurement Systems



GENERAL MICROWAVE SCALAR MEASUREMENT SYSTEMS

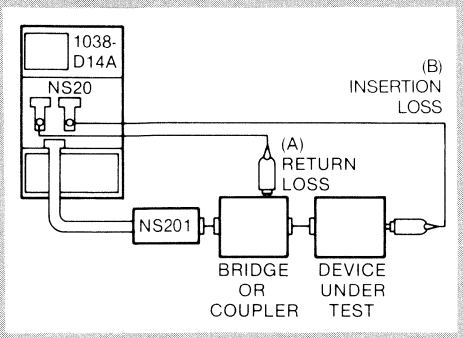
Introduction to Scalar Measurement Systems
Scalar swept measurements are made by sweeping a signal frequency over a specified frequency band and displaying the results. Scalar analyzers are used for testing:

- Filters
- Connectors
- Cables
- Solid State and TWT Amplifiers
- Couplers and Attenuators
- Subassemblies
- Antennas
- Mixers
- Systems

What To Look For
Transmission and reflection characteristics must be measured within the frequency band specified for the device under test (DUT) plus 10% to 50% for guardbands. The frequency can range from 1 MHz to >110 GHz, and the measuring system must have low residual error to display clearly defined results. The dynamic range must be at least 65 dB.

For best results, the output of the sweep generator (source) should be a clean sine wave with harmonics and spurious signals well below the measurement range of the DUT. The source should have sufficient power output to ensure full usage of the test system's dynamic range, be well matched to the system's impedance, and provide V∝F in a form compatible with the drive of the system.

How To Test
Typically, the system is connected as shown in the accompanying diagram. Residual setup errors are first entered into the memory without the DUT in the system, then the DUT is connected, and the desired data is read from the display. For automatic operation, a computer with appropriate software is used through the IEEE-488 Standard Bus.



Typical System Connections

Versatile
Simplicity, accuracy, and efficiency has been designed into the Model 1038-NS20, 1038-N10, and 1038-H/V swept systems. The choice of three systems allows you to select a system with just the necessary functions and features to suit your specific requirements; both in measuring capability and price. Swept frequency return loss, insertion loss/gain, and absolute power measurements are performed with ease and accuracy not available from other manufacturers.

Specific features and specifications of the Wavetek Pacific Measurements line of swept analyzers are detailed in the following pages. Some of the key points are:

- Complete system under the control of a single microprocessor. (N10 and NS20 systems)
- Microprocessor speed and convenience. (N10 and NS20 systems)
- Direct LED digital readout of the measured power. (N10 and NS20 systems)
- Patented, high performance balanced detectors. (N10 and NS20 systems)
- Nonvolatile memory to store up to 10 test setups. (NS20 system)
- Frequency change without recalibration. (N10 and NS20 systems)
- 76 dB analyzer dynamic range. (NS20 systems)
- Superior harmonic suppression. (N10 and NS20 systems)
- Precision calibrator for absolute power measurements. (All systems)
- Ability to select specific horizontal and vertical signal conditioning plug-ins to suit specific requirements. High accuracy at lower cost. (H/V system)

Literature
The following application notes are available upon request through your sales representative:

AN20 Swept Frequency Return and Insertion Loss Measurements, and Improved Reflectometer Accuracy, Using the Model 1038 Measurement System with Automemory®.

AN21 Model 1038-N10 Swept Frequency Measurement System GPIB Programming.

AN22 Model 1038-D14A/NS20 Network Measurement System GPIB Programming.

AN23 RF Diode Detectors for Microwave Power Meters and Scalar Analyzers.

AN24 Model 1038-N10 Scalar Analyzer Features and Capabilities.

MODEL 1038-NS20 MICROWAVE SCALAR MEASUREMENT SYSTEMS

Microwave Network Measurement System

- **10 MHz to 40 GHz Frequency Range**
- **+16 dBm to −60 dBm Dynamic Range**
- **Integrated Source and Analyzer**
- **Single Point Microprocessor Control Advantage**

Total Integration
Model 1038-NS20 Network Measurement System offers the highest accuracy and the most automation available from today's technology. The totally integrated design of RF Source and Analyzer permits many advanced features, making the NS20 faster, simpler, and easier to operate than any other system available.

Exceptionally accurate simultaneous or individual transmission, reflection, and ratio measurements can be made in just three easy steps:

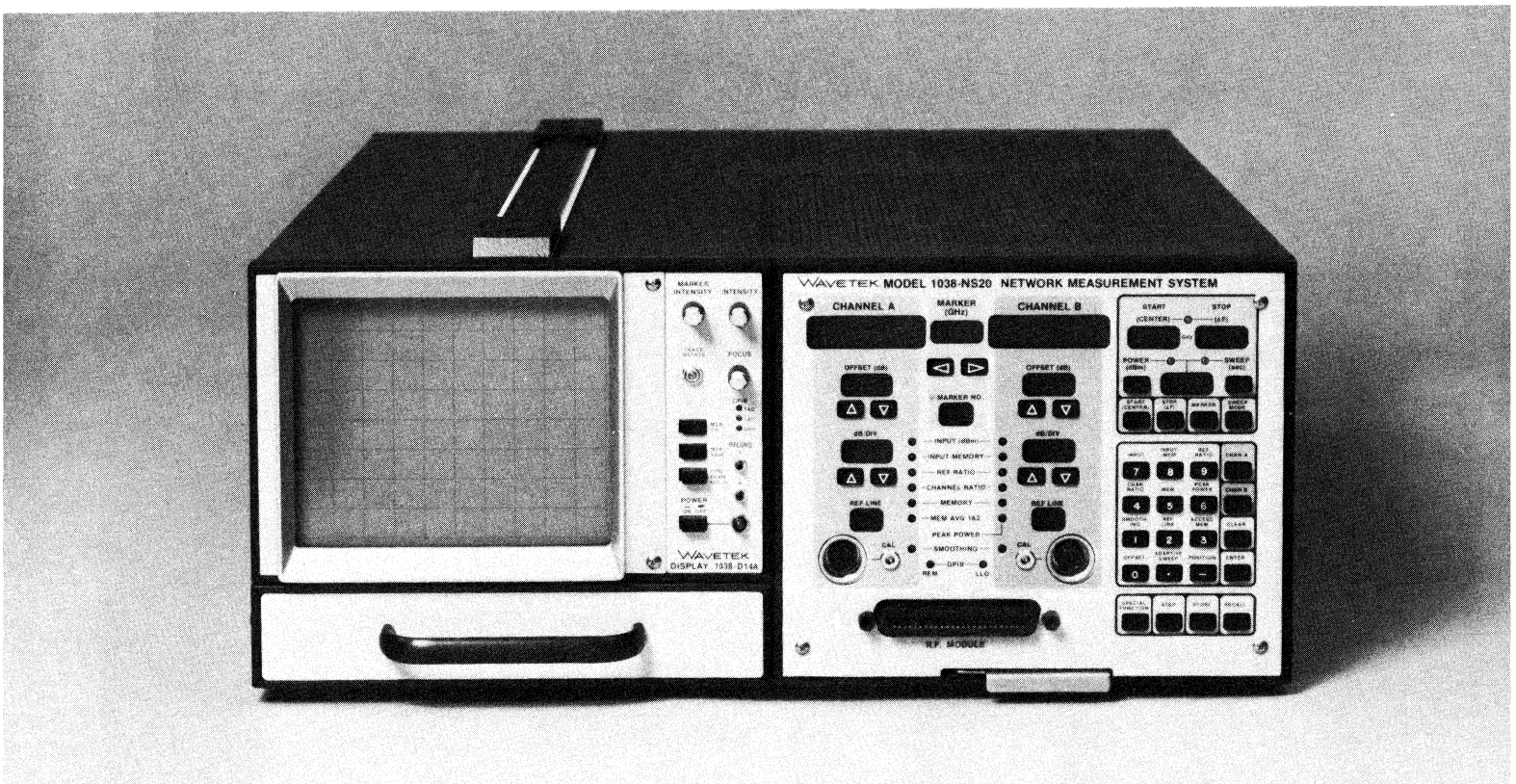
1. Set up equipment and turn it on.
2. Calibrate both channels — seven keys total.
3. Insert the test device and read the data directly from the digital readouts.

Advanced Features/Performance
The 1038-NS20 system has many advanced features that are not available in any other swept frequency system.

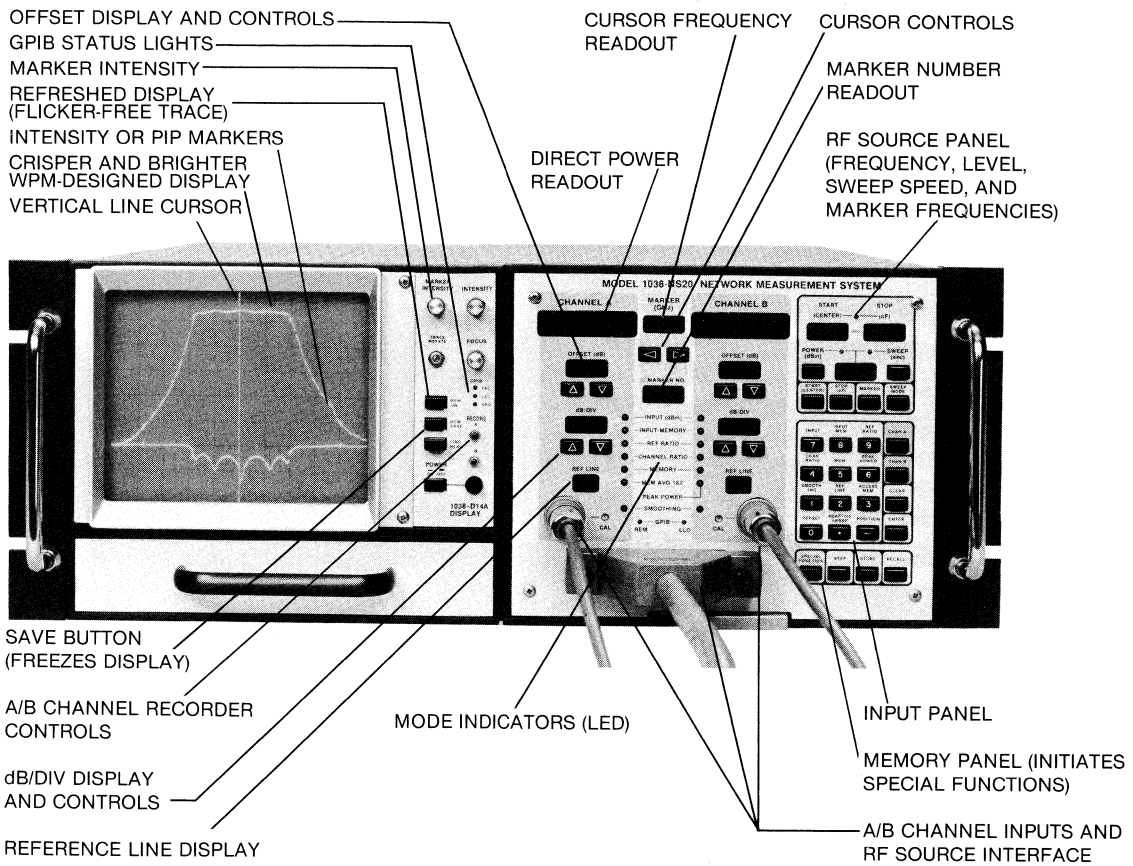
- High performance balanced detectors.
- Adaptive sweep.
- Automatic low-level drift correction.
- Frequency change without recalibration.
- User-definable software programs with unique CREATE mode.
- Special functions allow superior versatility in creating and performing measurement routines.

Versatile Mainframe
Model 1038-D14A Mainframe is standard with all of Wavetek Pacific Measurement's (WPM) swept systems, and has the following features:

- X-Y recorder interface through BNC connectors. Both TTL and switch closure logic are available. A calibration signal can be sent to the recorder at the push of a button on the D14A's front panel.
- Full-screen-height vertical cursor for at-a-glance positioning.
- Choice of intensity or pip markers for CRT photos or hardcopy indications, with a separate marker intensity control located on the front of the D14A.



MODEL 1038-NS20 MICROWAVE SCALAR MEASUREMENT SYSTEMS



System Configuration
- 1038-D14A Mainframe (Display)
- 1038-NS20 Analyzer Module
- 1038-NS20X RF Source Module
- Two RF Diode Detectors

RF Source
Seven RF Source modules cover the specified frequency range of 10 MHz to 40 GHz. Most modules have built in calibrators and feature both internal and external leveling. Refer to RF Source section for additional information.

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 Detector section for additional information.

CRT Display Controls
Five front panel controls can be operated manually or controlled remotely through the GPIB, and consist of:
- Offset controls
- Sensitivity controls
- Reference Line controls
- Cursor controls
- Marker controls

Adaptive Sweep
This feature automatically sets a fast sweep speed at high power levels and a slower speed at low levels, allowing high quality measurements to be taken at levels down to −60 dBm.

Low Level Drift Correction
Low level drift correction is done automatically at the detector input without the need for operator intervention.

Frequency Changes
Frequency changes can be made while testing without the recalibration required with other systems that have less memory.

IEEE BUS Operation
Comprehensive software allows the user to select from extensive menus those parameters that best fit the measurement requirements. The software is not only easy to use, but provides the capability to quickly and easily assemble text programs using WPM's unique "LEARN" mode and "CREATE" mode.

Nonvolatile Memory
Nonvolatile memory of the NS20 system will store up to 10 complete test setups for over 30 days after the last turn-off of the system.

Special Functions
In addition to all its other advanced features, the versatile NS20 also has 32 different special functions available. Functions such as a SELF TEST that automatically checks the analog circuitry, and CHANNEL MONITORING to allow the measurement of maximum and minimum power levels between assigned markers are just two of those available.

*US Patent 4,360,865—1982

MODEL 1038-NS20 MICROWAVE SCALAR MEASUREMENT SYSTEMS

SPECIFICATIONS

Frequency
10 MHz to 40 GHz with various wide band source models. (Refer to RF Source section)

Dynamic Range
76 dB (+16 to −60 dBm) measurement range will depend on the power available from the selected RF Source module.

Data Resolution
D14A Mainframe Refresh Memory has 512 points horizontally, and 1024 points vertically for both channels A and B. NS20 Normalizing Memory has 2048 points horizontally with a resolution of 0.006 dB for channel B and 0.04 dB for channel A. Data from the CRT display or LED displays can be manually read out after cursor positioning. CRT display resolution is 0.02 dB on channel A and 0.01 dB on channel B. LED readout resolution is 0.1 dB on channel A and 0.01 on channel B. Readout through the IEEE BUS has 0.02 dB resolution.

Measurement Accuracy
Constant accuracy is maintained within the specified temperature ranges due to special circuitry that continuously monitors the detector temperature and compensates the input voltage for any change in temperature. (Refer to RF Diode Detector section for detailed information.)

Environment
Operating: 0° to +65°C
Storage: −40° to +65°C

Design and Construction
To the intent of MIL-T-28800, Classification Type III, Class 5, Style E or F, Color R.

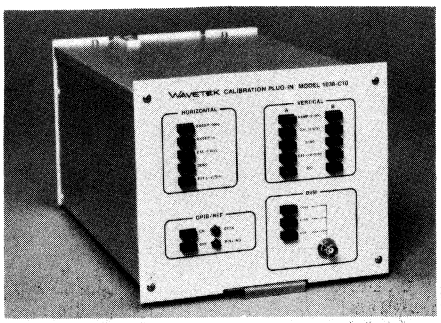
Power
For 1038-D14A Mainframe and 1038-NS20 Analyzer Module — 100, 120, 220, and 240 VAC ±10%; 50 to 400 Hz; 180 VA nominal.

OPTIONS

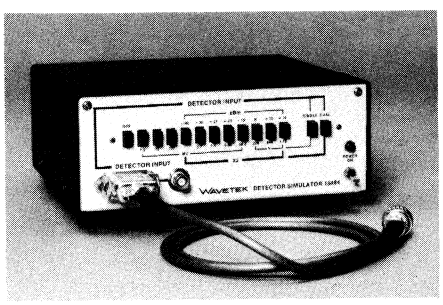
01: Rack Mount Configuration
02: Mainframe Fan Assembly
03: Horizontal Bench Configuration
04: IEEE BUS Interface
05: Vertical Bench Configuration

ACCESSORIES

The following items are available as accessories to the 1038-NS20 system:



Model C10 Calibration Fixture and Extender Kit
Provides for direct calibration of the D14A Mainframe. It has extension cables and board to permit calibration and maintenance of the NS20.



Power Input Calibration Unit (Detector Simulator)
Provides accurate calibration voltages to the NS20 to allow the amplitude correction circuitry of the NS20 to be quickly and precisely calibrated.

Detector Extension Cables
Each detector is supplied with standard 5 ft cable. 10 ft and 25 ft cables are available from stock. Longer cables on special order.

Adapters
N type 50Ω to WE 75Ω, BNC 75Ω, F 75Ω, or BNC 75Ω thick pin. N type (male) to SMA (female) both 50Ω.

Viewing Hood

Adapter Cable
For mm Wave Detectors or Autotesters.

X-Y Recorder Interface Cables

FACTORY/FOB

Sunnyvale, CA

MODEL NS20X MICROWAVE SCALAR MEASUREMENT SYSTEMS

RF Source Modules for NS20 Systems

The seven RF Source Modules currently available for use with the NS20 system cover the seven most used frequency bands within the range of 10 MHz to 40 GHz. All of the source modules provide superior technical performance, and most of the modules feature a built-in calibrator and have both internal and external leveling. All modules are available in both bench and rack mount configurations.

SPECIFICATIONS

Specifications are common to all modules.

Temperature Stability
<1 MHz/°C.

Frequency Pulling
<0.1 MHz at 12 dB return loss.

CW/Swept Accuracy
(at 25°C)
NS201 thru NS206:
±20 MHz below 2 GHz,
±10 MHz ±0.1% from 2 GHz to 18.5 GHz,
±10 MHz ±0.2% from 18.5 GHz to 40 GHz.
NS207:
±25 MHz below 2 GHz
±20 MHz ±0.1% from 2 GHz to 26.5 GHz.

Frequency Variation with Line Voltage Fluctuation
Negligable.

Leveling Range
(Not applicable to NS202)
Internal/External: >15 dB range.

Spectral Purity
Harmonics: < −50 dBc (−35 dBc below 2 GHz).
Spurious: < −60 dBc.
Sub-harmonics: None.

External FM and Phase Lock Sensitivity
Approximately 6 MHz/V.

Impedance:
(Not applicable NS202, NS203.)
50Ω nominal.

Calibrator Output
(Not applicable to NS202)
50 MHz ±1 MHz, 0 dBm ±0.06 dB, Type N connector.

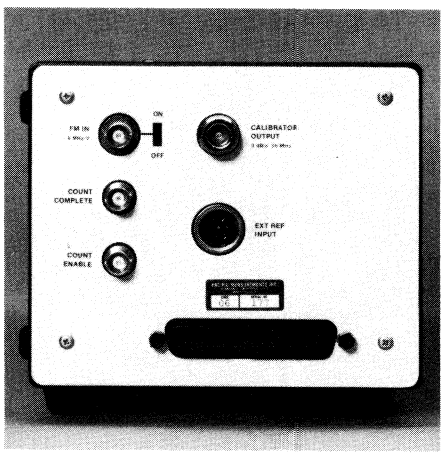
Environment
Operating: 0° to +50°C.
Storage: −40° to +65°C.

OPTIONS

01: Rack mount for NS201 — NS207
02: APC7 Calibrator Output Connector

FACTORY/FOB

Sunnyvale, CA



SPECIFICATION DIFFERENCES AMONG MODULES

	NS201	NS202	NS203	NS204	NS205	NS206	NS207
Frequency Range	2-18.5 GHz	26.5-40 GHz	18-26.5 GHz	2-8.4 GHz	10 MHz-8.4 GHz	10 MHz-18.5 GHz	10 MHz-26.5 GHz
Output (25° ± 10°C							
Max Leveled Power	>5 dBm	>0 dBm*	>5 dBm	>10 dBm	>10 dBm	>5 dBm	>5 dBm
Residual FM (15 Hz to 15 kHz band)†	<10 kHz peak	<20 kHz peak	<10 kHz peak	<10 kHz peak	<10 kHz	<10 kHz peak	<15 kHz peak
Output Match at 50Ω	>15 dB RL <1.42 VSWR	>30 dB RL** <1.42 VSWR	>30 dB RL <1.07 VSWR	>15 dB RL <1.42 VSWR	>15 dB RL <1.42 VSWR	>15 dB RL <1.42 VSWR	>15 dB RL <1.42 VSWR
Built-in Ref Channel	YES	YES	YES	YES	YES	YES	YES
Built-in Calibrator	YES	NO	YES	YES	YES	YES	YES
Physical Dimensions (L × W × H)	368 × 165 × 140 mm	368 × 165 × 140 mm	368 × 165 × 140 mm	368 × 165 × 140 mm	368 × 330 × 140 mm	467 × 426 × 133 mm	467 × 426 × 133 mm
Weight	6.4 kg	5.5 kg	5.5 kg	5.5 kg	5.5 kg	14 kg	15 kg

*Not Leveled—Minimum Power is 0 dBm **Indicates Performance of Internal Reference Channel †Typical Below 2.0 GHz

MODEL 1038-N10 MICROWAVE SCALAR MEASUREMENT SYSTEMS

Network Analyzer System

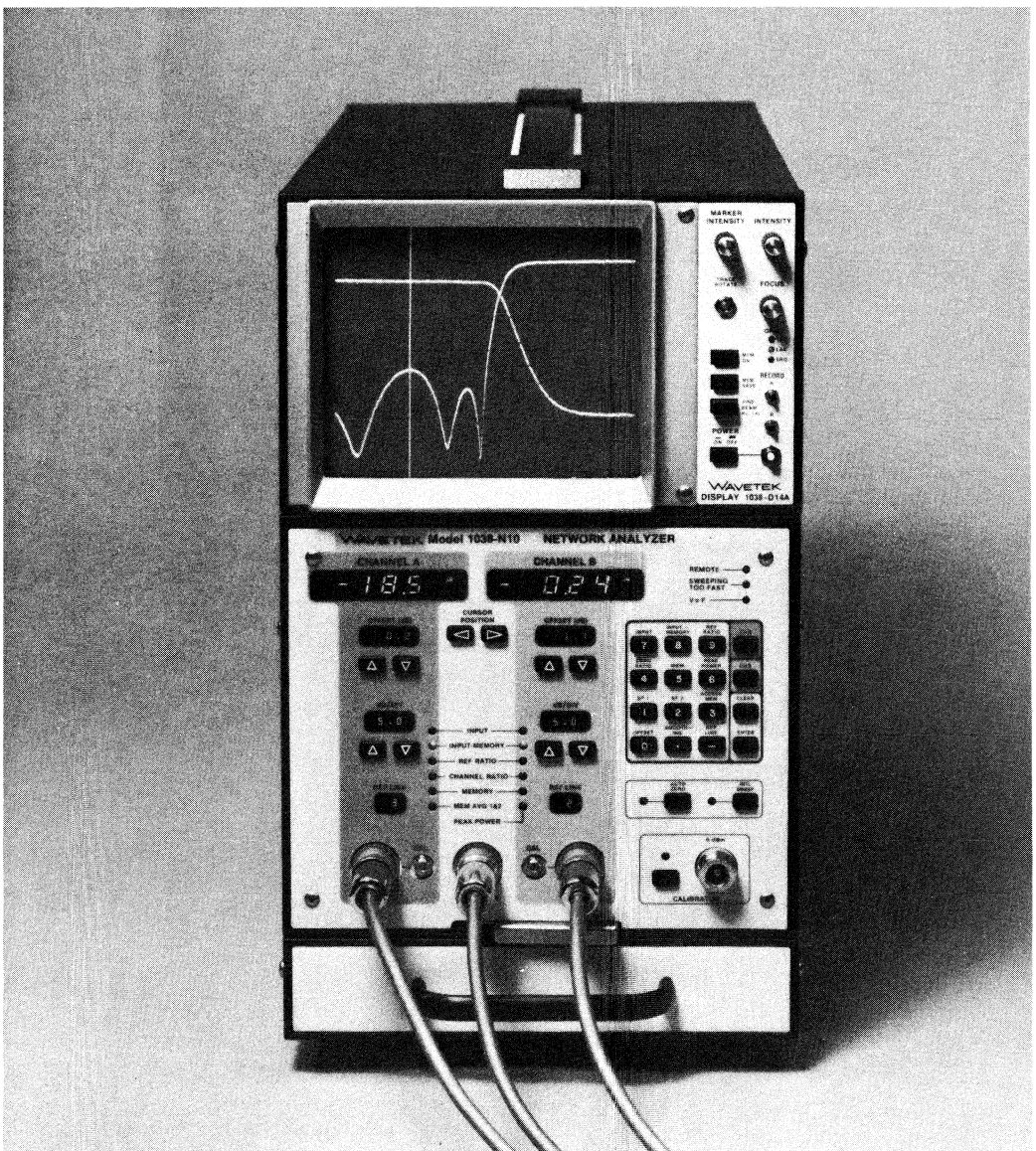
- **76 dB Dynamic Range (+16 to −60 dBm)**
- **Frequency Range of 100 kHz to >200 GHz**
- **Direct LED Power Readout**
- **Change Frequency Limits Without Recalibration**
- **Use With Any Late Model Sweeper**

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 RF Diode Detectors

Versatile Mainframe

Model 1038-D14A Mainframe is standard with all of Wavetek Pacific Measurement's (WPM) swept systems. Refer to 1038-NS20 system section for additional mainframe information.

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 Detector section for additional information.

Auto Zero Modes

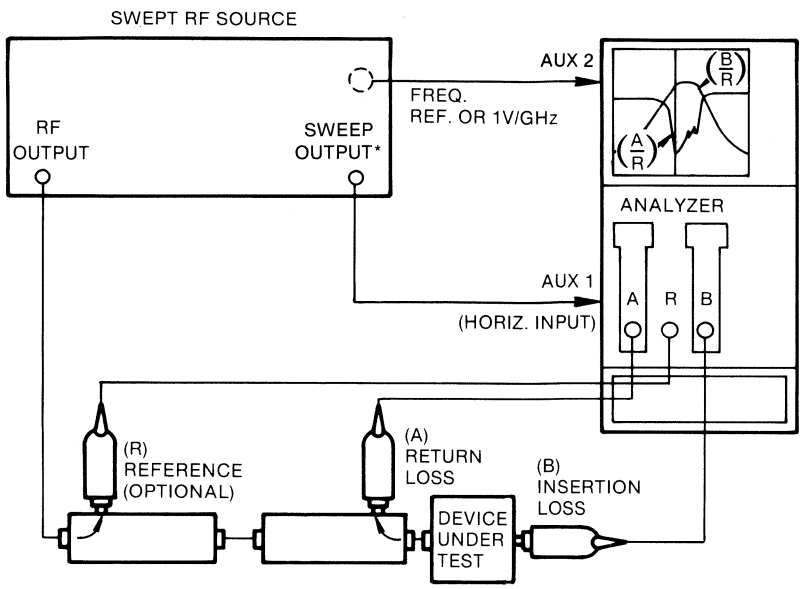
Two Auto Zero modes to ensure drift free low level operation no matter what kind of swept source is used. (Any late model sweeper can be used, and does not have to be bus controlled.) If the sweeper turns off the RF power completely during retrace, the Auto Zero is automatic, or it can be done manually 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.

*US Patent 4,360,865—1982

MODEL 1038-N10 MICROWAVE SCALAR MEASUREMENT SYSTEMS



Typical N10 System Return Loss and Insertion Loss/Gain Set-up

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

Specifications for the 1038-N10 system are the same as for the 1038-NS20 system except for the following:

Frequency

100 kHz to 40 GHz, expandable to above 200 GHz with mm detectors and the WPM adapter cable.

Dynamic Range

Balanced Detectors: 76 dB (+16 to −60 dBm).

Waveguide Detectors: 70 dB (+10 to −60 dBm).

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.

Mismatch to Detector: SWR < 1.07.

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
04: IEEE BUS Interface
05: Vertical Bench Configuration

ACCESSORIES

The accessories for the 1038-N10 system are the same as for the 1038-NS20 system.

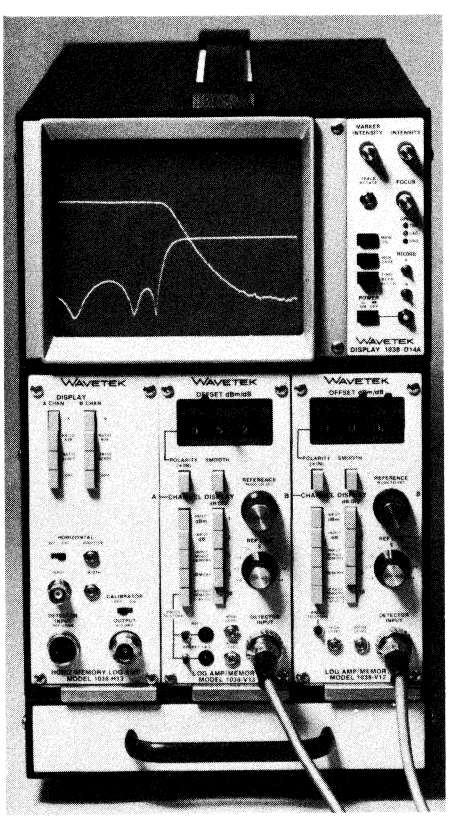
FACTORY/FOB

Sunnyvale, CA

Swept Frequency Measurement System

- **For Return Loss, Insertion Loss/Gain, & Absolute Power Measurements**
- **Accuracy, Flexibility, & Dependability at Reasonable Cost**
- **Built-in Calibrator & Automatic X-Y Plotting**

For those who don't require all of the features and the functions of the NS20 or N10 systems, the Model 1038-H/V Swept Frequency Measurement System is the simple, accurate, and low cost solution for making simultaneous or individual swept transmission, reflection, and absolute power measurements in the 100 kHz to 40 GHz frequency range with Wavetek Pacific Measurements detectors (to over 110 GHz with other mm band detectors).



The 1038-H/V system consists of the powerful D14A Mainframe (See Model 1038-NS20 features), and your choice of one horizontal and either one or two vertical signal conditioning plug-ins. Then, selection of either one, two, or three RF detectors allows you to tailor a complete system to your specific needs and budget.

Plug-in Units

Three different horizontal and three different vertical plug-ins are offered to meet your measurement needs:

- **Model H11:** CRT Trace positioning (10-20 Vp-p) detector calibrator.
- **Model H11 Spec 5116:** Same as H11 plus linear ramp output.
- **Model H13:** Same as H11 plus vertical reference channel for comparison with vertical plug-ins.
- **Model V12:** Log and conditioning amplifiers.
  60 dB dynamic range (+10 to −50 dBm).
  Frequency range determined by detector being used.
  1024 point normalizing memory.
- **Model V13:** Same as V12 plus dual memory to allow open/short reflections to be averaged for return loss measurements.
- **Model V20:** Similar to V12 except linear amplification and no detector input.

SPECIFICATIONS

Mainframe
D14A. (See Model 1038-NS20 specifications.)

Coaxial Detectors
Return Loss: 18.0 dB from 2 to 12.4 GHz and 14.0 dB to 26.5 GHz.
Flatness: (Maximum total variation.) With APC3.5 connectors; 1.0 dB from 1 MHz to 18 GHz and 2.0 dB to 26.5 GHz.
With type N or APC7 connectors: 2.0 dB to 18 GHz.
Measurement Accuracy: 0.1 dB/10 dB plus 0.5 dB at −50 dBm.

Waveguide Detectors
(See RF Diode Detectors page.)

Environment
Operating: 0° to 45°C.
Storage: −40° to +65°C.

Design and Construction
To the intent of MIL-T-28800, Classification Type III, Class 5, Style E or F, Color R.

Power
For 1038-D14A Mainframe and Selected Plug-in Modules: 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

FACTORY/FOB

Sunnyvale, CA

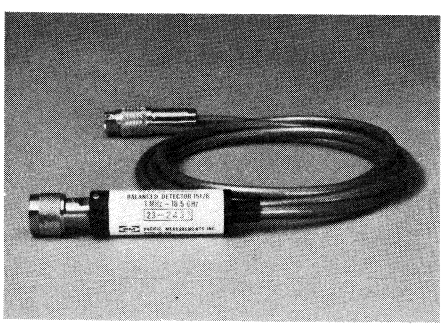
RF Diode Detectors

Wavetek Pacific Measurements has taken great care to ensure ruggedness and reliability in allof the detectors it produces. Features such as our new internal beads to strengthen the detector element, external plastic housing to reduce thermal shock when handling, thermistors for temperature compensation, networks for linearity compensation, and low pass filters are standard features.

Detector Types

Two types of detectors are provided for use with the NS20 and N10 systems. These are the balanced coaxial models and the balanced element waveguide detector. The coaxial detectors (1 MHz to 18.5 GHz or 1 MHz to 26.5 GHz, 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.

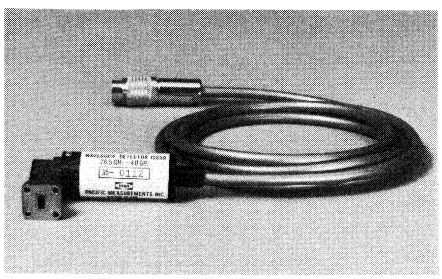
Balanced Detectors



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 harmonics, 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 -1.5 dB up to 26.5 GHz
- 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.

Literature

Please request Application Note AN23 to obtain full details and comparisons between RF detectors, and to find out why Wavetek Pacific Measurement diode detectors are among the most accurate, reliable, and versatile devices available for measuring RF power at microwave frequencies.

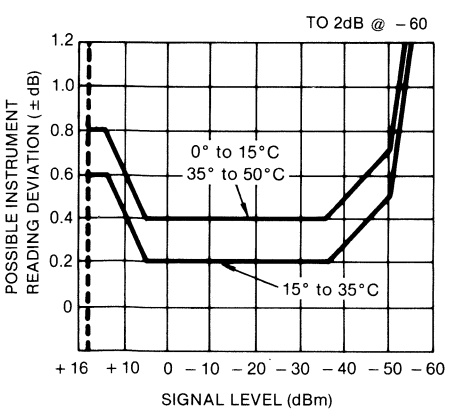


Figure 1. Model 1038-N10 and NS20 System Coaxial Detector Accuracy from 30 MHz to 26.5 GHz. (An additional 0.2 dB is added to the deviation reading for operation from 1 to 30 MHz.)

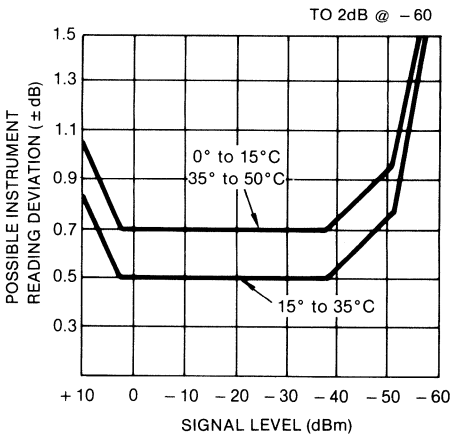


Figure 2. Model 1028-N10, NS20, and H/V System Waveguide Detector Accuracy from 26.5 GHz to 40 GHz

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 3.5 above 18.5 GHz)	20	18	16	10	—	—
Waveguide	—	—	—	—	10	10

*Typical special order only

FACTORY/FOB

Sunnyvale, CA

Microwave Power Meters

GENERAL MICROWAVE POWER METERS

Microwave power meters are used for bench, production and system testing of hardware such as:

- Transmitters
- Transistors
- Receiver Systems
- Amplifiers
- Components
- Antennas
- Sweepers
- Signal Generators
- Synthesizers
- Radar
- TACAN

Types Of Power Meters

Microwave power meters fall into two general groups:

- CW power meters used to measure power at a specific frequency.
- Peak power meters used to measure the power at a specific location on a pulse.

What To Look For

Microwave power meters provide a wide variety of capabilities, and should be selected with the specific application in mind.

CW power meters should have a dynamic range from +10 to -50 dBm. Peak power meters should cover from +10 to -20 dBm.

Peak power meters should be capable of measuring single pulses, or of selecting a specific pulse to measure from a train of pulses. Narrow pulse capability is useful, and the instrument should measure the power independent of pulse interval and pulse shape.

All CW power meters should have a detector calibrator, and traceability to the National Bureau of Standards (NBS). Peak power meters should have a CW capability, and a calibrator to provide traceability for peak power measurements.

A variety of RF detectors are available for the meters, each providing its own benefits and liabilities:

- Thermistor Detectors
- Thermocouple Detectors
- Diode Detectors

The type of detector selected will affect the accuracy, the dynamic range, and the speed with which the measurement can be taken. For a complete discussion of the advantages and disadvantages of the various types of RF detectors, please request Application Note AN23.

Power meters are available for portable, bench, and Automatic Test Equipment (ATE) applications.

Portable meters should be very rugged and battery powered for field use. The use of wide range diode detectors reduces the number of detectors needed, and makes the meter easier to use and carry.

Bench meters should provide necessary accuracy over both the frequency and power range of interest.

ATE meters must be fast and completely controllable over the GPIB.

The availability of multiple detectors for the same meter is useful for ATE applications, and also convenient for bench use.

Wavetek Power Meters

Three models of power meters are offered to answer specific power measuring requirements. These power meters have very high specification standards, with emphasis on ease of use. General features include high quality diode detectors with temperature and level compensating circuits, and calibrators to provide traceability to NBS.

Model 1018B Peak Power Meter

Model 1018B measures peak RF pulse power as well as CW power. Pulses can be single or repetitive. Average pulse power can also be measured. Thus the 1018B is useful in TACAN, weather radar, IFF transponder, and radar altimeter applications, as well as an invaluable laboratory tool.

Model 1045/01 RF Power Meter

Model 1045/01 Ultra Fast RF Power Meter is used for automatic and swept frequency testing, and for various tuning, adjustment, and matching processes. Up to four detectors are used for the direct display of gain, insertion loss, or the difference between matched channels. Detector selection is made within five milliseconds.

Model 1034A Portable RF Power Meter

Model 1034A Portable Power Meter, a rugged, laboratory quality instrument, makes high accuracy measurements in remote or difficult field locations (such as an antenna tower). The meter weighs just 3.86 kg, and operates with either battery (10 hours continuous use with 16 hour recharge) or from AC line.

Literature

Application notes are available from your sales representative:

AN14 Microwave Swept Frequency Gain or Power Testing at 0.1 to 26.5 GHz Under Pulse Modulated Conditions.

AN15 Digital Measurement of Peak Power at 0.1 to 26.5 GHz with IEEE Bus Operation.

AN17 RF Power Ratio Measurements.

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

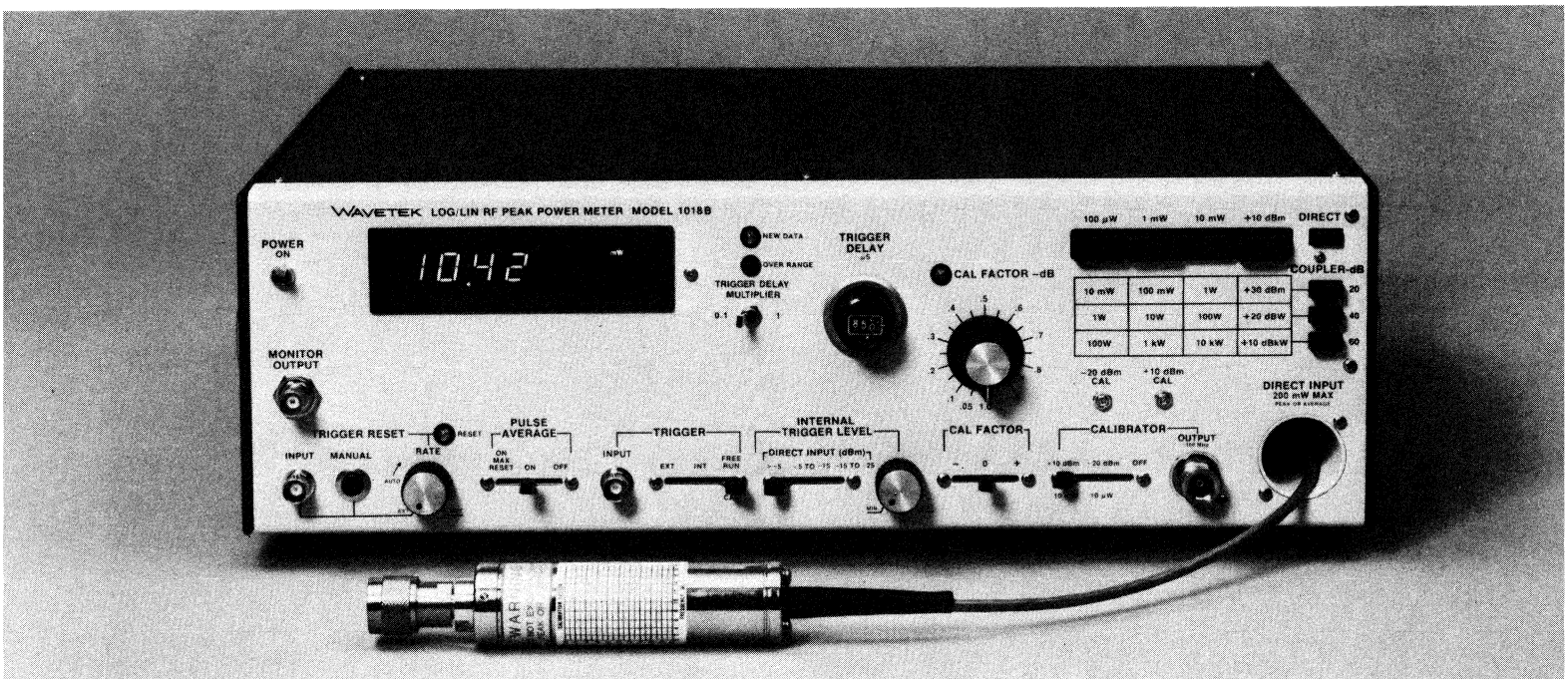
Frequency Range
100 MHz to 18 GHz (to 26.5 GHz with Option 07).
Power Range
10 μW to 10 mW (-20 to +10 dBm).
Accuracy
Linear (μW, mW): 5% of reading.
Logarithmic (dBm): ±0.3 dB.
Calibrator Output
High Level: +10 dBm ±0.15 dB.
Low Level: −20 dBm ±0.5 dB.
Impedance: 50Ω.
Return Loss: 31 dB.
Frequency: 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.
Power
100, 120, 220, 240 VAC, ±10%, 50 to 400 Hz, 40 VA maximum.

OPTIONS

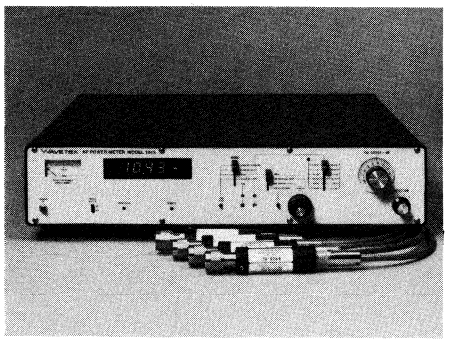
02: APC-7 Connector
04: Isolated Data Output
05: GPIB (includes Option 06)
06: Trigger Delay Divider
07: 26.5 GHz Measurement Range
Model 1031: Rack Adapter for Model 1018B

FACTORY/FOB

Sunnyvale, CA



Microwave CW Power Meters



Model 1045/01 RF Power Meter
Model 1045/01 RF Power Meter is a high speed, wide dynamic range, multiple detector, CW power meter for bench and ATE applications. It uses standard single diode detectors with Type N, APC7, and APC3.5 connectors. Readings are taken on a large LED display in db, dBm, W, mW, μW (includes over-range indication).

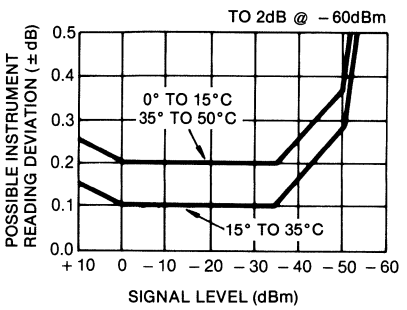
SPECIFICATIONS

Frequency Range
1 MHz to 26.5 GHz.

Power Range
– 50 dBm to + 10 dBm.
– 20 dBm to + 40 dBm.
(Range depends on detector used.)

Speed
Up to 500 readings/s.
Data to bus: 200k bytes/s.

Instrument Accuracy



Model 1045 Detector Measurement Accuracy from 1 MHz to 28.5 GHz

Response Time
1 ms to 10 s depending upon level change between readings.

Detector Calibration
30 MHz @ 10 mW ± 1.3%.
50Ω impedance.

Analog Output
dBm ranges: 100 mV/dB ± 1%.
Watt ranges: 1.0V per 1000 counts ± 1%.

Environment
Operating: 0° to + 50°C.

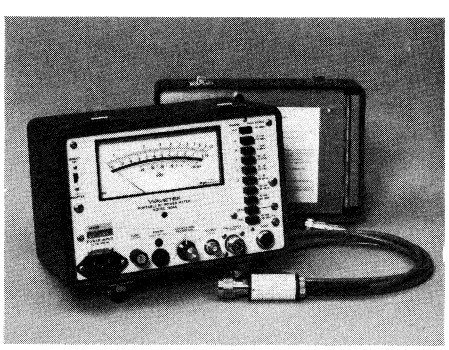
Power
100, 120, 220, and 240 VAC ± 10%; 50 to 440 Hz; 24 VA nominal.

OPTIONS

02: APC7 Connector on Calibrator Output
04: BCD data output
05: GPIB Capability

FACTORY/FOB

Sunnyvale, CA



Model 1034A Portable Power Meter
Model 1034A is a lightweight, portable CW power meter for both bench and field use. A durable, moisture-proof case and the ability to operate with either battery or AC power makes the unit excellent for field use. It has many outstanding and unique features, not usually found in a small power meter. No warm-up is required unless the unit has been subjected to a sudden, drastic change of ambient temperature. Even then, a half hour warm-up is adequate. Power readings are shown on a large analog meter with 7 ranges in dBm and watts, including one range covering -40 to + 10 dBm. All readings are taken with a single diode detector having a Type N connector. Adapters available for other types.

System Configuration
Model 1034A comes complete with internal ni-cad battery pack and RF detector.

SPECIFICATIONS

Frequency Range
1 MHz to 18 GHz

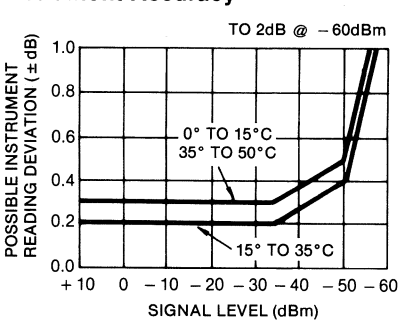
Power Range
60 dB (-50 to + 10 dBm)

Detector Calibrator
30 MHz @ 10 mW ± 1.5%.

Analog Output
1.1V full scale.

Environment
Operating: 0° to + 50°C.

Instrument Accuracy



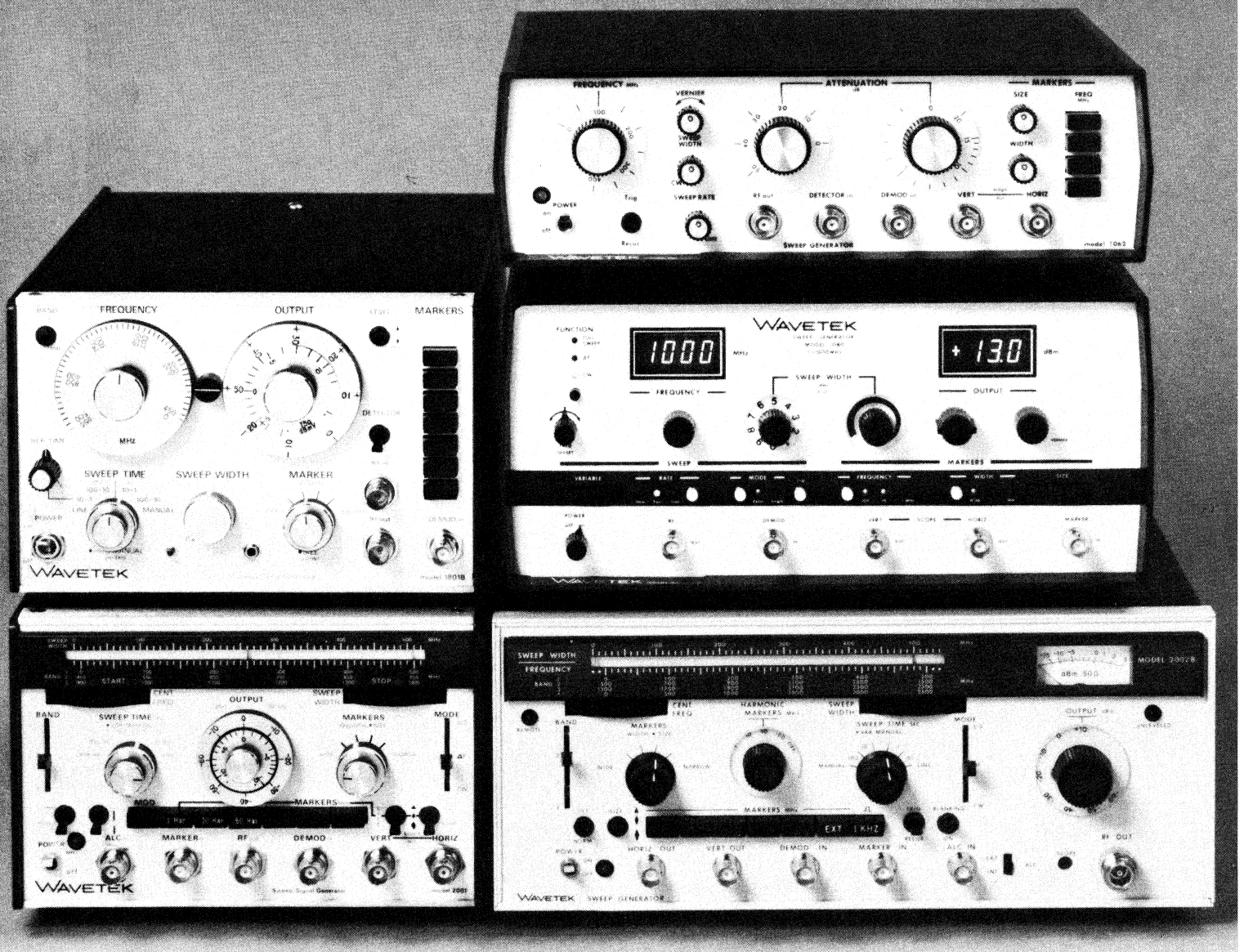
Model 1034A Detector Measurement Accuracy from 1 MHz to 10 GHz. (Add 0.2 dB to the above for frequencies from 10 GHz to 18 GHz.)

Power
115/230 VAC ± 10%; 50 to 400 HZ; 10 VA nominal.

FACTORY/FOB

Sunnyvale, CA

Sweep Generators



SWEEP GENERATOR SELECTION GUIDE

MODEL	1062	1067	1080 1081	1083 1084	1801B (VHF)	1801B (VHF and UHF)	1801C	2001	2002B	2005
Frequency Range (MHz)	1 to 400*	1 to 400*	1 to 1000	2.5 to 3.5 GHz (1083) 3.5 to 4.5 GHz (1084)	1 to 500	1 to 950	1 to 1000	1 to 1400	1 to 2500	1 to 4500
Output Power (dBm)	+10 to −60	+50 to −20 (dBmV)	+13 to −70	+13 to −60	+57 to −33 (dBmV)	+57 to −33 (dBmV)	+57 to −33 (dBmV)	+10 to −80	+13 to −77	+13 to −57
Flatness (dB)	±0.25	±0.5	±0.25	±0.5	±0.25	±0.35	±0.25	±0.5	±0.5	±0.75
Spurious Content Harmonic (>30 dBc above 10 MHz)	•	•	>30 dBc above 20 MHz	>30 dBc	•	•	•	•	•	See Page 183
Frequency Bands (MHz) (1 Band)	•	•	•	•	•	See Page 178	•	See Page 180	See Page 182	See Page 182
Impedance										
75Ω Standard		•	1081		•	•	•			
50Ω Available					•	•	•			
50Ω Standard	•		1080	•				•	•	•
75Ω Available										
Sweep Time (Variable/Line-Locked/Calibrated Manual)	Variable/ Line Locked	Variable/ Line Locked	Variable/ Line Locked	Variable/ Line Locked	•	•	•	•	•	•
Operating Modes (ΔF, CW)	•	•	Full Sweep •	Full Sweep •	•	•	•	Start- Stop •	Start- Stop •	Start- Stop •
AM/FM Capability (Standard)	•	•	FM Only	FM Only	•	•	•	•	•	•
Remote Programming (Standard for Center Frequency, Sweep Width and Output Level)	•	•	•	•	•	•	•	•	• GPIB Option C-2	• GPIB Option C-2
Square Wave Generator (Option A-4)	•	•			•	•	•	•	Std.	Std.
Optional Marker System (Available)	•	•	Incl.	Incl.	•	•	•	•	Incl.	Incl.
Featured on Catalog Page	172	172	174	174	178	178	178	180	182	182

*Frequency 1 to 500 MHz with −522 Version.

Economical 400 & 500 MHz Sweepers

- **1 to 400 MHz Frequency Range (Option to 500 MHz)**
- **Calibrated Output (+10 to −60 dBm)**
- **Built-in RF Detector**
- **Complete Crystal Marker System**

1 to 400 MHz Frequency Range
The 1060 Series of sweep generators are economical, laboratory quality, broadband sweepers designed to meet the needs of engineering, production and maintenance facilities, and educational institutions.

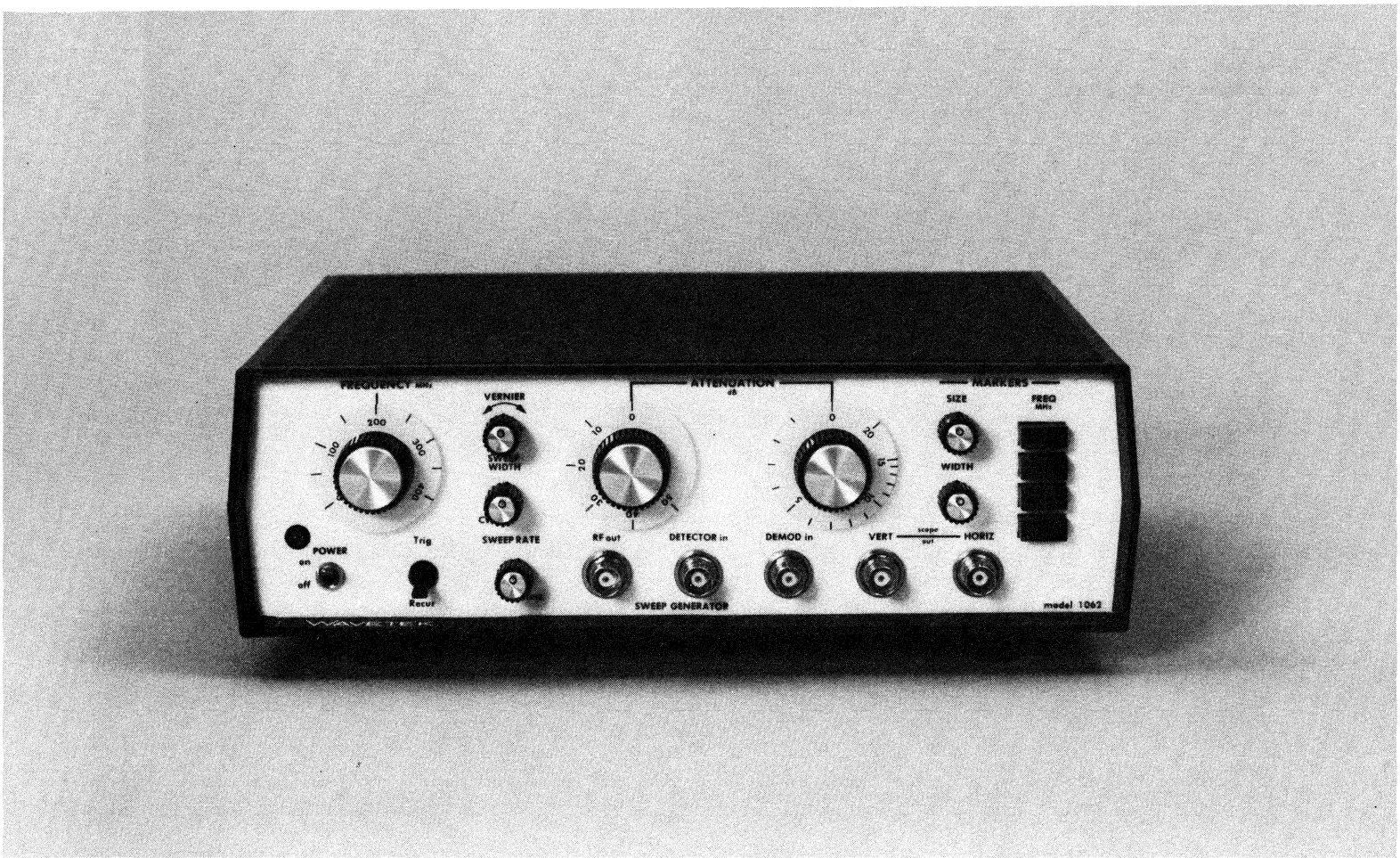
These small, compact sweepers will sweep any portion of their wide, 1 to 400 MHz frequency range. RF output is controlled by a calibrated 20 dB continuously variable PIN diode attenuator and a 10 dB per step 50 dB turret attenuator.

This series offers variable sweep rates, triggering capability, and either 50 or 75Ω source impedance.

Marker System
The marker system accepts up to six 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.

Full Performance
The units are extraordinary sweepers, providing 10 mW RF output, 2% sweep linearity and ±0.25 dB flatness. These features are typically found only in sweepers selling for much more.

Expanded Range CATV Version
Model 1067-522, a 75Ω instrument tailored to the CATV industry, extends the RF frequency range to 500 MHz. It is a very desirable tool for CATV test applications, especially when options such as the tilt control, notch filter, and pulse markers are installed.



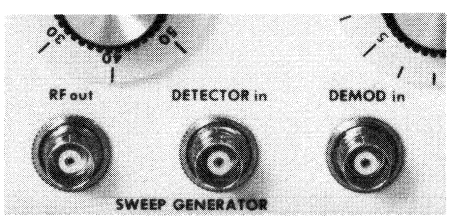
RF FREQUENCY

Frequency Range
Models 1062, 1067: 1 to 400 MHz.
Model 1067-522: 1 to 500 MHz.
Dial Calibration
50 MHz intervals (fine frequency vernier included).
Accuracy
5% full scale.
Sweep Width
0.2 to 400 MHz.
Display Linearity
2%.
Operating Modes
Sweep and CW.
Drift
Less than:
100 kHz for 5 minutes;
2 MHz for 8 hours.
NOTE: At a constant temperature after ½ hour warm-up.

RF OUTPUT

Impedance
Model 1062: 50Ω.
Model 1067: 75Ω
Model 1067-522: 75Ω.
Power Level Range
Model 1062: +10 to −60 dBm.
Model 1067, 1067-522: +57 to −7 dBmV.
Output Flatness
±0.25 dB (at 10 dBm).
Attenuation
Range: 70 dB total; 50 dB in 10 dB steps plus 0 to 20 dB PIN diode attenuator.
Accuracy:
Step Attenuator: ±0.2 dB/10 dB.
Vernier Attenuator: ±1 dB.
Output Connector Type
Model 1062: BNC.
Models 1067, 1067-522: F.
Spectral Purity
Harmonic and nonharmonic, <30 dBc (10 to 400 MHz).
Residual FM
Less than 10 kHz peak.

SWEEP CHARACTERISTICS



Built-in Detector

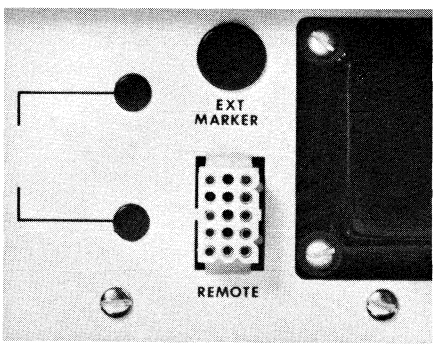
Sweep Modes
Recurring, single sweep and trigger.
Sweep Rate
Continuously variable from less than 0.5 Hz to greater than 60 Hz.
Horizontal Output
10 Vp-p symmetrical about ground.
Blanking
Blanking of RF output during retrace; removed for CW operation.

MARKER SYSTEM

RF Markers
Provision for up to 6 crystal controlled plug-in birdy bypass marker modules (see Options A-1, A-2 and A-3).
Marker Switches
Individual on/off switches are in the following combination. The first three pushbuttons control the first three markers; the fourth switch controls the fourth and fifth markers. The sixth marker position is always on; it is normally used for the external marker module, Option A-3.
Accuracy
±0.005%.
Amplitude
Adjustable from approximately 2 mV to 2 Vp-p.
Width
Adjustable from approximately 100 to 400 kHz.

REMOTE PROGRAMMING

Rear panel jack connections for remote control of center frequency, sweep width and 0 to 20 dB vernier level control.



Rear Panel Inputs

GENERAL

Dimensions
28.6 cm (11 in.) wide; 10.2 cm (4 in.) high; 26.7 cm (10½ in.) deep.
Weight
3.7 kg (8¼ lb) net; 6.8 kg (12½ 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.
NOTE: Harmonic type 0.1 MHz markers with associated 1.0 MHz markers are available
A-3
External Marker.
Marker provided by combining a CW signal (0.1V min. into 50Ω) from an external source through a rear panel BNC connector with a sample of the sweep oscillator signal.
A-4
IF Marker.
Crystals for A-4
B-2
Pilot Carrier Notches.
B-3
Tilt Control.

ACCESSORIES

K015
Rack Mount Adapter.
(P/N 1019-00-0119)

FACTORY/FOB

Beech Grove, IN

1000 MHz Single Band Sweepers

- **Ranges 1-1000 MHz, 2500-3500 MHz or 3500-4500 MHz**
- **CW, ΔF and Full Sweep Modes**
- **Digital Readout**
- **1% Display Linearity**
- **Auto Zero (Models 1080 and 1081)**

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 while Models 1083 and 1084 have the same power level but different frequency ranges.

CW, ΔF, Full Sweep
Frequency in CW mode is set by a ten-turn control and displayed with 1 MHz resolution on a 3½ 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.

Models 1080 and 1081
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 3½ digit readout with 0.1 dB resolution. An "auto-zero" circuit improves frequency accuracy. Models 1081 is a 75Ω version with a calibrated output of +60 to −10 dBmV.

Models 1083 and 1084
Both are 50Ω, have an output power range of +13 to −60 dBm, are continuously adjustable with a 10 dB/Step attenuator and an 11 dB vernier, and have output level displayed on a 3½ digit readout with 0.1 dB resolution.

Marker System
The birdy bypass marker system in the Series 1080 is controlled by a front-panel switch for selection of harmonic markers at 1, 10 and 100 MHz. Differences in marker amplitudes make identification of markers easy, and marker width is adjustable for optimum wide and narrow band operation. A calibrated variable marker is provided in the full sweep mode. External marker input is standard.

FREQUENCY

Range
Models 1080, 1081: 1 to 1000 MHz.
Model 1083: 2.5 to 3.5 GHz.
Model 1084: 3.5 to 4.5 GHz.

Readout
3 ½ digit vacuum Fluorescent display.

Resolution
1 MHz.

Accuracy
CW, Center Frequency of ΔF, and Variable Marker: ±10 MHz. Frequency accuracy can be improved to ±1 MHz at a specific frequency.
Sweep Width at 100 MHz Intervals: ±10 MHz.

Sweep Width
Models 1080, 1081: ΔF, 200 kHz to 1000 MHz.
Models 1083, 1084: ΔF, 500 kHz to 1000 MHz.
Full Sweep: Same as range.

Display Linearity
1% at maximum sweep width.

Operating Modes
CW, ΔF, and Full Sweep

Drift
Models 1080, 1081: <200 kHz for 10 min.
Model 1083: <500 kHz for 10 min.
Model 1084: <800 kHz for 10 min.
NOTE: At a constant temperature after ½ hour warm up.

RF OUTPUT

Impedance
Models 1080, 1083, 1084: 50Ω.
Model 1081: 75Ω.

Power Level Range
Model 1080: +13 to −70 dBm.
Model 1081: +60 to −10 dBmV.
Models 1083, 1084: +13 to −60 dBm.

Output Flatness
Models 1080, 1081: ±0.25 dB.
Models 1083, 1084: ±0.75 dB.

Attenuation
Continuously adjustable in 10 dB steps with an 11 dB vernier. Output level is displayed on a 3 ½ digit readout with 0.1 dB resolution.

Accuracy
Models 1080, 1081:
Step Attenuator: ±0.3 dB +1% of attenuation.
Vernier Attenuator: ±0.5 dB.
Models 1083, 1084:
Step Attenuator: ±0.5 dB +2% of attenuation.
Vernier Attenuator: ±0.5 dB.

Output Connector
Models 1080, 1081: Type BNC.
Models 1083, 1084: Type N.

SPECTRAL PURITY

Harmonic Output
Models 1080, 1081:
1 to 2 MHz: <−15 dBc;
2 to 10 MHz: <−25 dBc;
10 to 1000 MHz: <−30 dBc in 1 to 2000 MHz band.
Models 1083, 1084: <−30 dBc.

Nonharmonics
Models 1080, 1081:
1 to 400 MHz: <−50 dBc;
400 to 1000 MHz: <−35 dBc.
Models 1083, 1084: Nondetectable.

Residual FM (CW Mode)
Models 1080, 1081: <10 kHz peak.
Models 1083, 1084: <50 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 ½ of AC line period.

Horizontal Output
0 to 10V, 1000Ω impedance.

Blanking
RF output is blanked during sweep retrace.

MARKER SYSTEM

RF Markers
Birdy bypass marker system is controlled by front-panel switch which provides selection of harmonic markers in these combinations: 100 MHz only: 100 MHz and 10 MHz; or 100 MHz, 10 MHz and 1 MHz.

Accuracy
±0.005%.

Amplitude
Adjustable from approximately 1 mV to 250 mVp-p.

Width
Adjustable from approximately 10 to 500 kHz.

Variable Marker
(Full Sweep Mode Only.) 10-turn potentiometer and 3½ digit frequency display function as a variable marker. Marker produces a bright spot on the display by momentarily delaying sweep ramp for approximately 2 ms. Accuracy is ±10 MHz.

External Marker
BNC input accepts CW signal for conversion to a birdy marker. Input level must be ≥100 mV into 50Ω.

REMOTE PROGRAMMING

Frequency
Rear-panel jack permits remote control of center frequency, sweep width and external frequency modulation.

Level
Rear-panel jack permits external control of RF output level over greater than 13 dB range.

Trigger
TTL input, during high to low transition. Also, by contact closure to ground.

OUTPUTS

Pen Lift
Contact closure during sweep.

Blanking
−15V during sweep, +15V during retrace.

Sweep
0 to 10V.

Reference
Output of 1V/100 MHz.

Power Supply
+18V, −18V, and common. External current limited to 10 mA.

GENERAL

Dimensions
28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 26.7 cm (10½ 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 adapts the instrument for center mounting in a standard 19 in. rack. 6 31/32 in. height.

FACTORY/FOB

Beech Grove, IN

Scalar Analyzer System

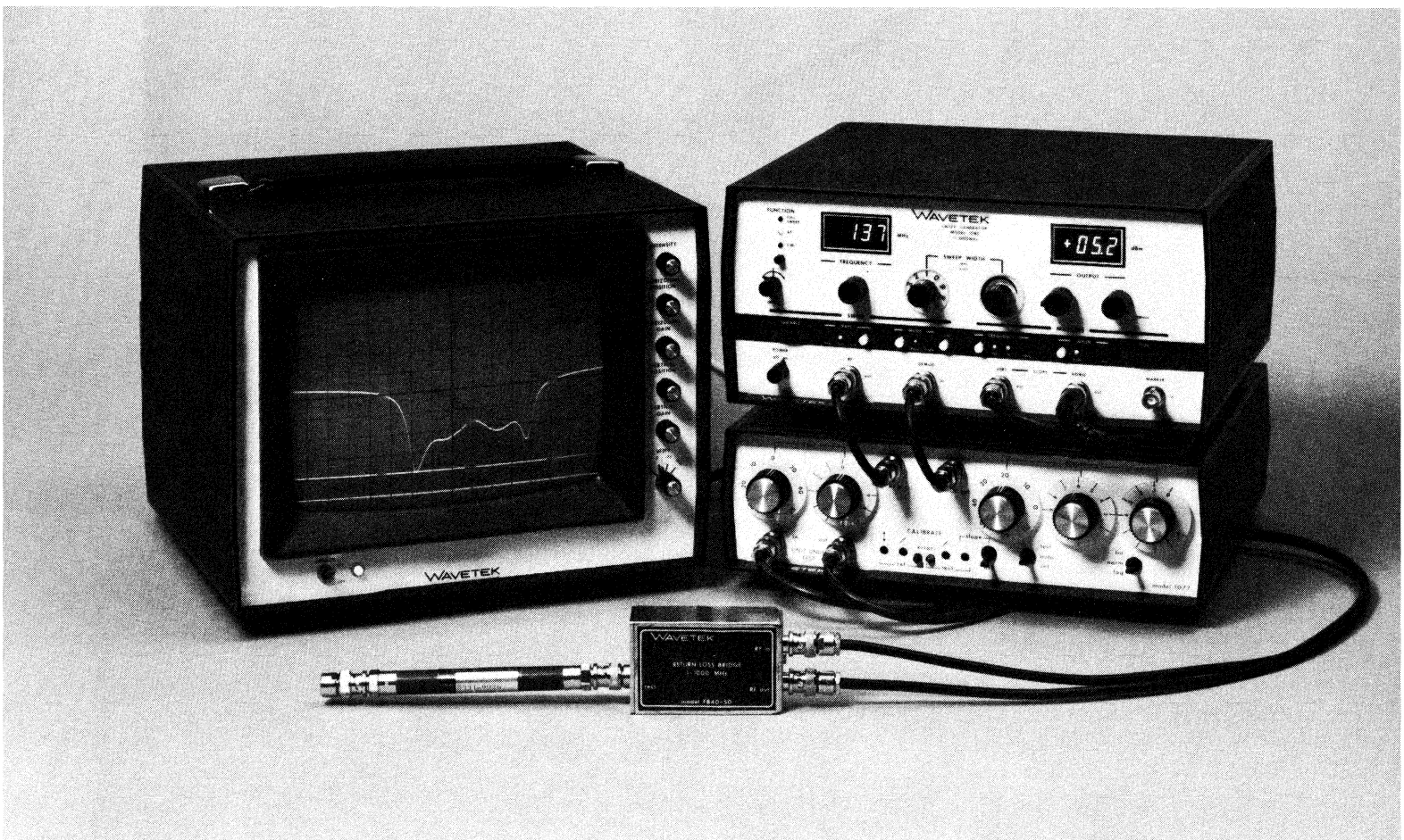
- **Sweeps 1 MHz to 1 GHz in a Single Band**
- **Broadband Search Mode**
- **System Level Correction**
- **Versatile Display**

Wavetek's 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 50Ω or (75Ω) impedance.

System Components
The system consists of a sweep frequency source, Model 1080 (1081); a calibrated dual-channel switching RF comparator, Model 1077 (1076); an RF return loss Bridge, Model FB40-50 (FB40-75); and a large-screen oscilloscope, Model 1905, to simultaneously display both test and reference channels. Alternative displays are available from Wavetek which allow gain or loss, return loss and calibrated power level reference to be displayed simultaneously.

Measurement to 1 GHz in a Single Band
The system sweeps from 1 MHz to 1 GHz in a single band. One oscillator is used to cover the whole band, eliminating errors introduced by switching transients used in other systems. 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
After identifying a point of interest on a wideband response curve, the user may quickly switch to a preset narrow sweep around the marker



frequency. 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 rolloff of system components (such as adapters, cables, or "lossy" connectors) may be compensated for via the slope control on either the Model 1080 (1081) Sweep Generator or the Model 1077 (1076) RF Sweep Comparator. By looking at the detected response of this network, the operator can adjust the slope control (±1 dB/GHz) to compensate for inherent system errors which typically result in undesirable high-frequency rolloff. 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.

Measurement of gain or loss at any frequency is made by allowing the reference and test traces to be superimposed. Gain is measured to 79.9 dB by attenuating the test channel until the traces meet. Loss is measured to 65 dB by attenuating the reference channel. Resolution is 0.1 dB.

Versatile Display

A switch on the front panel of the Wavetek Model 1077 (1076) RF Sweep Comparator controls the choice of linear, logarithmic or unshaped vertical display. Logarithmic display provides a typical dynamic range of 40 dB required to test very sharply tuned devices.

FREQUENCY

Range
1 MHz to 1 GHz in one band.

Sweep Width
Δ: 0.2 to 1000 MHz.
Full Sweep: same as range.

Display Linearity
1% at maximum sweep width.

Drift
Measured at constant temperature, after 1/2 hour warm-up.
<200 kHz for 10 min.

Operating Modes
CW, ΔF and Full Sweep.

RF OUTPUT

Impedance
50Ω or 75Ω.

Power Level Range
50Ω: +13 to −70 dBm.
75Ω: +60 to −10 dBmV.

Output Flatness
±0.25 dB.

AMPLITUDE VS. FREQUENCY

Gain Measurement Range
0 to 79.9 dB (resolution: 0.1 dB).

Loss Measurement Range
0 to >60 dB (resolution: 1 dB).

Step (dB)	Accuracy (dB)	
	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.

REMOTE PROGRAMMING

Frequency
Center frequency and sweep width control.

Level
RF output level control over >13 dB range.

GENERAL

Dimensions
Model 1080/1081: 13.3 cm (5 1/4 in.) high; 28.6 cm (11 1/4 in.) wide; 26.7 cm (10 1/2 in.) deep.
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 1905: 24.8 cm (9 3/4 in.) high; 29.8 cm (11 3/4 in.) wide; 25.7 cm (10 1/8 in.) deep.
Model FB40-50/FB40-75: 3.2 cm (2 in.) high; 11.5 cm (4 1/2 in.) wide; 3.2 cm (1 1/4 in.) deep.

Weight
Model 1080/1081: 4.9 kg (10.8 lb) net; 6.8 kg (15 lb) shipping.
Model 1076/1077: 3.0 kg (6.5 lb) net; (10 lb) shipping.
Model 1905: 6.7 kg (15 lb) net, 10 kg (22 lb) shipping.
Model FB40-50/FB40-75: 0.35 gram (10 oz) net; 2.3 kg (5 lb) shipping.

Power
Model 1080/1081: 90 to 110 V; 105 to 125 V; 190 to 220 V; or 210 to 250 V; 50 to 400 Hz; approx 35 watts.
Model 1076/1077: Supplied by associated sweep.
Model 1905: 115 or 230 V ±10%; 50 or 60 Hz; approx 75 watts.

NOTE: For more information
Model 1080: page 174;
Model 1081: page 174;
Model 1905: page 204;
Models FB40-50, FB40-75: page 201.

FACTORY/FOB

Beech Grove, IN

VHF/UHF Sweep/Signal Generators

- **1 to 500 MHz and 1 to 1000 MHz Frequency Ranges**
- **Calibrated Output (+57 to −33 dBmV)**
- **Excellent Flatness and Linearity**
- **Complete Crystal Marker System**
- **Features for CATV Applications**

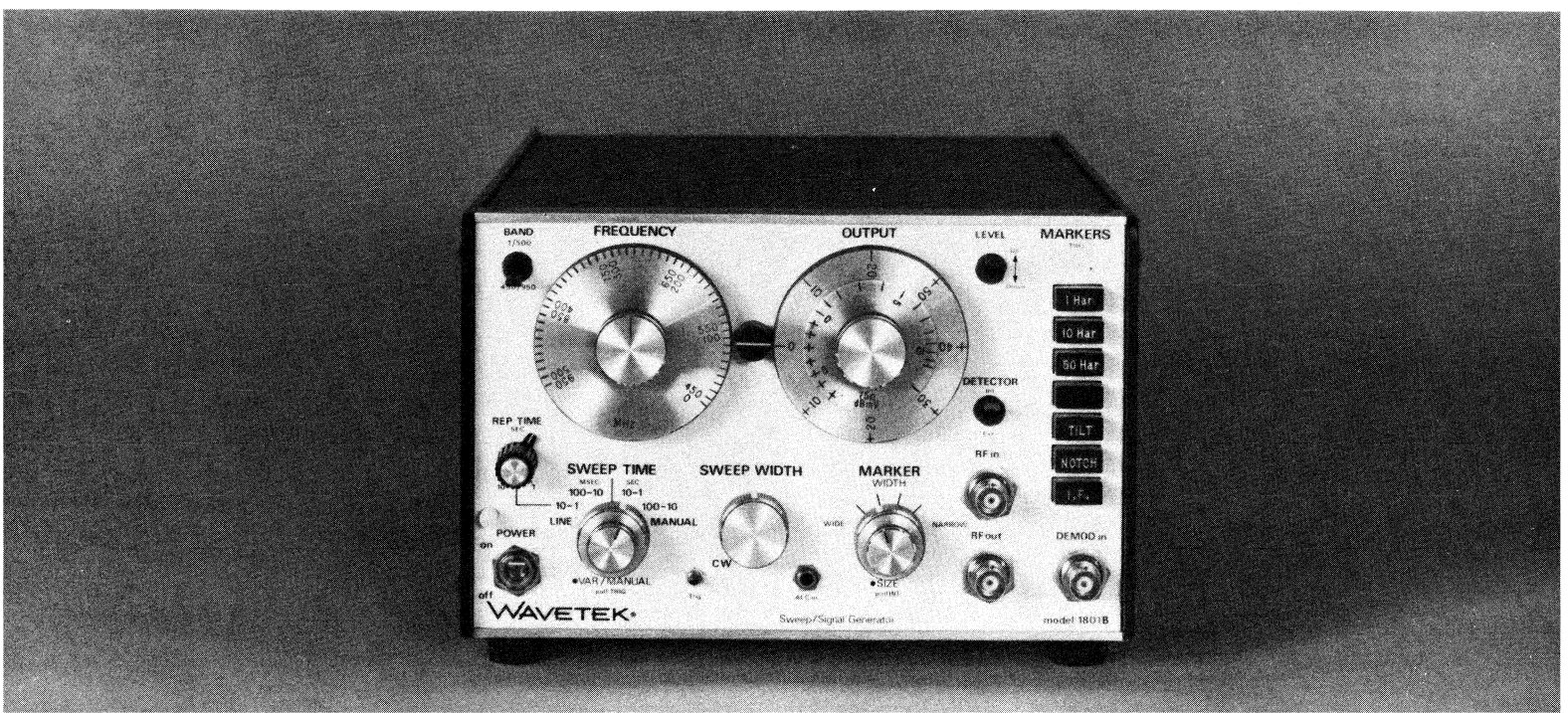
1 to 1000 MHz Frequency Range
Solid state Models 1801B and 1801C Sweep/Signal Generators provide features and options ideally suited for the manufacturer of TV and CATV equipment and for the installers and operators of CATV systems. Model 1801B frequency range of 1 to 500 MHz is optionally expandable with a UHF 450 to 950 MHz range. Model 1801C's 1 to 1000 MHz frequency range is standard.

Calibrated Output
The ultra-flat (±0.25 dB, 1 to 1000 MHz on Model 1801C) 75Ω output system is calibrated from +57 to −33 dBmV. 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.

Marker System
The crystal controlled birdy marker system may be used to modulate (blank) the RF output so both sweep and markers may be on a single cable. This is very useful for an accurate frequency indication when sweeping long lines or cable systems.

Sweep Rate Versatility
Models 1801B and 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. Models 1801B and 1801C may be used with any available sweep receiver.

Special CATV Features
Models 1801B and 1801C can operate in conjunction with Model 1075 or 1076 Comparator-Attenuator. When Model 1075 is plugged into Model 1801B or C, the PIN diode attenuator is time shared with the equalization, tilt and 0.1 dB attenuator by the comparator. Models 1801B and 1801C will accept the tilt, notch filter and pulse marker options that are very desirable in most CATV test applications.



RF FREQUENCY

Range
Model 1801B: 1 to 500 MHz optional 450 to 950 MHz.
Model 1801C: 1 to 1000 MHz.

Dial Calibration
Model 1801B: 10 MHz/div with 5 MHz vernier.
Model 1801C: 20 MHz/div with 20 MHz vernier.

Accuracy
Model 1801B: 10 MHz or 2% of selected frequency (whichever is greater).
Model 1801C: 20 MHz.

Sweep Width
Model 1801B: 100 kHz to 500 MHz.
Model 1801C: 200 kHz to 1000 MHz.

Display Linearity
Model 1801B: 2%.
Model 1801C: 1%.

Spurious Signals
– 30 dB above 10 MHz.

Residual FM
Model 1801B: <7.5 kHz peak.
Model 1801C: <10 kHz peak in CW mode.

Drift
(At constant temperature after ½ hour warm-up.)
<100 kHz/5 minutes;
2 MHz for 8 hours.

RF OUTPUT

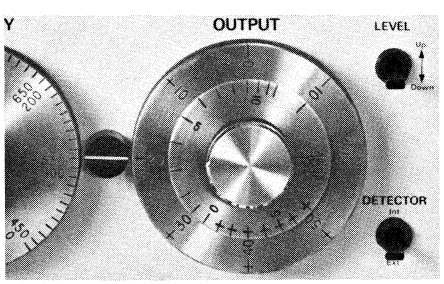
Maximum Output Amplitude
+ 57 dBmV 0.7 Vrms.

Impedance
75Ω (50Ω available).

Output Flatness
Model 1801B: ± 0.35 dB, 1 to 950 MHz.
Model 1801C: ± 0.25 dB, 1 to 1000 MHz.

Attenuation
Continuously adjustable from + 57 to – 33 dBmV. 70 dB in 10 dB steps plus a 20 dB PIN diode attenuator calibrated in 1 dB increments.

Accuracy
± 0.5 dB to 500 MHz.
± 1.0 dB to 100 MHz.



Calibrated RF Output

Reference Attenuator
Internally adjustable from 0 to 0.5 dB above and below output level.

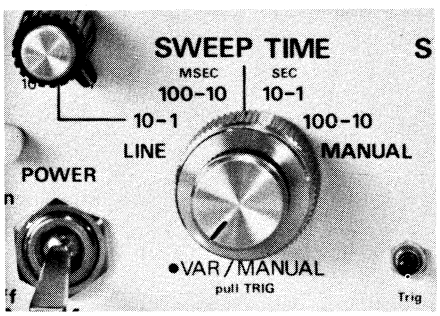
Slope Adjustment
(Model 1801C) To compensate for external cables, detectors, etc., up to ± 1 dB/GHz of slope may be imposed on the RF output via the front panel slope control.

Output Connector
Type BNC (type F available).

SWEEP CHARACTERISTICS

Sweep Modes
Recurring, single sweep, external trigger, manual and line lock.

Sweep Time
Continuously variable from 10 to 100 ms and from 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.



Cable System Sweeping

MARKER SYSTEM

RF Markers
Provision for up to 6 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 Vp-p.

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.

External FM
± 16 V results in full deviation at rates up to 4 kHz. With reduced deviation and linearity, modulation rates up to 100 kHz are possible.

External AM
0 to – 5 V signals are applied to 20 dB vernier output attenuator. With average voltage set to midrange, modulation possible to 50 kHz.

External Leveling
External negative signal (ALC) between 0.2 and 2 V may be used to level RF output.

External Triggering
10 V pulse will trigger a single sweep.

GENERAL

Dimensions
20.9 cm (8¼ in.) wide; 14.3 cm (5¾ in.) high; 34.9 cm (13¾ 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 200 V 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 1, 5, 10, 50 or 100 MHz. Specify frequency.

NOTE: Harmonic type 0.1 MHz markers with associated 1.0 MHz markers are available.

A-4
1 kHz Square Wave Generator.
Plug-in module provides square wave modulation of RF output.

A-5
Pen Lift.
Provides contact closure during forward sweep trace. Binding post terminals are provided on rear panel.

A-6
Single Frequency Marker.
35 to 52 MHz. Up to five pulses selected by plug-in crystals.

A-7
Pilot Carrier Notches.
Blanks (shuts off) RF output at two frequencies; notch frequencies and widths internally adjustable. Enabled by front panel switch.

A-8
UHF Option.
450 to 950 MHz.

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.)

FACTORY/FOB

Beech Grove, IN

1400 MHz Sweeper

- **Wide Frequency Range**
- **Start/Stop, ΔF and CW Modes**
- **Calibrated RF Output System**
- **Calibrated Sweep Width**

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.

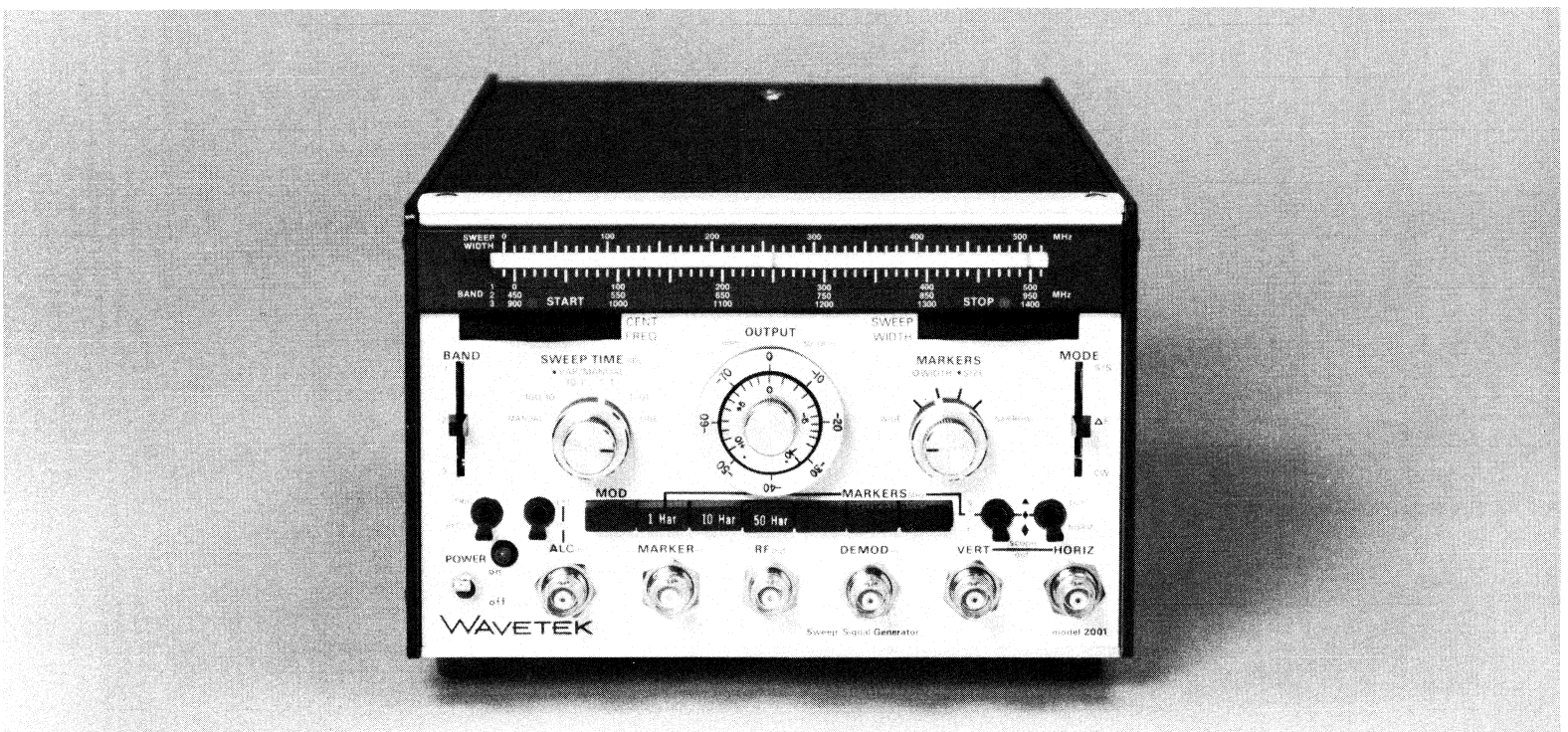
Sweep Rate Versatility
The three frequency bands are PIN diode switched and may be swept from CW to a full 500 MHz width. Sweep may be line locked or at rates of 50 sweeps per second to 1 sweep every 100 seconds. Manual and triggered modes are provided.

Calibrated RF Output
The high output (10 mW) is internally leveled to within ± 0.5 dB over the entire range and has provision for external leveling. The RF output system is calibrated from + 10 to − 80 dBm in 1 dB intervals.

Marker System
An optional crystal controlled birdy bypass marker system of up to six plug-in marker modules (each with individual of/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).

All 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. In application, 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.

Available Options
Other options include pen lift and 1 kHz square wave modulation for low level recovery applications. The unit will interface with most network analyzers and attenuation test sets.



MODEL 2001 SWEEP GENERATORS

RF FREQUENCY

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 and Start/Stop.

Display Linearity
2%.

Spurious Signals
– 30 dB (10 to 1400 MHz).

Residual FM
Less than 7.5 kHz peak.

Drift
Less than:
100 kHz to 5 minutes;
1 MHz for 8 hours.
NOTE: At a constant temperature after ½ hour warm-up.

Blanking
Blanking of RF output during retrace; removed for CW operation.

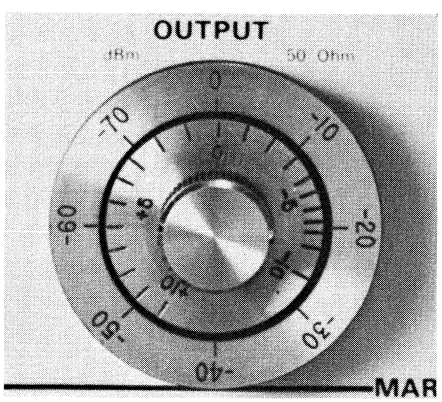
RF OUTPUT

Impedance
50Ω (75Ω available at no additional cost).

Maximum Output Amplitude
+ 10 dBm.

Output Flatness
± 0.5 dB (at 10 dBm).

Attenuation
Continuously adjustable from + 10 to – 80 dBm. 70 dB in 10 dB steps plus a 20 dB PIN diode attenuator calibrated in 1 dB increments.



Attenuator

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, in 4 decade steps, plus vernier.

Horizontal Output
16V p-p symmetrical about ground (0 to + 10V available upon request).

MARKER SYSTEM

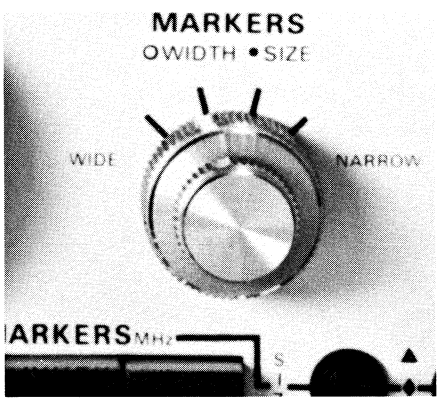
RF Markers
Provision for up to 6 crystal controlled plug-in birdy bypass markers, plus external marker input. Markers may be either discrete frequency (Option A-1) or harmonic type (Option A-2).

Marker Switches
Individual on/off switches provided for each marker.

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 μV to 50 mV p-p.



Marker Adjustment

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 50Ω.

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.

External FM
± 16V results in full deviation at rates up to 4 kHz. With reduced deviation and linearity, modulation rates to 100 kHz are possible.

External AM
0 to – 18V external signals are applied to 20 dB vernier output attenuator. With average voltage set to midrange, modulation possible to 50 kHz.

External Leveling
External negative signal (ALC) between 0.2 and 2V may be used to level RF output.

GENERAL

Dimensions
20.9 cm (8¼ in.) wide; 14.3 cm (5½ in.) high; 34.9 cm (13¾ 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 1, 5, 10, 50 or 100 MHz. Specify frequency.
NOTE: Harmonic type 0.1 MHz markers with associated 1.0 MHz markers are available.

A-4
1 kHz Square Wave Generator.
Plug-in module provides square wave modulation of RF output.

A-5
Pen Lift.
Provides contact closure during forward sweep trace. Binding post terminals are provided on rear panel.

ACCESSORIES

K103
Rack Mount for mounting one unit (PN 1019-00-0028).

K104
Rack Mount for mounting two units (PN 1019-00-0029).

FACTORY/FOB

Beech Grove, IN

2500 and 4500 MHz Sweepers

- **Start/Stop, ΔF and CW Modes**
- **Analog Programmable**
- **GPIB Programmable**
- **Crystal-Controlled Harmonic Markers**
- **Crystal-Controlled Single Frequency Markers**

1 to 2500 MHz Range
Model 2002B covers the 1 to 2500 MHz range in three bands: Band 1, a 1 to 500 MHz heterodyne sweep oscillator; band 2, two fundamental oscillators which sweep from 500 to 1000 MHz and 1000 to 1500 MHz, respectively; band 3, a single fundamental oscillator sweeping from 1500 to 2500 MHz. Additionally, all four oscillators may be stacked (sequentially swept) to cover the entire 1 to 2500 MHz instrument range as band 4.

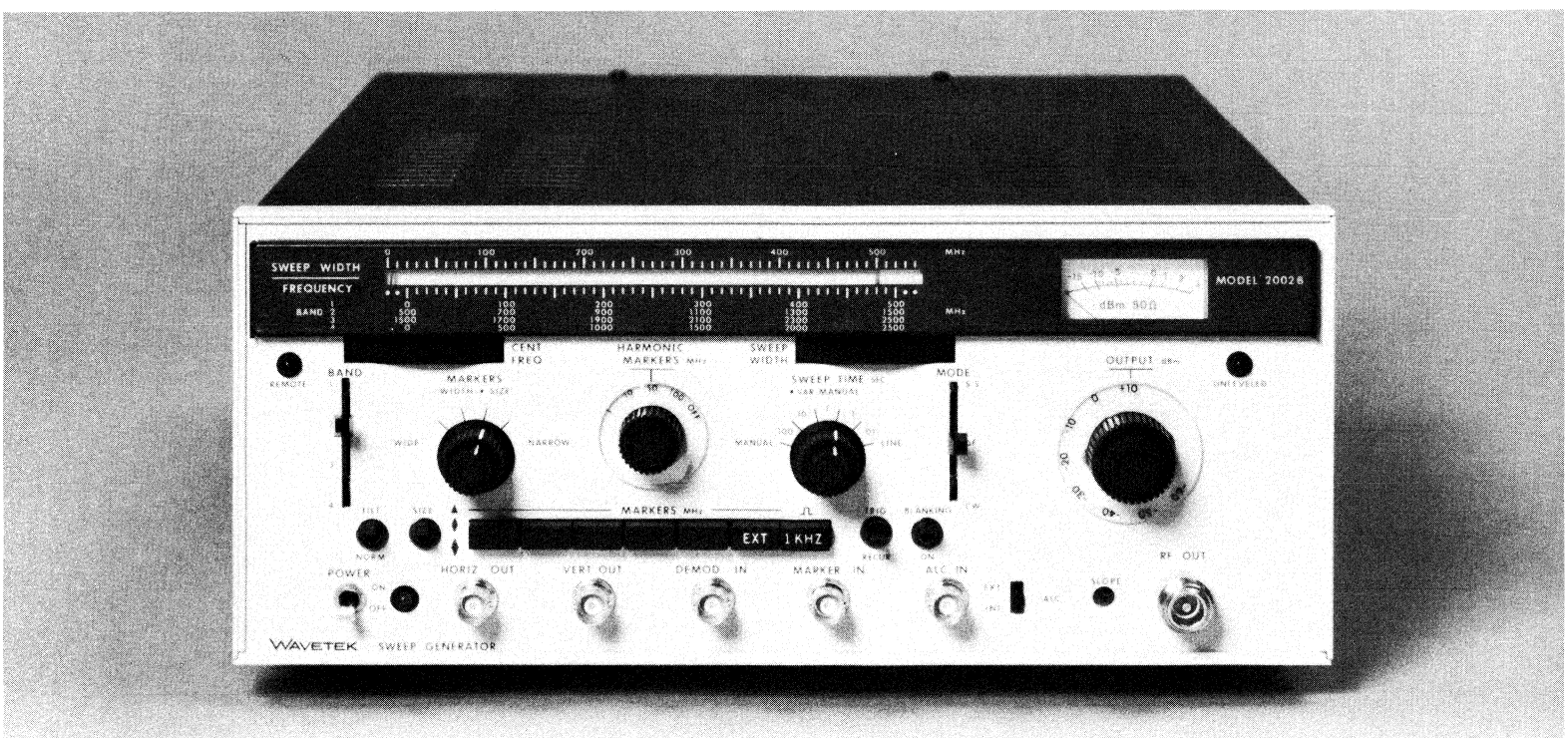
1 MHz to 4.5 GHz Range
Model 2005 has four bands in the same manner as Model 2002B. Band frequencies are: band 1, 1 to 1500 MHz; band 2, 1.5 to 2.5 GHz; band 3, 2.5 to 4.5 GHz; and for band 4, oscillators are stacked to cover the entire 1 MHz to 4.5 GHz frequency range.

Sweep System
Each of the four frequency bands may be used in three modes of operation: start/stop, ΔF or CW. Frequency can be swept over any portion of a given band, in either direction, at any rate from 50 sweeps per second to 1 sweep every 100 seconds. Manual, triggered, or recurring sweeps are also available.

Marker System
Crystal-controlled harmonic markers are at 1, 10, 50, and 100 MHz intervals. Model 2005 has an additional harmonic marker at 500 MHz. Front-panel size and width controls enable optimum adjustment of the marker display. In addition to the standard harmonic markers, there are provisions for the installation of five optional marker modules. These markers may be single-frequency or harmonic type. Each marker has its own front-panel switch.

Options
Optional features include a rear-panel auxiliary RF output, a pen-lift circuit for use with X-Y plotters, and a 0 to 70 dB programmable attenuator.

Remote Operation
The instruments may be remotely controlled by an optional GPIB interface or a standard rear-panel programming connector. Functions controlled are band switching, frequency, sweep width, and output level.



MODELS 2002B & 2005 SWEEP GENERATORS

RF FREQUENCY

Range

Model 2002B:
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).

Model 2005:
1 to 4500 MHz in 4 bands:
1 to 1500 MHz (band 1);
1500 to 2500 MHz (band 2);
2500 to 4500 MHz (band 3);
1 to 4500 MHz (band 4 stacked).

Dial Calibration Increments

	Model 2002B	Model 2005
Band 1	10 MHz	30 MHz
Band 2	20 MHz	20 MHz
Band 3	20 MHz	50 MHz
Band 4	50 MHz	100 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.)
Model 2002B:
1 to 1500 MHz: <100 kHz/5 min, <2 MHz/8 hr.
1500 to 2500 MHz: <200 kHz/5 min, <4 MHz/8 hr.
Model 2005:
1 to 2500 MHz: <500 kHz/5 min, <4 MHz/8 hr.
2500 to 4500 MHz: <1 MHz/5 min, <10 MHz/8 hr.

Blanking
Controlled by front-panel on/off switch.

CALIBRATED RF OUTPUT

Impedance
50Ω.

SWR
<1.5:1 10 dB attenuation minimum.

RF Output Range
Model 2002B: + 13 dBm to − 77 dBm.
Model 2005: + 13 dBm to − 57 dBm.

Attenuation
10 dB steps with 10 dB vernier.

	Step Attenuator	Vernier Attenuator
Model 2002B	70 dB	20 dB
Model 2005	60 dB	11 dB

Attenuator Accuracy
Step: ± 0.5 dB or 2% of attenuation.
Vernier: ± 0.5 dB (top 11 dB of range).

Output Flatness
Model 2002B: ± 0.5 dB.
Model 2005: ± 0.75 dB.

Slope Adjustment
Up to ± 1 dB/GHz.

Modulation
1 kHz square wave controlled by front panel switch. Ext AM and FM rear 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
Model 2002B:
1 to 10 MHz: < − 20 dBc;
10 to 2500 MHz: < − 30 dBc.
Model 2005: (at + 13 dBm.)
1 to 2 MHz: < − 25 dBc;
2 to 1500 MHz: < − 30 dBc;
1500 to 4500 MHz: < − 24 dBc.

Nonharmonics
Model 2002B:
1 to 500 MHz: < − 35 dBc;
>500 MHz: nondetectable.
Model 2005: (at + 13 dBm.)
1 to 1500 MHz < − 45 dBc;
>1500 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 + 10 volts. Impedance 10kΩ.

MARKER SYSTEM

RF Markers
1, 10, 50 and 100 MHz harmonic (plus 500 MHz in 2005) and external marker input plus Options A-1 and A-2 (plug-in).

Marker Switches
Individual front-panel on/off switches.

Accuracy
0.005%. Model 2005 at frequencies >2.5 GHz: 0.01%.

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
Adjustable 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: ΔF and CW modes, band, level and sweep trigger. Also AM and FM inputs.

EXTERNAL FM

Up to 10 kHz rates, ± 50 MHz dev.

EXTERNAL AM

Simultaneous AM and level control.

Frequency Range
DC to 10 kHz (3 dB bandwidth).

Sensitivity
1 Vp-p per 10% AM.

Maximum Modulation %
Level dependent.
Model 2002B: 10 to 90%.
Model 2005: 10 to 50%.

GENERAL

Operating Temperature
0° to 50°C.

Dimensions
31.8 cm (12 ½ in.) wide; 13.3 cm (5¼ 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.

A-2
Harmonic-Type Comb Marker.
1,5, 10, 50 or 100 MHz. 1 to 1500 MHz range. Specify frequency.

B-4
Pen Lift.
Contact closure during forward sweep.

B-5
Auxiliary RF Output (≈ − 10 dB).

C-2
GPIB: ΔF, S/S, CW modes; band and level.

C-3
GPIB: 0 to 70 dB Attenuator.

ACCESSORIES

K108
Rack Mount (P/N 1019-00-0031).

FACTORY/FOB

Beech Grove, IN

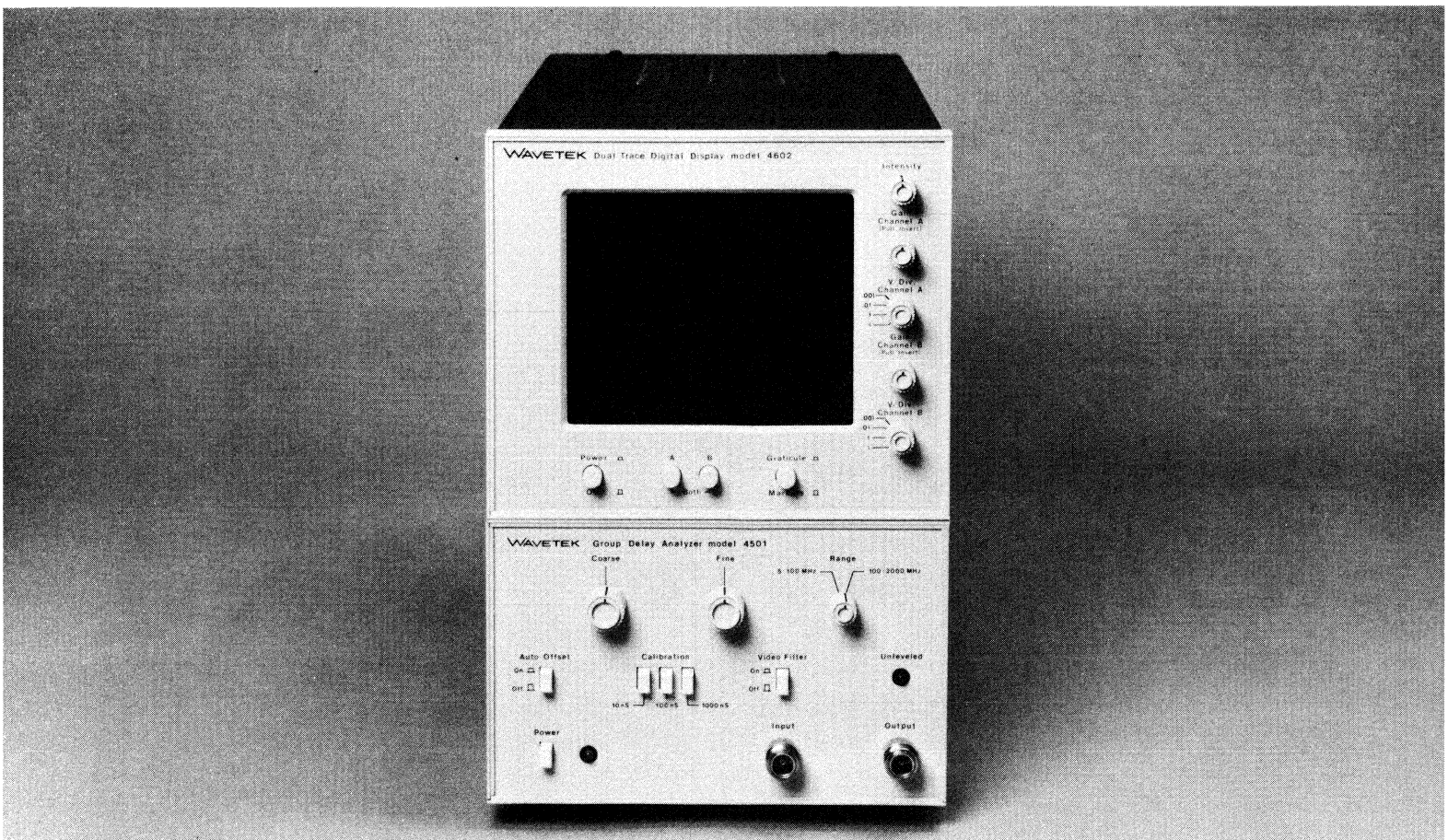
Group Delay Analyzer

- **Direct Readout of Group Delay**
- **Broad Band Coverage from 5 to 2000 MHz**
- **Accuracy to ±1 Nanosecond**
- **Internal Calibrator**
- **Pass Band Viewing**

Direct Readout of Group Delay
Model 4501 Group Delay Analyzer, which utilizes swept frequency techniques, reads group delay by measuring the phase shift of the modulating envelope of an amplitude modulated RF carrier as it passes through the device under test. This phase shift is converted to a voltage directly proportional to time delay, suitable for display on a long-persistence Model 4602 Display Oscilloscope. The signal may also be digitized and stored in memory when used in an automatic test system.

Broadband Coverage
Model 4501, when used with a Wavetek Sweep Generator and the Model 4602 Display Oscilloscope, indicates variations in group delay over the desired operating frequency of the device under test. This eliminates time-consuming point-by-point measurements and elaborate computations. Model 4501 is a real time instrument where the effects of changes in group delay and passband insertion loss of the D.U.T. may be observed as they occur. This is especially useful during manufacturing or when optimizing a device design.

22,000 Nanosecond Offset
Small variations of less than 1 nanosecond may be observed in the presence of large group delays by offsetting as much as 22,000 nanoseconds fixed group delay with front-panel controls. Wavetek Model 2002B Sweep Generator and the Model 4602 Display Oscilloscope are recommended for use with the Model 4501; although it may also be used with the Model 1080 Sweeper and any suitable X-Y Display Oscilloscope.



MODELS 4501 & 4602 GROUP DELAY ANALYZER

MODEL 4501 GROUP DELAY ANALYZER

Frequency Range
5 to 1500 MHz.
RF Input Level
3 dBm ±3 dB.
Modulator Output Level
(With ±3 dBm input.)
5 to 100 MHz: −20 dBm ±3 dB.
100 to 1500 MHz: −17 dBm ±3 dB.
Demodulator Input Level
(35 dB dynamic range.)
−42 dBm to −7 dBm.
Insertion Loss
Range: 20 dB.
Flatness:
(Measured at maximum positive input slope.)
5 to 1500 MHz: ±3 dB.
Group Delay
Range: 30 dB (20 dB attenuation, 10 dB gain).
Frequency Response:
5 to 20 MHz: ±20 ns.
20 to 100 MHz: ±3 ns.
100 to 1000 MHz: ±3 ns.
1000 to 1500 MHz: ±3 ns.
Accuracy:
5 to 100 MHz: ±4.5% ±3 ns.
100 to 1500 MHz: ±2% ±5 ns.
Displayed Noise
Unfiltered: 2 ns rms.
Video Filtered: 1 ns rms.
Connectors
Type "N" standard; other types optional.
RF Terminal Impedance
50 or 75Ω (specify when ordering).
Output Dynamic Range
±2.5V.
Maximum Sweep Rate
10 Hz.
Maximum Delay Offset
22,000 ns.
Calibrator Range
10, 100, 1000 ns.
(No calibration routine if calibrated display is used.)
Output Drift
20 ns/hr after 1/2 hr warm-up. (This will not affect a relative tg measurement.)
Automatic Offset and Drift Cancellation
Samples trace at center of sweep, compares to reference, and gates offset control to keep trace on screen.
Output Impedance
1000Ω DC coupled.
Horizontal Input
0 to 10 V.

GENERAL

Temperature Operating Range
25° ± 5°C.
Dimensions
13.4 cm (5¼ in.) high; 20.9 cm (8¼ in.) wide; 48.3 cm (19 in.) deep.
Weight
7.2 kg (16 lb).
Power
115 or 230V ±10%; 50 to 400 Hz; approximately 50 watts.

MODEL 4602 DIGITAL DISPLAY

Display
CRT: 17.7 cm (7 in.) diagonal display.
Pixels: 460 vertical by 512 (each channel) horizontal.
Phosphor: P20.
Graticules: Electronically generated. When fixed graticule mode is selected: 15 vertical by 12 horizontal.
Vertical Channel
(Channel A and Channel B)
Input Voltage Range: (Four position selectable) 1.0 V/div; 0.1 V/div; 0.01 V/div; 0.001 V/div. Vernier control will have at least a 10:1 attenuation. Full clockwise (CAL position) will produce minimum attenuation.
Frequency Response:
Analog: DC to 10 kHz.
Digital: Depends on max sweep rate of sweep generator used. At a sweep rate of 10 Hz, max input frequency should be limited to <2.5 kHz.
Slew Rate: 10 V/ms min.
Input Impedance: 1 MΩ nominal shunted by 30 pF max.
Vertical Position: Adjustable by a rear-panel control.
Horizontal Channel
Sweep source is external to display coming from sweep generator being used.
Voltage Range: 0 to 10V.
Sweep Rate: 10 Hz max.
Marker Channel
This channel is compatible with marker signals from Model 2002B or Model 1080 sweepers.
Detection Process: Level detection of detected marker envelope.
Minimum level: 1.2 Vp-p.
Display Mode: Marker display is implemented using pin-ball markers representing position of marker within sweep. Selectable by front-panel switch.

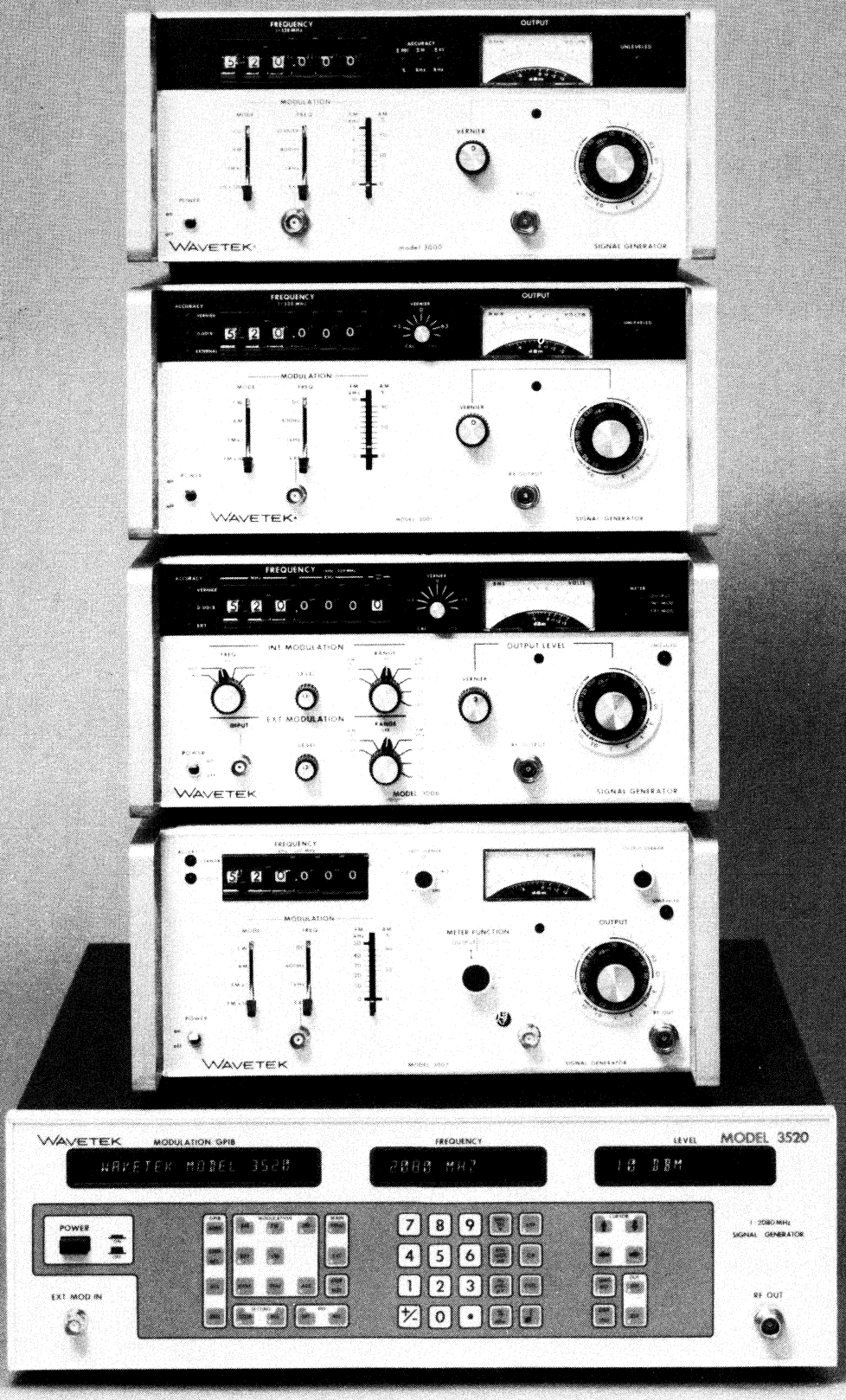
GENERAL

Dimensions
18.4 cm (7¼ in.) high; 20.9 cm (8¼ in.) wide; 48.3 cm (19 in.) deep.
Weight
9.5 kg (21 lb).
Power
115 or 230V ±10%; 50 to 400 Hz; approximately 85 watts.

FACTORY/FOB

Beech Grove, IN

Signal Generators



SIGNAL GENERATOR SELECTION GUIDE

		Dots (•) indicate values are as noted in left-hand column.						
MODELS		**3000**	**3000-200**	**3001**	**3006**	**3007**	**3510**	**3520**
Frequency Range								
Lower	**1 MHz**	•	•	•	1 kHz	•	•	•
Upper	**520 MHz**	•	•	•	•	•	1040 MHz	2080 MHz
Frequency Resolution	**1 kHz (6 digits)**	•	•	•	100 Hz (7 digits)	•	100 Hz (7 digits)	100 Hz (7 digits)
RF Output	**+13 to −137 dBm**	•	•	•	•	•	•	+10 to −137 dBm
Frequency Accuracy AM/CW	**±0.001% Typical: ±0.0002%**	•	•	•	•	•	•	•
FM	**±0.01% Typical: ±0.002%**	See page 188	•	•	•	•	•	•
Flatness	**+13 to −7 dBm: ±0.75 dB, Typical ±0.5 dB**	•	•	•	•	•	+13 to −6.9 dBm: ±1 dB	+10 to −6.9 dBm: ±1.5 dB
Modulation Modes (AM, FM)		•	•	•	Complex AM/FM	•	Complex AM/FM	
Modulation Frequencies (Both AM and FM)								
Internal	**Two: 400 Hz and 1 kHz**	•	•	•	Four*	•	Programmable 80 Hz to 10 kHz	
External	**AM: DC to 20 kHz**	•	•	•	•	•	30 kHz	30 kHz
	FM: DC to 25 kHz		•	•	•	•	60 kHz	60 kHz
Modulation Scales	**1 AM, 2 FM**	•	•	•	2 AM	•	—	—
Modulation Indicator	**Calibrated Slide**	•	•	•	Meter	•	Display	Display
Vernier Controls		Output level only	Frequency and output level				Cursor	Cursor
Programmability								
Frequency	**(BCD Standard)**	•	•	•	•	•	GPIB	GPIB
RF Level (BCD)	**0.1 dB Steps**	Requires Option 01C	—	Requires Option 01C	Requires Option 01C	—	GPIB	GPIB
Options (Not all options are available on all models. For model/option availability, see page 200.		RF Level Programming (01C); Reverse Power Protection (03); Auxiliary RF Output (04); External Reference (05); External Reference/High Stability (05A); High Stability Reference (06); Low Level Leakage (07); Low Frequency Extension to 1 kHz (08).						
Featured on Catalog Page		188	188	190	192	194	196	198

*Four: 400 Hz, 1000 Hz and two user selected frequencies in the range of 100 Hz to 10 kHz.

520 MHz Signal Generators

- **1 to 520 MHz Frequency Range With 1 kHz Resolution**
- **Phase-Lock Stability Over Entire Range**
- **Built-In Frequency Programmability**
- **Front Panel FM Deviation Meter (Model 3000-200)**
- **Internal and External AM/FM Capability**

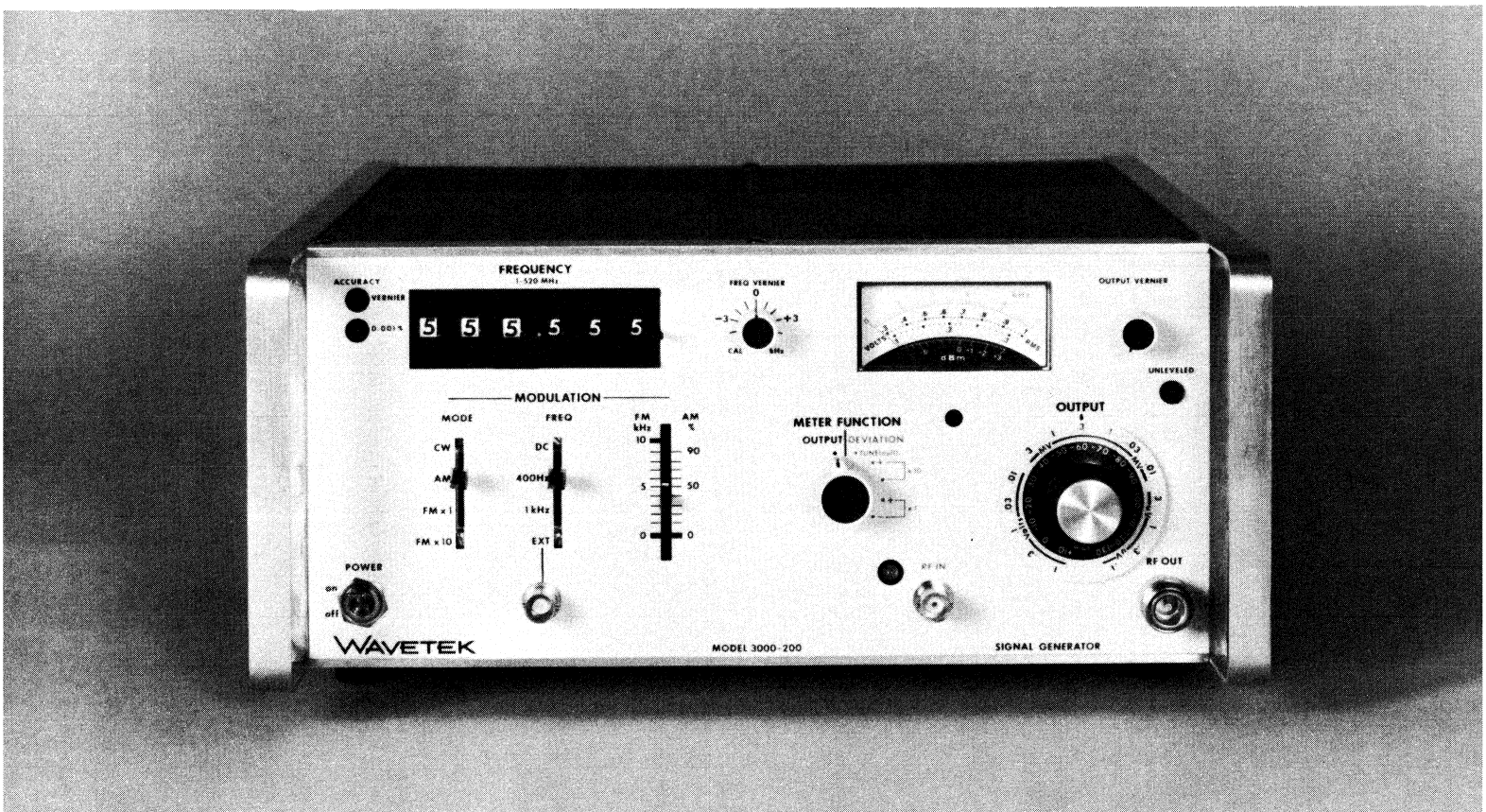
Model 3000
Model 3000 Signal Generator is a rugged, completely solid-state instrument covering the VHF frequency range of 1 to 520 MHz. Ease of operation and exceptional accuracy, stability, dynamic range and AM/FM capability are the key features of this high value unit.

Hgh stability signals are accurate to 0.001% in CW and AM modes. In FM mode, frequency is accurate to 0.001% ± 10 kHz up to 50 kHz peak deviation and 0.001% ± 45 kHz up to 500 kHz peak deviation. In AM mode, amplitude can be modulated to 90%.

Flexibility
Frequency is set via front panel lever/indicator switches to a resolution of 1 kHz. Remote frequency programmability is standard.

Output power is monitored on a front panel meter calibrated in both dBm and Vrms. A 15 position, 10 dB step attenuator used in conjunction with an 11 dB vernier control gives a range of +13 to −137 dBm. The calibrated output of Model 3000 is leveled to within ± 0.75 dB across its complete frequency range.

Model 3000-200
Model 3000-200 Signal Generator incorporates a complete 1 to 520 MHz FM, AM and CW signal generator and an FM deviation meter, in one compact, rugged instrument. The combination of two instruments in one is ideal for testing both transmitter and receiver sections of FM transceivers. The signal generator section is a synthesized signal source capable of being remotely programmed while the deviation meter section permits quick and accurate measurements of FM deviation. Two deviation ranges of 0 to 5 kHz and 0 to 50 kHz with + and − position are provided to check deviation symmetry.



FREQUENCY

Range
1 to 520 MHz selectable in 1 kHz steps.

Readout
6 digit lever/indicator switches.

Resolution
1 kHz.

Accuracy
±0.001% in CW and AM modes. (Typical: ±0.0002% after 2 hr.)
±(0.001% +10 kHz) in FM × 1 mode.
±(0.001% +45 kHz) in FM × 100 mode.

Stability
0.2 ppm/hr in CW and AM modes.
500 Hz/10 min in FM × 1 mode.

Programmability
Frequency programmable through rear-panel input connector using BCD-coded TTL voltages or BCD-coded contact closures. Option 01C permits RF level programming.

RF OUTPUT

Power Level Range
+13 to −137 dBm (1V to 0.03 μV rms).

Level Control
Continuously adjustable in 10 dB steps with an 11 dB vernier. Output level is indicated on a front panel meter calibrated in volts and dBm.

Total Level Accuracy
+13 to −7 dBm: ±1.25 dB. (Typical: ±0.75 dB.)
−7 to −77 dBm: ±1.95 dB. (Typical: ±1.25 dB.)
−77 to −137 dBm: ±2.75 dB. (Typical: ±1.5 dB.)

Accuracy Breakdown
Flatness (+13 to −7 dBm): ±0.75 dB (Typical: ±0.5 dB.)
Output Meter: 0.5 dB.
Step Attenuator:
±0.5 to 70 dB (±0.2 dB calibration error).
±1.0 to 130 dB (±0.5 dB calibration error).

Impedance
50Ω (SWR <1.2 at RF output levels below 0.1V).

Leakage
<1 μV into a 2 turn, 1 in. diameter loop held 1 in. from any surface.

Output Connector
Type N.

SPECTRAL PURITY

Harmonic Output
1 to 10 MHz: <−26 dBc.
10 to 520 MHz: <−30 dBc.

Subharmonics
Nondetectable.

Nonharmonics

Fundamental	Spurious Level
1 to 3 MHz	<−60 dBc in 1 to 3 MHz band
3 to 250 MHz	<−65 dBc in 3 to 250 MHz band
3 to 350 MHz	<−55 dBc in 3 to 350 MHz band
3 to 520 MHz	<−35 dBc in 3 to 1000 MHz band

Residual AM
50 Hz to 15 kHz post-detection bandwidth: <−65 dBc.

Residual FM
300 Hz to 3 kHz post-detection bandwidth: <100 Hz (Typical: <50 Hz).
50 Hz to 15 kHz post-detection bandwidth: <200 Hz (Typical: <100 Hz).

AMPLITUDE MODULATION

Frequency
Internal (±5%): 400 Hz and 1 kHz.
External: DC to 20 kHz (±3 dB bandwidth). A 10V p-p signal into 600Ω is required to provide calibrated % modulation control.

Range
0 to 90%.

Distortion
Measured at 1 kHz.
0 to 70% AM: <3%. (Typical, 0 to 30% AM: <1.5%.)
0 to 90% AM: <5%.

Modulation Control
Calibrated from 0 to 90%.

Accuracy
±(5% +5% of reading) at a frequency of 1 kHz.

FREQUENCY MODULATION

Frequency
Internal (±5%): 400 Hz and 1 kHz.
External: DC to 25 kHz (±1 dB bandwidth). A 10V p-p signal into 600Ω is required to provide calibrated deviation control.

Peak Deviation Standard Ranges
0 to 5 kHz and 0 to 500 kHz. Other frequency deviation ranges available on special order.

Deviation Control Calibrations
0 to 5 kHz, ×1 and ×100.

Accuracy
±250 Hz on ×1 range.
±35 kHz on ×100 range.

Distortion
Measured at 1 kHz.
10 kHz to max deviation: <2%.
3 kHz to 10 kHz deviation: <4%.

FM DEVIATION METER

(Model 3000-200 only.)

Frequency Range
30 to 500 MHz.

Input Level Range
10 mV to 5V rms.

Impedance
50Ω.

Deviation Range
0 to ±5 kHz.
0 to ±50 kHz.

Frequency Response
100 Hz to 8 kHz.

Deviation Accuracy
4% F.S. at 1 kHz.
6% F.S. from 100 Hz to 8 kHz.

GENERAL

Dimensions
30.3 cm (12 in.) wide; 13.4 cm (5¼ in.) high; 34.9 cm (13¾ in.) deep.

Weight
13 kg (28.6 lb) net; 13.6 kg (30 lb) shipping.

Power
115 or 230V ±10%; 50 to 400 Hz; approximately 40 watts.

OPTIONS

NOTE: Option combinations are restricted as shown on model/option availability chart (page 200). Options are also described on this page.

01C
RF Level Programming
0.1 dB steps (Model 3000 only).

03
Reverse Power Protection
(Standard for Model 3000-200.)

04
Auxiliary RF Output
(Model 3000 only.)

07
Low Level Leakage

ACCESSORIES

NOTE: See page 228 for rack mounting details.

K108
Rack Mount Adapter
(P/N 1019-00-0031)

FACTORY/FOB

Beech Grove, IN

520 MHz Signal Generator

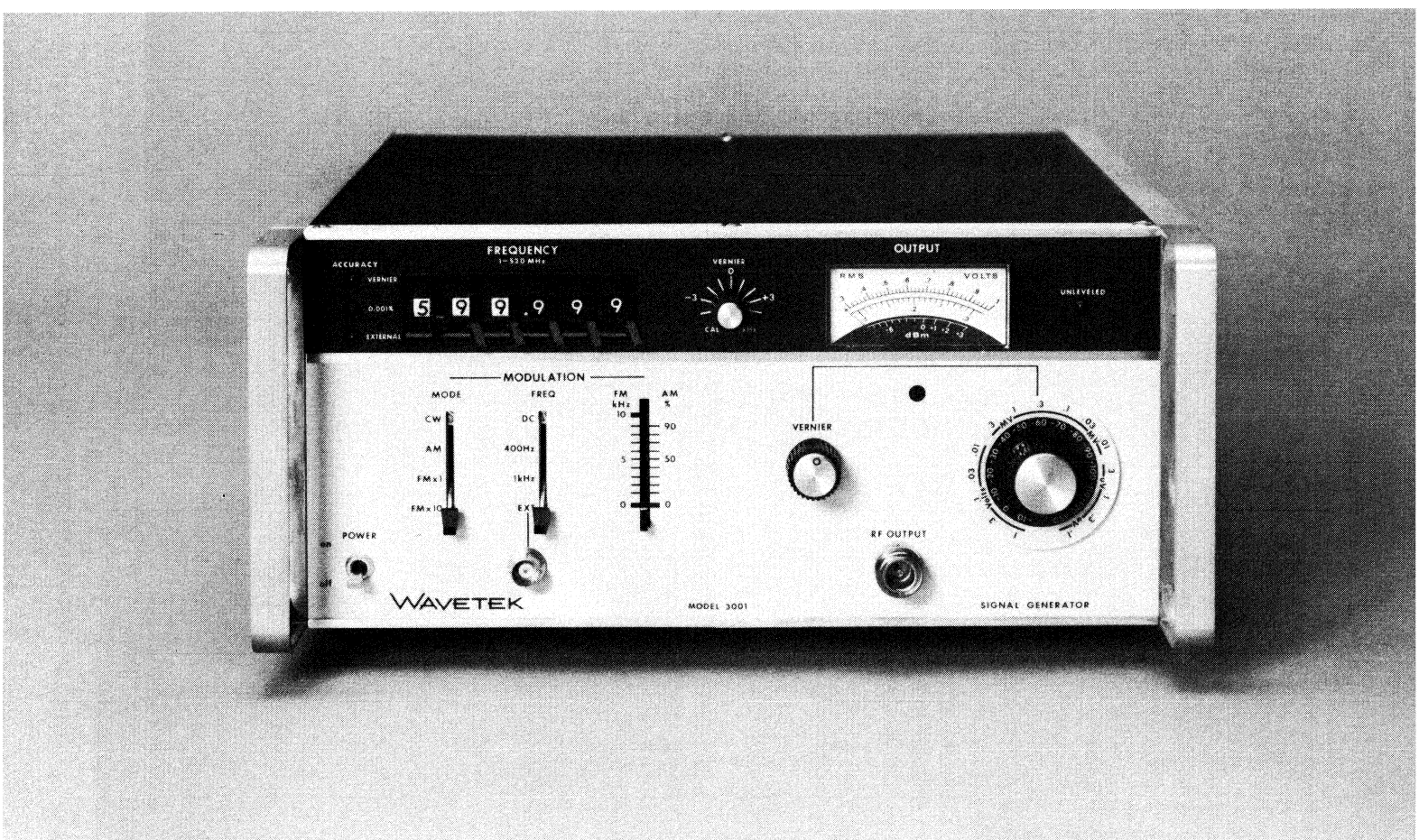
- **Broad Frequency Range**
- **Phase Locked Over Entire Range**
- **Programmable Frequency and RF Level**
- **GPIB Compatible**
- **Simplified Operation**

Versatility
Model 3001, with a frequency range of 1 to 520 MHz, is a rugged, solid state instrument, offering the utmost in measurement convenience when testing receiver sensitivity, antenna gain, channel selectivity, signal-to-noise ratio, gain bandwidth, and transmission line characteristics of various passive and active components.

High Accuracy and Stability
Model 3001 signal accuracy is 0.001% (typically 0.0002%) over the entire frequency range. Standard stability is 0.2 ppm/hour. Option 05, External Reference, allows accuracy over the entire frequency range to equal the accuracy of an external standard. Option 06, High Stability Reference, used in conjunction with Option 05 provides typical overall accuracy of 0.2 ppm (0.00002%) and aging of 0.005 ppm/day.

Human Engineering
Frequency is set via six front panel level/indicator switches to a resolution of 1 kHz. This method of selecting frequency is faster than other methods (range switches, tuning controls, frequency counters, etc.) and is practically error-free. As a further user convenience, one control sets the modulation and provides a readout for percent AM or FM deviation.

Programmability
Frequency is programmable through a rear panel input connector using BCD-coded TTL voltages or BCD-coded contact closures. Option 01C permits RF level programming, making Model 3001 an ideal instrument for automatic and semiautomatic test applications.



MODEL 3001 SIGNAL GENERATORS

FREQUENCY

Range
Model 3001: 1 to 520 MHz selectable in 1 kHz steps.

Readout
6 digit lever/indicator switches.

Resolution
1 kHz.

Accuracy
±0.001% in all modes. (Typical: ±0.0002% after 2 hours.)
±0.001% ±10 kHz when frequency vernier is not in CAL position.

Stability
0.2 ppm/hr.
500 Hz/10 min when frequency vernier is not in CAL position.

Programmability
Frequency programmable through rear-panel input connector using BCD-coded TTL voltages or BCD-coded contact closures.

RF OUTPUT

Power Level Range
+13 to −137 dBm (1V to 0.03 μV rms).

Level Control
Continuously adjustable in 10 dB steps with an 11 dB vernier. Output level is indicated on a front panel meter calibrated in volts and dBm.

Total Level Accuracy
+13 to −7 dBm: ±1.25 dB. (Typical: ±0.75 dB.)
−7 to −77 dBm: ±1.95 dB. (Typical: ±1.25 dB.)
−77 to −137 dBm: ±2.75 dB. (Typical: ±1.5 dB.)

Accuracy Breakdown
Flatness (+13 to −7 dBm): ±0.75 dB (Typical: ±0.5 dB.)
Output Meter: ±0.5 dB.
Step Attenuator:
±0.5 to 70 dB (±0.2 dB calibration error).
±1.0 to 130 dB (±0.5 dB calibration error).

Impedance
50Ω (SWR <1.2 at RF output levels below 0.1V).

Leakage
<1 μV into a 2 turn, 1 in. diameter loop held 1 in. from any surface.

Output Connector
Type N.

SPECTRAL PURITY

Harmonic Output
1 to 10 MHz: <−26 dBc.
10 to 520 MHz: <−30 dBc.

Subharmonics
Nondetectable.

Nonharmonics

Fundamental	Spurious Level
1 to 3 MHz	<−60 dBc in 1 to 3 MHz band
3 to 250 MHz	<−65 dBc in 3 to 250 MHz band
3 to 350 MHz	<−55 dBc in 3 to 350 MHz band
3 to 520 MHz	<−35 dBc in 3 to 1000 MHz band

Residual AM
50 Hz to 15 kHz post-detection bandwidth: <−65 dBc.

Residual FM
300 Hz to 3 kHz post-detection bandwidth: <100 Hz (Typical: <50 Hz).
50 Hz to 15 kHz post-detection bandwidth: <200 Hz (Typical: <100 Hz).

AMPLITUDE MODULATION

Frequency
Internal: 400 Hz and 1 kHz ±5%.
External: DC to 20 kHz (±3 dB bandwidth). A 10V p-p signal into 600Ω is required to provide calibrated % modulation control.

Range
0 to 90%.

Distortion
Measured at 1 kHz.
0 to 70% AM: <3%. (Typical, 0 to 30% AM: <1.5%.)
0 to 90% AM: <5%.

Modulation Control
Calibrated from 0 to 90%.

Accuracy
±(5% +5% of reading) at a frequency of 1 kHz.

FREQUENCY MODULATION

Frequency
Internal (±5%): 400 Hz and 1 kHz.
External: DC to 25 kHz when frequency vernier is not in CAL position. A 10V p-p signal into 600Ω is required to provide calibrated deviation control.

Peak Deviation Standard Ranges
0 to 10 kHz and 0 to 100 kHz. Other frequency deviation ranges available on special order.

Deviation Control Calibrations
0 to 10 kHz, ×1 and ×10.

Accuracy
±500 Hz on ×1 range.
±5 kHz on ×10 range.

Distortion
Measured at 1 kHz.
10 kHz to max deviation: <2%.
3 to 10 kHz deviation: <4%.

GENERAL

Dimensions
30.3 cm (12 in.) wide; 13.4 cm (5¼ in.) high; 34.9 cm (13¾ in.) deep.

Weight
13 kg (28.6 lb) net; 13.6 kg (30 lb) shipping.

Power
115 or 230V ±10%; 50 to 400 Hz; approximately 40 watts.

OPTIONS

NOTE: Option combinations are restricted as shown on model/option availability chart (page 200). Options are described on this page also.

01C
RF Level Programming (0.1 dB steps)

03
Reverse Power Protection

04
Auxiliary RF Output

05
External Reference (Required with Option 06)

05A
External Reference/High Stability Reference (1 ppm accuracy)

06
High Stability Reference (Requires Option 05)

07
Low Level Leakage

ACCESSORIES

NOTE: See page 228 for rack mounting details.

K108
Rack Mount Adapter (P/N 1019-00-0031)

2102
Precision Frequency Standard

FACTORY/FOB

Beech Grove, IN

520 MHz Signal Generator

- **100 Hz Resolution**
- **Phase Locked Over Entire Range**
- **Complex Modulation: AM/FM, FM/FM, AM/AM**
- **Four Internal Modulation Frequencies**
- **BCD Programmable**

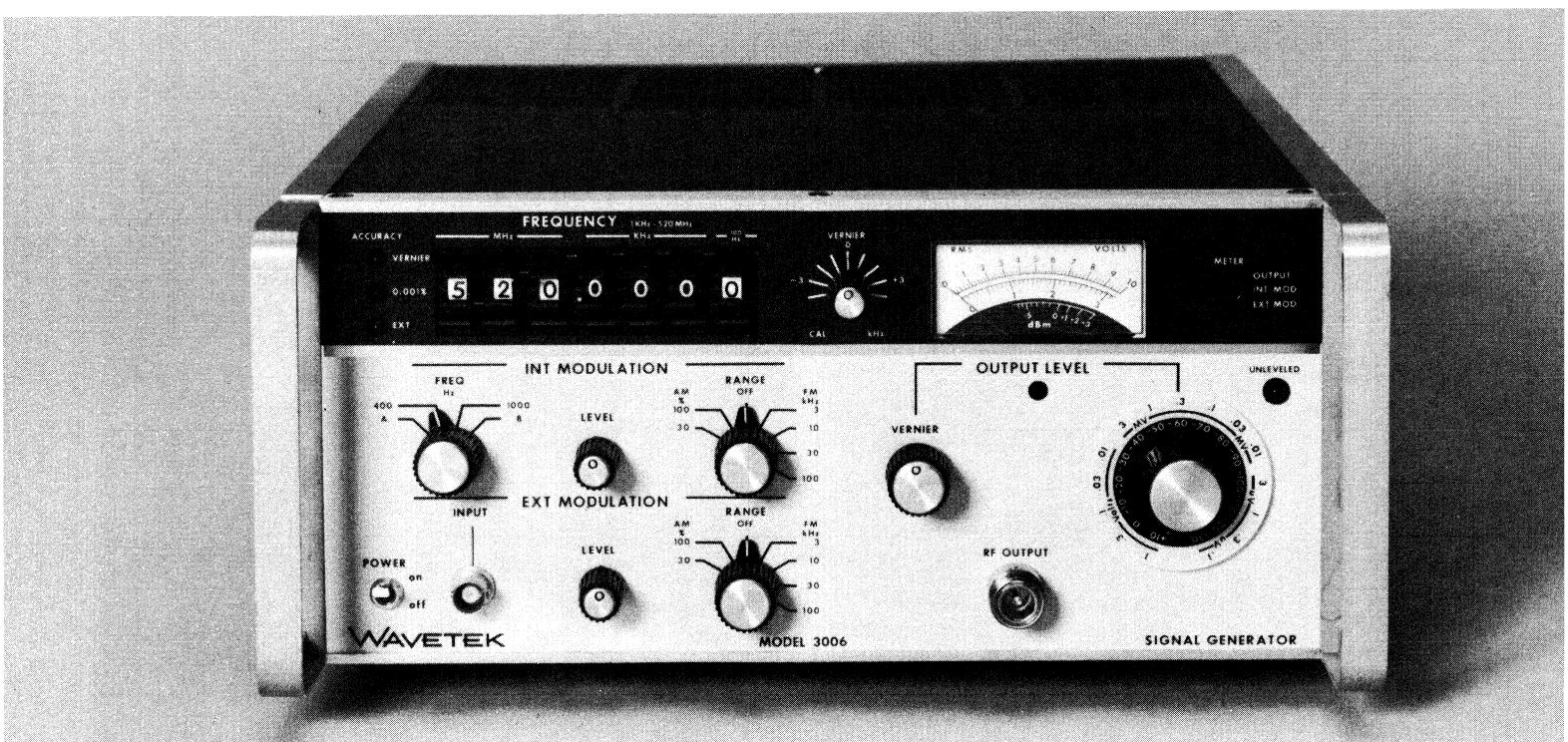
Versatility
Model 3006 is a rugged, solid state, synthesized signal generator which incorporates unique modulation capabilities, excellent accuracy and stability, and many standard and optional features. The frequency range is 1 kHz to 520 MHz, with 100 Hz resolution.

Modulation Flexibility
Internal and external modulation capabilities provide unique complex, or simultaneous, modulation: FM on FM, AM on AM or AM on FM. This feature makes these Wavetek models ideal in tests of two-way radios, mobile telephones, paging receivers, and other systems that utilize techniques which superimpose subaudible tones or tone coded signals on voice (or other) channels.

Easily operated front panel controls allow the selection of not just two modulation frequencies (as in most generators), but four: the two standard frequencies of 400 Hz and 1 kHz, plus any other two, user-preset frequencies between 100 Hz and 10 kHz. Internal or external FM deviation (0 to 100 kHz) and percent AM modulation (0 to 90%) are easily set and read on the large, front panel meter. For increased readability and accuracy, two AM scales (30 or 100% full scale) and four FM scales (3, 10, 30, or 100 kHz full scale) are provided.

High Accuracy and Stability
Frequency of Model 3006 is set via seven level/indicator switches with 100 Hz resolution. Signal accuracy is 0.001% (typically 0.0002%) over their entire frequency range. Standard stability is 0.2 ppm/hour. Option 05, External Reference, allows accuracy over the entire frequency range to equal the accuracy of an external standard. Option 06, High Stability Reference, used in conjunction with Option 05 provides typical overall accuracy of 0.2 ppm (0.00002%) and aging of 0.005 ppm/day.

Programmability
Frequency programmability through rear panel input connector using BCD coded TTL voltages or BCD coded contact closures is standard. Option 01C permits RF level programming. The programmability of Model 3006 makes it ideal for automatic and semi-automatic test applications.



FREQUENCY

Range
1 kHz to 520 MHz.
Readout
Leveler/Indicator Switches: 7 digits.
Resolution
100 Hz.
Accuracy
±0.001% in all modes.
(Typical: ±0.0002% after 2 hours.)
Stability
0.2 ppm/hr. 500 Hz/10 min when frequency vernier is not in CAL position.
Programmability
Frequency programmability through rear-panel input connector using BCD-coded TTL voltages or BCD-coded contact closures is standard. Option 01C permits RF level programming.

RF OUTPUT

Power Level Range
+13 to −137 dBm (1V to 0.03 μV rms).
Level Control
Continuously adjustable in 10 dB steps with an 11 dB vernier. Output level is indicated on a front panel meter calibrated in volts and dBm.
Total Level Accuracy
+13 to −7 dBm: ±1.25 dB.
(Typical: ±0.75 dB.)
−7 to −77 dBm: ±1.95 dB.
(Typical: ±1.25 dB.)
−77 to −137 dBm: ±2.75 dB.
(Typical: ±1.5 dB.)
Accuracy Breakdown
Flatness (+13 to −7 dBm):
±0.75 dB (Typical: ±0.5 dB.)
Output Meter: ±0.5 dB.
Step Attenuator:
±0.5 to 70 dB (±0.2 dB cal. error);
±1.0 to 130 dB (±0.5 dB cal. error).
Impedance
50Ω (SWR <1.2 at RF output levels below 0.1V).
Leakage
<1 μV into a 2 turn, 1 in. dia. loop held 1 in. from any surface.

SPECTRAL PURITY

Harmonic Output
1 to 10 MHz: >26 dBc.
10 to 520 MHz: >30 dBc.
1 kHz to 1 MHz: >30 dBc.
Subharmonics
None detectable.
Nonharmonics

Fundamental	Spurious Level
1 kHz to 3 MHz	>60 dBc in 1 to 3 MHz band
3 to 250 MHz	>65 dBc in 3 to 250 MHz band
3 to 350 MHz	>55 dBc in 3 to 350 MHz band
3 to 520 MHz	>35 dBc in 3 to 1000 MHz band

Residual AM
>65 dB below carrier in a 50 Hz to 15 kHz post-detection bandwidth.
Residual FM
<100 Hz in 300 Hz to 3 kHz post-detection bandwidth. (Typical: <50 Hz.)
<200 Hz in a 50 Hz to 15 kHz post-detection bandwidth. (Typical: <100 Hz.)

AMPLITUDE MODULATION

Internal Frequency
400 Hz, 1000 Hz and two preset frequencies between 100 Hz and 10 kHz (accuracy: ±2%).
External Frequency
DC to 20 kHz (3 dB bandwidth). Input level required: 1V rms into 600Ω to provide full-scale adjustment with EXT MOD LEVEL control.
Range
0 to 90%.
Distortion
(Measured at 1 kHz.)
0 to 70% AM: <3%. (Typical, 0 to 30% AM: <1.5%.)
0 to 90% AM: <5%.
Meter
Scales of 30% AM and 100% AM.
Accuracy: ±(2% of full-scale reading +5% of meter reading) at 1 kHz modulation frequency.

FREQUENCY MODULATION

Internal Frequency
400 Hz, 1000 Hz and two preset frequencies between 100 Hz and 10 kHz (accuracy: ±2%).
External Frequency
50 Hz to 20 kHz (1 dB bandwidth) with frequency vernier in CAL. DC to 25 kHz (1 dB bandwidth) with frequency vernier not in CAL. Input level required: 1 Vrms into 600Ω to provide full-scale adjustment with EXT MOD LEVEL control.
Range
0 to 100 kHz deviation.
Distortion
(Measured at 1 kHz.)
10 kHz to Max Deviation: <2%.
3 kHz to 10 kHz Deviation: <4%.
Meter
Scales of 3, 10, 30 and 100 kHz deviation.
Accuracy: ±3% of full scale reading. (Measured with 1 kHz modulation.)

GENERAL

Output Connector
Type N.
Dimensions
30.3 cm (12 in.) wide; 13.4 cm (5¼ in.) high; 34.9 cm (13¾ in.) deep.
Weight
13 kg (28.6 lb) net; 13.6 kg (30 lb) shipping.
Power
115 or 230V ±10%; 50 to 400 Hz; approximately 40 watts.

OPTIONS

NOTE: Option combinations are restricted as shown on model/option availability chart (page 200). Options are described on this page also.

01C
RF Level Programming (0.1 dB steps)
03
Reverse Power Protection
04
Auxiliary RF Output
05
External Reference (Required with Option 06)
05A
External Reference/High Stability Reference (1 ppm accuracy)
06
High Stability Reference (Requires Option 05)
07
Low Level Leakage

ACCESSORIES

NOTE: See page 228 for rack mounting details.

K108
Rack Mount Adapter
(P/N 1019-00-0031)
2102
Precision Frequency Standard

FACTORY/FOB

Beech Grove, IN

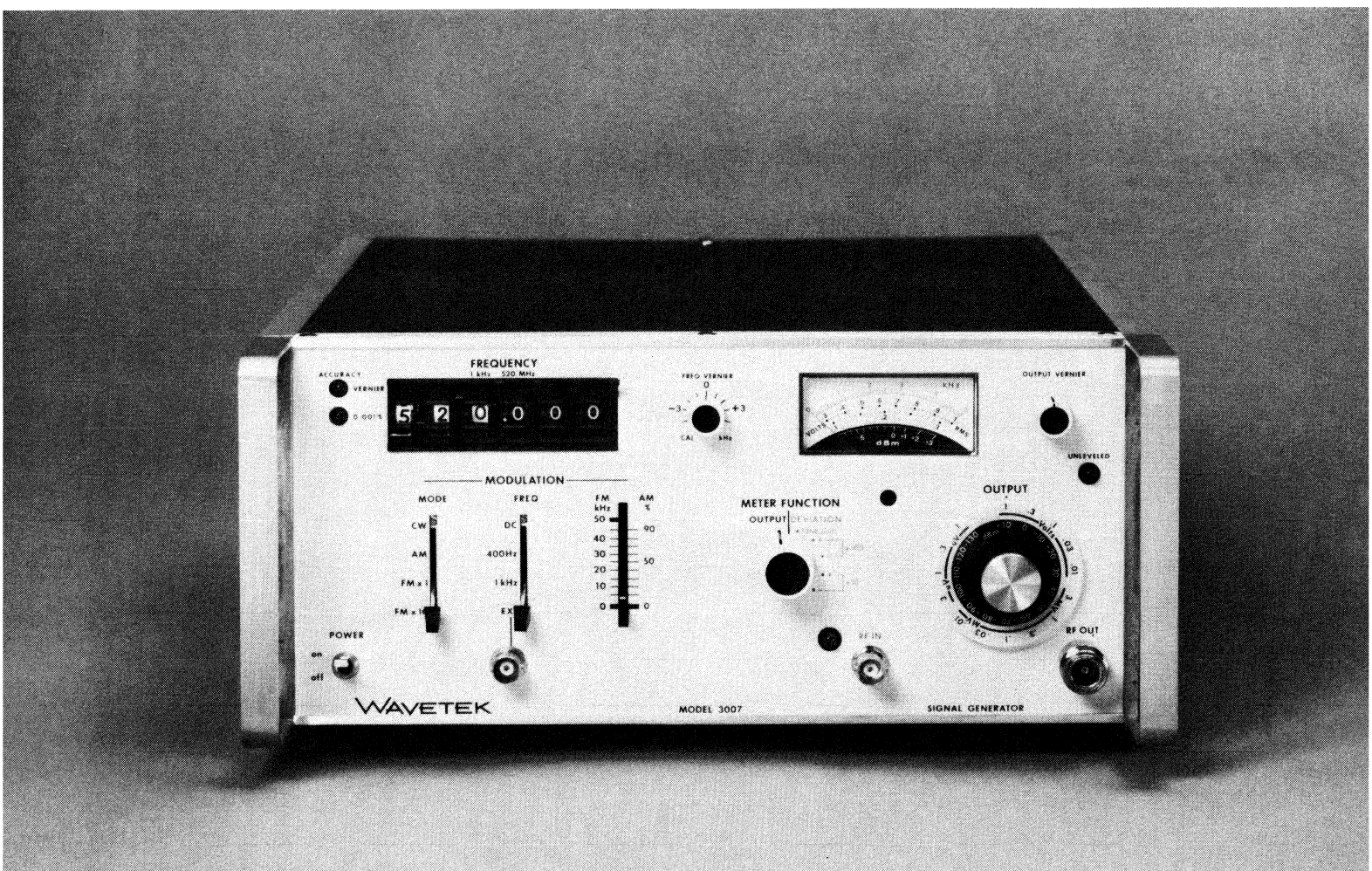
Signal Generator/Deviation Meter

- **1 to 520 MHz with 1 kHz Resolution**
- **Front Panel FM Deviation Meter**
- **Modular Construction**
- **Reverse Power Protection**
- **Synthesized Signal Accuracy**

Capability
Model 3007 Signal Generator incorporates a complete 1 kHz to 520 MHz FM, AM and CW signal generator, and an FM deviation meter in one compact, ruggedized instrument. The combination of two instruments in one is ideal for testing both transmitters and receiver sections of the FM transceivers.

Signal Generation
The signal generator portion of Model 3007 is a synthesized signal source capable of being remotely programmed. The leveled RF output can be accurately controlled from + 13 to − 137 dBm through the use of a 10 dB per step attenuator with an 11 dB overlapping vernier. External and internal modulation capability allows for FM and AM operation.

Deviation Measurement
The deviation meter section of Model 3007 permits quick and accurate measurements of FM deviation. A green lamp lights in the presence of an RF signal at any level within the range of 10 mV to 5V rms to indicate a "go" condition for FM deviation measurement. Meter nulling is not critical. Any null less than "1" on the scale is sufficient. Two deviation ranges of 0 to 50 kHz and 0 to 500 kHz with + and − positions are provided to check deviation symmetry.



MODEL 3007 SIGNAL GENERATORS

FREQUENCY

Range
1 to 520 MHz selectable in 1 kHz steps.
Readout
6 digit leveler/indicator switches.
Resolution
1 kHz.
Accuracy
±0.001% in all modes.
(Typical: ±0.0002% after 1 hour.)
±0.001% ±10 kHz when frequency vernier is not in CAL position.
Stability
0.2 ppm/hr.
500 Hz/10 min when frequency vernier is not in CAL position.
Programmability
Frequency programmability through rear-panel input connector using BCD-coded TTL voltages or BCD-coded contact closures is standard.

RF OUTPUT

Power Level Range
+13 to −137 dBm (1V to 0.03 μV rms).
Level Control
Continuously adjustable in 10 dB steps with an 11 dB vernier. Output level is indicated on a front panel meter calibrated in volts and dBm.
Total Level Accuracy
+13 to −7 dBm: ±1.25 dB.
(Typical: ±0.75 dB.)
−7 to −77 dBm: ±1.95 dB.
(Typical: ±1.25 dB.)
−77 to −137 dBm: ±2.75 dB.
(Typical: ±1.5 dB.)
Accuracy Breakdown
Flatness (+13 to −7 dBm): ±0.75 dB.
Output Meter: ±0.5 dB.
Step Attenuator:
±0.5 to 70 dB (±0.2 dB calibration error).
±1.0 to 130 dB (±0.5 dB calibration error).
Impedance
50Ω (SWR <1.2 at RF output levels below 0.1V).
Leakage
<1 μV into a 2 turn, 1 in. diameter loop held 1 in. from any surface.

RF OUTPUT PROTECTION

Type
Resettable RF circuit breaker.
Frequency Range
1 kHz to 520 MHz.
RF Trip Voltage
5V rms nominal.
Maximum Reverse Power
50W (50V rms).
Trip Time
<2 ms.
Insertion Loss
<0.2 dB.

SPECTRAL PURITY

Harmonic Output
1 kHz to 10 MHz: >30 dBc.
1 to 10 MHz: >26 dBc.
10 to 520 MHz: >30 dBc.
Subharmonics
None detectable.
Nonharmonics

Fundamental	Spurious Level
1 kHz to 3 MHz	>60 dBc in 1 to 3 MHz band
3 to 250 MHz	>65 dBc in 3 to 250 MHz band
3 to 350 MHz	>55 dBc in 3 to 350 MHz band
3 to 520 MHz	>35 dBc in 3 to 1000 MHz band

Residual AM
>65 dB below carrier in a 50 Hz to 15 kHz post-detection bandwidth.
Residual FM
<100 Hz in 300 Hz to 3 kHz post-detection bandwidth. (Typical: <50 Hz.)
<200 Hz in a 50 Hz to 15 kHz post-detection bandwidth. (Typical: <100 Hz.)

AMPLITUDE MODULATION

Frequency
Internal (±5%): 400 Hz and 1 kHz.
External: DC to 20 kHz (±3 dB bandwidth). A 10 Vp-p signal into 600Ω is required to provide calibrated % modulation control.
Range
0 to 90%.
Distortion
(Measured at 1 kHz.)
0 to 70% AM: <3%. (Typical, 0 to 30% AM: <1.5%.)
0 to 90% AM: <5%.
Modulation Control
Calibrated from 0 to 90%.
Accuracy
8% maximum at a frequency of 1 kHz.

FREQUENCY MODULATION

Frequency
Internal (±5%): 400 Hz and 1 kHz.
External: 50 Hz to 100 kHz when frequency vernier in CAL position. DC to 100 kHz when frequency vernier is not in CAL position. A 10 Vp-p signal into 600Ω to provide calibrated deviation control.
Peak Deviation Standard Ranges
0 to 50 kHz and 0 to 500 kHz. Other frequency deviation ranges available on special order.
Deviation Control Calibrations
0 to 50 kHz, ×1 and ×10.
Accuracy
±2.5 kHz on ×1 range.
±25 kHz on ×10 range.
Distortion
(Measured at 1 kHz.)
3 to 100 kHz Deviation: <4%.

FM DEVIATION METER

Frequency Range
30 to 500 MHz.
Input Level Range
10 mV to 5V rms.
Impedance
50Ω.
Deviation Range
0 to ±50 kHz.
0 to 500 kHz.
Frequency Response
100 Hz to 8 kHz.
Deviation Accuracy
4% F.S. at 1 kHz.
6% F.S. from 100 Hz to 8 kHz.

GENERAL

Output Connector
Type N.
Environment
Meets the requirements of MIL-T-28800 for Type III, Class 5, Style E Equipment.
Dimensions
30.3 cm (12 in.) wide; 13.4 cm (5¼ in.) high; 34.9 cm (13¾ in.) deep.
Weight
13 kg (28.6 lb) net; 13.6 kg (30 lb) shipping.
Power
115 or 230V ±10%; 50 to 400 Hz; approximately 40 watts.

OPTION

07
Low Level Leakage

ACCESSORIES

K108
Rack Mount Adapter
(P/N 1019-00-0031)
2102
Precision Frequency Standard

FACTORY/FOB

Beech Grove, IN

1 to 1040 MHz Signal Generator

- **1 MHz to 1040 MHz Frequency Range**
- **GPIB Programmability**
- **32 Complete Front-Panel Stored Settings**
- **Nonvolatile Memory**
- **Programmable Internal Modulation Source**
- **50 Watt Reverse Power Protection**

Model 3510, a microprocessor-controlled Signal Generator, covers the frequency spectrum of 1 to 1040 MHz. Standard features include a programmable internal audio source for AM and FM modulation, a nonvolatile memory and full GPIB programmability.

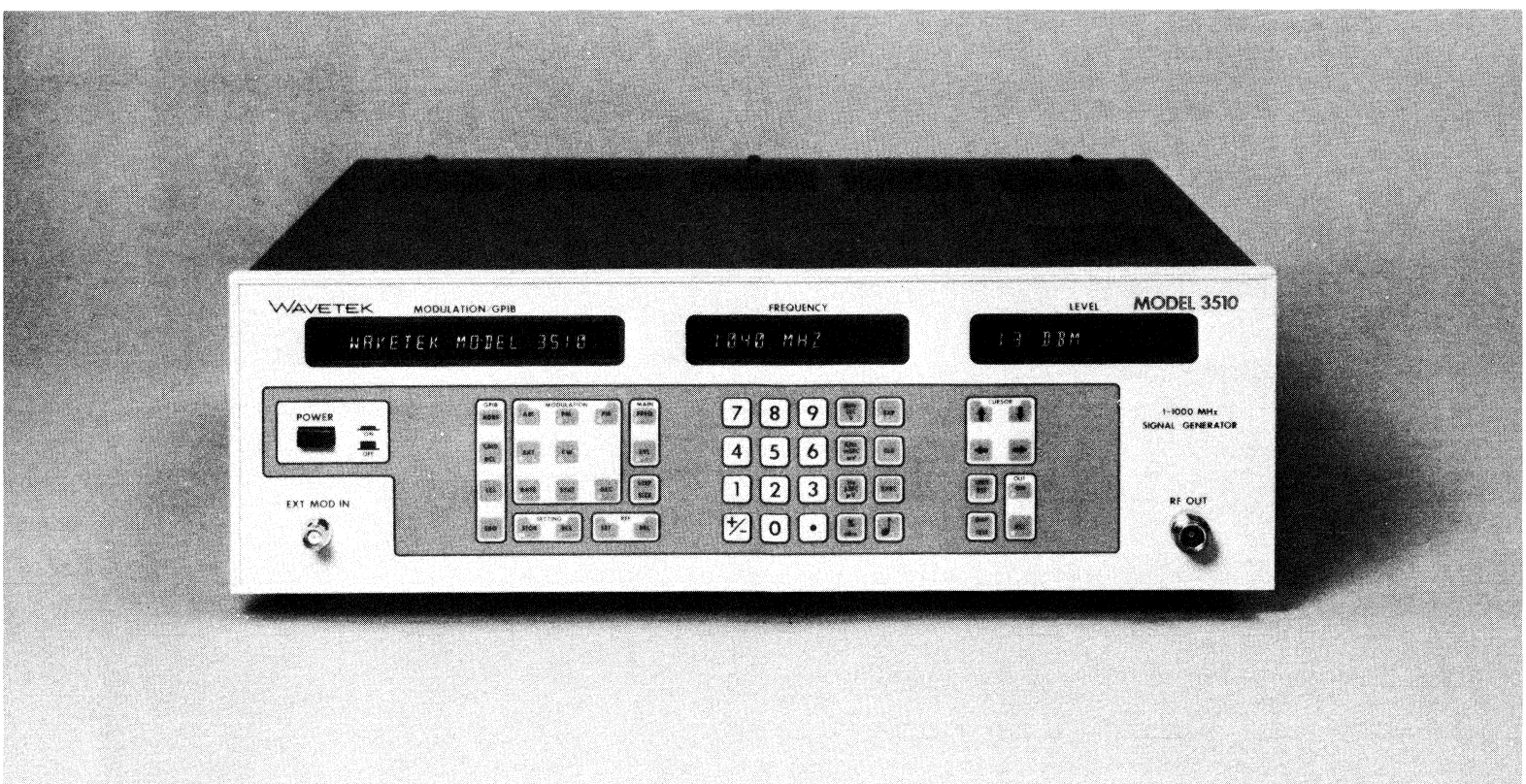
+13 dBm Output;
0.001% Frequency Accuracy
RF output power range is +13 dBm to −137 dBm with flatness to ±1 dB (+13 to −6.9 dBm). Frequency resolution is 100 Hz and accuracy is 0.001% (typically 0.0002%). The standard stability of 0.2 ppm/hr may be improved by using the optional External Reference input, the optional Internal/External Reference and/or the optional High Stability Internal Reference.

Modulation Flexibility
The internal modulation signal can be at any 10 Hz increment between 80 Hz and 10 kHz. This internal source may be combined with an external source to create complex or simultaneous modulation such as AM on FM, FM on FM or AM on AM.

Simple Operation
Manual control is via a 48-key touch pad front panel. A "beeper" indicates a button has been pressed. All settings are displayed. Output levels are conveniently read out in dBm or volts. Up to 32 complete front-panel settings may be stored in a nonvolatile memory and recalled to the front panel on command.

A unique cursor system has selectable increment sizes. A reference mode allows frequency or level references to be set; subsequent display values are relative to the reference value.

All functions are GPIB programmable except power on/off. Programming is "free format," and multiple function changes can be executed simultaneously. Frequency switching and settling time over the bus is typically 75 ms.



MODEL 3510 SIGNAL GENERATORS

FREQUENCY

Range
1 to 1040 MHz.

Resolution
100 Hz.

Accuracy
±0.001% in all modes with ALC on; ±(0.001% +10 kHz) in all modes with ALC off.

Stability
(After 2 hr warmup)
1 to 520.9999 MHz: 0.2 ppm/hr with ALC on, 500 Hz/10 min with ALC off.
521 to 1000 MHz: 0.4 ppm/hr with ALC on, 1 kHz/10 min with ALC off.

Switching Speed
Typically <200 ms.
(<40 ms for steps >1 MHz).

RF OUTPUT

Impedance
50Ω (SWR less than 1.3 at RF levels less than 0.1 Vrms).

Output Connector
Type N.

Power Level Range
1 to 1000 MHz: +13 to −137 dBm (1 volt to 0.0316 μVrms).

RF Level Control
Adjustable in 0.1 dB steps in dBm mode. Three significant digits in voltage mode.

Total Level Accuracy (1 to 1000 MHz)
+13 to −36.9 dBm: ±1.3 dB below
−36.9 dBm: ±(1.3 dB + .1 dB/10 dB decrease).

Accuracy Traits (1 to 1000 MHz)
Flatness (+13 to −6.9 dBm): ±1 dB.
Step Attenuator: ±0.3 dB or 1% of attenuation, whichever is greater.

Leakage
<1 μV into a two-turn, 1 inch diameter loop held 1 inch from any surface.

SPECTRAL PURITY

Harmonic Output
1 MHz to 10 MHz: <−26 dBc;
10 MHz to 1 GHz: <−30 dBc.

Sub-Harmonics
1 to 520.9999 MHz: none detectable;
521 to 1000 MHz: <−30 dBc.

Non-Harmonics

Fundamental	Spurious Level
1 to 3 MHz	<−60 dBc in 1 to 3 MHz band
3.0001 to 250 MHz	<−65 dBc in 3 to 250 MHz band
3.0001 to 350 MHz	<−55 dBc in 3 to 350 MHz band
3.0001 to 1000 MHz	<−35 dBc in 3 to 1000 MHz band
3.0001 to 1000 MHz	<−30 dBc in 3 to 2000 MHz band

Phase Noise
1 to 520.9999 MHz: <−93 dBc typical (offset 20 kHz from carrier with 1 Hz bandwidth);
1 to 520.9999 MHz: <−120 dBc typical (offset 500 kHz from carrier with 1 Hz bandwidth);
521 to 1000 MHz: <−87 dBc typical (offset 20 kHz from carrier with 1 Hz bandwidth);
521 to 1000 MHz: <−114 dBc typical (offset 500 kHz from carrier with 1 Hz bandwidth);

Residual AM
<−65 dBc in a 50 Hz to 15 kHz post-detection bandwidth.

Residual FM
In 50 Hz to 15 kHz Post-Detection Bandwidth:
1 to 520.9999 MHz: <200 Hz (typically <100 Hz).
521 to 1000 MHz: <400 Hz (typically <200 Hz).

MODULATION

Internal Frequency Source
Internal modulation source settable in 10 Hz increments between 80 Hz and 10 kHz (accuracy ±5% of reading).

External Frequency Source
AM: DC to 30 kHz (3 dB bandwidth) with ALC off; 100 Hz to 30 kHz with ALC on.
FM: DC to 60 kHz (1 dB bandwidth) with ALC off; 100 Hz to 60 kHz with ALC on.
Input Level Required to Provide Calibrated Display:
ALC On: 0.1V to 1 Vp-p into 600Ω;
ALC Off: 10 Vp-p into 600Ω.

Modulation Depth Resolution
0.1%.

Modulation Depth Indicator Accuracy
0 to 90%: ±6% of reading.

Modulation Range
0 to 100%.

Modulation Distortion
(Measured at 1 kHz.)
0 to 30% AM: <1.5%.
30 to 70% AM: <3%.
70 to 90% AM: <5%.

Deviation Resolution
100 Hz for deviations <10 kHz.
1 kHz for deviations ≥10 kHz.

Deviation Indicator Accuracy
±5% of reading.

Deviation Range
0 to 100 kHz deviation.

Distortion
(Measured at 1 kHz.)
10 to 100 kHz deviation: <2%.
3 to 10 kHz deviation: <4%.

GPIB REMOTE PROGRAMMING

Conforms to IEEE-488 standards. Controls all functions except power On/Off.

Function
Listens and talks, gives error status and instrument status. Implements: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E2.

GENERAL

Readout
Alpha-numeric vacuum-fluorescent display.

Front Panel Control
Soft touch membrane switches.

Reverse Power Protection
Trip Time: <2ms.
RF Trip Level: Approx 0.7W.
RF: 50W.
DC Blocking Voltage: 50V.

Environment
Specifications Apply: 25° ± 5°C.
Slight Degradation of Specifications: 25° ± 15°C.

Dimensions
43.2 cm (17 in.) wide × 14.6 cm (5¾ in.) high × 40.6 cm (16 in.) deep.

Weight
14.5 kg (32 lb).

Power
90 to 110, 110 to 130, 180 to 220, or 220 to 240 VAC; 50 to 400 Hz; approximately 75 watts.

OPTIONS

05
External Reference. Required with Option 06.

05A
External Reference/High Stability Reference.

06
High Stability Reference.

08
Low Frequency Extension (1 kHz to 1040 MHz).

ACCESSORIES

K0234
Rack Mount Kit (P/N1019-00-0234)

FACTORY/FOB

Beech Grove, IN

1 to 2080 MHz Signal Generator

- **1 MHz to 2080 MHz Frequency Range**
- **GPIB Programmability**
- **32 Complete Front-Panel Stored Settings**
- **Non-volatile Memory**
- **Programmable Internal Modulation Source**
- **50 Watt Reverse Power Protection**

Model 3520, a microprocessor-controlled Signal Generator, covers the frequency spectrum of 1 to 2080 MHz. Standard features include a programmable internal audio source for AM and FM modulation, a non-volatile memory and full GPIB programmability.

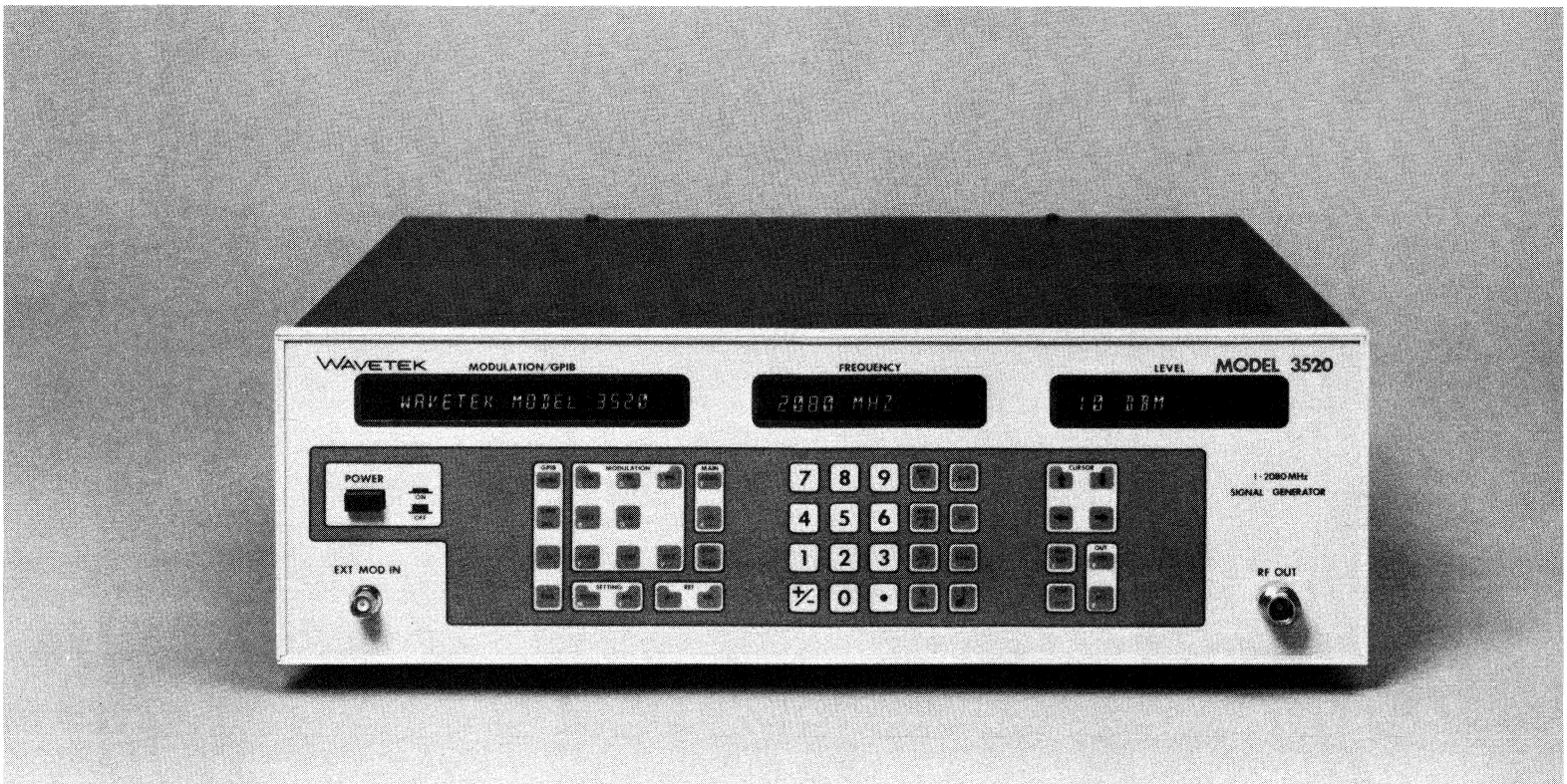
+10 dBm Output with 0.001% Frequency Accuracy
RF output power range is +10 dBm to −137 dBm with flatness to ±1 dB (+10 to −6.9 dBm). Frequency resolution is 100 Hz to 1040 MHz and 200 Hz to 2080 MHz. Accuracy is 0.001% (typically 0.0002%). The standard stability of 0.2 ppm/hr may be improved by using the optional External Reference input, the optional Internal/External Reference and/or the optional High Stability Internal Reference.

Modulation Flexibility
The internal modulation signal can be at any 10 Hz increment between 80 Hz and 10 kHz. This internal source may be combined with an external source to create complex or simultaneous modulation such as AM on FM, FM on FM or AM on AM.

Simple Operation
Manual control is via a 48-key touch pad front panel. A "beeper" indicates a button has been pressed. All settings are displayed. Output levels are conveniently read out in dBm or volts. Up to 32 complete front-panel settings may be stored in a non-volatile memory and recalled to the front panel on command.

A unique cursor system has selectable increment sizes. A reference mode allows frequency or level references to be set; subsequent display values are then relative to the reference value.

All functions are GPIB programmable except power on/off. Programming is "free format," and multiple function changes can be executed simultaneously. Frequency switching and settling time over the bus is typically 115 ms.



MODEL 3520 SIGNAL GENERATORS

FREQUENCY

Range
1 MHz to 2080 MHz.
Resolution
100 Hz (1 to 1040 MHz);
200 Hz (1041 to 2080 MHz).
Accuracy
±0.001% in all modes with ALC on;
±(0.001% +10 kHz) in all modes with ALC off.
Stability
(After 2 hr warmup)
1 to 520.9999 MHz: 0.2 ppm/hr with ALC on, 500 Hz/10 min with ALC off.
521 to 1000 MHz: 0.2 ppm/hr with ALC on, 1 kHz/10 min with ALC off.
1000 to 2000 MHz: 0.2 ppm/hr with ALC on, 2 kHz/10 min with ALC off.
Switching Speed
Typically <275 ms (<115 ms for steps >1 MHz).

RF OUTPUT

Impedance
50Ω (SWR less than 1.3 at RF levels less than 0.1 Vrms).
Output Connector
Type N.
Power Level Range
+10 to −137 dBm (0.717V to 0.0316 μVrms).
RF Level Control
Adjustable in 0.1 dB steps in dBm mode. Three significant digits in voltage mode.
Total Level Accuracy
+10 to −36.9 dBm: ±2.0 dB.
Below −36.9 dBm: ±(2.0 dB +0.2 dB/10 dB decrease).
Accuracy Traits
Flatness (+10 to −6.9 dBm): ±1.5 dB.
Step Attenuator: ±0.5 dB or 2% of attenuation, whichever is greater.

SPECTRAL PURITY

Harmonic Output
1 MHz to 520.9999 MHz: < −26 dBc;
521 MHz to 1000 MHz: < −30 dBc;
1000 to 2080 MHz: < −25 dBc.
Sub-Harmonics
1 to 520.9999 MHz: Nondetectable;
521 to 2080 MHz: < −30 dBc.
Non-Harmonics

Fundamental	Spurious Level
1 to 3 MHz	< −60 dBc in 1 to 3 MHz band
3.0001 to 250 MHz	< −65 dBc in 3 to 250 MHz band
3.0001 to 350 MHz	< −55 dBc in 3 to 350 MHz band
3.0001 to 1000 MHz	< −35 dBc in 3 to 1000 MHz band
3.0001 to 2080 MHz	< −30 dBc in 3 to 4160 MHz band

Phase Noise
1 to 520.9999 MHz: < −93 dBc typical (offset 20 kHz from carrier with 1 Hz bandwidth);
1 to 520.9999 MHz: < −120 dBc typical (offset 500 kHz from carrier with 1 Hz bandwidth);
521 to 1040 MHz: < −87 dBc typical (offset 20 kHz from carrier with 1 Hz bandwidth);
521 to 1040 MHz: < −114 dBc typical (offset 500 kHz from carrier with 1 Hz bandwidth);
1041 to 2080 MHz: < −81 dBc typical (offset 20 kHz from carrier with 1 Hz bandwidth);
1041 to 2080 MHz: < −108 dBc typical (offset 500 kHz from carrier with 1 Hz bandwidth).
Residual AM
< −65 dBc in a 50 Hz to 15 kHz post-detection bandwidth.
Residual FM
(In 50 Hz to 15 kHz post-detection bandwidth.)
1 to 520.9999 MHz: <200 Hz (typically <100 Hz);
521 to 1040 MHz: <400 Hz (typically <200 Hz);
1041 to 2080 MHz: <800 Hz.

MODULATION

Internal Frequency Source
Internal modulation source settable in 10 Hz increments between 80 Hz and 10 kHz (accuracy ±2% +6 Hz of reading).
External Frequency
AM: DC to 30 kHz (3 dB bandwidth) with ALC off; 100 Hz to 30 kHz with ALC on.
FM: DC to 60 kHz (1 dB bandwidth) with ALC off; 100 Hz to 60 kHz with ALC on.
Input level required to provide calibrated display:
ALC On: 0.25 V to 1 Vp-p into 600Ω;
ALC Off: 10 Vp-p into 600Ω.
Modulation Depth Resolution
0.1%.
Modulation Depth Indicator Accuracy
0 to 90%: ±6% of reading.
Modulation Range
0 to 100%.
Modulation Distortion
Measured at 1 kHz:
0 to 30% AM: <1.5%.
30 to 70% AM: <3%.
70 to 90% AM: <5%.
Deviation Resolution
Deviations <10 kHz: 100 Hz;
Deviations ≥10 kHz: 1 kHz.
Deviation Range
0 to 100 kHz deviation.
Distortion
(Measured at 1 kHz)
10 to 100 kHz deviation: <2%.
3 to 10 kHz kHz deviation: <4%.
Readout
Alpha-numeric vacuum-flourescent display.

FRONT-PANEL CONTROL

Soft-touch membrane switches.

REVERSE POWER PROTECTION

Trip Time: <2ms
RF Trip Level: Approx. 0.7W
RF: 50 W
DC Blocking Voltage: 50 V

REMOTE PROGRAMMING

Interface: GPIB
Conforms to IEEE-488, Standard. Controls all functions except power on/off.
Function
Listens and talks, gives error status and instrument status. SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E2.

GENERAL

Operating Temperature
All Specifications Apply: 25° ± 5°C.
Slight Degradation of Specifications: 25° ± 15°C.
Dimensions
43.2 cm (17 in.) wide; 14.6 cm (5¾ in.) high; 40.6 cm (16 in.) deep.
Weight
14.5 kg (32 lb).
Power
90 to 110, 110 to 130, 180 to 220, or 220 to 240 Vac; 50 to 400 Hz; approximately 75 watts.

OPTIONS

05
External Reference. Required with Option 06.
05A
External Reference/High Stability Reference.
06
High Stability Reference.
08
Low Frequency Extension (1 kHz to 2080 MHz).

ACCESSORIES

K0234
Rack Mount Kit (P/N1019-00-234)

FACTORY/FOB

Beech Grove, IN

Options for 3000 Series

Option 01C
RF Level Programming. BCD programmable through rear panel input connector by TTL or contact closure. Attenuation is remotely controlled over 139.9 dB range in 0.1 dB steps. (0 dB reference is + 13 dBm.) Front panel manual control is adjustable from + 13 to − 97 dBm in 10 dB steps with an 11 dB vernier. Reverse power protection is provided.

Option 03
Reverse Power Protection. Circuit breaker prevents damage to the instrument if RF (50W max) is accidentally applied to the RF output connector. Breaker is reset by swtiching the unit off, then on. Option 03 is not required if Option 01C is selected.

Option 04
Auxiliary RF Output. A leveled signal (− 10 dBm) from a rear panel BNC connector.

Option 05
External Reference. A rear panel BNC accepts an external frequency reference. Improves accuracy from 10 ppm to that of the external source. Frequency can be 1, 2, 2.5, 5 or 10 MHz. Minimum level 50 mV into 1 kΩ. Required with Option 06.

Option 05A
External Reference/High Stability Reference. A rear-panel BNC accepts an external frequency reference (5 or 10 MHz, 0.5 50 5 Vrms). Used to improve accuracy from 10 ppm to that of the external source. Includes an internal TCXO ± 1 ppm accuracy which can be used in lieu of the external source and used to drive other devices requiring a high stability TTL input.

Option 06
High Stability Reference. A high stability rear panel TTL output which can be used to drive Option 05. Option 06 can drive up to four other devices or instruments. Aging 0.005 ppm/day, 0.05 ppm/month, 0.3 ppm/year. Typical overall accuracy 0.2 ppm at 25 ± 15°C. Option 05 is required.

Option 07
Low Level Leakage. A 20 dB reduction. Reduces RF leakage to less than 0.1 μV into a 2 turn, 1 in. dia. loop, held 1 in. from any surface.

Option 08
Low Frequency Extension. Extends lower frequency range to 1 kHz.

3000 SERIES SIGNAL GENERATOR OPTION AVAILABILITY

Option	Signal Generator											
	3000	3000-200	3001*		3006*		3007	3510		3520*	
01C RF Level Programming (0.3 dB Steps)	•		•	•	•	•		Std		Std	
02 Pulse Modulation***											
03 Reverse Power Protection Power Protection	•	Std	•	•	•	•	Std	Std		Std	
04 Axuiliary RF Output	•		•	•	•	•					
05 External Reference				•		•			•		•
05A External Reference/High Stability Reference (1 ppm)			•		•			•		•	
06 High Stability Reference** (0.1 ppm) Option 05 required				•		•			•		
07 Low Level Leakage	•	•	•	•	•	•	•				
08 Low Frequency Extension to 1 kHz								•	•	•	•

*Select options from within the same column.
**Model 2102, Precision Frequency Standard, may be used in lieu of Option 06.
***Consult Factory for Details.

Return Loss Bridges

- **1 to 1000 MHz Frequency Range**
- **Performance and Economy**
- **40 dB Directivity**

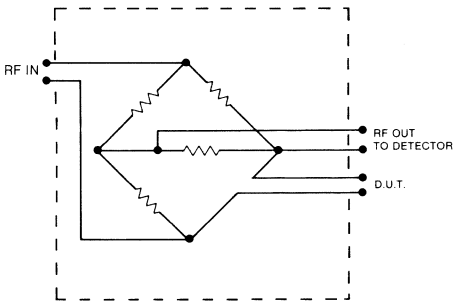
Performance and Economy
Models FB40-50 and FB40-75 Return Loss Bridges allow fast and accurate measurement of return loss when used with a standard sweep generator and display oscilloscope. Model FB40-50 is designed for 50Ω general purpuse applications and Model FB40-75 is designed for 75Ω (TV and CATV) applications.

Wide Frequency Range
Models FB40-50 and FB40-75 feature a full 1 to 1000 MHz frequency range, a fixed internal 50Ω or 75Ω reference, and a directivity of greater than 40 dB.

Both Return Loss Bridges provide a residual imbalance of less than – 40 dB.

SPECIFICATIONS

Frequency Range
1 to 1000 MHz.
Impedance
Model FB40-50: 50Ω.
Model FB40-75: 75Ω.
Open-Short Change
± 1.2 dB.
Insertion Loss
15 dB nom.
Directivity
>40 dB.
Connectors
BNC connectors are standard. Contact factory for other options.
Dimensions
11.5 cm (4½ in.) wide; 5 cm (2 in.) high; 3.2 cm (1¼ in.) deep.
Weight
0.35 gram (10 oz.).



FACTORY/FOB

Beech Grove, IN

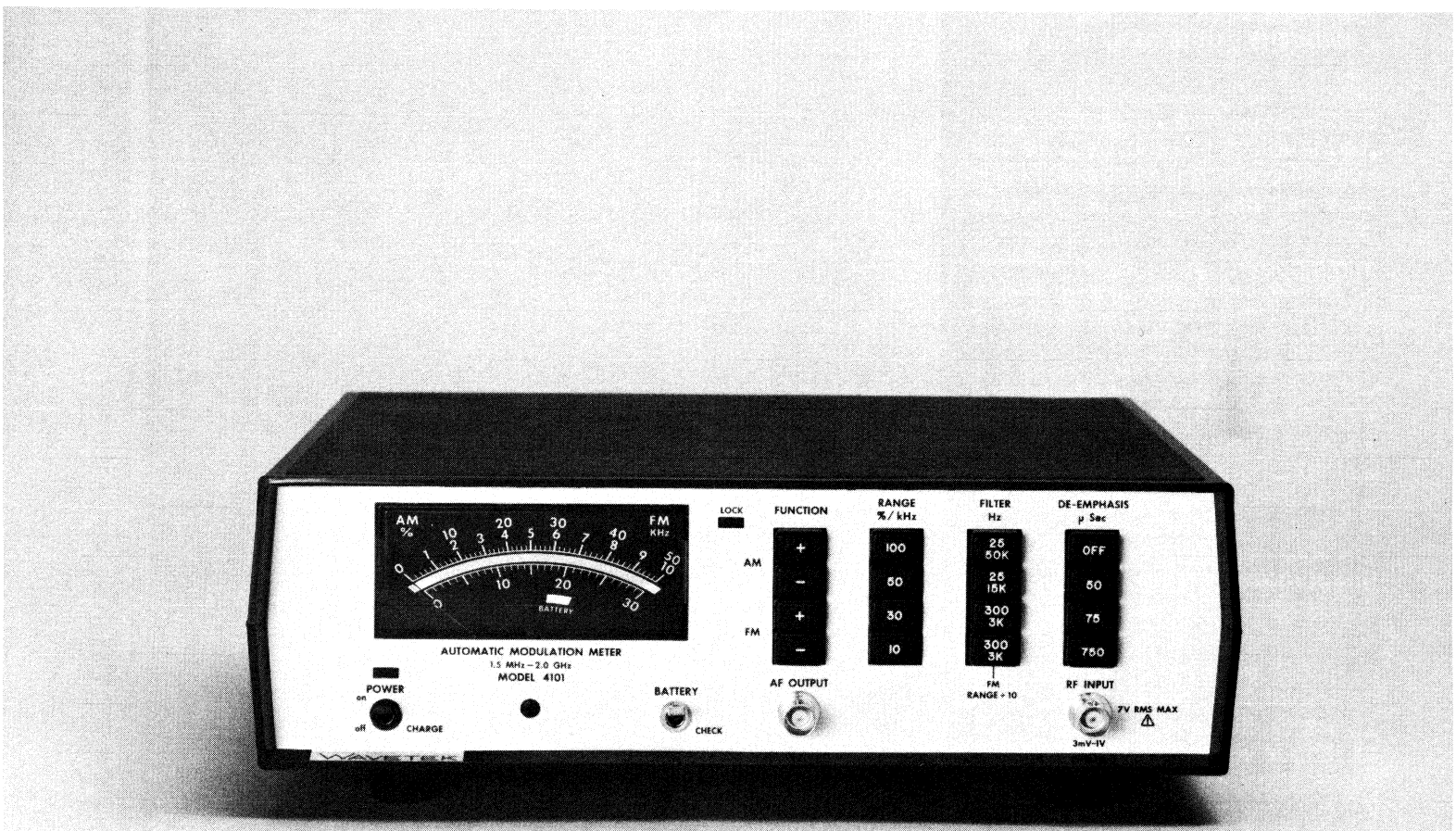
Modulation Meter

- **Automatic Measurement to 2.0 GHz**
- **Single Input: 3 mV to 1V**
- **Wide Choice of De-emphasis and Audio Filters**
- **Large Easy-to-Read Meter**
- **Battery Option for Portable Use**

Versatile Performance
Model 4101 is a fully Automatic Modulation Meter that makes rapid and accurate modulation measurements of AM and FM signals. Selection of function, meter range, filter and de-emphasis is made by simple pushbutton switches.

An optional rechargeable battery, mounted inside the case, provides six hours of operating time.

Applications
Model 4101 simplifies testing of communication gear, AM and FM transmitters and signal generation equipment, both in the field and in manufacturing facilities.



MODEL 4101 MODULATION METER

RF INPUT

Frequency Range
1.5 MHz to 2.0 GHz.
Input Impedance
50Ω.
Input Level
From 3 mV to 1V. All specifications apply from 10 mV to 1V.
Maximum Safe Input
1 watt (7 Vrms).

FM MEASUREMENT

Modulation Frequency Range
25 Hz to 50 kHz.
Deviation Ranges
1, 3, 5, 10, 30, 50 & 100 kHz. Measurements of positive and negative as well as positive/negative difference can be made.
Accuracy
At 1 kHz modulating frequency: ±2% of FS, ±2% of reading, + residual FM.
Residual FM
1.5 MHz to 100 MHz: <20 Hz.
100 MHz to 2 GHz: Increases linearly with frequency at a rate of 20 Hz per 100 MHz.
Modulation Frequency Response
Referenced to 1 kHz.
25 Hz to 50 kHz With 25 Hz to 50 kHz Filter: ±0.5 dB.
25 Hz to 15 kHz With 25 Hz to 15 kHz Filter: ±0.5 dB.
300 Hz to 3 kHz With 300 Hz to 3 kHz Filter: −3 ± 0.5 dB.
De-emphasis
Selectable: 50, 75, 750 μs or off.
Time constant accuracy: 5%.

AM MEASUREMENT

Modulation Frequency Range
25 Hz to 50 kHz.
AM Range
10, 30, 50 and 100%.
Measurements of peak or trough as well as peak/trough difference can be made.
Accuracy
At 1 kHz modulating frequency:
±2% of FS, ±2% of reading, + residual AM.
Residual AM
<0.5% with 15 kHz bandwidth selected.
Modulation Frequency Response
Same as FM response.

SIGNAL OUTPUTS

IF Output
Connector: Rear Panel BNC.
Frequency: ≅420 kHz.
Level: 100 mV into 50Ω.
AF Output
Connector: Front Panel BNC.
Frequency Response: Controlled by selected filter. See AM and FM frequency response.
Level: 0.5 Vrms at 1 kHz modulating frequency equals meter full scale on any range.
Output Impedance: 600Ω.
Distortion At 1 kHz Modulating Frequency:
<1% for 50 kHz deviation.
<1% for 80% AM.

GENERAL

Environment
Specifications Apply: 15° to 30°C.
Operation: 0° to 40°C.
Storage: −20° to +65°C.
Dimensions
28.6 cm (11¼ in.) wide; 10.2 cm (4 in.) high; 26.7 cm (10½ in.) deep.
Weight
2.7 kg (6 lb) net; 4.0 kg (9 lb) shipping.
Power
100, 120, 220, or 240 VAC, +5%, −10%; 50 to 400 Hz; approximately 5 watts.

OPTIONS

BA-1
Rechargeable Battery. Internal Nicad cell provides approximately 7 hr operating time. Recharging time: 14 hr.

ACCESSORIES

K015
Rack Mount Kit.
(P/N 1019-00-0119)

FACTORY/FOB

Beech Grove, IN

Single and Dual Trace Scopes

- **Large 9 and 12 Inch Diagonal CRTs**
- **OEM Versions Available**
- **Ideal for Production Testing**
- **Excellent Sensitivity**
- **Economical**

Models 1901C, 1905 and 1910 are low cost, electromagnetic, X-Y display scopes, ideal for use in displaying the sweep response of passive or active circuits. High performance and low cost make these scopes excellent choices for engineering laboratories, production facilities, educational institutions, and original equipment manufacturers of such devices as medical instrumentation and automotive test equipment.

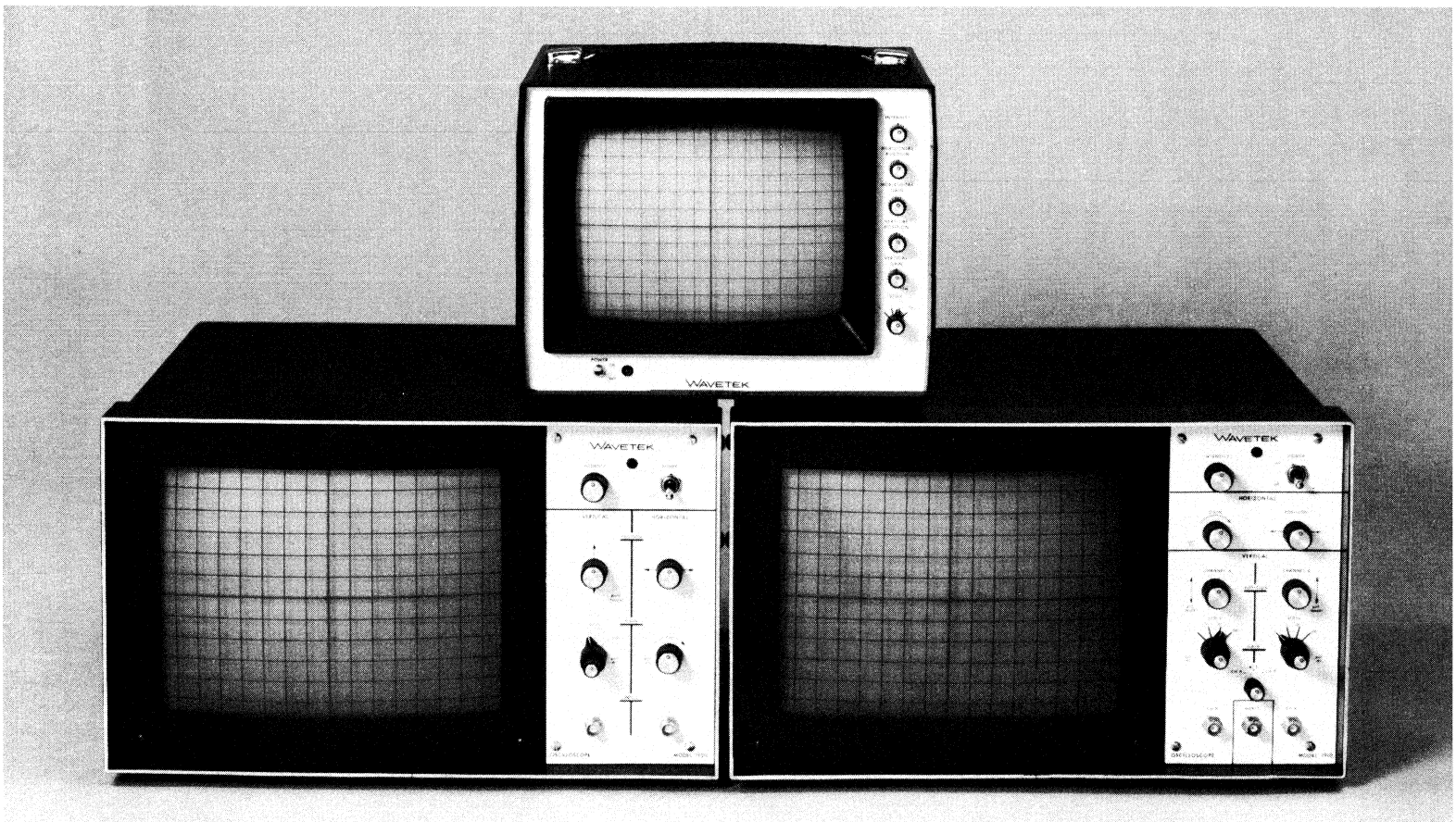
Individual Features
Models 1901C and 1905 are single trace, general purpose scopes. Model 1910 is a dual trace version of these models and all may be intensity modulated.

Models 1901C and 1910 feature 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 persistence phosphor (P1) is standard; other phosphors are available. Model 1905 has a 9-inch diagonal CRT.

Models 1901C and 1905 feature Z-axis intensity modulation, permitting grey scale operation. Model 1910 uses a two-state intensity modulation scheme that increases the brightness of the trace when a pulse above +2V or below −2V is supplied to the Z-axis input.

Models 1901C and 1910 feature a marker adder which accepts both birdy and pulse markers. Marker amplitude is constant regardless of vertical gain.

OEM
OEM versions are available. Please contact factory for additional information.



DISPLAY

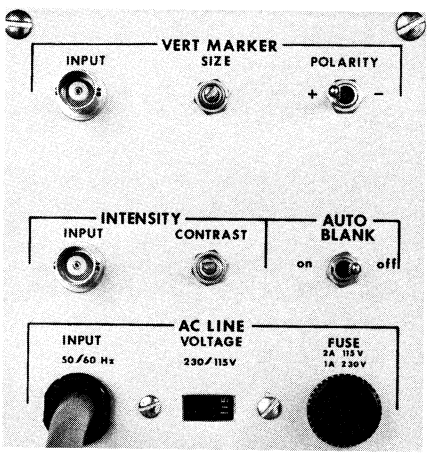
CRT
Models 1901C, 1910: 12-in. (30 cm) diagonal.
Model 1905: 9-in. (23 cm) diagonal.
Phosphor
P1 (medium persistence, green).
Optional for 1901C and 1910: P4, medium short persistence, white. P7, long persistence.
Graticule
Models 1901C, 1910: 1.5 cm/div, 12 cm vertical, 16 cm horizontal.
Model 1905: 1.2 cm/div., 10 cm vertical, 14 cm horizontal.
Deflection
Magnetic.
Acceleration Voltage
Models 1901C, 1910: 9 kV nominal.
Model 1905: 8 kV nominal.

VERTICAL

Modes (Model 1910 only)
Channel A, Channel B or alternating at 1/2 horizontal rate.
Sensitivity
4-position step attenuator for 1, 10, 100 mV and 1 V/div; continuously variable vernier between steps.
Impedance
374 kΩ.
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).
Input Connector
Models 1901C, 1910: BNC, front panel.
Model 1905: BNC, rear panel.
Drift
Typically <1/2 div for 8 hr (at a constant temperature after 1/2 hr warm-up).
Polarity
Models 1901C, 1910: Front-panel switch for inversion of vertical signal.
Model 1905: Rear-panel switch for inversion of vertical signal.

HORIZONTAL

Sensitivity
Continuously adjustable from 0.1 V/div to over 10 V/div.
Impedance
>320 kΩ.
Bandwidth
DC to 1.5 kHz.
Coupling
Switchable AC-DC (when AC coupled, max DC voltage plus AC peak not to exceed 200 V).
Linearity
3%.
Input Connector
Models 1901C, 1910: BNC, front panel.
Model 1905: BNC, rear panel.
Drift
Typically <1/2 div for 8 hr (at a constant temperature after 1/2 hr warm-up).
Protection Circuit
Models 1901C, 1910: Prevents burnout of CRT by blanking beam when horizontal signal is < approx 4 div (60 Hz rate). When operating at slower rate, or for servicing, rear-panel switch can disable the protection circuit.
Model 1901: Autoblanking protects phosphors on loss of deflection signal. Either horizontal or vertical signals of approx 4 div. (<60 Hz) will cause "unblanking".



Intensity Modulation

INTENSITY MODULATION (Z AXIS)

Sensitivity
Models 1901C, 1905: Adjustable from 1 to 10 V for full modulation.
Model 1910: Pulse above + 2V or below − 2V will brighten the trace. Rear-panel control adjusts Z input (intensity) and is independent of front-panel control.
Input Impedance
Models 1901C, 1905: 20 kΩ in parallel with 10 pF.
Model 1910: 10 kΩ.
Bandwidth
(Models 1910C and 1905 only.) Flat from DC to 1 MHz; 3 dB down at 3.5 MHz, 10 dB down at 10 MHz.
Polarity
(Models 1901C and 1905 only.) Positive going voltage intensifies trace. Internally changeable for positive blanking.
Input Connector
BNC at rear panel.

MARKER ADDER

(Models 1901C, 1910 only.)
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 15 kΩ.

GENERAL

Dimensions
Models 1901C, 1910: 26.2 cm (10 5/16 in.) high; 41.9 cm (16 1/2 in.) wide; 36.2 cm (14 1/4 in.) deep.
Model 1905: 24.8 cm (9 3/4 in.) high; 29.8 cm (11 3/4 in.) wide; 25.7 cm (10 1/8 in.) deep.
Weight
Models 1901C, 1910: 11.8 kg (26 lb) net; 15 kg (35 lb) shipping.
Model 1905: 6.8 kg (15 lb) net; 10 kg (22 lb) shipping.
Power
115 or 230 V ± 10%; 50/60 Hz; approximately 75 watts.

OPTIONS

A
P4 Medium Short Persistence Phosphor (white).
B
P7 Long Persistence Phosphor. (Models 1901C and 1910 only.)
C
Clear Faceplate (in lieu of graticule).
D
Amber Faceplate
(Normally used with P7 phosphor without graticule.)
E
Amber Faceplate with Graticule. (Models 1901C and 1910 only.)
F
P39 Long Persistence Phosphor. (Model 1905.)

NOTE: Faceplace may be ordered separately. Specify C, D or E.

ACCESSORIES

Rack Mount
Part #1019-00-0030

FACTORY/FOB

Beech Grove, IN

CATV Sweep Recovery System

- **Easy to Use**
- **Accurate, Dependable Measurements**
- **Field Proven on CATV, Data and Other Broadband Cable Systems**
- **Portable, Battery Operated**
- **The Standard of the Industry**

Portable, Easy To Use
The Sweep Recovery System consists of Model 1855B, a transmitter, and Model 1865B, a receiver—both microprocessor controlled. The transmitter, installed at the head end of a cable system, sweeps every 5 seconds, unnoticed by cable subscribers. The portable, battery-operated receiver evaluates the swept response at any point in the system.

These instruments provide an easy technique for maintaining or auditing any cable system, and 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.

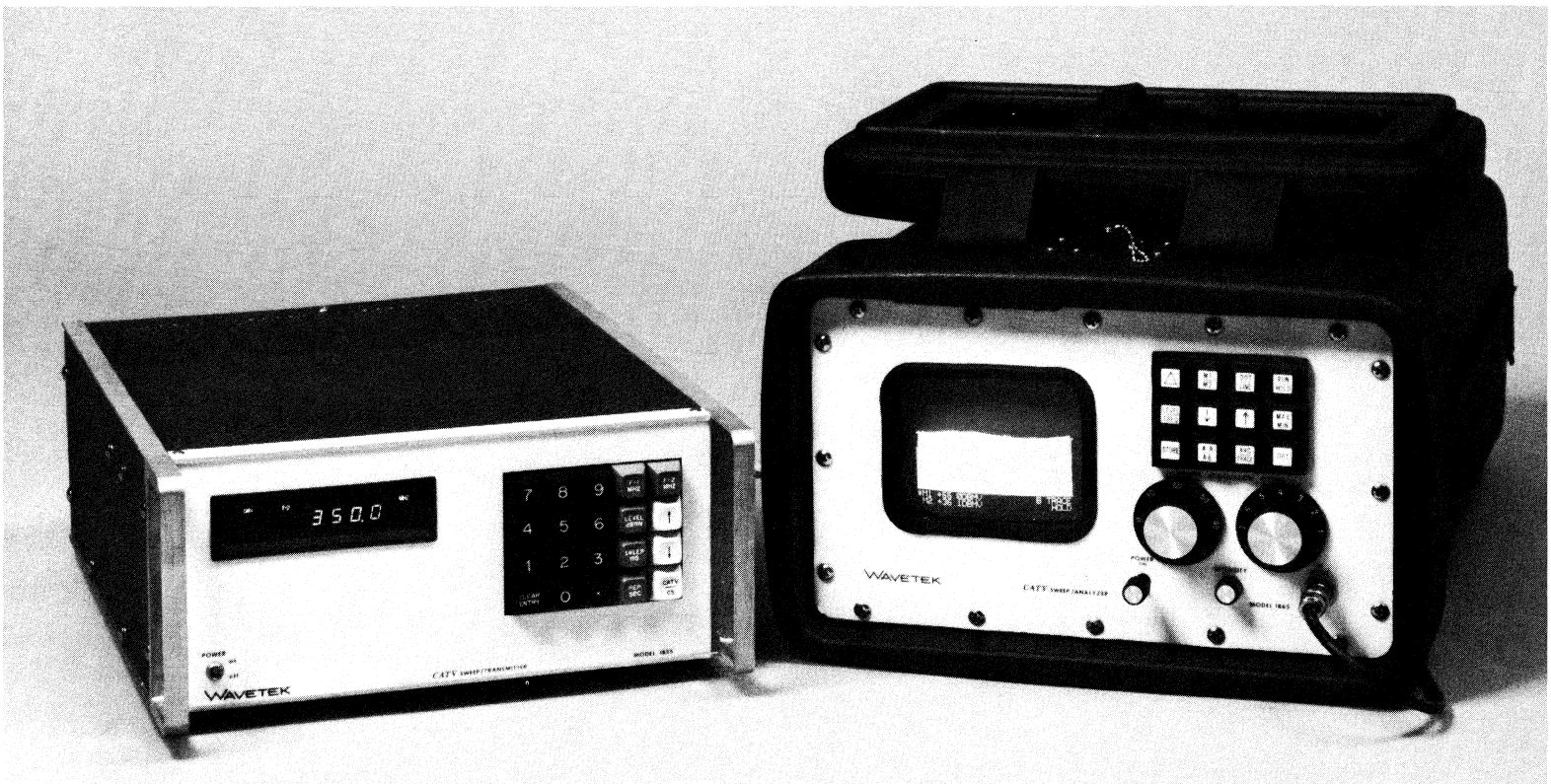
Model 1855B
Model 1855B's entry and control settings are automatically transmitted to the receiver on a phase modulated 50 MHz pilot carrier operating 20 dB below the sweep output level.

An internal frequency counter accurately sets the start/stop sweep frequencies. Up/down keys provide convenient automatic tuning in 100 kHz intervals from 1 to 450 MHz. Operate or standby mode can be remotely selected by contact closure.

Model 1865B
Model 1865B Sweep Analyzer features digital storage, refreshed display, alphanumeric readout, a moveable cursor/measurement system, and a battery-saver circuit. Model 1865B receives the Model 1855B signal and decodes the phase-modulated pilot carrier. It then presets itself for the sweep duration, repetition rate, and start/stop frequencies that were entered into Model 1855B.

More Information

For the CATV Test Instrumentation Catalog, contact:
Wavetek
5808 Churchman, P.O. Box 190
Beech Grove, IN 46107
Phone: (800) 431-9191,
(317) 788-5960 (In Indiana)
Telex: 687-6038



System Analyzer

- **1 GHz Frequency Range**
- **Built-in Preamp and Filters**
- **Fast, Accurate, Dependable Measurements**
- **Portable Battery Operated Convenience**
- **Easy to Read Results**

Model 1881 performs a wide variety of routine tests in a full 4 MHz to 1 GHz range. You'll have the one instrument you need to perform daily system checks even if your system grows to 100 channels and more.

Pushbutton Testing
Specific instructions are in memory to perform these tests:
- Carrier-to-noise
- Hum modulation
- FM deviation
- Cross-modulation
- 2nd/3rd order (composite triple beat)

Results are displayed in both analog and alphanumeric form.

Enter a channel number and the 1881 automatically selects a 10 MHz frequency span and centers the display of the center frequency of the channel you've selected.

Composite Triple Beat to 96 dB
You have sufficient measurement range to locate exactly which amplifier is contributing more than its share of distortion. The 1881 makes it simple to locate problems.

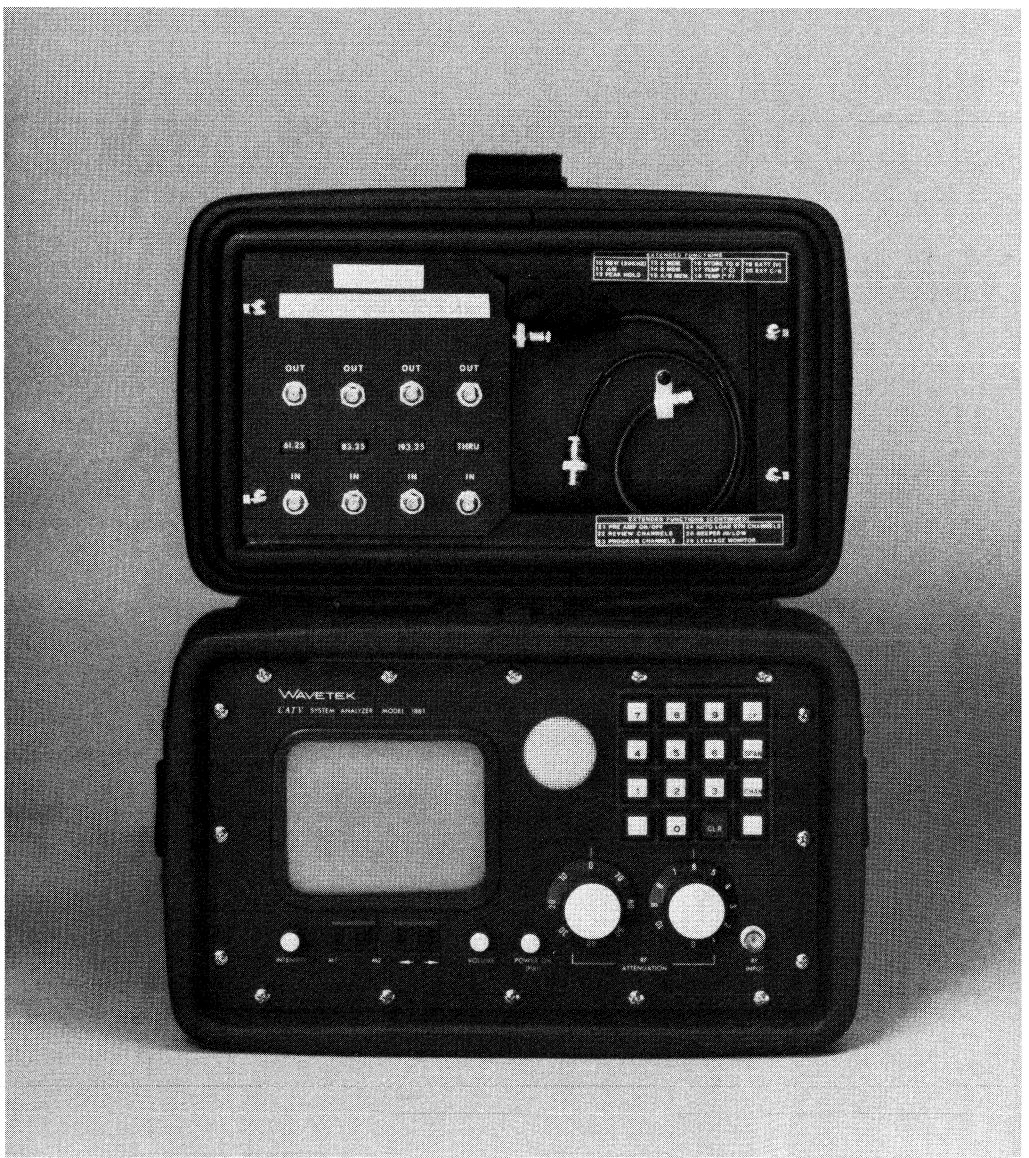
Carrier-to-Noise, Quickly and Easily
Make quick and accurate measurements of carrier-to-noise, without removing a carrier. It samples the noise between any two adjacent channels for your measurement.

And for those test points where signal level is low, the 1881 features a built-in pre-amplifier and filter.

Digital Measurement Precision
The resolution of 0.1 dB is routine. You can read frequency to within 0.1 MHz; FM deviation with 1.0 kHz; and hum modulation with 0.1%.

Split-screen Display
You can simultaneously view any two selected portions of the frequency band, in varying dispersions.

More Information
For the CATV Test Instrumentation Catalog, contact:
Wavetek
5808 Churchman, P.O. Box 190
Beech Grove, IN 46107
Phone: (800) 431-9191,
(317) 788-5960 (In Indiana)
Telex: 687-6038



Signal Analysis Meters

- **Microprocessor Controlled**
- **Direct Keyboard Entry Tuning**
- **RS-232 Compatible Interface**
- **Dedicated 7-Inch Spectrum Analyzer Display**
- **19-Inch Standard Rack Mount**

Model SAM IV
The SAM IV Signal Level Meter is a microprocessor controlled, rack-mounted measurement system with built-in display for spectrum analysis. The spectrum analysis function is directly connected to the built-in 7-inch CRT display. A display range of >50 dB on screen, amplitude range of −40 to +60 dBmV, calibrated log display, and built-in calibration, all combine to make the SAM IV an extremely versatile spectrum analyzer.

Model SAM IIID
The SAM IIID has all the features of the SAM IV with the exception of the built-in spectrum analyzer display.

Preprogrammed Keyboard Tuning
The SAM IIID and SAM IV feature direct entry keyboard tuning to any of 60 preprogrammed standard channels, and 60 HRC format channels, either video or audio, across the standard 4 to 450 MHz band. A unique feature of both models enables the operator to tune up to the next channel with the touch of a button.

RS-232 Compatible Interface
The standard RS-232 interface allows remote activation and control. This feature allows a remote location to be monitored, either automatically or manually, depending on the type of controller used and, if the controller is a computer, the capabilities of its software.

More Information
For more information, contact
Wavetek
5808 Churchman, P.O. Box 190
Beech Grove, IN 46107
Phone: (800) 431-9191,
(317) 788-5960 (In Indiana)
Telex: 687-6038

RF Detectors

MODELS	D151	D152	D153	D171	M151
Frequency Range (MHz)	0.2 to 1000	0.2 to 2000	1.0 to 12,400	0.2 to 1000	0.2 to 1000
Impedance (Ohms)	50	50	50	75	50
VSWR	1.15	1.5	1.2 to 4.5 GHz 1.3 to 7.0 GHz 1.4 to 12.4 GHz	1.15 (>23 dB return loss)	1.5
Max Input	3.0V	3.0V	100 mW	3.0V	3.0V
Output Polarity*	Negative*	Negative*	Negative**	Negative*	Negative*
Frequency Response (dB)	±0.3	±0.5	±0.2 per octave to 8 GHz ±0.5 overall	±0.3	±0.5
Connectors RF Input DC Output	 Male BNC Female BNC	 Male BNC Female BNC	 Male N Female BNC	 Male BNC Female BNC	 Female BNC Female BNC
Dimensions — Diameter :	1.4 cm ($^{9}/_{16}$ in.)	1.4 cm ($^{9}/_{16}$ in.)	2.1 cm ($^{83}/_{100}$ in.)	1.4 cm ($^{9}/_{16}$ in.)	1.4 cm ($^{9}/_{16}$ in.)
Length:	5.7 cm (2¼ in.)	5.7 cm (2¼ in.)	6.3 cm ($^{47}/_{100}$ in.)	5.7 cm (2¼ in.)	5.7 cm (2¼ in.)

*May be reversed by reversing diode. **Order D153-P for positive output.

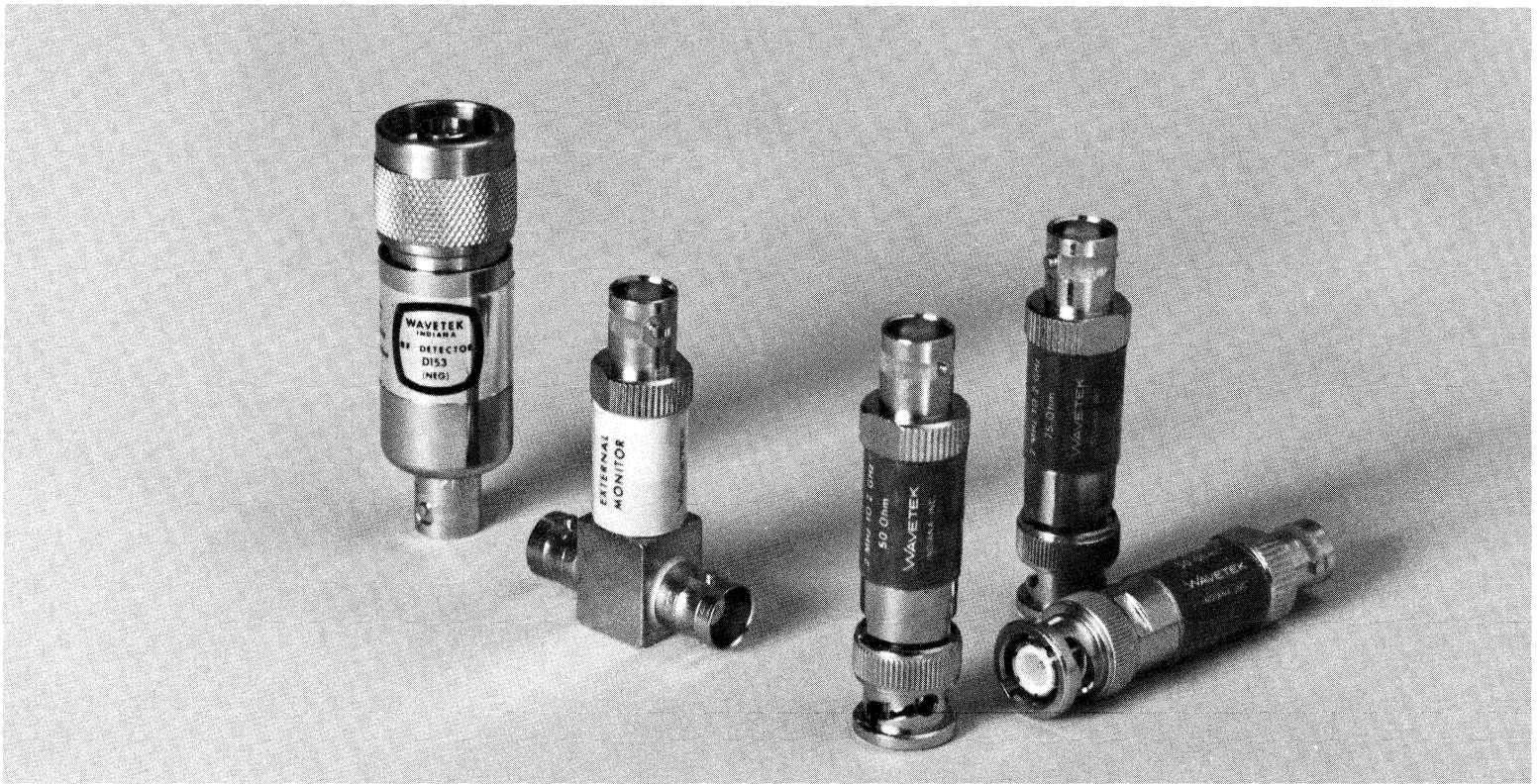
Low VSWR
Series 150 and 170 Detectors are designed for applications requiring low VSWR and flat frequency response across broad operating ranges.

50 and 75Ω Units
Models D151 and D152 are 50Ω units with typical VSWRs of 1.2 at 1000 MHz. D151 has a 1000 MHz upper limit and D152 can be operated up to 2 GHz.

Model D171 is a 75Ω detector that operates over the frequency range of 200 kHz to 1000 MHz with a response of ±0.3 dB and a return loss of greater than 23 dB. This is accomplished through use of the Wavetek designed 75Ω BNC connector and associated frequency compensating circuitry.

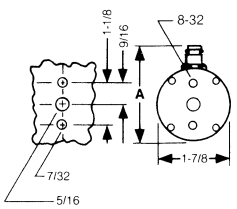
Model D153 has a frequency range of 1.0 to 12,400 MHz with a VSWR typically less than 1.20.

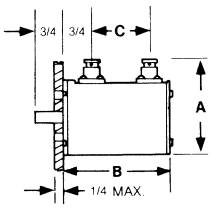
Model M151 is equipped with female BNC input and output connectors.

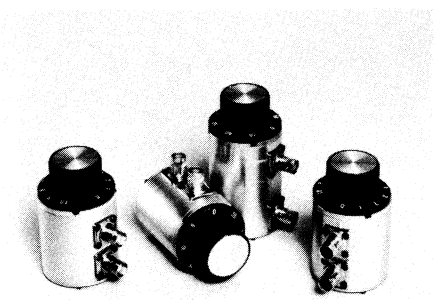


Turret Attenuators

- **Broadband Operation**
- **Low VSWR**
- **High Repeatable Accuracy**
- **Ideal for OEM Applications**







OEM or Bench Use
The Series 5000 and 7500 Attenuators are miniature turret type units that operate over wide frequency ranges making them equally suitable for bench setups, field use, or in OEM test instrumentation.

Low VSWR
Direct reading units with 0.1, 1.0, 5.0 and 10.0 dB steps are available in either 50 or 75 ohm version. The VSWR of all units is less than 1.2 up to 1000 MHz.

CATV Applications
The 7500 Series Attenuators, designed primarily for the CATV industry, have VSWRs of less than 1.1 up to 500 MHz (26 dB return loss).

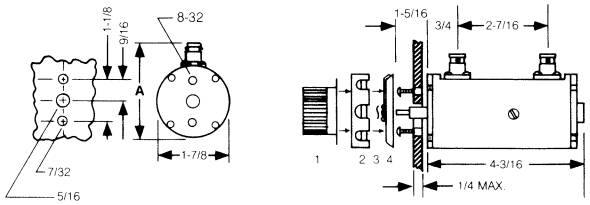
Panel Mounting
All units are ruggedly constructed and have provision for panel mounting.

MODELS	5001	5010	5035	5070	7501	7510	7535	7570
Attenuation (dB)	1-2 in 0.1 steps	0-10 in 1.0 steps	0-35 in 5.0 steps	0-70 in 10.0 steps	1-2 in 0.1 steps	0-10 in 1.0 steps	0-35 in 5.0 steps	0-70 in 10.0 steps
Frequency Range (MHz)	0 to 1200	0 to 2000	0 to 2000	0 to 2000	0 to 1000	0 to 1000	0 to 1000	0 to 1000
Impedance (Ohms)	50	50	50	50	75	75	75	75
Insertion Loss (dB)	1 dB + 0.3 max	0.3 max	0.3 max	0.4 max	1 dB + 0.2 max	0.2 max	0.2 max	0.3 max
Accuracy (dB)	±0.1	±0.2 to 500MHz ±0.3 to 1000MHz ±1.0 to 2000MHz	±0.5 to 500MHz ±1.0 to 1000MHz ±3.0 to 2000MHz	±0.3 to 500MHz ±1.0 to 1000MHz ±3.0 to 2000MHz	±0.1	±0.2	±0.5 to 500MHz ±1.0 to 1000MHz	±0.5 to 500MHz ±1.0 to 1000MHz
VSWR (1.1 max to 500 MHz) (1.2 max to 1000 MHz)	1.25 max	1.2 max to 1000MHz 1.5 max to 2000MHz	1.2 max to 1000MHz 1.5 max to 2000MHz	1.2 max to 1000MHz 1.5 max to 2000MHz	•	•	•	•
Max. Input Power (Watts)	3	1	½	½	3	1	½	½
Angle Between Steps	30°	30°	45°	45°	30°	30°	45°	45°
Connectors								
BNC Female (SMA, TNC, N)	•	•	•	•				
BNC Female (SMA, TNC, F)					•	•	•	•
Dimensions A	6.2 cm (2-7/16 in.) BNC, TNC; 6.4 cm (2½ in.) F, SMA; 7.0 cm (2¾ in.) Type N							
B	5.4 cm (2 1/8 in.)	5.4 cm (2 1/8 in.)	5.4 cm (2 1/8 in.)	7.0 cm (2 3/4 in.)	5.4 cm (2 1/8 in.)	5.4 cm (2 1/8 in.)	5.4 cm (2 1/8 in.)	7.0 cm (2 3/4 in.)
C	2.1 cm (27/32 in.)	2.1 cm (27/32 in.)	2.1 cm (27/32 in.)	3.8 cm (1 1/2 in.)	2.1 cm (27/32 in.)	2.1 cm (27/32 in.)	2.1 cm (27/32 in.)	3.8 cm (1 1/2 in.)

NOTES: 1. Model 5001 and 7501 dial calibration is from 0 to 1 in 0.1 steps.
2. All accuracy is with reference to the minimum loss position.

80 dB Step Attenuators

- **Available in 50 and 75 Ohms**
- **Broad Frequency Range**
- **Positive Detent Action**
- **Use as Calibration Reference**



Dual Concentric

Models 5080 and 7580 are direct reading, dual concentric, turret-type attenuators that provide a total of 80 dB, variable in 1 dB steps. They are ideally suited for use in test sets requiring wide attenuation settings in the frequency range of 0 to 2000 MHz.

0.1 dB Resolution

Models 5080.1 and 7580.1 Attenuator Sets consist of 10 dB, 1 dB and 0.1 dB per step turret type attenuators, mounted in a cabinet for bench top use. Each set has a total attenuation range of 0 to 81 dB with a fixed 1 dB insertion loss. Model 7580.1A includes dc blocks in both input and output.

Panel Mounting

Models 5080 and 7580 have provision for panel mounting.

MODELS	5080	7580	5080.1	7580.1*
Attenuation (dB)	0-80 in 1.0 steps	0-80 in 1.0 steps	0-81 in 0.1 steps	0-81 in 0.1 steps
Frequency Range (MHz)	0 to 2000	0 to 1000	0 to 1000	0 to 1000
Impedance (Ohms)	50	75	50	75
Insertion Loss (dB)	0.7 max	0.7 max	1 dB +1.0 max	1 dB +1.0 max
Accuracy (dB)	±0.5 to 500 MHz ±1.0 to 1000 MHz ±3.0 to 2000 MHz	±0.5 to 500 MHz ±1.0 to 1000 MHz	±1.0 to 400 MHz ±2.0 to 1000 MHz	±1.0 to 500 MHz ±2.0 to 1000 MHz
VSWR	1.2 to 1000 MHz 1.5 to 2000 MHz	1.1 to 500 MHz 1.2 to 1000 MHz	1.2 to 400 MHz 1.4 to 1000 MHz	1.2 to 500 MHz 1.3 to 1000 MHz
Max Input Power (Watts)	½	½	½	½
Angle Between Steps	30° from 0 to 10 dB 45° from 0 to 70 dB	30° from 0 to 10 dB 45° from 0 to 70 dB	—	—
Connectors	BNC Female (SMA, TNC and N available)	BNC Female (F available)	BNC Female (SMA, TNC and N available)	BNC Female (F available)
Dimensions	A = 6.2 cm (2 7/16 in.) BNC, TNC; 7.0 cm (2¾ in.) N; 6.4 cm (2½ in.) F, SMA	A = 6.2 cm (2 7/16 in.) BNC, TNC; 7.0 cm (2¾ in.) N; 6.4 cm (2½ in.) F, SMA	Height: 10.2 cm (4 in.) Width: 17.8 cm (7 in.) Depth: 10.2 cm (4 in.)	Height: 10.2 cm (4 in.) Width: 17.8 cm (7 in.) Depth: 10.2 cm (4 in.)

NOTE: All accuracy is with reference to the minimum loss position.
**7580.1A has dc blocks in both input and output.*

Tunable Bandpass Filters

- **30 to 2000 MHz**
- **Octave Frequency Bands**
- **2.2 Typical Form Factor**
- **±1% Accuracy and Resettability**

Rejects Noise
Wavetek Series 5200 Tunable Bandpass Filters are extensively used where wide band noise or harmonic rejection is required and for specific channel selection in diplexers and multiplexer applications.

5 Percent, 3 dB Bandwidths
Wavetek direct reading tunable bandpass filters cover the frequency range of 30 MHz to 2 GHz in 6 octave band units. These capacitively tuned, iris-coupled, four section filters with 5%, 3 dB bandwidths have typical 30 dB/3 dB form factors of 2.2. Insertion loss is less than 1.0 dB; power rating is 60 watts.

Rugged Construction
Rugged construction of the filters makes them ideally suited for both laboratory and production applications.

SPECIFICATIONS

Frequency Range	Model
31 to 62 MHz	5201
62 to 125 MHz	5202
125 to 250 MHz	5203
250 to 500 MHz	5204
500 to 1000 MHz	5205
1 to 2 GHz	5206

Impedance
50Ω.

VSWR
1.5:1.

Insertion Loss
Less than 1.0 dB.

Form Factor
30 dB/3 dB, 2.5 maximum 2.2 typical.

Calibration Accuracy
±1% of indicated frequency.

Power
60 watts maximum.

Connector
Type N female (other connectors available on request).

GENERAL

Dimensions
Models 5201 thru 5205: 13.9 cm (5-7/16 in.) wide; 7.1 cm (2-13/16 in.) high; 19 cm 7-5/8 in.) deep.
Model 5206: 8.9 cm (3-5/8 in.) wide; 7.1 cm (2-13/16 in.) high; 14.7 cm (5-11/16 in.) deep.
Dimensions do not include knobs, feet or connectors.

Weight
1.8 kg (4 lb) net; 2.3 kg (5 lb) shipping.

FACTORY/FOB

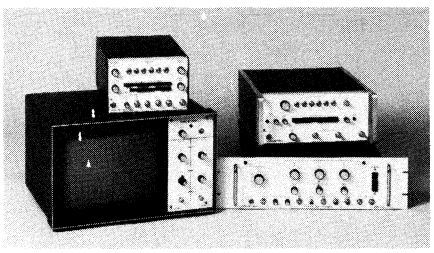
Beech Grove, IN

Computer-Aided VHF/UHF Tuner Alignment System

- **Microprocessor Controlled**
- **Digital Programming**
- **Display Alphanumerics**
- **Display Graphics**
- **Digitally-Stored Display**

Models 1681, 1781 and 1981 Tuner Alignment System uses the latest digital technology to provide instrument capabilities not attainable with analog test equipment. This user-friendly system provides improved quality and reduced alignment time by prompting the operator with pass-fail indicators, programmable tolerance lines and other display information that only a digitally-stored display can provide.

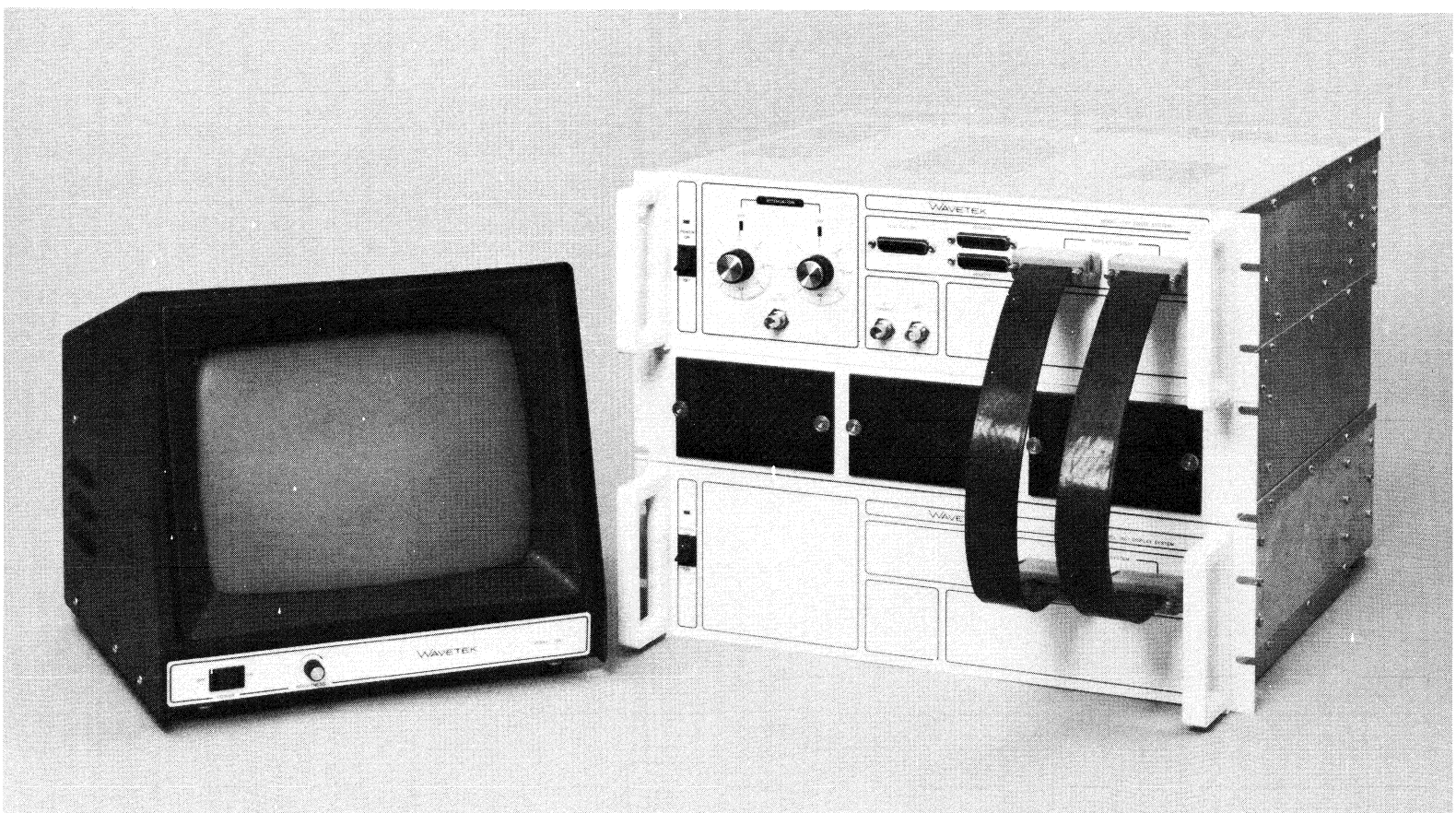
Other TV & Radio Test Instruments
- All World TV Standards
- Expanded Resolution of Traps
- Combination IF-Chroma-Sound
- CATV Converter Alignment Equipment
- UHF-VHF Programmables



TV Test Instruments

Wavetek test instruments are available for TV alignment to all standards of the world. Specialized options for all units provide the ultimate in price-vs-performance for the production line, quality control and the engineering laboratory.

For the TV & Radio Test Instrumentation catalog, contact:
Wavetek
TV Test Products Applications Engineering Group
5808 Churchman, P.O. Box 190
Beech Grove, IN 46107
(317) 788-5970
Telex 687-6029



PROM and Logic Programmers

Introduction
Wavetek-Digelec offers a full range of programming equipment — a product to meet the requirements of every individual user.

R&D and Engineering
Model UP-803, interactive PROM and logic programmer, programs over 800 different devices for R&D engineers requiring flexibility in design and the capability of programming future devices.

The FAM-52 plug-in module turns the UP-803 into a fully integrated logic center. It offers design, programming, and test of over 100 PAL® and IFL logic devices.

Production Programming
Throughput and yield are the name of the game and Wavetek-Digelec is geared to meet your most stringent requirements. The GP-810, 828, and 829 production programmers program up to 16 devices simultaneously. Fast programming algorithms are ready.

For high volume programming, hook the UP-803 onto an IC-handler. A Multi-Board Programming System (MBPS) is also offered.

Field Service Programming
Models 804, 824, and 825 portable programmers offer high reliability and wide range of devices. Models 824 and 825 contain an internal UV eraser.

Approvals
Wavetek-Digelec programmers have written approvals from all major semiconductor manufacturers.

Close cooperation with semiconductor manufacturers during the complete life cycle of Wavetek-Digelec products, is your best guarantee of up-to-date programming equipment at all times.

DIGIPACK
To help you find the equipment most suitable for you we have introduced the DIGIPACK equipment package. Look for the detailed list of DIGIPACKS. One of them will suit your needs.

CUPL™ — High Level Logic Design
CUPL is the first high level universal compiler software to support programmable logic devices. CUPL supports all PAL and IFL devices now on the market and allows the design engineer to second source at the socket level. CUPL runs on a wide variety of operating systems from CP/M® and PC-DOS™ to UNIX® and VMS® . The second generation CUPL includes entry capabilities for Boolean equations, state machines, and function tables in addition to having a minimization capability.

Multi-Board Programming System (MBPS)
MBPS is the perfect solution for programming on-board EPROMS. MBPS can successfully program up to 8 boards with 8 EPROMs on each board. MBPS is a self-contained system, including all of the hardware and software required for the programming of EPROM types 2764, 27128 or 27256. Custom-tailored board programmers are also available.

SOFTLINK — Remote Control Software
Our programmers can be operated from a host computer or development system via the RS-232C serial port. SOFTLINK, a software driver, allows remote control of a programmer from an IBM® PC or an INTEL® MDS system.

Wavetek-Digelec's world-wide application and service support is just a phone call away. Call us with any questions that you may have.

CUPL is a trademark of Assisted Technology Inc.
CP/M is a registered trademark of Digital Research.
UNIX is a registered trademark of AT&T Bell Laboratories.
VMS is a trademark of Digital Equipment Corp.
IBM PC and PC-DOS are trademarks of International Business Machines.
INTEL MDS is a registered trademark of INTEL Corp.
PAL is a registered trademark of Monolithic Memories Inc.

PROM AND LOGIC PROGRAMMER SELECTION GUIDE

MODEL	803	804	824	825	810	828	829
EPROMS	•	•*	•	•	•	•	•
E^2PROMS	•	•	•	•	•	•	•
Single Chip Microprocessors	•	•	•	•			
Bipolar, ECL, CMOS PROMS	•						
PAL® , IFL Devices	•						
RAM Standard (Kbyte)	32	8	64	64	—	—	64 – 256
RAM Expandable (Kbyte)	64	32	128	128	—	—	256
Remote Control Standard	•	•	•	•			•
Display	5-in. CRT, 20 Line, 49 Char. Ea.	16 Char. Alpha-numeric	16 Char. Alpha-numeric	16 Char. Alpha-numeric	5 Char. 7 Segments Alphanumeric	16 Char. Alpha-numeric	16 Char. Alpha-numeric
Fast Prog. Algorithm	•	•	•	•	•	•	•
Multiple Programming (No. of sockets)	1	1	1	5	10	16	16
Featured on Catalog Page	216	222	220	220	226	224	224

*Model EP-804 also simulates EPROMs.

Universal PROM and Logic Programmer

- **Programs over 800 MOS and Bipolar PROMs**
- **Design, Program and Test over 100 PAL® and IFL Logic Devices**
- **Built-in CRT with Menu-Driven Operation**
- **Remote Control Standard (RS-232C)**
- **Written IC Manufacturers' Approvals**

The field-proven UP-803 Interactive PROM and Logic Programmmer handles all your current and future programming requirements.

UP-803 programs over 800 types of PROMs and logic devices, including 512K EPROMs, E^2PROMs and fuse-link, AIM, DEAP, and ISC-Z bipolar devices and single-chip microprocessors.

With a single plug-in unit you can design, program and test over 100 PAL® and IFL logic devices.

Software-controlled programming algorithms provide flexibility for incorporation of future devices.

The UP-803 is a powerful tool for the development laboratory. UP-803 offers a wide range of communication formats for interfacing with most computers, development systems and other compatible RS-232C instruments.

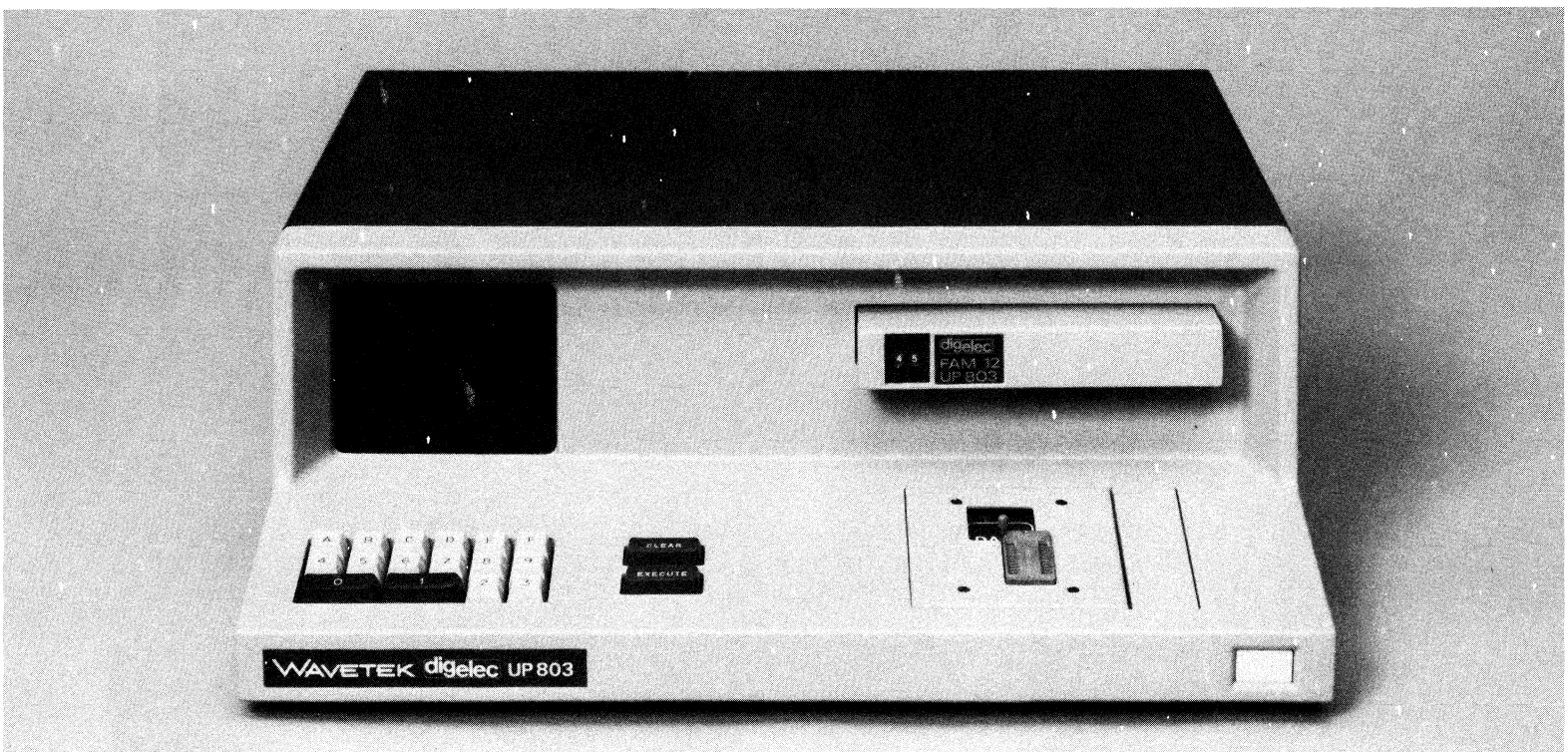
A special production mode and optional IC-handler interface make UP-803 a hard-working member of your production team.

User Very Friendly

You need to sit in front of our UP-803 in order to appreciate the true sense of user-very-friendliness. Enjoy the *built-in CRT* that provides 20 lines of data, control and status messages in plain language—no more deciphering of select and error codes.

The *full screen editor* lists 64 addresses at a time. Scroll up and scroll down to view data in your preferred presentation: hex, decimal, octal, or binary—with ASCII displayed as a standard bonus.

At every stage, *menu driven software* guides you—with an appropriate array of choices. A single keystroke will advance you to the next operation. No more manuals to consult, no more searching operator's card for a code.



By minimizing operator errors and reducing the training time required, user-very-friendliness will also improve your *bottom line*.

Proven Performance Today
UP-803 *programs over 800 different types of programmable devices* with just three (FAM) plug-in units that allow you to handle all your current and future programming needs.

You always have the option of choosing the best device for your application (EPROMs, E^2PROMs, PROMs, single-chip microprocessors, PAL, and IFL), your preferred technology (MOS, CMOS, ECL, fuse-link, AIM, DEAP, and ISO-Z bipolar) as well as your preferred IC manufacturer—we support over 25.

Written approvals from every major semiconductor manufacturer provide the best proof of the UP-803's superb programming capabilities.

Intelligent programming algorithms cut programming times for large devices. Proven design and precision components assure that programming voltages and timing signals meet semiconductor manufacturer's specifications at all times without requiring calibration.

Built-in Flexibility for the Future
The dynamic and changing world of programmable devices means that the "future" must be built into the programmer you buy today. The UP-803 is *designed for the future*. All operating and programming procedures are software controlled. When a new device is introduced or an existing programming algorithm is enhanced by the IC manufacturer, we release a software update incorporating the new algorithms. These updates are released on a regular basis.

The combined FAM/DA concept (programming plug-in and device adapter) of the UP-803 provides the necessary flexibility for the future. The FAMs contain the software and hardware for programming. The low-cost removable device adapters (DA) allow easy adaptation to new pin-out configurations and device packages.

Programmable logic arrays are extensively used in the UP-803 and are easily reprogrammed to adapt hardware to new requirements.

Close cooperation between Wavetek-Digelec and the semiconductor manufacturers is your guarantee that you will always be up to date.

Ideal for Engineering
UP-803 communicates directly with your development system or host computer. Fifteen built-in communication formats and a user definable format support the RS-232C serial port.

Remote control is standard. Driver programs for the INTEL® MDS and IBM® PC are available.

UP-803's ease of operation and menu driven software will speed up your product's entry into the market.

Perfect for Production
UP-803 features a reduced instruction subset for the production floor. This enables single keystroke and fool-proof operation by unskilled operators.

For higher production volume, UP-803 offers an optional interface for automatic and manual IC-handlers.

To assure *reliability and yield*, UP-803 performs extensive tests on the device before and after programming—including a parametric voltage test and a pin continuity test.

Indispensable for Programmable Logic
A FAM-52 plug-in module turns the UP-803 interactive programmer into a fully integrated logic center. It offers design, programming, and test of over 100 different types of PAL and IFL devices. The resident PAL assembler allows direct keyboard entry of Boolean equation or fuse matrix. The unique *disassembly function* displays the Boolean equation corresponding to your PAL fuse matrix. IFL devices are designed with *H & L tables*.

Four test methods assure the in-circuit performance of the logic device: fuse verification, pseudo-random signature test, user defined vector test and a combined vector/random test.

Data transfer of logic designs is performed in the JEDEC format via the RS-232C serial port.

SPECIFICATIONS

FUNCTIONAL

RAM
32K × 8 standard.
64K × 8 optional.

Display
5 in. CRT, 20 lines of 49 characters, brightness control.

Keyboard
16-key hexadecimal.
2 control keys.

Operation
Menu driven. Guides the user at every stage.

Error Message
Clear English messages on built-in CRT.

Calibration
Not required.

Address Formats
Decimal, Octal, and Hex.

Data Format
Binary, Octal, Hex and ASCII.

SERIAL PORT

Baud Rate
50, 110, 150, 300, 600, 1200, 2400, 4800, and 9600.

Parity Formats
Even, Odd, and None.

Stop Bits
1, 2.

Translation Formats
BPNF, BHLF, B10F, Binary, Binary (RUBOUT), ASCII Hex (SPACE), ASCII Hex, TELEX BPNF, MOSTEK Z80, MOTOROLA Hex, INTEL Hex-85, INTEL Hex-86, TEKTRONIX Hex.
In addition, a universal format is available which enables the user to define his own format.

Note: Additional formats are available.

GENERAL

Temperature
0° to 40°C.
Humidity
Up to 85% RH (non-condensing).
Dimensions
50 cm (19.8 in.) wide; 18 cm (7.1 in.) high; 52 cm (20.6 in.) deep.
Weight
15.5 kg (34 lb) net; 23.5 kg (52 lb) shipping.
Power
100, 120, 220, and 240 VAC, switch selectable; 48 to 60 Hz.

ACCESSORIES

FAM-12
Programming module for over 600 Bipolar PROMs, MOS E^2/EPROMs, and single chip microprocessors including intelligent algorithms.
FAM-14
Programming module for over 30 of the latest devices based on DEAP and AIM technology.
FAM-52
Design, programming, and test module for over 100 PAL and IFL logic devices.
DA-nn
Device adapter. Specify required number (nn).
TS-50
Logic device test add-on.
CUPL™
High level logic software.

FACTORY/FOB

North America: Sunnyvale, CA
All Others: Switzerland

Model UP-803/32
(UP-803 Programmer with 32K RAM)
Model UP-803/64
(UP-803 Programmer with 64K RAM)
DIGIPACK 1
(Includes UP-803/32, FAM-12, DA88, 2 × DA)
DIGIPACK 2
(Includes UP-803/64, FAM-12, DA88, 2 × DA)
DIGIPACK 3
(Includes UP-803/16, FAM-52, TS-50, 2 × DA)
DIGIPACK 4
(Includes UP-803/16, FAM-52, CUPL, 2 × DA)
DIGIPACK 5
(Includes UP-803/64, FAM-12, FAM-52, TS-50, DA88, 4 × DA)
DIGIPACK 6
(Includes UP-803/64, FAM-12, FAM-52, CUPL, DA88, 4 × DA)

PAL is a registered trademark of Monolithic Memories, Inc.
CUPL is a trademark of Assisted Technology, Inc.
IBM PC is a registered trademark of International Business Machines.
INTEL MDS is a registered trademark of INTEL CORP.

FAM-52 Logic Design Center

- **Design, Program and Test over 100 PAL® & IFL Logic Devices**
- **PAL Boolean Equations and Fuse Matrix Entry**
- **PAL Disassembler**
- **Pseudo-Random Signature Testing**
- **User Defined Vector Test**

The FAM-52 plug-in module turns the UP-803 Interactive Programmer into a fully integrated logic center. It offers design, programming, and test of over 100 different types of PAL and IFL devices. The resident PAL assembler allows direct keyboard entry of Boolean equation or fuse matrix. The *unique disassembly function* displays the Boolean equation corresponding to your PAL fuse matrix. IFL devices are designed with *H & L tables*.

Four test methods assure the in-circuit performance of the logic device: fuse verification, pseudo-random signature test, user-defined vector test, and a combined vector/random test. Data transfer of logic design is performed in the JEDEC

format via the RS-232C serial port.

Simple Logic Design
The UP-803 programmer equipped with the FAM-52 plug-in module, enables you to design a logic device from A to Z. The *resident PAL assembler* allows direct keyboard entry of *Boolean equations* relating to any selected output. The corresponding fuse matrix is displayed simultaneously and is updated as new logic terms are entered. *Direct fuse matrix design* is also available. While the fuse matrix is displayed on the CRT, the cursor can select any fuse to be blown or left intact. The phantom fuses are clearly displayed but any attempt to program them is rejected.

The *unique disassembly function* displays the Boolean equation relating to a given PAL device or fuse matrix. To document your design you simply print the equations, fuse matrix, and number of fuses blown on a standard printer. The *H & L tables* allow the design of IFL devices. The tables are displayed on the CRT in the form recommended by the device manufacturer. Convenient design data entry is supported by the screen editor and cursor control.

Simple Logic Programming
With a single plug-in unit, the FAM-52, you can program logic devices manufactured by AMD, Fairchild, Harris, MMI, National, Signetics, and Texas Instruments. New devices are added as they are introduced to the market. All programming operations are performed using the new menu-driven software. The *security fuse* can be blown at the operator's request. *Written approvals* from every major semiconductor manufacturer provide the best proof of the FAM-52's superb programming capabilities.

Simple Logic Testing
Four different tests are available on the FAM-52 Logic Center to assure a reliable logic device. The *fuse verification test* checks that all the fuses are blown according to the fuse matrix. Since this test alone cannot guarantee faultless in-circuit operation of the device, three optional tests are available. The *user defined vector test* enables the user to create and modify a set of input/output test vectors. These vectors will be applied to the inputs of the device under test (DUT) and actual outputs will be compared with the expected vectors. The programmer will respond with an immediate pass/fail indication. A unique "self-teaching" feature enables UP-803 to determine the output vectors of a given device without the user having to define them.

The *signature test* (a quick automatic functional test) generates pseudo-random test patterns to be fed to the DUT. The outputs are sampled and accumulated in a 16-bit signature register. At the end of the test this register will contain the entire "DUT signature". Comparing this signature to that of a known good device gives an easy go/no-go indication. The minimum test sequence is 64K vectors long and can be increased up to 256 times this length.

In the *combined vector/signature test,* the user defined vectors are first applied to the DUT followed by the signature test. This combination permits the presetting of register-type logic devices to assure a more effective signature test.

CUPL™—High Level Logic Design
CUPL is the first *High Level Universal Compiler Software* to support programmable logic devices. It supports all PAL and IFL devices now on the market and allows the design engineer to second source at the socket level. CUPL runs on a wide variety of operating systems from CP/M and PC-DOS to UNIX and VMS. The second generation CUPL includes entry capabilities for *Boolean equations, state machines,* and *function tables* in addition to having a minimization capability.

SPECIFICATIONS

RS-232C SERIAL PORT
JEDEC and HEX formats

DEVICE TESTING

Bit Tests
Blank check.
Illegal bit check.
Fuse Verification
Vector Test
User-defined vector test.
Maximum number of vectors: 500 (depending on device type).
Signature Test
Pseudo-random functional test.
Vectors per cycle: 64,000.
Maximum number of cycles: 256.

GENERAL

Dimensions
18 cm (7 in.) wide; 3 cm (1.2 in.) high; 25 cm (10 in.) deep.
Weight
0.8 kg (1.8 lb) net; 1.0 kg (2.2 lb) shipping.

FACTORY/FOB

North America: Sunnyvale, CA
All Others: Switzerland

Model FAM-52
CUPL
DIGIPACK 3
(Includes UP-803/16, FAM-52, TS-50, 2 × DA)
DIGIPACK 4
(Includes UP-803/16, FAM-52, CUPL, 2 × DA)

PAL is a registered trademark of Monolithic Memories, Inc.
CUPL is a trademark of Assisted Technology, Inc.

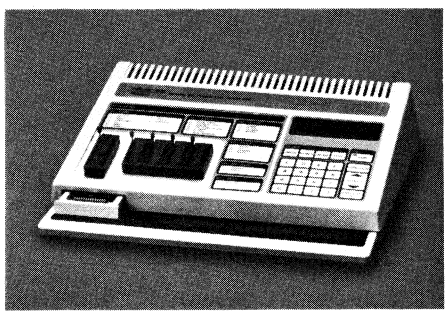
Portable Programmers

- **Program E^2/EPROM and Single Chip Microprocessors Without Adapters**
- **Built-in UV Eraser**
- **Software-Pack for Easy System Update**
- **Program A Set of 4 E^2/EPROMs Simultaneously (Model 825 Only)**
- **Time Saving "Speedy Mode"**

Model 824 Portable E^2/EPROM Programmer, shown below, programs all available EPROMs, E^2PROMs, and single-chip microprocessors with a capacity of *up to 512K bits.* Dual sockets assure that devices can be programmed without an adapter.

Set Programming In R&D

Model 825 Portable Set Programmer enables you to download a complete file from your host computer or development system and program complete sets of multiple EPROMs. It starts with a single keystroke and ends long before you expect it. This feature is a real time saver and it saves time right where you need it most, during development time. No more engineers hanging around during programming. Your product will be in the market faster.



Model 825 Portable Set Programmer

The unique combination of a 40-pin socket and four 28-pin sockets allows programming of all available E^2/EPROMs, and single-chip microprocessors with capacity of up to 512 Kbits without additional adapters.

User Friendly

Models 824 and 825 are user friendly. Interactive software simplifies programming by guiding the user in plain English through each stage of operation. The combination of dedicated function keys and select code operations increases the range of operations and maximizes speed. The most frequently used functions are single keystroke activated to save you time. All other functions are listed on the front panel allowing them to be accessed quickly without dependence on the user's manual.

MODELS 824 & 825 PROM AND LOGIC PROGRAMMERS

Clear operator messages are displayed if there is an error in manipulation or if incorrect data is entered.

Time Saving Speedy Mode
"Speedy Mode" enables true single keystroke operation. While other programmers burden the user with a lengthy dialogue before each operation, "Speedy Mode" slashes time on the routine work by relying on default values. This minimizes key-in time, while maximizing operating capability.

Set-Mode Increases Throughput
The "Set-Mode" enables you to download a complete file from the computer and to program complete sets of multiple EPROMs with a single keystroke. This feature is a real time saver for the increased size of today's programs.

"Software Packs" — Quick Update Capability
Both programmers feature "Software Packs" — our innovative firmware cartridge concept. Enjoy the latest software updates without having to return your programmer to the factory or service center. Plug in a new cartridge and in just seconds update your programmer to accommodate the programming algorithms of the latest devices.

Customized "Software Packs"
Customized "Software Packs" for OEM application are optional. Dedicated menus can be tailored to suit your special requirements (e.g., telecommunication equipment).

Built-In UV Eraser
The built-in EPROM UV Eraser makes either programmer a complete and self-supporting programming station. Take them where they are needed — they will always do the complete job.

Signature Recognition
Models 824 and 825 can recognize the device type in use, by comparing the on-chip "signature" (comparable to Intel's "Intelligent Identifier"™). The exact programming algorithm is applied, eliminating operator error and increasing throughput and yield.

Remote Control
Models 824 and 825 can be operated from a remote computer or terminal via the RS-232C serial port. The wide range of communication formats which are available for interfacing with various computers make either programmer an integral part of your microprocessor development system. Driver programs for remote control from INTEL® MDS and IBM® PC are available.

Portable And Rugged
Models 824 and 825 are lightweight units using a molded impact-resistant housing to assure reliable operation in rugged conditions. A flip-out carrying handle provides the portability necessary for the field service engineer.

RAM

Standard: 64Kx8.
Optional To: 128Kx8.

RS-232C SERIAL PORT

Remote Control: Standard computer remote control.
Baud Rate: 50 to 19.2K Baud
Parity Formats: Odd, even, none.
Stop Bits: 1, 2.
Number of Bits: 5, 6, 7, 8.
Translation Formats: BINARY, BINARY (RUBOUT), ASCII-HEX (SPACE), ASCII-HEX, SIGNETICS HEX, MOSTEK (Z80), MOTOROLA, INTEL HEX, TEKTRONIX and INTEL HEX 86. New formats are added on a regular basis, supported by user oriented application notes.

PROGRAMMABLE DEVICES

The following devices are currently supported by Models 824 and 825. Ask a Wavetek representative for a programming guide for a complete and updated list of programmable devices.

EPROM: 2758, 2716, 27C16, 27C16H, 2516, 2732, 2732A, 2732B, 27C32, 27C32H, 2532, 2764, 2764A, 2764H, 27C64, 2564, 27128, 27128A, 27C128, 27256, 27C256, 27512, 68732, 68764, 68766, 5133, 5143.
E^2PROM: 5213, 52B13, 52B23, 52B33, 2815, 2816, 2816A, 48016, 2817, 2817A, 2832, 2864, 2864A.
Single Chip: 8741, 8742, 8744, 8748, 8748H, 8749H, 8751, 8751H, 8755A.

EDITING FUNCTIONS

The following functions are available for editing the data in the user RAM: List/Edit, Delete, Insert, Complement, Fill, Move, Search, Split/Shuffle, and Checksum.

DEVICE FUNCTIONS

The following functions are performed on the device: Program, Verify, Read, Select Type, Checksum, Illegal Bit Check, Blank Check, List Device and RAM, E^2PROM Erase, E^2PROM Test, and Read Signature. A checksum is displayed after all device functions.

ADDITIONAL FUNCTIONS

Transmit, Receive, Format, RS-232C, UV Timer, Options, and Self Test.

ADDITIONAL FEATURES

Automatic Detection: Reversed chip, dislocated chip, Textool empty, and overload.
Power-down: Parameter retention during power-down.

GENERAL

Environment
Temperature: 0° to 40°C.
Humidity: Up to 85% RH (non-condensing).
Dimensions
37 cm (14.6 in.) wide; 10 cm (3.9 in.) high; 25 cm (9.8 in.) deep.
Weight
4 kg (9 lb).
Power
User selectable 110/220V; 50/60 Hz.

FACTORY/FOB

North America: Sunnyvale, CA
All Others: Switzerland

Model 824
(Portable Programmer)
824-Soft
(Additional software pack for Model 824. Please specify revision.)
Model 825
(Portable Set Programmer)
825-Soft
(Additional software pack for Model 825. Please specify revision.)

IBM® PC is a registered trademark of International Business Machines.
Intel® MDS and "Intelligent Identifier" are trademarks of INTEL Corporation.

E² / EPROM Programmer & Simulator

- **Programs All EPROMS Up To 27256**
- **Programs And Erases E²PROMS**
- **Programs Single-Chip Microprocessors**
- **Intelligent Programming 2764, 27128, 27256**
- **Remote Control Standard (RS-232C)**

The EP-804 Universal EPROM Programmer and Simulator programs over 100 MOS EPROMs and E²PROMs.

Software-controlled programming algorithms provide flexibility for incorporation of future devices. The EP-804 offers a wide range of communication formats for interfacing with most computers, microprocessor development systems and other compatible RS-232C instruments.

The EP-804 makes programming simple. Once data is in the RAM, it can be edited by commands entered from either the front panel or a remote instrument.

The EP-804 is user-friendly too. The 16-character alphanumeric display prompts users in plain English. Interactive software guides users through each stage for a minimum of operator errors. Lightweight and compact, EP-804 is the perfect companion for the field service engineer.

RS-232C Serial Port
The standard RS-232C port allows the EP-804 to interface with most computers, microprocessor systems, and other compatible RS-232C instruments. Currently available formats are: Intel-Hex, Motorola Exorciser, ASCII-HEX (Space), ASCII-BNPF, X-on/X-off, and Manual format. New formats are added on a regular basis, supported by user oriented application notes.

All serial port parameters may be specified via the keyboard: Baud rate (50 to 19.2K Baud), Parity (odd, even, none), Stop bits (1, 2), and Mode (full or half duplex).

Remote Control
The standard remote control feature makes the EP-804 an integral part of

your software development system. You can operate the EP-804 from the console of your computer or development system. Control programs for the Intel® MDS system and PHILIPS PMDS are available.

Operating Functions

Each of the 18 operating functions may be activated with a single keystroke. The current mode and function are clearly indicated by LEDs.

EPROM Simulator

The simulator resident in the EP-804 saves time in development and debugging of programs. Programs are loaded into the EP-804 RAM, test-run and modified until fault-free operation is achieved, followed by the programming of an EPROM. RAM size during simulation is determined by the device type selected (0.5K to 32K Byte). A 300 ns access time assures that even the fastest EPROMs can be simulated.

PROGRAMMABLE DEVICES

The following devices and their equivalents can currently be programmed on the EP-804:

EPROM
2704, 2708, 2758, 2716, 27C16, 2516, 2732, 2732A, 27C32, 2532, 2764, 2764A, 27C64, 2564, 27128, 27128A, 27C128, 27256, 27C256, 68732, 68764, 68766.

E²PROM
2815*, 2816*, 2816A*, 2817*, 48016.

Single Chip*
8741A, 8742, 8748, 8749H, 8751, 8751H, 8755A.

*Requires device adapter.

RAM FUNCTIONS

Load RAM
Loads RAM from keyboard, master EPROM or RS-232C communication line.

Fill RAM
Fills RAM with constant data.

Move
Moves a data block in RAM.

Search
Search for a string of data.

Split/Shuffle
Split and Shuffle for 16-bit data manipulation.

Display RAM
Displays RAM data on the built-in display.

Transmit RAM
Transmits RAM data via RS-232C serial port.

DEVICE FUNCTIONS

Check
Performs a blank check, illegal bit check or 4 digit checksum.

Verify
Compares data in EPROM to RAM.

Program
Automatically performs illegal bit check, programming and verify sequence.

Erase
Erases E²PROMs.

Display EPROM
Displays EPROM data on built-in display.

Transmit EPROM
Transmits EPROM data via RS-232C serial port.

DEVICE FUNCTIONS

Clear
Clears data entry or execution error.

Repeat
Repeats the last operation.

Self Test
Self test is performed each time power is turned on or new functions are selected.

Initialization
Enters EPROM type, base address, data format and initializes the RS-232C interface.

GENERAL

Environment
Operating Temperature: 0° to 40°C.
Humidity: To 85% RH (non-condensing).

Dimensions
32.0 cm (12.6 in.) wide; 8.5 cm (33 in.) high; 20.8 cm (8.2 in.) deep.

Weight
2.0 kg (5 lb).

Power
Switch selectable 110/220V; 50/60 Hz.

ACCESSORIES

Model 804-71
16 Kbyte RAM expansion kit.

Model 804-72
32 Kbyte RAM expansion kit.

Model 8041
Device adapter for 2815, 2816, 2816A.

Model 8042
Device adapter for 8775A.

Model 8043
Device adapter for 8751, 8751H.

Model 8044
Device adapter for 2817.

Model 8045
Device adapter for 8741H, 8742, 8748, 8749H.

Model 804-2030
Interface cable for PHILIPS PMDS.

Model 804-2032
Interface cable for Intel MDS (please specify system and port number).

Model 804-SW
Software update for EP-804.

FACTORY/FOB

North America: Sunnyvale, CA
All Others: Switzerland

Model EP-804/8
(Programmer with 8K RAM)

Model EP-804/16
(Programmer with 16K RAM)

Model EP-804/32
(Programmer with 32K RAM)

INTEL MDS is a trademark of INTEL CORP.

Production/Set Programmers

- **Programs EPROMs Up to 27512**
- **Programs, Erases, and Tests E^2PROMs**
- **Multiple Set Programming in any Combination (Model 829 Only)**
- **"Software Pack" For Easy System Update**
- **Intelligent Programming Algorithms**

Models 828 and 829 are advanced production programmers that can program up to 16 devices simultaneously. The 828 programs all available E^2/EPROMs with a capacity of up to 512 Kbits.

Models 828 and 829 meet the stringent demands of the production floor by using fast programming algorithms that drastically increase programming throughput, automatic multiple testing of devices to assure reliability, and a clear and easy to use keyboard that allows operation by unskilled personnel. Interactive software simplifies programming by guiding the user in plain English.

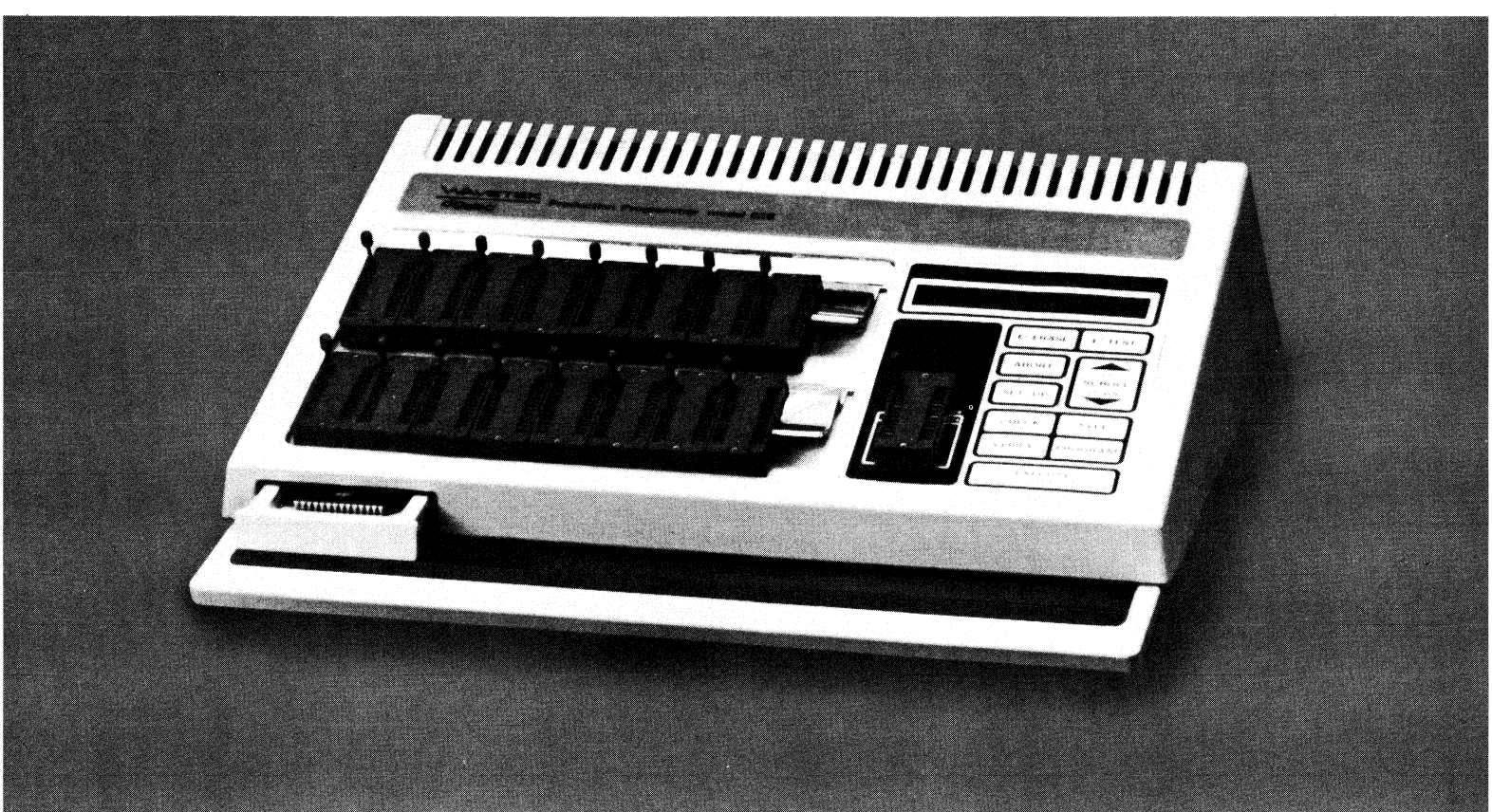
Close cooperation between Wavetek-Digelec and the semiconductor manufacturer during the programmer development results in the highest component programming yield.

Programming is performed with a single keystroke that invokes an automatic testing and programming sequence which includes master EPROM checksum, blank check, programming, verify checksum of programmed device and indication of a checksum error.

Device type is software-selectable, so that no adapters or characterizers are needed.

"Software Packs" — Quick Update Capability
Both programmers feature "Software Packs" — our innovative firmware cartridge concept. Enjoy the latest software updates without having to return your programmer to the factory or service center. Plug in a new cartridge and in just seconds your programmer is set to accommodate the programming algorithms of the latest devices.

Set-Mode: Increases Throughput (829 Only)
The "Set-Mode" enables you to download a complete file from a computer and to program complete



sets of multiple EPROMs with a single keystroke. This feature is a real time saver for the increased size of today's programs.

Signature Recognition (829 Only)
Device type is recognized by reading the on-chip "signature" (comparable to Intel's "Intelligent Identifier"™). The exact programming algorithm is applied, eliminating operator error and increasing throughput and yield.

Remote Control (829 Only)
Operation can be from a remote computer or terminal via the RS-232C serial port. The wide range of communication formats which are available for interfacing with various computers make the Model 829 an integral part of your microprocessor development system.

Driver programs for remote control from INTEL® MDS and IBM® PCs are available.

Time Saving "Speedy Mode"
"Speedy Mode" enables true single keystroke operation. While other programmers burden the user with a lengthy dialogue before each operation, "Speedy Mode" slashes time on the routine work by relying on default values. This minimizes key-in time, while maximizing operating capability.

RAM

64 Kbytes, 128 Kbytes, 256 Kbytes.

RS-232C SERIAL PORT (MODEL 829)

Remote Control
Standard computer remote control.
Baud Rate
50 to 19.2K Baud.
Translation Formats
BINARY, BINARY (RUBOUT), ASCII-HEX (SPACE), ASCII-HEX, SIGNETIC HEX, MOSTEK (Z80), MOTOROLA, INTEL HEX, TEKTRONIX and INTEL HEX 86.

New formats are added on a regular basis, supported by user oriented application notes.

PROGRAMMABLE DEVICES

The following devices are currently supported by the Model 828 and 829 programmers. Ask a Wavetek Representative for a complete and updated list of programmable devices.

EPROM
2758, 2716, 27C16, 27C16H, 2516, 2732, 2732A, 2732B, 27C32, 27C32H, 2532, 2764, 2764A, 2764H, 27C64, 2564, 27128, 27128A, 27C128, 27256, 27C256, 27512, 68732, 68764, 68766, 5133, 5143.

E^2PROM
5213, 52B13, 52B23, 52B33, 2815, 2816, 2816A, 48016, 2817, 2817A, 2832, 2864, 2864A.

OPERATING FUNCTIONS (MODEL 828)

The following functions are performed on the device. A checksum is displayed after all device functions.

Program
Program 16 devices with the data from master PROM.
Verify
Compare the data in the master PROM with the data in the device.
Select Type
Select the device type.
Checksum
Calculate a 4 digit checksum for data in the device.
Illegal Bit Check
Check that the devices can be programmed with the data in the master PROM.
Blank Check
Check that the device is in its virgin state.
E^2PROM Erase
Erase E^2PROM by electronic signals.
E^2PROM Test
Perform an ERASE/WRITE/ERASE test on the E^2PROM.

OPERATING FUNCTIONS (MODEL 829)

In addition to all the functions performed by the Model 828, the Model 829 performs all editing, RAM, and communication functions performed by the Model 824.

ADDITIONAL FEATURES

Automatic Detection
Reversed chip, dislocated chip, textool empty, and overload.
Power-down
Parameter retention during power-down.

GENERAL

Environment
Operating Temperature: 0° to 40°C.
Humidity: Up to 85% RH (non-condensing).
Dimensions
37 cm (14.6 in.) wide; 10 cm (3.9 in.) high; 25 cm (9.8 in.) deep.
Weight
Model 828: 6 kg (14 lb).
Model 829: 8 kg (18 lb).
Power
User selectable 110/220V; 50/60 Hz.

FACTORY/FOB

North America, Sunnyvale, CA
All Others: Switzerland

Model 828
(Production Programmer)
828-Soft
(Additional software pack for 828. Please specify revision.)
Model 829
(Production Set Programmer)
829-Soft
(Additional software pack for 829. Please specify revision.)

Gang Programmer

- **Programs 10 EPROMs Simultaneously**
- **Programs and Erases E²PROMs**
- **Automatic Programming and Test Sequence**
- **Blank Check, Verify, and Checksum Tests**
- **Intelligent Programming 2764, 27128, 27256**

GP-810, an advanced Gang Programmer, programs up to 10 EPROMs or E²PROMs simultaneously — including the latest 27256 and CMOS versions.

GP-810 meets the stringent demands of production lines with fast programming algorithms and total testing procedures that multiply the programming throughput. Device type is software-selectable — no adapters or characterizers needed and only a simple software revision is needed for most future devices.

SPECIFICATIONS

PROGRAMMABLE DEVICES

EPROMs

16K-bit: 2516, 2716, 27C16
32K-bit: 2532, 2732, 2732A, 27C32, 27C32A
64K-bit: 2564, 2764, 2764A, 27C64
128K-bit: 27128, 27128A, 27C128
256K-bit: 27256, 27C256

E²PROMs

2816, 48016

OPERATING FUNCTIONS

- **Blank Check**
- **Automatic Program**
- **Verify**
- **Reset**
- **Erase**
- **Device Selection**
- **Improper Insertion Checks**

LAMP INDICATORS

- **Device Type**
- **Blank**
- **Verify**
- **EPROM Reversed**
- **Checksum**

GENERAL

Environment
Operating Temperature: 0°C to 40°C.
Humidity: To 85% RH (non-condensing).
Dimensions
37.4 cm (14.7 in.) wide; 8.9 cm (3.1 in.) high; 24.5 cm (9.6 in.) deep.
Weight
5.7 kg (12.6 lb).
Power
Selectable 110/120/200/240V; 50/60 Hz.

FACTORY/FOB

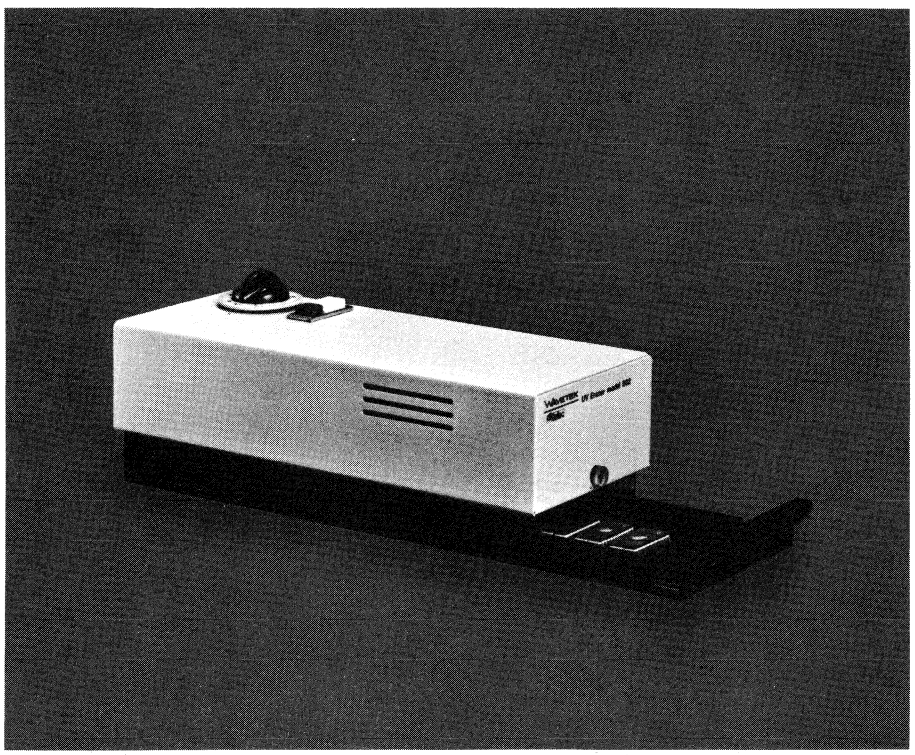
North America: Sunnyvale, CA
All Others: Switzerland

F

Model GP-810
(Gang Programmer)
Model 810-SW
(Software update for GP-810)

Ultra-Violet Eraser

- **Erases up to 20 EPROMS Simultaneously**
- **Presettable Built-in Timer**
- **Safety Interlock**
- **Automatic UV Light Shut-off**
- **Latched Drawer Prevents UV Exposure**



Model UVE-802 is an *advanced ultra-violet eraser* for UV-erasable PROMs. Housed in a rugged metal case, the UVE-802 consists of a UV light source with a built-in presettable timer. Depending upon the model, the UVE-802 can erase from 1 to 20 EPROMs at a time (including single-chip microprocessors).

The UVE-802 is safe and reliable. A safety mechanism protects against accidental exposure to hazardous shortwave UV light by preventing the erasure operation unless the drawer is completely inserted into the housing. Chips are *electrostatic charge protected* by a conductive foam pad in the drawer.

SPECIFICATIONS

ULTRAVIOLET LIGHT SOURCE

UV Lamp
6 watts.
Wavelength
2737 A° (253.7 nm).
Intensity
UVE-802/11: 11,000 microwatts/cm^2.
UVE-802/21: 12,500 microwatts/cm^2.
Lamp Life Expectancy
5000 hours.

TIMER

Automatically turns off UV lamp. Presettable up to 30 minutes ± 10%.

MAXIMUM CAPACITY

UVE-802/11: 10 EPROMs
UVE-802/21: 20 EPROMs

ERASE TIME

Erase energy 6W-s/cm^2
UVE-802/11: 8 minutes.
UVE-802/21: 7 minutes.
Erase energy 15W-s/cm^2
UVE-802/11: 24 minutes.
UVE-802/21: 21 minutes.

GENERAL

Dimensions
10.7 cm (4.2 in.) wide; 8.2 cm (3.2 in.) high; 25.4 cm (10 in.) deep.
Drawer Inner Dimensions
18.0 cm (7.0 in.) long.
4.8 cm (1.9 in.) wide (UVE-802/11).
9.5 cm (3.7 in.) wide (UVE-802/21).
8.0 mm (5/16 in.) deep with foam pad.
14.0 mm (9/16 in.) deep without foam pad.
Weight
UVE-802/11: 2.0 kg. (4.5 lb).
UVE-802/21: 2.7 kg. (6.0 lb).
Power
100 to 120V (60 Hz) or 200 to 240V (50 Hz).

FACTORY/FOB

North America: Sunnyvale, CA
All Others: Switzerland

Model UVE-802/11 (220V)
Ultraviolet Eraser for 10 EPROMS (200-240 V; 50 Hz)
Model UVE-802/11 (110V)
Ultraviolet Eraser for 10 EPROMS (100-120 V; 60 Hz)
Model UVE-802/21 (220V)
Ultraviolet Eraser for 20 EPROMS 200-240 V; 50 Hz)
Model UVE-802/21 (110V)
Ultraviolet Eraser for 20 EPROMS (100-120 V; 60 Hz)

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 Wavetek or your local Wavetek representative. Catalog featured instruments not listed below are not rack mountable.

Rack Mounts and Adapters

Instrument	Rack
20, 21, 22, 23	1, 5
132	1, 2, 3, 10
143, 145, 148A	1, 2, 3
152, 159	10*, S20
164, 166	10
171	1, 2, 3
172B	10*, S22
175, 178	10*, S20
180, 182A	4, 5
183 through 187	1, 2, 3
188, 190	4, 5
189, 191, 193	1, 2, 3
270, 271, 273, 275, 278	12, 13, S20
432, 442, 452	Opt 04, M128
512/S, 541A, 716,	11**
601, 602, 603	10*
751A, 752A, 753A	11*, M128
801, 802	1, 2, 3
816	11*, M134
852	Opt 04, M128
859	10*, S22
904, 907, 907A	10*
952, 954, 955, 957	14, 15
1001A, 1002	K103, K104
1018B	1031
1038 Series	Opt 01
1045/01	1047
1062, 1067-522	K015
1080, 1081,1083, 1084	K019
1801B, 1801C	K107
1901C, 1905, 1910	K107
2000, 2001	K015
2002B, 2005	K108
2102	K015
3000, 3000-200, 3001	K108
3002, 3003, 3004	K108

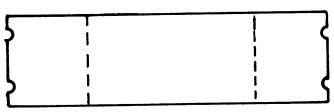
Rack Mounts and Adapters (Continued)

Instrument	Rack
3005, 3006, 3020	K108
3510, 3520	K0234
4101	K015
5100, 5110	11*, M128
5120A/5121A, 5130A/ 5131A, 5135A/5136A	11*, Opt 08
5155A/5156A	11*,Opt 08
5820/5830	Opt 01
6000†	
7530A***	

*Standard with instrument.
**Standard with instrument. Pem nuts installed for Chassis Trak drawer slides Model C300S-122.
***Use with rack mountable Tektronix 7000 Series mainframe.
†Consult factory.

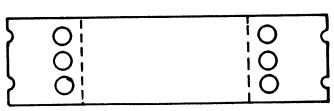
RACK MOUNT PANELS

Style 1 (Factory Only)



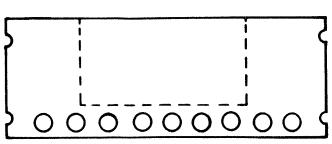
19 × 5¼ in. solid panel. The instrument price will be increased.

Style 2 (Factory Only)



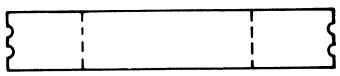
19 × 5¼ in. solid panel. Instrument is center mounted between six feedthrough BNCs as shown. The instrument price will be increased.

Style 3 (Factory Only)



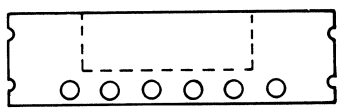
19 × 7 in. solid panel. Instrument is center mounted above nine feedthrough BNCs as shown. The instrument price will be increased.

Style 4 (Factory Only)



19 × 3½ in. solid panel. The instrument price will be increased.

Style 5 (Factory Only)



19 × 5¼ in. solid panel. Instrument is center mounted above six feedthrough BNCs as shown. The instrument price will be increased.

RACK ADAPTERS

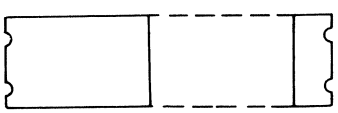
Style 10

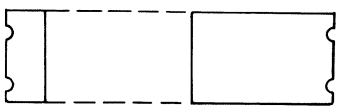
Pair of "ear" adapters that attach to the right and left sides of the standard instrument. Rack height is instrument height and instrument is centered in the 19 in. rack.

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 K015
Kit adapts the instrument for center mounting in a standard 19 × 5¼ in. rack.

Style K019
Kit adapts the instrument for center mounting in a standard 19 × 7 in. rack.

Style K103
Kit adapts the instrument for left or right hand mounting in a standard 19 × 5¼ in. rack.

Style K104
Kit adapts two instruments for dual mounting in a standard 19 × 7 in. rack.

Style K107
Kit adapts the instrument for center mounting in a standard 19 × 9-7/8 in. rack.

Style K108
Kit adapts the instrument for center mounting in a standard 19 × 5¼ in. rack.

Style K0234
Pair of "ear" adapters that attach to the right and left sides of the standard instrument. Rack height is instrument height.

Model 1047
Kit adapts 1045/01 for 19 × 3½ in. rack. Includes 2 front panel handles with a pull-out slide feature.

Model 1031
Kit adapts 1018B for 19 × 5¼ in. rack. Includes 2 front panel handles.

RACK SLIDES

If your needs are not covered by these styles, consult the applicable instrument factory.

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

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.

International Sales and Service Centers

ARGENTINA
IOTA S.A.C.I.F.I.A.
No. 232 - Suc. 5
1045 Buenos Aires, Argentina
Tel: (1)431-0911, Tlx: 9901 + CATHEDRAL

FFT Spectrum Analyzers
SEARCH SA
Corrientes 617/6 Piso
1045 Buenos Aires CC, BS AS Argentina
Central 5470-1000,
Tel: (1)394-5882, Tlx: 24447 + SEARHAR

AUSTRALIA
SCIENTIFIC DEVICES (PTY) LTD.
2 Jacks Road, P.O. Box 43
South Oakleigh, Victoria 3167, Australia
Tel: (3)579-3622, Tlx: 32742 + ANSWER

PROM/Logic Programmers
A.J. DISTRIBUTORS PTY. LTD.
44, Prospect Road, P.O. Box 71
Prospect, South Australia
Tel: (71)82635, Tlx: 82635 + FERGAD A

AUSTRIA
WALTER REKIRSCH ELECTRONISCHE GERAETE GMBH CO. KG.
Obachgasse 28
1220 Wien (Vienna), Austria
Tel: (0222)235-555, Tlx: 134759 + REKEL A

PROM/Logic Programmers
L.B. ELECTRONICS Ges.m.b.H
Rudolf-Kassner-Gasse 32
A-1190 Wien, Austria
Tel: (0222)324-152/53, Tlx: 133722 + LIND A

BELGIUM
AIR-PARTS INTERNATIONAL B.V.
Avenue Huart-Hamoir 1-Box 19
B-1030 Brussels, Belgium
Tel: (02)241-8130, Tlx: 25146 + API B

PROM/Logic Programmers
M.C.A.B. S.P.R.L.
Avenue de Sumatra 41
1180 Bruxelles, Belgium
Tel: (02)3743565, Tlx: 64446 + HCABRU

BRAZIL
COSELE INSTRUMENTOS ELECTRONICOS, LTDA.
Rua da Consolacao, 867
3.° And. - Conj. 32
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