



New 10-500 Megacycle A-M Signal Generator

ANY signal source intended to operate through the VHF region and into the UHF region encounters a transition around 300 megacycles where a change from lumped to distributed constants occurs. This transition has barred the development of high-quality signal generators covering the region up to 500 mc. The new -hp- 608A VHF Signal Generator covers the range from 10 to 500 mc with a new circuit technique—one that results in a high-frequency signal generator whose performance and operation in

many ways exceed the performance and operation of good lower frequency signal generators.

For sheer useability, the signal generator is ideal: more than 1 volt into rated load is available at all frequencies, the source impedance is approximately 50 ohms over the entire frequency range, the output system is direct-reading from 1 volt to 0.1 microvolt, the circuit includes a tuned output amplifier for suppression of spurious frequencies and for modulation advantages, per cent modulation is indicated on a direct-reading meter, internal sinusoidal modulation up to 100 per cent can be obtained, modulation by external pulses is possible, leakage is low, residual fm is very slight, and carrier stability is very high.



Figure 1. New -hp- 608A VHF Signal Generator Covers Range from 10 to 500 Megacycles.

**ISOLATED MASTER OSCILLATOR
HAS LOW F-M**

Figure 2 shows the circuit of the -hp- 608A to be a master-oscillator tuned power-amplifier arrangement. At lower frequencies the use of this type circuit has been standard practice in signal generators, since the oscillator operates under fixed conditions that make for good stability, while the tuned amplifier has high gain, suppresses harmonics, and has desirable modulation characteristics. Until now, the master-oscillator tuned-amplifier arrangement has not been practical up into the 300-500 mc region, so that substitute methods of a less satisfactory nature have necessarily been used.

The -hp- 608A oscillator and tuned amplifier are designed to change from lumped-constants circuits at lower frequencies to distributed-constants circuits at the higher frequencies without change of circuit components. That this circuit gives very high performance can be seen from the specifications; accuracy of calibration within 1%, incidental f-m less than 0.002% at 30% a-m modulation, and less than 0.0025% at 90% a-m modulation. Tuning circuits for the oscillator and amplifier are ganged for easy tuning, as in lower frequency generators, through a single-dial precision drive that allows resetting within 0.2%. A panel trimmer control makes minor adjustments in tracking.

The very low incidental f-m is obtained by loose coupling and by operation of oscillator and amplifier with fixed supply voltages. Incidental f-m is as much as 30 times better than that achieved heretofore. The nominal f-m of 20 parts per million is believed sufficiently low to permit measurements on the highest-slope circuits encountered in practice without obscuring the desired measurement; for circuits having a frequency-sensitive transmission or gain characteristic act as detectors of

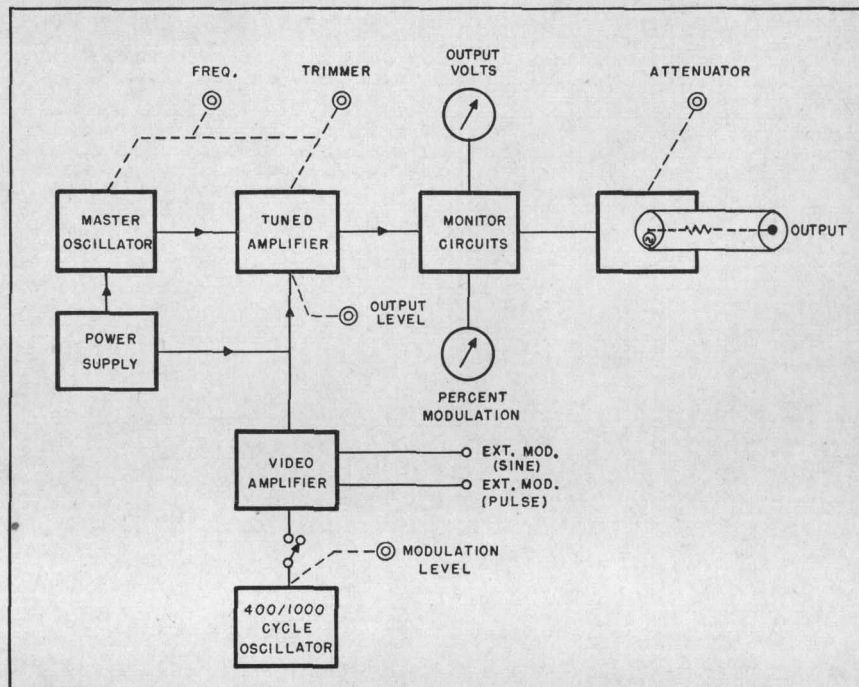


Figure 2. Circuit Block Diagram of -hp- 608A VHF Signal Generator.

f-m, providing a spurious signal that may obscure the desired a-m signal.

**HIGH OUTPUT VOLTAGE FROM
CONSTANT SOURCE IMPEDANCE**

The high output voltage from the amplifier is coupled to the output jack through a precision piston attenuator that is continuously-variable over a range from 0.5 volt to 0.1 microvolt. Outputs between 0.5 volt and 1 volt are obtained by advancing the rf level control and are read directly on the output meter, which operates from a monitoring circuit connected across the attenuator input.

Signal generators that operate at medium rf frequencies and below are usually designed with a low internal impedance. However, at high frequencies where transmission circuits are confined to 50-ohm coaxial cables, it is desirable that the internal impedance of the signal generator match the impedance of the transmission system. Then, maximum

power transfer can occur, and any reflections from the load will be absorbed by the generator instead of being partially re-reflected. That is, optimum conditions will exist for a low standing-wave ratio. Heretofore, to obtain a 50-ohm source, it was often necessary to place pads across the output terminals, thus wasting 50% to 75% of the available output voltage. This loss is minimized in the -hp- 608A with a special matching circuit built into the pick-up loop of the attenuator. The special circuit makes the impedance looking back into the output jack approximately 50 ohms at all frequencies and all voltage levels. This constancy of source impedance allows the signal generator to simulate the source impedances encountered in practice, thereby providing proper conditions for accurate measurements. A full 1 volt output can be obtained across a 50-ohm load at all frequencies.

Another measurement aid arises from a constant source impedance:

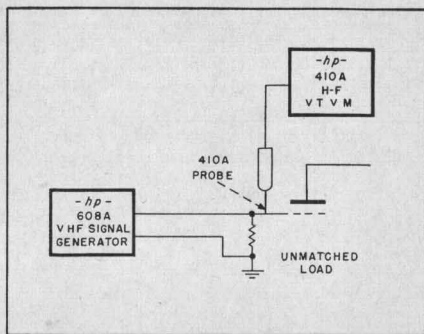


Figure 3. Set-Up for Measuring Driving Voltage for Loads having Unknown Impedance.

accuracy of the output system is improved. This results from the fact that a constant fraction of the generator open-circuit voltage is impressed across the load when the load impedance is constant. The combination of constant source impedance, use of the rf monitor at the attenuator input, and the accuracy of the rf monitor circuit itself enables the output power from the -hp- 608A to be accurate within 1 db in rated load of 50 ohms resistive.

UNMATCHED LOADS

Often at high frequencies some load device whose impedance is unknown must be driven by a known voltage. The problem then is to apply proper voltage to the load from the signal generator. The high voltage output of the -hp- 608A allows the characteristic of these unmatched loads to be measured with the use of the -hp- 410A high-frequency VT-VM. Figure 3 shows the required set-up.

The -hp- 608A signal generator is connected to the load device under test, while driving voltage at the load is monitored by the -hp- 410A voltmeter. Output voltage from the -hp- 608A is ample for a full-scale or nearly full-scale deflection on the voltmeter with all but very-low-impedance loads.

Usually, proper driving voltage for the load device will be much less than full voltage from the -hp- 608A.

Under these conditions, the desired transmission characteristic can be obtained first by using sufficient generator output to provide a readable deflection on the -hp- 410A. Then, driving voltage is reduced to the desired level by inserting the necessary attenuation with the output attenuator. The relative calibration of the attenuator will still hold under these conditions as long as the impedance of the load does not change with voltage. For example, driving voltage can be monitored at a high level such as 0.5 volt by the -hp- 410A. However, desired driving voltage may be only 0.5 millivolt. This driving voltage is readily obtained by inserting an attenuation of one thousand times (60 db) with the -hp- 608A output attenuator.

GAUSSIAN VIDEO AMPLIFIER

The video amplifier in the modulation channel is designed to allow modulation by externally-applied pulses. Bandwidth of the amplifier is from 50 cps to 1 mc, sufficient to

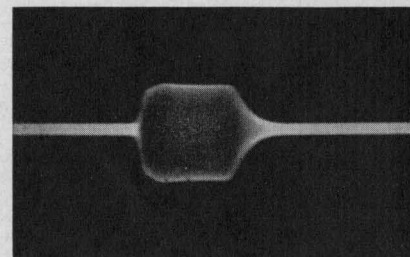


Figure 4. 150-Megacycle Carrier from -hp- 608A Modulated by 2-Microsecond Pulse.

allow modulation by quite short pulses.

Optimum pulse transmission has been shown¹ to occur when the high-frequency response of a circuit corresponds to the gaussian statistical curve. This type of response has been designed into the video amplifier and modulation filter, allowing modulation by short pulses without marked deterioration of pulse shape. This is clearly shown in Figure 4, a photograph of a 2-microsecond modulating pulse on a 150-megacycle carrier.

¹N. B. Schrock, *A New Amplifier for Milli-Micro-second Pulses*, -hp- Journal, Vol. 1, No. 1, Sept., 1949.

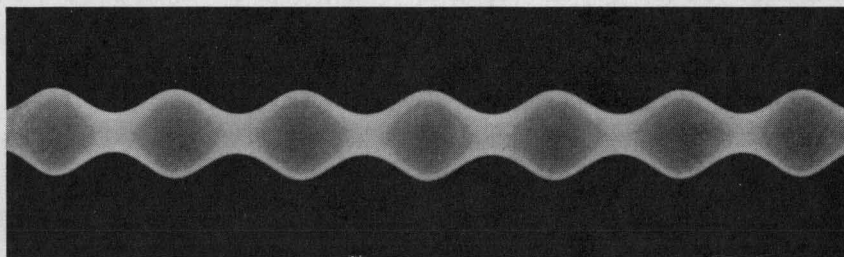


Figure 5. 100-Megacycle Carrier from -hp- 608A Modulated by 10 kc Sine-Wave.

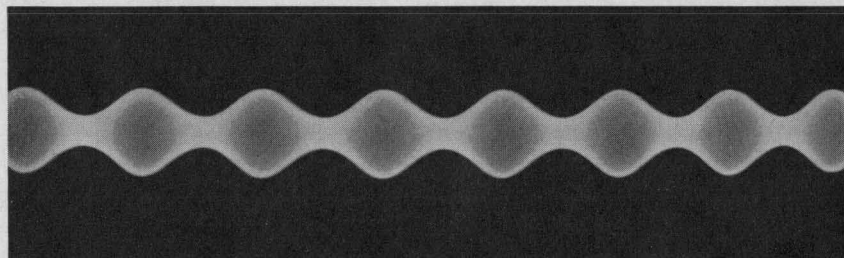


Figure 6. 100-Megacycle Carrier from -hp- 608A Modulated by Internal 1000 cps Oscillator.

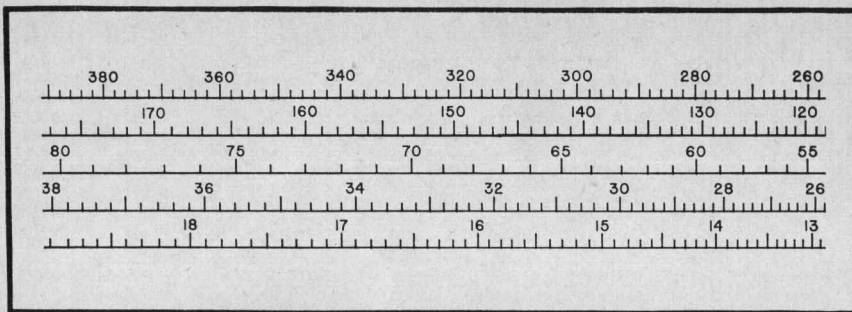


Figure 7. Portion of -hp- 608A Tuning Dial; Shown Approximately One-Half Actual Size.

SINE-WAVE MODULATION

The internal audio oscillator uses an RC circuit and operates at either of two frequencies, 400 or 1000 cps, as determined by the setting of a panel switch. Sine wave modulation by externally-applied voltages can be obtained over the range from 50 cps to 1 mc, because of the characteristics of the video amplifier. Maximum carrier level at high percentage modulations is 0.5 volt.

At the standard-signal level of 30% modulation, envelope distortion is less than 1%. Figure 5 shows the modulation envelope at 30% modulation of a 100-megacycle carrier modulated by an externally-applied 10 kc sine-wave signal. Figure 6 shows approximately 50% modulation of a 100-megacycle carrier by the internal 1000 cps oscillator.

Percentage modulation is directly indicated by a modulation monitor that samples the r-f voltage directly. The monitor consists of a detector and audio voltmeter which is calibrated in percentage modulation.

LONG-SCALE TUNING DIAL

The tuning dial is a large 7-inch diameter drum, calibrated to provide an individual scale length of more than 16 inches or an overall scale length of about 7 feet for the five frequency bands. This long-length calibration combined with the anti-backlash tuning drive allows resetting of the tuning dial within 1 megacycle at 500 megacycles (resetability within 0.2%). The calibration approximates a straight-line frequency characteristic.

—H. E. Overacker

SPECIFICATIONS FOR -hp- MODEL 608A VHF SIGNAL GENERATOR

FREQUENCY RANGE: 10 to 500 megacycles in 5 bands; 10-20 mc, 20-45 mc, 45-95 mc, 95-220 mc, 220-500 mc.

CALIBRATION ACCURACY: Within 1%. Frequency settings can be duplicated within 0.2% (1 mc at 500 mc).

OUTPUT VOLTAGE: 0.1 microvolt to 1.0 volt, continuously-variable. Direct-reading controls calibrated in voltage and dbm.

RATED LOAD IMPEDANCE: 50 ohms resistive.

INTERNAL IMPEDANCE: 50 ohms; maximum VSWR 1.2.

OUTPUT VOLTAGE ACCURACY: Within 1 db in rated load over entire frequency range.

A-M MODULATION: Internal or external; continuously-variable from 0 to 90%.

INTERNAL MODULATION: Two fixed modulating frequencies, 400 and 1000 cps.

ENVELOPE DISTORTION: Approx. 1% at 30% modulation.

EXTERNAL MODULATION: By any modulating frequency from 50 cps to 1 mc. 4 volts input across 100,000 ohms required.

PULSE MODULATION: By external positive or negative pulses of 4 volts peak amplitude. Good r-f pulse shape at 1 microsecond length.

LEAKAGE: Negligible; permits receiver sensitivity measurements down to at least 0.1 microvolt.

RESIDUAL FM: Not more than 0.0025% at 90% modulation.

POWER: Operates from nominal 115 or 230-volt, 50/60 cycle source. Requires approx. 150 watts.

MOUNTING: Provided in cabinet for table mounting.

SIZE: 14" high, 12" wide, 18" deep.

WEIGHT: 55 lbs.; shipping weight, approx. 85 lbs.

CABLES SUPPLIED: 7 foot detachable power cord.

PANEL CONNECTORS: RF output, type N jack; Pulse input, type BNC jack; external modulation input, -hp- binding posts spaced 3/4 inch.

PRICE: \$850.00 f.o.b. Palo Alto, California.

Data subject to change without notice.

HEWLETT-PACKARD COMPANY

Laboratory Instruments for Speed and Accuracy

395 PAGE MILL ROAD

PALO ALTO, CALIF.

