

MODEL 6100
& MODEL 600
SYNTHESIZED
MICROWAVE
SIGNAL
GENERATORS

6100
600



Giga-tronics

RESOLUTION, STABILITY, ACCURACY, SPECTRAL PURITY AND RELIABILITY... AT HALF WHAT YOU WOULD EXPECT TO PAY!

When you said you needed the performance of a synthesized instrument, but your narrow-band applications couldn't afford multi-band prices, Giga-tronics developed a unique, new technology to provide the answer.

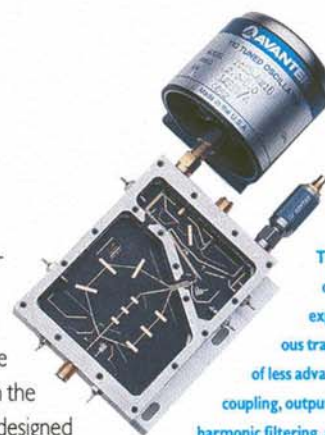
A REVOLUTION IN SINGLE-BAND MICROWAVE DESIGN

In the past, engineers responsible for designing, testing or maintaining components, subassemblies or systems that operated over narrow-band microwave frequencies had two choices of signal generators. One choice was the excellent performance but high price tag of a wide-band digital instrument. The other choice was the reasonable price but relatively poor performance of a single-band analog instrument.

Giga-tronics' engineers made two design breakthroughs that allowed them

to optimize both performance and price in a single instrument: The consolidation of several expensive microwave components in the RF path into one specially designed module and the elimination of an expensive YIG-tuned oscillator in the reference loop.

The reference YIG-tuned oscillator was replaced with a sophisticated but much less expensive frequency reference, and the task of controlling the complex frequency relationships required to phase-lock the output YIG to the crystal-controlled time base oscillator was given to the instrument's advanced microprocessor system. This technique allows the economical generation of high resolution (1 kHz) signals over single-band ranges with synthesized accuracy and stability.



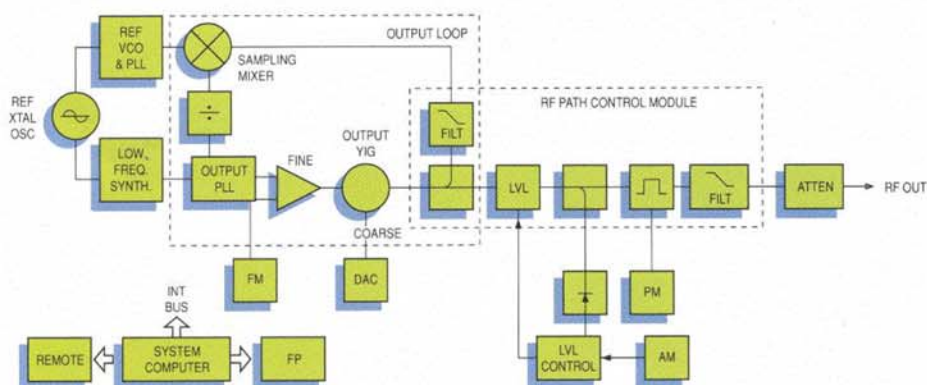
This specially designed hybrid control module replaces several expensive components and numerous transitions found in the RF path of less advanced instruments. It provides coupling, output leveling, fine attenuation, harmonic filtering, amplitude modulation, and intra-pulse signal termination. The YIG-tuned output oscillator is shown attached to the module's input, while the leveling detector is shown attached to one of its outputs.

THE DESIGN EFFORT PRODUCED TWO OTHER IMPORTANT BENEFITS—INCREASED RELIABILITY AND MORE USABLE OUTPUT POWER

Because the specially designed module allows the management and control of microwave signals with a minimum number of components and power wasting transitions, our Series 600 and Series 6000 instruments are even more dependable, and can deliver the test signal power to meet your most demanding requirements.

For over ten years, Giga-tronics has been a leader in the design, development and manufacture of synthesized microwave test instruments for both military and commercial applications. All of our instruments meet the requirements of MIL-T-28800D for Type III, Class 5, Style E test equipment. Our ongoing analysis of field performance indicates that Giga-tronics products have achieved an enviable MTBF approaching 10,000 hours.

This history of proven reliability and our continuing commitment to quality assure you that a Giga-tronics instrument will not only live up to your expectations at the time of purchase, but will continue to do so throughout its life.



Performance, reliability and cost are optimized by a new frequency reference design which is both simple and elegant. The frequency of a VCO is varied so that an appropriate multiple is available to mix the output frequency down to an IF of 10 to 80 MHz. This IF, divided by 2, 4 or 8, is one input to the output phase-lock loop. The other input to the loop is a high resolution, low frequency synthesized signal. The output YIG is phase-locked at the desired output frequency under the control of an advanced microprocessor.

ALL THE ADVANTAGES OF INDIRECT SYNTHESIS, PLUS *BUILT-IN*, DIGITALLY CONTROLLED PULSE AND FUNCTION GENERATORS FOR MODULATING THE RF SIGNAL

Whatever the frequency band, these cost-effective signal generators give you frequency accuracy and stability in parts per million, or in parts per billion. You also get 1 MHz or 1 kHz frequency resolution, plus external and internal control of AM, FM, and pulse modulation.

THE RIGHT INSTRUMENT FOR THE JOB

Our Model 600 and Model 6100 signal generators are each available in seven standard frequency ranges. This means you can choose the specific band and instrument you need for microwave component development, system alignment, simulation of dynamic operating conditions, or other radar or telecommunications applications.

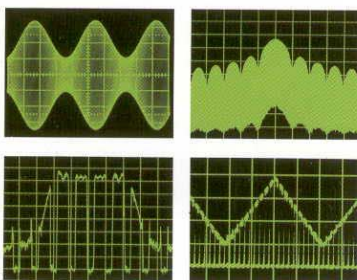
- 10 MHz to 8 GHz
- 10 MHz to 12 GHz
- 2 GHz to 8 GHz
- 2 GHz to 12 GHz
- 5.4 GHz to 12.5 GHz
- 6 GHz to 18 GHz
- 10 GHz to 18 GHz

A complement of options and accessories (see specification pages) lets you configure your 600 or 6100 exactly as you want it.

THE PERFORMANCE YOU'VE ALWAYS NEEDED FROM A SINGLE-BAND INSTRUMENT

Leveled output power controlled in 0.1 dB steps from +10 to -120 dBm, with ± 2 dBm output power accuracy; available frequency resolution to 1 KHz; time base stability of 1 part in 10^6 or 10^9 , plus excellent spectral purity mean that you've got what it takes to assure integrity of test results over a wide variety of testing applications. A built-in pulse generator provides precision rep rate, delay and width control of pulse modulation with a greater than 80 dB on/off ratio,

and less than 25 nsec rise and fall times. Two built-in function generators provide sine, square, and triangle wave modulation of amplitude and frequency.



Regardless of test complexity, these advanced signal generators will economically provide a wide range of amplitude modulation, frequency modulation and pulse modulation to satisfy the requirement. Each type of modulation is independently controlled and may be utilized individually for specific test requirements, or in any combination for complete device performance verification under multiple modulation conditions.

Model 6100 Microwave Signal Generator (top), and the Model 600 Microwave Signal Generator. Both models shown with 1 kHz resolution option.

EASY OPERATION—FROM THE FRONT PANEL, OR VIA THE IEEE-488 BUS

The 600 or 6100 can easily be integrated into small bench-top systems, or into large ATE applications. All digitally controlled parameters of these instruments may be programmed via the IEEE-488 bus.

The Model 6100's innovative data entry system allows you to easily and quickly access a number of special functions: For example, you can store up to 10 complete front panel set-ups of frequency, output level and modulation parameters. You can also initiate self-test routines, or reset to initial conditions, or even define special functions.

OTHER GIGA-TRONICS INSTRUMENTS

Giga-tronics has a complete line of microwave signal generation instruments that economically serve a great variety of applications. Ask your local Giga-tronics sales representative, or call 1-800-726-GIGA (FAX 415-680-7736) for information on any of our fine single or multi-band signal generators, sources and sweepers.

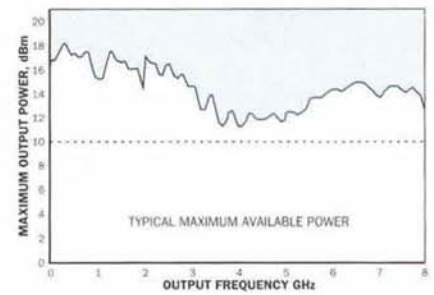
The Model 6100 features a data entry system that lets you control functions as easily from the front panel as your computer can via the IEEE-488 bus. You enter numerical data with the keypad, or with the variable resolution digi-dial and up/down push-buttons. The entry menu prompts your selections, or lets you review the setting of any parameter.

For added convenience, the push-buttons illuminate to show you which parameters and modes are in use.





Complete system verification goes quickly and easily (with a minimum of peripheral test equipment) using the Model 6100's built-in AM, FM and pulse modulation generators.

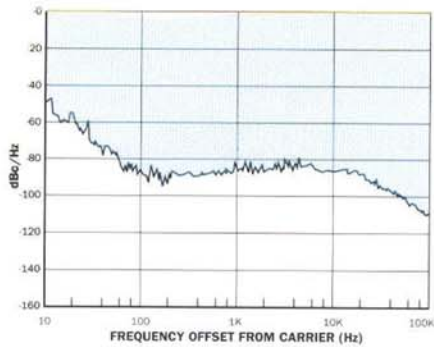


At least +10 dBm output power means sufficient power will be delivered to the device being tested, even through the often complex switching paths of ATE systems.

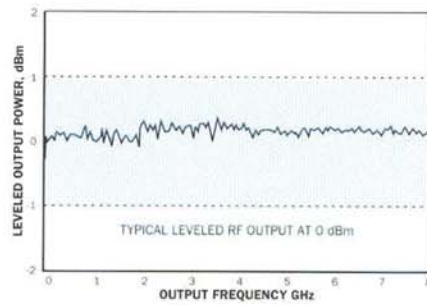


All digitally controlled parameters of the Model 600 and the Model 6100 can be programmed via the IEEE-488 bus to allow integration into ATE applications.





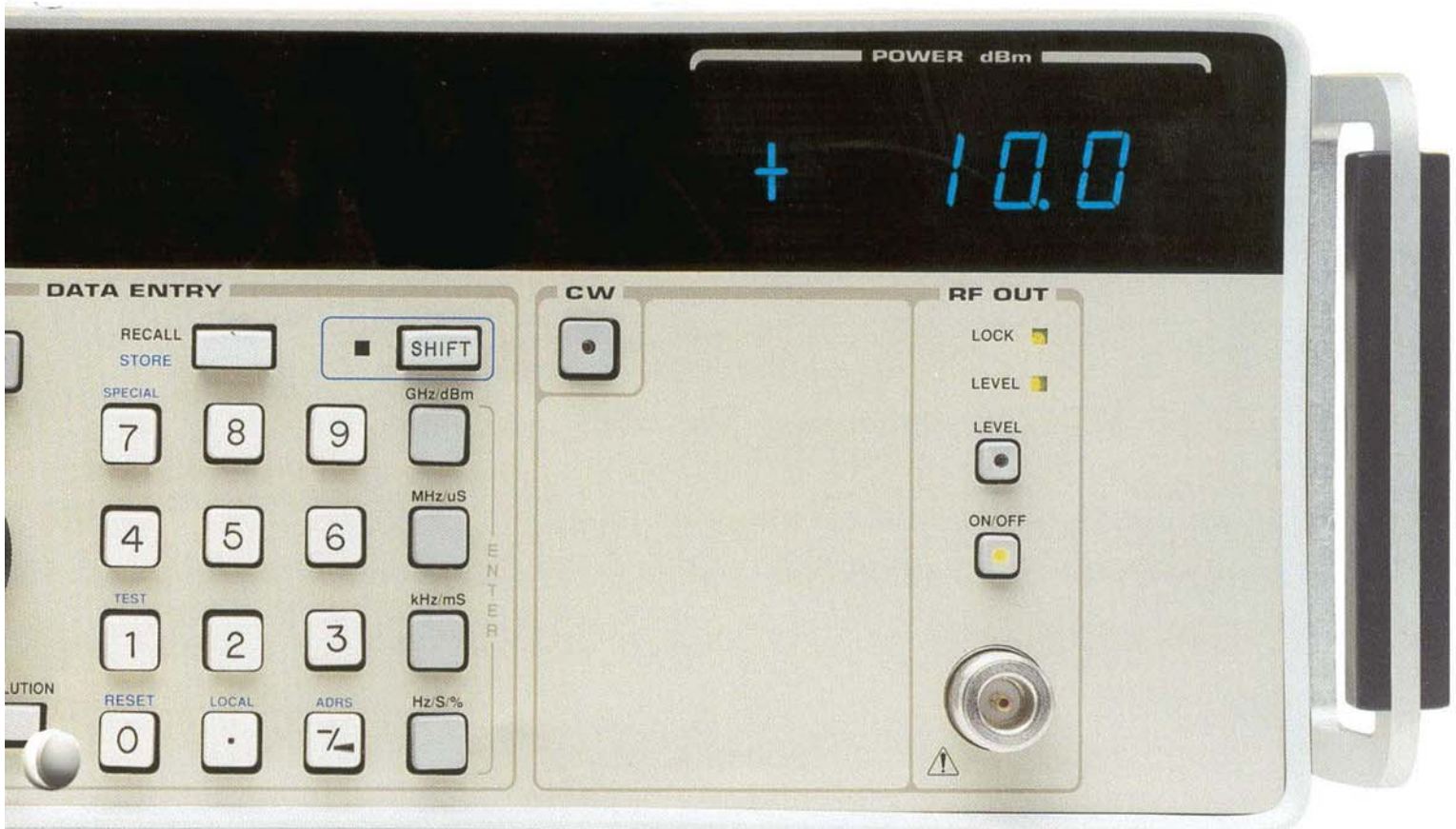
Excellent SSB phase noise specifications (shown here typically at 4 GHz), plus excellent harmonic and spurious specifications assure signal purity throughout the frequency range.



Accurately controlled and calibrated output power results from a specially designed control module, and high quality power attenuators.



Accuracy and stability assures the integrity of test results and adherence to regulatory requirements.



MODEL 6100 and 600 SPECIFICATIONS

Except as noted, all specifications apply to both the Model 6100 and the Model 600. For ease of understanding, specifications that are peculiar to the Model 6100 are highlighted in blue, those peculiar to the Model 600 are highlighted in gray.

ORDERING INFORMATION

MODEL NUMBERS AND FREQUENCY RANGES:

Model Number	Frequency Range
6100/or 600/.01 - 8	10 MHz to 8 GHz
6100/or 600/.01 - 12	10 MHz to 12 GHz
6100/or 600/2 - 8	2 GHz to 8 GHz
6100/or 600/2 - 12	2 GHz to 12 GHz
6100/or 600/6 - 12	5.4 GHz to 12.5 GHz
6100/or 600/6 - 18	6 GHz to 18 GHz
6100/or 600/10 - 18	10 GHz to 18 GHz

AVAILABLE OPTIONS:

Option 03: Provides 1 kHz Frequency Resolution in lieu of the standard 1 MHz.

Option 06: Provides High Stability Time Base, $< 1 \times 10^{-9}$ /day, in lieu of the standard 1×10^{-6} /year.

Option 19: Provides Reverse Power Protection (2 kW, peak, 1 μ sec pulse, 0.1% duty factor or 4 W, continuous) in 2 to 8 and 6 to 12 GHz models only. This option may decrease maximum output power by as much as 2 dB.

Option 22: Moves the RF Output Connector from the instrument's front panel to its rear panel. This option may decrease maximum output power by as much as 2 dB.

Option 23A: Provides a type SMA Output Connector in lieu of the standard Type N.

AVAILABLE ACCESSORIES:

Accessory A002: Instrument configured for standard rack mounting with chassis slides.

Accessory A003: Instrument configured for standard rack mounting without chassis slides.

Accessory A006: Extra Extender Board Service Kit (One furnished with each instrument).

Accessory A010: Extra Operation and/or Maintenance Manuals (One furnished with each instrument; specify type of manual when ordering).

Accessory A011: Ruggedized Carrying Case with cushioned interior.

SPECTRAL PURITY

Harmonics (up to maximum frequency of generator):

Model 6100: < -45 dBc (< -50 dBc typical), 2 to 18 GHz; < -30 dBc, .01 to 2 GHz. Model 600: < -40 dBc, 2 to 18 GHz; < -30 dBc, .01 to 2 GHz (< -50 dBc in 10 to 18 GHz models; may degrade to < -10 dBc, typical, above 5.3 GHz in .01 and 2 to 12 GHz models)

Subharmonics: None

Nonharmonics: < -55 dBc

Power Line/Fan Rotation Related: < -45 dBc, typical Single-Sideband Phase Noise (1 Hz Noise Bandwidth, 10 kHz Offset, All Power Levels): < -75 dBc

Residual FM (50 Hz to 15 kHz Bandwidth): < 200 Hz, rms

RF FREQUENCY PARAMETERS

All Model 6100 variable RF frequency parameter values may be set via the GPIB or from the front panel by keyboard, digi-dial or up/down push-button entry. Model 600 variable RF frequency parameter values are set via the GPIB or from the front panel by self-indicating leverwheel switches.

CW OPERATION

Range: Various ranges from 10 MHz to 18 GHz (see Ordering Information)

Resolution: 1 MHz throughout the entire frequency range (1 kHz with Option 03)

Accuracy and Stability: Identical to time base oscillator

Time Base (Internal): 10 MHz

Aging Rate: $< 1 \times 10^{-6}$ /year after 20 minutes of continuous operation ($< 1 \times 10^{-9}$ /day after 72 hours of continuous operation with option 06)

Time Base (External): 10 MHz $\pm 1 \times 10^{-6}$ or better

RF OUTPUT POWER PARAMETERS

All Model 6100 variable RF output parameter values may be set via the GPIB or from the front panel by keyboard, digi-dial or up/down push-button entry. Model 600 variable RF output parameter values are set via the GPIB or from the front panel by self-indicating leverwheel switches.

RF OUTPUT POWER

Maximum Levelled Output: $> +10$ dBm ($> +6$ dBm in Model 600/2 - 12, $> +4$ dBm in Model 600/.01 - 12 and $> +3$ dBm in Model 600/6 - 18)

Resolution: 0.1 dB

Minimum Levelled Output: -120 dBm

RF Off (Model 6100 only): Typically attenuates a 0 dBm signal to < -140 dBm at the output connector

Output Accuracy (Internally Levelled, AM Off): ± 2 dB

Flatness: Included in accuracy

Output Impedance: 50 ohms, nominal

Output SWR: $< 2:1$

Reverse Power Protection: 100 mW, maximum (2 kW, peak; 4 W, continuous with Option 19 in 2 to 8 or 6 to 12 GHz models)

External Leveling: Negative detector, gain and offset adjustments provided

MODULATION PARAMETERS

All Model 6100 variable modulation parameter values may be set via the GPIB or from the front panel by keyboard, digi-dial or up/down push-button entry. Model 600 variable modulation parameter values are set from the front panel by range switch and/or potentiometer vernier controls. Two vernier settings (one preset front panel potentiometer and one preset internal potentiometer) and range may be selected for each variable modulation parameter via the GPIB.

AMPLITUDE MODULATION (AM)

Amplitude Modulation specifications apply for waveforms whose envelope peak is at least 1 dB below maximum specified output power when the instrument is internally leveled, FM and PM off. AM may be operated simultaneously with FM and/or PM. In Model 600, AM and FM share a common internal rate generator.

AM Envelope Parameters

Depth:

Range: 0 to at least 82% (measured at 7 dB below max rated power)

Resolution: Model 6100, 0.1% increments; Model 600, continuous analog control

Readout: 3 digits, 0.1% resolution

Accuracy: $\pm 10\%$ at 1 kHz rate and 50% depth

Bandwidth: (50% Depth): 10 Hz to 10 kHz (50 kHz, typical), 3 dB points referenced to 1 kHz

Harmonic Distortion (Relative to externally supplied AM envelope): $< 10\%$ at 1 kHz rate and 50% depth (measured at 7 dB below max rated power)

Externally Supplied AM Envelope

Waveform: Any waveform compatible with bandwidth considerations

Rate: See Bandwidth, above

Sensitivity: 1 V, p-p, is 50% (nominal) modulation at 1 kHz rate

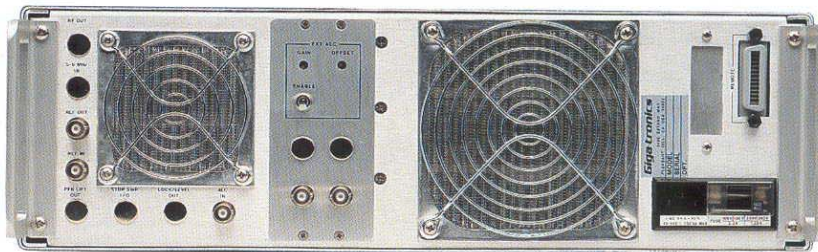
Input Impedance: 600 ohms, nominal, AC coupled

Internally Generated AM Envelope

Waveform: Sine wave and square wave (also triangle wave in Model 6100)

Rate:	Model 6100 Resolution	Model 600 Resolution
Range		
10 Hz to 99.9 Hz	0.1 Hz	Continuous
100 Hz to 999 Hz	1 Hz	analog control within
1 kHz to 9.99 kHz	10 Hz	4 ranges.
10 kHz to 99.9 kHz	100 Hz	

Accuracy (Model 6100): $\pm 10\%$ of setting



Model 6100 Rear Panel

FREQUENCY MODULATION (FM)

Frequency modulation specifications apply with AM and PM off. FM may be operated simultaneously with AM and/or PM. In Model 600, FM and AM share a common internal rate generator.

FM Envelope Parameters

Deviation:

Range: ± 10 kHz to ± 5 MHz, peak

Resolution: Model 6100, 10 kHz increments; Model 600, continuous analog control

Readout: 3 digits, 10 kHz

Accuracy: $\pm 10\%$ at 100 kHz rate and 3 MHz, peak, deviation

Bandwidth: ± 3 dB, 10 Hz to 1 MHz

Residual FM: ≤ 1.5 kHz, rms, typical

Distortion (relative to externally supplied FM envelope): $< 5\%$ at 500 kHz rate and 5 MHz, peak, deviation

Externally Supplied FM Envelope

Waveform: Any waveform compatible with bandwidth considerations

Rate: See Bandwidth, above

Sensitivity: 2 V, p-p, is maximum (nominal) deviation

Input Impedance: 50 ohms, nominal

Internally Generated FM Envelope

Waveform: Sine wave and triangle wave (also square wave in Model 6100)

Rate:	Model 6100	Model 600
Range	Resolution	Resolution
10 Hz to 99.9 Hz	0.1 Hz	Continuous
100 Hz to 999 Hz	1 Hz	analog control
1 kHz to 9.99 kHz	10 Hz	within
10 kHz to 99.9 kHz	100 Hz	4 ranges.

Accuracy (Model 6100): $\pm 10\%$ of setting

PULSE/SQUARE WAVE MODULATION (PM)

Pulse modulation specifications apply with AM and FM off. PM may be operated simultaneously with AM and/or FM.

PM Envelope Parameters

On/Off Ratio: > 80 dB

Rise/Fall Times: < 25 nsec

Overshoot, Undershoot and Ringing: ± 2 dB, (Maximum, Model 6100; typical, Model 600)

Settling Time (to within 1 dB): < 100 nsec, Model 6100

Externally Supplied PM Envelope

One PM envelope produced by each pulse supplied

Repetition Rate: DC to 1 MHz

Pulse Delay (Output envelope leading edge referenced to input pulse leading edge): 30 nsec, typical

Input Pulse Required: TTL level pulse, > 50 nsec wide (leveled output); > 25 nsec wide (unleveled output). Positive level = RF "on."

Internally Generated PM Envelope

Rate:	Model 6100	Model 600
Range	Resolution	Resolution
10 Hz to 99.9 Hz	0.1 Hz	Continuous
100 Hz to 999 Hz	1 Hz	analog control
1 kHz to 9.99 kHz	10 Hz	within
10 kHz to 99.9 kHz	100 Hz	control
100 kHz to 999 kHz	1 kHz	5 ranges.

Accuracy (Model 6100): $\pm 0.33\%$ of setting

Jitter (Model 6100): Same as time base

Pulse Delay (Referenced to sync output)

Range (Model 6100)	Resolution
0.0 μ sec to 99.9 μ sec	100 nsec
100 μ sec to 999 μ sec	1 μ sec
1.00 msec to 9.99 msec	10 μ sec
10.0 msec to 99.9 msec	100 μ sec

Accuracy (Model 6100): ± 30 nsec, typical

Jitter (Model 6100): Same as time base

Range (Model 600): Continuously variable from 10 nsec to 0.1 sec in 7 ranges

Duty Factor: $\geq 75\%$

Pulse Width (Referenced to pulse leading edge)

Range (Model 6100)	Resolution
0.1 μ sec to 99.9 μ sec	100 nsec
100 μ sec to 999 μ sec	1 μ sec
1.00 msec to 9.99 msec	10 μ sec
10.0 msec to 99.9 msec	100 μ sec

Accuracy (Model 6100): ± 30 nsec, typical

Jitter (Model 6100): Same as time base

Range (Model 600): Continuously variable from 100 nsec to 0.1 sec in 6 ranges

Duty Factor: $\geq 75\%$

Externally Triggered PM Envelope

One PM envelope produced by each trigger supplied

Repetition Rate: 10 Hz to 1 MHz

Pulse Delay: Set by internal delay control (see above)

Jitter (Model 6100, referenced to trigger pulse): ≤ 100 nsec

Pulse Width: Set by internal width control (see above)

Input Trigger Required: TTL level pulse, > 50 nsec wide

SPECIAL FUNCTIONS (Model 6100)

Special functions are available to the operator via a SHIFT key and the data entry keyboard

STORE/RECALL: Stores up to 10 complete front panel set-ups of frequency, output level, AM, FM and PM in the instrument's non-volatile memory for recall at any time

ADRS: Allows setting of the instrument's IEEE 488 bus address via the data entry keyboard and displays it at the entry readout

LOCAL: Returns control of all parameters to the instrument's front panel

RESET: Initializes all parameters

TEST: Initiates instrument's self test routines

SPECIAL: Allows user defined and/or future special functions and features

INPUTS/OUTPUTS

All connectors are type BNC unless otherwise stated

Front Panel

RF OUT: Generator's RF output signal on type N connector (Option 22 for rear panel output, Option 23A for type SMA connector)

AM IN: Input signal for external amplitude modulation

FM IN: Input signal for external frequency modulation

PM IN: Input signal for external pulse modulation

PM SYNC OUT: TTL level, 50 nsec wide trigger pulse out, coincident with leading edge of pulse modulation envelope waveform

PM VIDEO OUT: TTL level pulse modulation envelope waveform

AM/FM SYNC OUT (Model 600): TTL level square wave at set internal AM/FM rate

Rear Panel

ALC IN: Signal input for remote leveling of output power by negative polarity ZBS detectors.

Range: 500 μ V to 2 V, loop bandwidth: 50 kHz, nominal, input impedance: 10 kohms, nominal

REF IN: External time base input signal, 10 MHz $\pm 1 \times 10^{-6}$ or better, 0.5 to 5 V, p-p, overrides internal time base. Input impedance is 100 ohms, nominal

REF OUT: Buffered time base output, 10 MHz, 2 V, p-p, into 50 ohms, derived from internal or external time base

AM SIG OUT (Model 6100): Amplitude modulation waveform output, 2 V, p-p (typical), into 10 kohms

FM SIG OUT (Model 6100): Frequency modulation waveform output, 2 V, p-p (typical), into 10 kohms

GENERAL SPECIFICATIONS

Remote Interface (GPIB): IEEE STD 488-1978

Operating Temperature: 0 to 50°C

Environmental: Complies with MIL-T-28800D,

Type III, Class 5, Style E

Power: 100/120/220/240 VAC $\pm 10\%$, 50-400 Hz, 250 W, nominal

Weight and Dimensions:

	Net	Packed for Air Shipment
Width	16.75 in. (42.5 cm)	24 in. (60.9 cm)
Depth	6100 20.00 in. (50.7 cm) 600 18.00 in. (45.6 cm)	31 in. (76.7 cm)
Height	5.25 in. (13.3 cm)	11.25 in. (28.6 cm)
Volume	6100 1.02 ft. ³ (.029 m ³) 600 .92 ft. ³ (.026 m ³)	4.84 ft. ³ (.137 m ³)
Weight	6100 48 lb. (21.8 kg) 600 40 lb. (18.2 kg)	63 lb. (28.6 kg) 55 lb. (25.0 kg)



Model 600 Rear Panel

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Scientific Devices Australia Pty. Ltd.
South Oakleigh, Victoria
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Fax: (03) 579-0971

Salisbury, South Australia
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Fax: (08) 281-4194

Maroubra, NSW
Tel: (02) 344-5200
Fax: (02) 349-2602

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Air Parts Electronics
Brussels
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Fax: (0) 2-241-8130

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Fax: (514) 336-9607

Nepean, Ontario
Tel: (613) 726-8888
Fax: (613) 820-3213

Rexdale, Ontario
Tel: (416) 674-8970
Fax: (416) 674-8986

Burnaby, British Columbia
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Fax: (604) 430-3035

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Fax: 1-8419630

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Tel: 21-4319532
Fax: 21-4319532

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Fax: 755-232239

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Fax: (1) 60 11 98 09

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PC-Electronic GmbH
Altenstadt
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Fax: 06047-6408

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Fax: (2) 271-2764

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LUXEMBOURG (See BELGIUM)

MALAYSIA (See SINGAPORE)

NETHERLANDS (31)

Air Parts International B.V.
Alphen Aan Den Rijn
Tel: (0) 1720 43221
Fax: (0) 1720-20651

OMAN, Sultanate of (968)

Mustafa and Jawad Trading Co.
Ruwi
Tel: 709953
Fax: 797277

SAUDI ARABIA (966)

A. Rajab & A. Silsilah & Co.
Jeddah
Tel: (2) 661-0006
Fax: (2) 661-0164/558

SCOTLAND

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TAIWAN (886)

Evergo Corporation
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Fax: (2) 712-2466

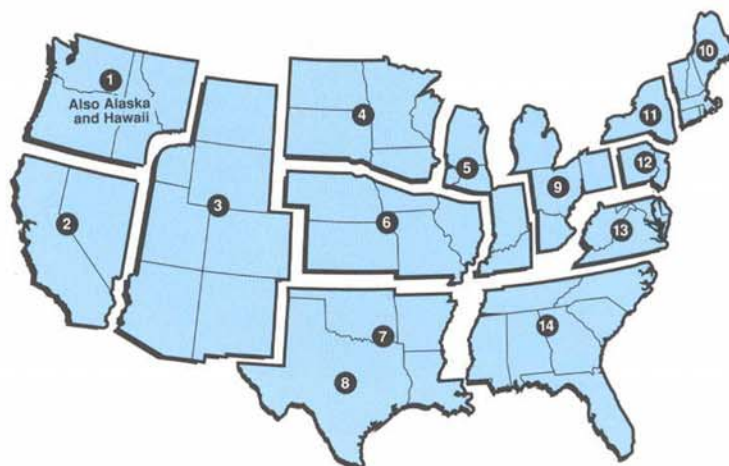
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1 Arva-Hudson Incorporated

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Fax: (206) 455-3002

2 Ward/Davis Associates Incorporated

Redondo Beach, CA
Tel: (213) 643-6977
Fax: (213) 643-6035

3 Technical Marketing Specialists

Phoenix, AZ
Tel: (602) 678-4940
Fax: (602) 678-4943

4 RG Associates

Wayzata, MN
Tel: (612) 471-8309
Fax: (612) 471-8765

5 Dytec/Midwest Incorporated

Arlington Heights, IL
Tel: (708) 255-3200
Fax: (708) 255-4874

6 Dytec/South Incorporated

Indianapolis, IN
Tel: (317) 849-9898
Fax: (317) 841-9060

7 Data Marketing Associates Inc.

Dallas, TX
Tel: (214) 661-0300
Fax: (214) 490-0836

8 Jack Howard Associates, Inc.

San Antonio, TX (Kelly AFB only)
Tel: (512) 828-5741
Fax: (512) 828-3207

9 WKM Associates Incorporated

Dayton, OH
Tel: (513) 434-7500
Fax: (513) 434-6590

10 Pat Jenks Associates Inc.

Beverly, MA
Tel: (508) 921-4600
Fax: (508) 921-4544

11 Northern Technical Sales

Liverpool, NY
Tel: (315) 451-1091
Fax: (315) 451-6980

12 Scientific Devices-East

Ridgefield Park, NJ
Tel: (201) 440-3430
Fax: (201) 440-4474

13 Creative Marketing Associates Ltd.

Columbia, MD
Tel: (301) 880-4161
Fax: (301) 725-5088

14 Southern Marketing Associates

Longwood, FL
Tel: (407) 682-7317
Fax: (407) 682-7443

Austin, TX
Tel: (512) 338-4701
Fax: (512) 338-0873

San Antonio, TX (except Kelly AFB)
Tel: (512) 342-3031
Fax: (512) 525-8680

Tulsa, OK
Tel: (918) 494-2711
Fax: (918) 494-8901

Metairie, LA
Tel: (504) 833-3655
Fax: (504) 833-0218

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Fax: (512) 828-3207

9 WKM Associates Incorporated

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Pittsburgh, PA
Tel: (412) 892-2953
Fax: (412) 653-1243

10 Pat Jenks Associates Inc.

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Fax: (508) 921-4544

11 Northern Technical Sales

Liverpool, NY
Tel: (315) 451-1091
Fax: (315) 451-6980

12 Scientific Devices-East

Ridgefield Park, NJ
Tel: (201) 440-3430
Fax: (201) 440-4474

Horsham, PA
Tel: (215) 956-0700
Fax: (215) 956-0706

13 Creative Marketing Associates Ltd.

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14 Southern Marketing Associates

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