SIGNAL GENERATORS TO 40 GHz

Signal generators

Hewlett-Packard offers a complete line of easy-to-use HF, VHF, UHF, and SHF signal generators covering frequencies between 50 kHz and 40 GHz. Each Hewlett-Packard generator incorporates the following:

(1) accurate, direct-reading, frequency calibration

(2) variable output, accurately calibrated and direct reading

(3) constant output impedance, well matched

(4) varied modulation capabilities

(5) low RF leakage

(6) low harmonic content

(7) freedom from spurious or incidental modulation.

This ensures the utmost convenience and accuracy for all kinds of measurements and signal simulations, including receiver sensitivity, selectivity or rejection, signal-to-noise ratio, gain bandwidth characteristics, conversion gain, antenna gain, transmission line characteristics, as well as power to drive bridges, slotted lines, filter networks, etc.

Sweeping signal generators

A result of Hewlett-Packard thin film and hybrid microcircuit technology, the 8601A Generator/Sweeper is one of a new breed of signal generators that also sweep. Intended to be a general purpose instrument, the 8601A also satisfies many specialized test and design applications. From 10 kHz to 32 MHz, the 675A Sweep Signal Generator also offers many convenient features, as described on Page 317.

HF to UHF signal generators

These signal generators, including HP 606A, 606B, 608E, 608F, and 612A, collectively cover frequencies from 50 kHz to 1.23 GHz and are characterized by extremely low drift and incidental frequency modulation. All may be amplitude (sine, square, pulse) modulated. A feedback loop in the 606A and 606B keeps their output and percent modula-

Table 1

Model	Frequency range	Characteristics	Page
606A/B Signal Generator	50 kHz to 65 MHz 606B also has:	output 3 V to 0.1 μV, mod. BW dc to 20 kHz, low drift and noise, low incidental FM, low distortion, auxiliary RF output, stabilized phase lock capability	286
8601A Generator Sweeper	100 kHz to 110 MHz	$\pm$1% of frequency dial accuracy, cal output +20 to −110 dBm into 50 ohms, leveled to $\pm$0.25 dB, very low drift, residual FM and RFI leakage, 30% AM, 75 kHz dev FM, aux output, crystal cal	288
608E Signal Generator	10 to 480 MHz	output 1 V to 0.1 μV, into 50-ohm load; AM, pulse modulation, direct calibration, leveled power output, aux RF output	292
608F Signal Generator	10 to 455 MHz	output 0.5 V to 0.1μV into 50 ohms, amplitude, pulse modulation, direct calibration, low incidental FM and drift, leveled output, aux RF output, stabilized phase lock capability	292
8708A Synchronizer	50 kHz to 455 MHz	Companion for 606B or 608F permitting 2/10^7 continuous settability & stability, FM and phase modulation	294
612A Signal Generator	450 to 1230 MHz	output 0.5 V to 0.1 μV into 50-ohm load; AM, pulse or square-wave modulation, direct calibration	297
614A Signal Generator	0.8 to 2.1 GHz	output at least 0.5 mW to −127 dBm (0.1 μV) into 50 ohms, pulse or frequency modulation, direct calibration	300
8614A Signal Generator	0.8 to 2.4 GHz	output +10 to −127 dBm into 50 ohms, leveled below 0 dBm; internal square-wave; external pulse, AM and FM; auxiliary RF output	298
8614B Signal Source	0.8 to 2.4 GHz	output 15 mW; precision attenuator 130 dB range; internal square-wave, external pulse and FM; auxiliary RF output	298
616B Signal Generator	1.8 to 4.2 GHz	output 1 mW to −127 dBm (0.1 μV) into 50-ohm load, pulse or frequency modulation, direct calibration	300
8616A Signal Generator	1.8 to 4.5 GHz	output +3 to −127 dBm into 50 ohms, leveled below 0 dBm; internal square-wave, external pulse, AM and FM; auxiliary RF output	298
8616B Signal Source	1.8 to 4.5 GHz	output 3 mW; precision attenuator 130 dB range; internal square-wave, external pulse and FM; auxiliary RF output	298
618C Signal Generator	3.8 to 7.6 GHz	output 1 mW to −127 dBm (0.1 μV) into 50 ohms, pulse, frequency or square-wave modulation, direct calibration, ext FM and pulse modulation, auxiliary RF output	302
620B Signal Generator	7 to 11 GHz	output 1 mW to −127 dBm (0.1 μV) into 50 ohms, pulse, frequency or square-wave modulation, direct calibration, ext FM and pulse modulation, auxiliary RF output	302
626A Signal Generator	10 to 15.5 GHz	output +10 dBm to −90 dBm; pulse, frequency or square-wave modulation, direct calibration	304
628A Signal Generator	15 to 21 GHz	output +10 dBm to −90 dBm; pulse, frequency or square-wave modulation, direct calibration	304
938A Frequency Doubler	18 to 26.5 GHz	driven by 9 to 13.25 GHz source, HP 626A, 8690 series sweepers or klystrons; 100 dB precision attenuator	306
940A Frequency Doubler	26.5 to 40 GHz	driven by 13.25 to 20 GHz source, HP 628A, 8690 series sweepers or klystrons; 100 dB precision attenuator	306

tion constant as frequency is varied. The 608E and 608F also offer level power output resulting in significant time saving and convenience when the generator is being used to conduct tests at several frequencies. The 606B, 608E, and 608F offer an auxiliary, fixed-level, CW signal which can be applied to a counter for very accurate indication of carrier frequency.

Stabilized RF signal generation

The HP 606B and 608F contain voltage variable capacitors in their oscillator circuits enabling phase-locked operation with the HP Model 8708A RF Synchronizer obtaining $2/10^7$ settability and stability. Phase-locked operation of the HP 606B and 608F Signal Generators can be obtained without compromise of the instruments' modulation or attenuation characteristics. The HP 8708A Synchronizer enables continuous tuning permitting continuous frequency response examination of devices such as highly-selective, narrow-band filters. The HP 8708A Synchronizer provides the additional benefit of phase and frequency modulation capability with the 606B and 608F Signal Generators.

Signal sources above 10 MHz

Signal generators available from Hewlett-Packard include general-purpose oscillators and amplifiers, FM signal generators, and specialized signal generators for aircraft navigation systems.

The 3200B VHF Oscillator is a compact, versatile source in the 10 to 500 MHz range suitable for general-purpose laboratory work. The 230B Signal Generator Power Amplifier provides a convenient means of obtaining power levels up to 4.5 watts in the 10 to 500 MHz range when operated in conjunction with a signal generator.

HP's FM signal generators offer unusual modulation linearity and stability. The 202H FM-AM Signal Generator operates in the 54 to 216 MHz range and is designed to serve the broadcast FM, VHF-TV, and mobile communications markets. The 202J Telemetering Signal Generator is specifically designed for VHF telemetry and covers the 195 to 270 MHz frequency range. An accessory 207H Unit converter provides additional coverage when used with either the 202H or 202J Signal Generators.

The 211A Signal Generator is specifically designed for the testing and calibration of aircraft VOR omni-range and ILS localizer receivers; an external modulator, such as the Collins 479-F3, is required to provide simulated course and bearing. The 232A Glide Slope Signal Generator is specifically designed for the testing and calibration of ILS glide slope receivers. The 8925A DME/ATC Test Set is designed to provide complete facilities for the testing and calibration of aircraft DME radios and ATC transponders; suitable external modulators are required, such as the Collins 578D-1 and 578X-1, to simulate ground station operation.

UHF to SHF signal generators and sources

This group of instruments, covering 800 MHz to 21 GHz, features extremely simple operation. The 614A, 616B, 618C, 620B, 626A and 628A Signal Generators provide large, direct-reading frequency and attenuator dials. They may be pulse, square-wave, and frequency modulated. Their versatility makes them useful for measuring signal-to-noise ratio, receiver sensitivity, SWR and transmission line characteristics.

The HP 8614A and 8616A Signal Generators are particularly easy to use. Frequency and attenuation are set on direct-reading digital dials, and leveled output enables frequency response testing without time-consuming readjustment of the generator at each new frequency. Each unit contains a unique PIN diode modulator which permits such a wide range of amplitude modulation that remote control of output level or precise leveling with external equipment is possible.

PIN modulators

The 8730 series of PIN Modulators increases the modulation capability of microwave signal sources and at the same time virtually eliminates incidental FM. The model 8403A provides complete control of the 8730 series of PIN modulators, supplying the bias wave-shapes and levels for fast rise times, rated on-off ratios and amplitude modulation as well as providing pulse and square wave signals for direct application to signal sources. See page 310.

Frequency doublers

Broadband frequency doublers, HP 938A and 940A, provide low-cost signal generator capability in the 18 to 40 GHz range. Designed to be driven by signal sources in the 9 to 20 GHz range, the frequency doublers preserve the versatility and stability of the driving source. Thus, the signals may be CW, pulsed or swept. An output monitor and precision attenuator provide a metered output, even though the input signal is uncalibrated.

Special purpose signal sources

Application	Frequency range	Modulation	Output	Model	Page
Down converter for 202H	100 kHz to 55 MHz	See specifications		207H	291
Test, calibrate FM receivers	54 to 216 MHz	FM, AM	0.2 V	202H	290
Telemetry tests	1430 to 1540 MHz 2150 to 2310 MHz	FM	−10 to −127 dBm	3205A	307
VOR/ILS tests	88 to 140 MHz	AM	0.2 V	211A	309
ILS tests	329.3 to 335 MHz	AM	0.2 V	232A	309
DME/ATC tests	962 to 1213 MHz	Pulse	−10 dBm	8925A	308
Receiver, Transmitter Tests	5280 to 7780 MHz[1]	FM, AM	1 mW	623B	301
	7100 to 8500 MHz	FM, AM	31.6 mW	5636	301
	8500 to 10,000 MHz	FM, AM	1 mW	624C	301

[1] Not continuous coverage, see specifications.

HF SIGNAL GENERATORS

Convenience and performance 50 kHz-65 MHz

Models 606B, 606A

606B

Description

The Hewlett-Packard 606B Signal Generator provides you with high quality, versatile performance with distinctive ease of operation in the important and widely used 50 kHz to 65 MHz frequency range. Output signals are stable and accurately known, output amplitude can be precisely established over a very wide dynamic range, and versatile modulation capabilities are incorporated to satisfy virtually all measurement requirements. Convenient size and shape, together with a simple, straightforward control panel layout, make the 606B well suited for production line use as well as laboratory or field applications.

Design

The 606B is a master oscillator-power amplifier (MOPA) design with a broadband buffer amplifier stage between the oscillator and power amplifier circuits for isolation. The MOPA design permits optimization of the oscillator circuit for highest stability including low drift, minimum residual FM, low harmonics, etc., without restricting the modulation characteristics. Modulation is applied to the power amplifier circuit with negligible effect on the oscillator frequency (because of the buffer stage). Very fine frequency settability is achieved through incorporation of a ΔF control which provides better than 10 ppm resolution.

Highest frequency stability

While the basic frequency stability of the 606B is excellent (less than 0.005% drift over a 10-minute period after warm-up), the inclusion of frequency control circuitry in the 606B makes it possible to achieve 250 times greater stability by phase-locking the 606B with the HP 8708A Synchronizer. The 8708A, which is fully compatible with the 606B in every respect, can stabilize the 606B at any frequency (not just at discrete points) with a resultant stability of $2 \times 10^{-7}/10$ minutes and a very high degree of spectral purity. The combination of the 606B and 8708A also permits you to perform narrow band frequency- or phase-modulation of the 606B carrier with very low modulation distortion. The 8708A is described on page 294.

Simplified operation

An outstanding feature of the 606B is the employment of feedback in the RF power amplifier section which results in superior performance characteristics and true ease of operation. The feedback circuit maintains both the output level and the percentage of modulation essentially constant over the entire frequency range, thus making it unnecessary to readjust controls when changing the operating frequency. The use of feedback also enables you to change the output level without affecting the degree of modulation. The constant output, constant modulation feature results in significant time saving as well as operator convenience, making the 606B an ideal choice for production line operations where semi-skilled personnel can make meaningful measurements.

Versatile amplitude modulation

The use of feedback in the power amplifier section also yields excellent amplitude modulation characteristics. Up to 95% modulation can be achieved with modulating frequencies ranging from dc to 20 kHz. Envelope distortion is very low, less than 1% at 30% AM and less than 3% at 70% AM; this allows you to make more accurate measurements of the distortion characteristics on receivers or detectors. Internal modulation oscillators of 400 Hz and 1000 Hz are provided, and the modulation percentage can be set and read directly on the accurate front panel modulation meter. The wide modulation bandwidth (dc to 20 kHz) means the 606B may be modulated with square waves or other complex signals including tone-burst modulation, or you can remotely program the output amplitude. The buffer stage between the master oscillator and power amplifier holds incidental FM with AM to a minimum, ensuring accurate measurements.

Accurate output level

The output level from the 606B is continuously adjustable from 3 volts to 0.1 microvolts rms into a 50 ohm load. Direct calibration is provided in both volts and dBm (+23 to −120 dBm) and the output calibration is accurate to within 1 dB at any frequency or level setting. The output system of the 606B is a well matched 50 ohm circuit which minimizes mismatch ambiguities as a factor in overall measurement accuracy. The extremely wide range of output amplitude control makes the 606B very useful for driving bridges and filters as well as complete receiver measurements including sensitivity, selectivity, and image rejection.

The 606B provides an auxiliary RF output; this fixed level (100 millivolts rms minimum) CW signal is for use with the 8708A Synchronizer and can also be applied to an HP 5245L Counter for very accurate indication of carrier frequency. Using the auxiliary RF output does not place any restriction on the modulation capabilities nor on the main RF output level. The 606B also contains a crystal calibrator to provide accurate frequency checkpoints at every 100 kHz or 1 MHz throughout the frequency range of the instrument.

Specifications, 606B

Frequency characteristics

Range: 50 kHz to 65 MHz in 6 bands (50-170 kHz, 165-560 kHz, 0.53-1.8 MHz, 1.76-6 MHz, 5.8-19.2 MHz, 19-65 MHz); total scale length approximately 95 in.

Accuracy: ±1%.

Drift: (attenuator on 1 volt range and below) less than 50 parts in 10^6 (or 5 hertz, whichever is greater) per 10 minute period after 2-hour warmup; less than 10 minutes to restabilize after changing frequency.

Stability when used with 8708A Synchronizer: 5×10^{-8}/minute, 2×10^{-7}/10 minutes, 2×10^{-6}/day; 2×10^{-7}/°C, 0° to 55°C; 2×10^{-7}/10% line voltage change.

Resettability: vernier control resettability better than 0.15% after initial warmup.

△F control: ultra-fine frequency vernier provides better than 10 parts in 10^6 settability; total range of △F control approximately 0.1%.

Crystal calibrator: provides frequency checkpoints every 100 kHz and 1 MHz; headphone jack provided for audio frequency output (headphone not included); crystal frequency accuracy better than 0.01% from 0° to 50°C; cursor on frequency dial adjustable over small range to aid in interpolation adjustment; calibrator may be turned off when not in use.

Residual FM: less than ±1 part in 10^6 or ±20 hertz peak, whichever is greater.

Frequency control input: BNC female connector for "frequency control output" from 8708A Synchronizer; can also be used for external frequency control: voltage change from −2 to −32 volts changes frequency more than 0.2% at low end of each band, and more than 2% at high end; nominally 4 kΩ input impedance, direct-coupled; voltage limits: 0 volt ≤applied voltage ≤50 volts negative.

Output level: continuously adjustable from 0.1 microvolt to 3 volts into 50-ohm resistive load; output attenuator calibrated in 10-dB steps from 3 volt full scale to 1.0 microvolt full scale (into 50 ohms), also calibrated in dBm (0 dBm=1 milliwatt in 50 ohms); vernier control provides continuous adjustment of voltage between full scale ranges; output level indicated on RF output meter calibrated in volts (0 to 1 and 0 to 3 volts) and dBm (−10 to +3 dBm).

Frequency response and output accuracy: at any output voltage below 1 volt, output level variation with frequency is less than 2 dB across the entire frequency range; output accuracy is better than ±1 dB at any frequency.

Impedance: 50 ohms, SWR less than 1.2 on 0.3 volt attenuator range and below.

RFI: meets all conditions specified in MIL-I-6181D; permits receiver sensitivity measurements down to at least 1.0 microvolt.

Harmonic output: at least 30 dB below the carrier.

Spurious AM: hum and noise sidebands are 70 dB below carrier down to thermal level of 50 ohm output system.

Auxiliary RF output: fixed level CW signal from RF oscillator provided at front panel BNC female connector for use with HP 8708A Synchronizer or other external equipment (e.g., frequency counter). Minimum output: 100 mV rms into 50 ohms from 50 kHz to 19.2 MHz, 200 mV rms from 19 to 65 MHz.

Modulation characteristics

Internal AM:

Frequency: 400 and 1000 Hz, ±5%; modulation signal available at front panel BNC female connector for synchronization of external equipment.

Modulation level: 0 to 95% on 1 volt range and below; 0 to at least 30% on 3 volt range.

Carrier envelope distortion: less than 1% at 30% AM; less than 3% at 70% AM (attenuator on 1 volt range and below).

Incidental frequency modulation (attenuator on 1 volt range and below, 30% modulation): less than 5×10^{-6} + 100 Hz peak.

External AM:

Frequency: dc to 20 kHz maximum, dependent on carrier frequency (f_c) and percent modulation as tablulated:

Maximum modulation frequency:

30% Mod:
0.06 f_c;
70% Mod:
0.02 f_c;
Squarewave Mod:
0.003 f_c (3 kHz max).

Modulation level: 0 to 95% on 1 volt attenuator range and below, 0 to at least 30% on 3 volt range.

Input required: 4.5 volts peak produces 95% modulation (maximum input 50 volts peak); input impedance 1000 ohms.

Carrier envelope distortion: less than 1% at 30% AM, less than 3% at 70% AM (attenuator on 1 volt range and below).

Modulation meter accuracy: ±5% of full scale, 0 to 90%, for modulation frequencies to 10 kHz, ±10% of full scale for frequencies from 10 kHz to 20 kHz.

Modulation level constancy (internal or external AM; attenuator on 1 volt range and below): modulation level stays constant within ±½ dB regardless of carrier frequency and output level changes.

General

Power: 115 or 230 V ±10%, 50 to 400 Hz, 135 W.

Dimensions: cabinet mount, 20¾" wide, 12½" high, 14¾" deep, (527 x 318 x 370 mm).

Weight: cabinet mount, net, 55 lb (24,8 kg); shipping, 65 lb (29,3 kg); rack mount, net, 50 lb (22,5 kg); shipping, 63 lb (28,4 kg).

Accessories available:

11507A Output Termination, provides 3 positions: 50 ohms (for use into high impedance); 5 ohms (10:1 voltage division); IEEE Standard Dummy Antenna (driven from 10:1 divider); see page 294.

11509A Fuse Holder, provides protection for output attenuator when 606B is used for transceiver tests; see page 294.

10534A Mixer, for use as nanosecond pulse modulator; see page 294. Price, $70.

Price: Model 606B (cabinet mount), $1650; Model 606BR (rack mount), $1635.

Model 606A

The Model 606A covers the same frequency ranges as the 606B, but does not include the frequency control input feature that allows frequency stabilization by the Model 8708A Synchronizer. Model 606B specifications apply to the 606A with the following exceptions: an auxiliary uncalibrated RF output is not included; harmonic output is less than 3%; the crystal calibrator provides check points at 100 kHz (useful to 6 MHz) and 1 MHz intervals; output power level frequency response is ±1 dB over the entire frequency range.

Price: HP 606A (cabinet), $1540; HP 606AR (rack mount) $1525.