



## A New Signal Generator for Aeronautical Radio and UHF Television

**T**HE new -hp- Model 612A UHF Signal Generator operates from 450 to 1230 megacycles. This range includes two major frequency allocations: the new 470-890 mc UHF TV band and the 960-1215 mc aeronautical radio band. Although it is important that any signal generator for use with these two bands be capable of pulse modulation, the TV band in particular imposes on the generator a number of special requirements. The new 612A has therefore been designed with special emphasis on its suitability and convenience for TV work. At the same time the generator is useful as a general-purpose signal generator for such measurements as sensitivity, selectivity, and image rejection, and as a signal source for use in standing-wave ratio measurements, antenna plotting, etc.



Fig. 1. New -hp- Model 612A signal generator operates from 450 to 1230 megacycles, includes many conveniences for UHF TV work.

The features that make the new 612A especially convenient for TV use include the following:

- The generator uses the time-proved master-oscillator power-amplifier type circuit arrangement to obtain the advantages of an isolated carrier oscillator and to obtain high performance a-m modulation with negligible incidental f-m.
- Provision is made for uni-directional modulation, either upward or downward, as well as conventional symmetrical modulation.
- The generator has a wide-band modulation characteristic to permit modulation by frequencies up to 5 megacycles or by pulses as short as 0.2 microsecond (see Fig. 5).
- The percent modulation meter is a peak-to-peak reading meter which is effective on sine wave, pulse, and upward and downward modulation.
- Output voltage is high— $\frac{1}{2}$  volt rms across 50 ohms or 1 volt open circuit. A 131 db piston type attenuator provides for accurate output levels as low as 0.1 micro-volt.
- The generator covers the 450 to 1230 mc band in one continuous range. The tuning dial has an expanded scale that covers 15 inches and is calibrated every 5 megacycles. The dial can be read to approximately 1 megacycle.
- The tuning drive is a precision system which gives high resetability with essentially no backlash.

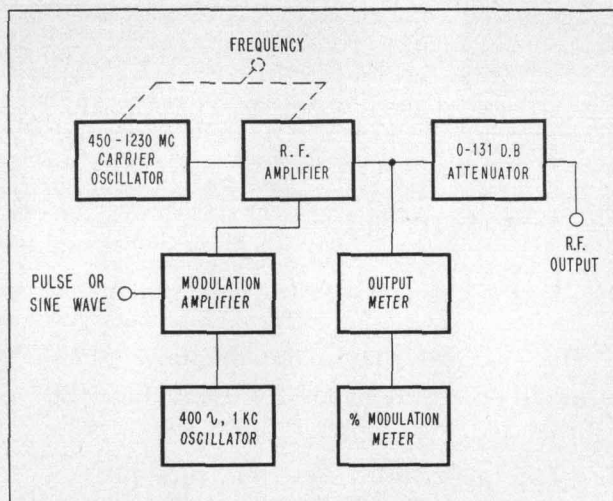


Fig. 2. Circuit block diagram of new -hp- Model 612A.

#### CIRCUITRY

A block diagram of the circuit of the 612A is shown in Fig. 2. The carrier oscillator and r-f amplifier both use pencil type triodes and are both tuned with coaxial line type resonators. The tubes are conservatively operated and care is taken to insure moderate temperatures for the tube seals. Tuning of the resonators is mechanically ganged to a single frequency control. The design and alignment of the system are such that no tuning trimmers are required. The frequency dial is direct-reading and is accurate within 1% under a wide range of conditions. Oscillator drift is low, as illustrated by the performance data in Fig. 3 which shows representative drift after an initial five-minute warm-up.

One of the features of the 612A circuit is that it is designed to achieve high-quality a-m modulation while keeping incidental f-m to a negligi-

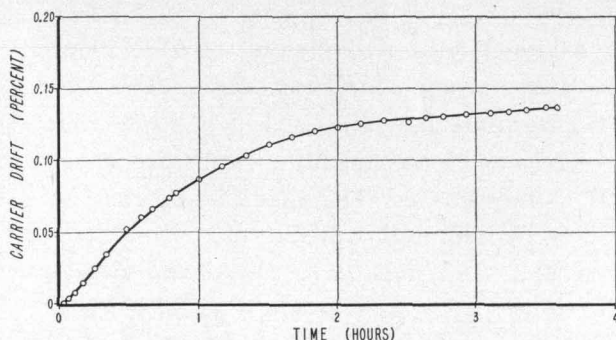


Fig. 3. The high stability of the new -hp- 612A is apparent in above representative drift curve measured after initial five-minute warm-up.

ble amount. Incidental f-m in a-m signal generators is always undesirable because, in applications such as receiver testing, f-m interferes with selectivity measurements while in slotted line applications it obscures the nulls in high standing-wave patterns so that inaccurate results are obtained.

Typical performance of the generator with regard to incidental f-m is indicated in Fig. 4. At the standard modulation level of 30%, incidental f-m typically is only about 10 parts per million.

The r-f amplifier is specially designed to accommodate modulation by short pulses. Since the amplifier used coaxial resonators and since these typically have a very high Q that distorts the envelope of a carrier modulated by short pulses, the resonators have been damped to reduce their Q. In addition, the amplifier is tuned by a double resonator arrangement in which the resonators are approximately critically coupled. These measures give the amplifier a minimum band width of approximately 15 megacycles at the lowest carrier frequencies and reduce the slope of the amplifier pass band.

The modulation amplifier which feeds the r-f amplifier is a wide band

system with a response essentially constant up to 5 megacycles. The amplifier is designed with a slow roll-off above 5 megacycles so that modulating pulses of fast rise times can be amplified without over-shoot.

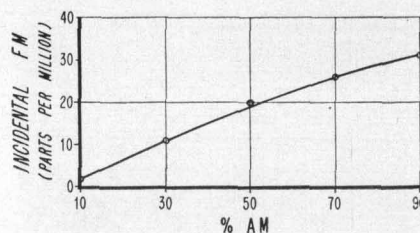


Fig. 4. Typical performance of -hp- 612A with respect to incidental f-m as a function of percent a-m.

The design of the r-f amplifier and modulation amplifier have resulted in a system capable of modulation by pulses as short as 0.2 microsecond. Fig. 5 shows the output when modulated by a pulse of 0.2 microsecond duration. The carrier was purposely modulated only 90% by this pulse so that it is apparent that freedom from overshoot is obtained without resort to amplifier saturation.

Fig. 6 shows the performance of the instrument when modulated by a pulse similar to a TV horizontal blanking and sync pulse. Fig. 7 shows the front porch area of the same pulse expanded to show the rise time of the system. The rise time can be evaluated by considering that the duration of the front porch in Fig. 7 is approximately 1.6 microsecond.

The modulation amplifier is designed so that 90% modulation of the carrier can be obtained with an audio or video input of 2 volts peak. The amplifier is further arranged with a limiting circuit which operates on approximately 4 volts peak input. This arrangement has the advantage that the amplifier has negligible recovery time because no grid current is drawn.

The quality of the sine-wave amplitude modulation of the 612A is indicated by Fig. 8. At 30% modulation, harmonic distortion is typically considerably less than 2% over the complete frequency range of the generator. At high modulation percentages the distortion is approximately 3% (Fig. 8).

#### MODULATION SELECTION

The panel modulation selector switch is provided with six positions: CW, Pulse 1, Pulse 2, Ext. Mod., 400~,



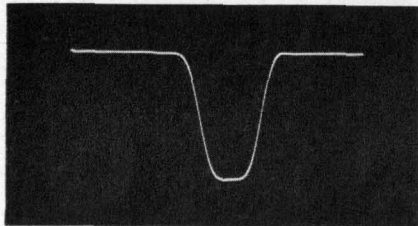


Fig. 5. Oscilloscope of 612A output when 90% modulated by 0.2 microsecond pulse.

and 1000~. The Pulse 1 and Pulse 2 positions are similar in that both are provided for applications where conventional 100% pulse modulation is desired. However, there are important differences in the operation of the instrument in the two positions. In the Pulse 1 position, the output of the modulation amplifier is applied to the r-f amplifier which is biased off in the interval between pulses and keyed on by each pulse. This arrangement makes available the full capabilities of the instrument with regard to fast rise time, minimum overshoot, and minimum incidental f-m.

For the Pulse 2 position, the circuits are switched so that the modulation amplifier output is applied to the carrier oscillator which is biased off in the interval between pulses. This arrangement, while giving more incidental f-m and poorer envelope shape, has the advantage that no carrier voltage exists between pulses. However, the Pulse 1 position is to be preferred except where maximum carrier-on to carrier-off ratio is required.

In both the Pulse 1 and Pulse 2 positions, a peak pulse voltage of approximately 4 volts is required at the modulation input terminal. In both positions, a panel switch permits either positive or negative video pulses to be applied to the modulation input terminal.

When the modulation switch is in the Ext. Mod. position, the carrier can be modulated by sine waves, pulses, or television type video signals. The percentage of modulation

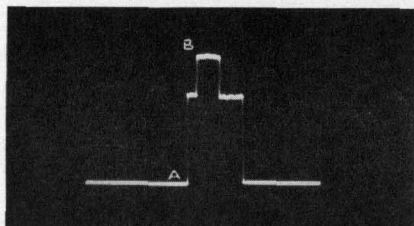


Fig. 6. Oscilloscope of 612A output when modulated by typical TV horizontal blanking pulse.

can be adjusted from 0 to at least 90% by a panel control. A panel switch permits upward, downward, or conventional modulation to be selected. The r-f amplifier is designed with sufficient reserve power to allow for a 6 db peak upward modulation from the normal output of +4 dbm. The modulation amplifier includes two d-c restorers to permit uni-directional modulation. A peak input voltage of approximately 2 volts is required to obtain 90% modulation.

The 400~ and 1000~ positions of the modulation switch apply the output of an internal modulating oscillator to the r-f amplifier. This oscillator is a conventional resistance-capacity circuit having good stability and wave form.

#### DRIVE SYSTEM

The mechanical drive for the oscillator is a simple, rugged arrangement designed to give smooth control of frequency without sacrificing durability. A photograph of the drive appears in Fig. 9. The plunger rods for the two oscillator resonators and two amplifier resonators are attached to a heavy cast drive plate which is driven by the spring-loaded traveller on the lead screw. The drive plate is suspended from the upper  $\frac{1}{2}$ " solid stainless steel bar by means of two linear ball bushings which minimize accuracy-reducing lateral motions.

The plunger rods are fabricated from a glass-reinforced plastic which has high strength and low coefficients of expansion with temperature

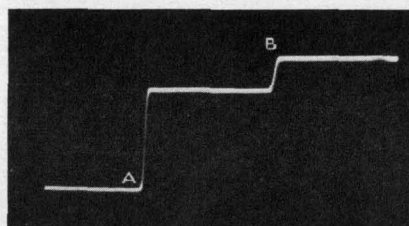


Fig. 7. Same as Fig. 6 but with front porch of pulse expanded.

and humidity. The plungers themselves are non-contacting type shorts so that there is no plunger friction to contribute to backlash. The quality of the overall system is such that a resetability of within 0.1% is obtained with essentially no backlash.

The tuning dial at the top of the drive is driven from the drive plate by means of a steel cable. The cable is heavily spring-loaded and runs on ball-bearing mounted pulleys. A cam in the cable system expands the higher frequency portion of the tuning dial.

#### OUTPUT SYSTEM

The r-f amplifier is coupled to a piston-type output attenuator which is calibrated over a range of 131 db. The attenuator has been carefully designed to provide a constant impedance vs. frequency characteristic. The VSWR of the output system is less than 1.2 over the complete frequency range. The nominal internal impedance of the output system is 50 ohms.

The generator provides a maximum output of 1 volt rms open circuit or 0.5 volt across 50 ohms (+7 dbm). However, the output reference level has been established at

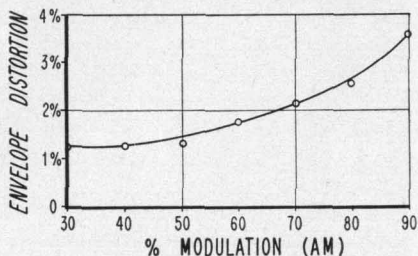


Fig. 8. Typical performance of the 612A with regard to envelope distortion when sine-wave modulated.

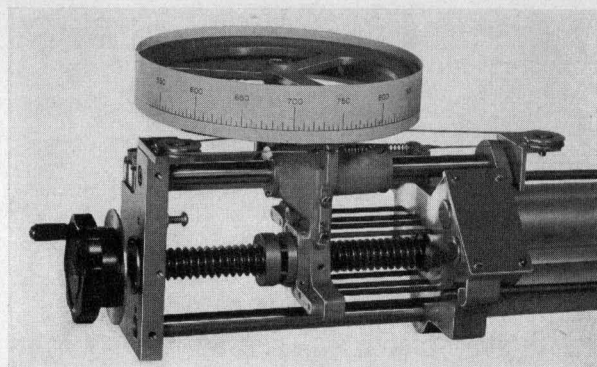


Fig. 9. Mechanical drive for carrier oscillator and r-f amplifier.

0.35 volt across 50 ohms (+4 dbm) to allow for a full 100% modulation of the output. The output attenuator is calibrated directly in dbm and in voltage from 0.35 volt to 0.1 microvolt (-127 dbm). The combination of a piston-type design for the attenuator and a low output VSWR assures an accuracy of within 1 db when the instrument is operated into a 50-ohm load.

cation is accurate on sine wave, pulse, and uni-directional modulation. On uni-directional modulation sensitivity of the meter is automatically changed so that accurate readings at 30% modulation are obtained.

#### 610B DISCONTINUED

The new 612A supersedes the former -hp- Model 610B Signal Generator which operated from 450 to 1200 megacycles. —H. E. Overacker

The output meter samples the r-f output directly at the attenuator input. The output meter detector circuit provides the percent modulation meter with a sample of the modulation envelope. The modulation meter is a peak-to-peak reading circuit so that its indi-

#### SPECIFICATIONS

-hp-

#### MODEL 612A

#### UHF SIGNAL GENERATOR

FREQUENCY RANGE: 450 to 1230 megacycles in one band.

CALIBRATION ACCURACY: Within  $\pm 1\%$ . Resetability within 1 mc at highest frequencies.

OUTPUT VOLTAGE: 0.5 volt (+7 dbm) maximum to 0.1 microvolt (-127 dbm). Attenuator calibrated in volts and dbm.

OUTPUT IMPEDANCE: 50 ohms. Maximum VSWR is 1.2.

ATTENUATOR ACCURACY: Within  $\pm 1$  db over entire range.

AMPLITUDE MODULATION: From 0 to 90%; percent modulation panel meter provided.

ENVELOPE DISTORTION: Not more than 2% at 30% modulation.

INTERNAL MODULATION: Internal oscillator provides 400 and 1000 cps for fixed frequency modulation.

EXTERNAL MODULATION: From 20 cps to 5 megacycles or by pulses as short as 0.2 microsecond. R-f oscillator can also be pulsed.

UNI-DIRECTIONAL MODULATION: D-c restorers permit up or down modulation.

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

POWER: Operates from nominal 115/230 volt, 50/60 cycle source; requires 225 watts.

DIMENSIONS: 12" w, 14" h, 20" d. Cabinet mounting. Weighs 65 lbs. Shipping wt. 100 lbs.

PRICE: \$1200.00 f.o.b. Palo Alto, California. Data subject to change without notice.

## Field Repair Stations

As another service to users of -hp- equipment, authorized repair stations are maintained by -hp- field engineering representatives in three major cities across the United States: New York, Chicago, and Los Angeles. Shown below is a portion of the repair facilities at -hp- representative Alfred Crossley and Associates, Chicago.

These stations, although independently operated, are provided with factory-built calibration equipment and replacement parts. In addition, station personnel receive periodic training courses at the factory. The stations supplement the complete repair facilities available at the factory and are equipped to repair many of the instruments in the -hp- line.

Before shipping equipment to the factory or to any of the field stations, it is desirable to obtain shipping recommendations so as to avoid delay and possible necessity for reshipping. In any case a complete description of trouble and return shipping instructions should accompany the equipment.

Telephone numbers and addresses of the repair stations are given below.

NEW YORK 13, NEW YORK  
Burlingame Associates  
103 Lafayette Street  
DIgby 9-1240

CHICAGO 40, ILLINOIS  
Alfred Crossley & Associates  
4501 No. Ravenswood Avenue  
UPtown 8-1141

LOS ANGELES 46, CALIFORNIA  
Neely Enterprises  
7418 Melrose Avenue  
WEBster 3-9201

