



A New 10-15.5 KMC 10 MW Signal Generator

THE new -hp- Model 626A SHF Signal Generator operates over the range from 10 to 15.5 kilomegacycles and provides a high output of many milliwatts over this range. Although the generator is rated as providing a maximum of at least 10 milliwatts over the whole range, it usually provides more than 15 milliwatts at all frequencies and over most of the range the output is in the 30-milliwatt or higher region. The generator is thus valuable as a signal source for rough test work as well as for reflectometer, slotted line, and receiver applications.

SEE ALSO

"Simple Regulated Power Supply", p. 3
"Obtaining Balanced Square Waves", p. 4

In addition to its relatively high maximum power output, the generator has the other features that make any signal generator convenient to use. These include a direct-reading

frequency dial accurate within 1%, a direct-reading attenuator with a 100 db range, and a flexible modulator that provides internal square-wave, pulse or f-m modulation of the output signal. The new generator has been developed as a companion to the recently-developed -hp- 15-21 kmc generator¹.

Fig. 2 shows the generator's circuit arrangement. The oscillator klystron operates with an external resonator which is tuned with a non-contacting type plunger. Oscillator tube life is thus unrelated to the number of times the instrument is tuned through its frequency range. Repeller voltage is automatically tracked with the frequency dial so that no repeller voltage adjustments are required.

The path from the klystron to the output terminals is all contained in wave guide. The klystron is followed by an uncalibrated wave guide attenuator which serves to adjust the power level applied to the main calibrated attenuator. This reference level is designed to be 10 milliwatts, and the attenuator calibration is based on a 10-milliwatt reference level. As mentioned earlier, however, much higher powers can be obtained when desired by operating the instrument with both attenuators set for minimum loss. The level at the input to the main attenuator is monitored by a compensated thermistor bridge which operates a panel meter. A wave guide directional coupler of the -hp- multi-hole type² splits off a sample of the power applied to the output attenuator for monitoring purposes.



Fig. 1. New -hp- Model 626A SHF Signal Generator has high power output over 10 to 15.5 kmc range, is provided with direct-reading frequency dial and output attenuator, has flexible modulator.

¹Wm. D. Myers, The New -hp- 15-21 KMC 10 MW Signal Generator, *Hewlett-Packard Journal*, Volume 6, No. 10, June, 1955.

²E. F. Barnett and J. K. Hunton, A Precision Directional Coupler Using Multi-Hole Coupling, *Hewlett-Packard Journal*, Volume 3, No. 7-8, March-April, 1952.

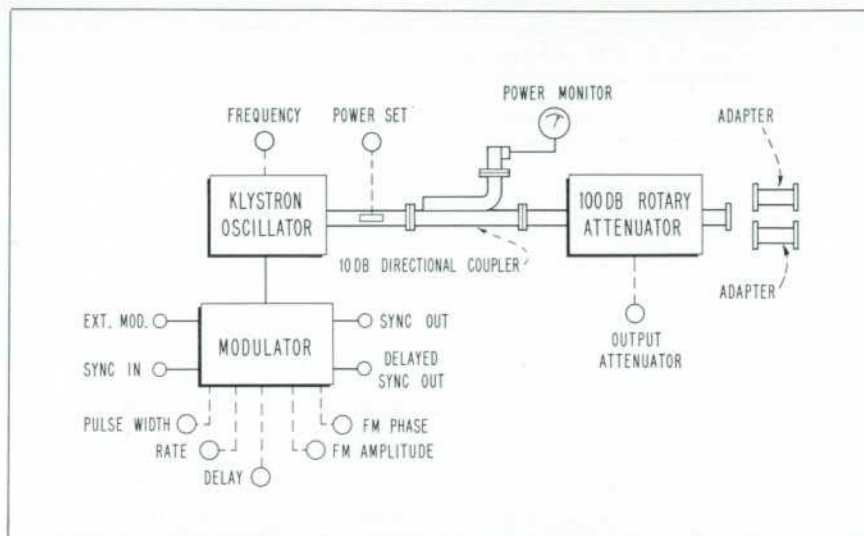


Fig. 2. Basic circuit arrangement of *hp-Model 626A SHF Signal Generator.*

The main output attenuator itself is of the rotary type³. In this attenuator a resistive film is rotated in a circular section of wave guide. The resultant attenuation is then related to the angle through which the film is rotated. The rotary attenuator has the advantages that its attenuation follows a mathematical law and that it is not sensitive to frequency over the range covered. A single rotary attenuator by itself has a practical range of 50 db. To achieve the 100 db range desired for the new generator, two such attenuators are mechanically ganged and operated as a single unit. The resulting attenuator is calibrated directly in power output over the range from +10 to -90 dbm (10 milliwatts to 1 micromicrowatt). Although the attenuator itself operates in circular guide, it is provided with transitions at each end so that the remainder of the guide used in the instrument is all rectangular.

The attenuator is a good match for a wave guide system. As a result, the output VSWR of the generator is not more than 1.2 at levels of 0 dbm and below. At higher levels where the attenuator is more nearly re-

moved from the circuit, the VSWR increases up to a maximum of 2.5 at full rated output.

The output from the generator is provided in type WR-75 rectangular wave guide which is terminated at the front panel in a flat cover flange. Two adapters are provided to enable the generator to be used with 8.2-12.4 kmc size guide or 12.4-18 kmc size guide. A wave guide cap on a chain attached to the panel permits the generator wave guide opening to be closed off during non-use periods.

The self-contained modulator is designed to make the generator useful for a wide range of applications. Pulsed outputs are available over a range from 0.5 to 10 microseconds at repetition frequencies from 40 to 4000 pps. Two positive sync pulses are provided, one of which is approximately coincident with the start of the r-f pulse and the other variable from 3 to 300 microseconds in advance of the r-f pulse.

Internal square wave modulation is also available over a range from 40 to 4000 cps.

Internal frequency modulation can be obtained at the power line frequency. Deviations up to ± 5 megacycles are available and phase

and deviation controls are provided.

Terminals are also provided so that the generator can be modulated by external pulses and so that frequency modulation by external sine- or square-waves can be obtained.

-Wm. D. Myers

SPECIFICATIONS
-hp-
MODEL 626A SHF SIGNAL GENERATOR

- FREQUENCY RANGE:** 10,000 to 15,500 mc.
- FREQUENCY CALIBRATION:** Dial direct reading in megacycles. Accuracy better than $\pm 1\%$.
- OUTPUT RANGE:** 10 mw to $1\mu\mu\text{w}$. (+10 dbm to -90 dbm, 0 dbm = 1 mw.) Attenuator dial directly calibrated in output dbm. SWR less than 2.5 at +10 dbm; 1.2 at 0 dbm and lower.
- OUTPUT MONITOR ACCURACY:** Better than ± 1 db.
- OUTPUT ATTENUATOR ACCURACY:** Better than $\pm 2\%$ of attenuation in db introduced by output attenuator.
- OUTPUT CONNECTOR:** 0.850 inches by 0.475 inches (external) wave guide with WR51 Flat Cover Flange.
- LEAKAGE:** Less than minimum calibrated signal generator output.
- MODULATION:** Internal or external pulsed, FM or square wave.
- INTERNAL PULSE MODULATION:** Repetition rate variable from 40 to 4,000 cps. Pulse width variable 0.5 to 10 microseconds.
- SYNC OUT SIGNAL:** 20 to 50 volts amplitude into 1,000 ohm load. Better than one microsecond rise time. (1) Simultaneous with r-f pulse—positive. (2) In advance of r-f pulse—positive, variable 3 to 300 microseconds.
- EXTERNAL SYNCHRONIZATION:** (1) Sine wave, 40 to 4,000 cps, amplitude 5 to 50 volts rms. (2) Pulse signals 0 to 4,000 cps, 5 to 50 volts amplitude, positive or negative. Pulse width 0.5 to 5 microseconds. Rise time 0.1 to 1 microsecond.
- INTERNAL SQUARE WAVE MODULATION:** Variable 40 to 4,000 cps controlled by "pulse rate" control.
- INTERNAL FREQUENCY MODULATION:** Power line frequency, deviation up to ± 5 mc.
- EXTERNAL PULSE MODULATION:** Pulse Requirements: Amplitude 15 to 70 volts peak positive or negative; width 0.5 to 2500 microseconds.
- EXTERNAL FREQUENCY MODULATION:** Provides capacitive coupling to repeller of klystron. Maximum deviation approximately ± 5 mc.
- POWER SOURCE:** 115/230 volts $\pm 10\%$, 50/60 cps, approx. 200 watts.
- SIZE:** Cabinet Mount: $16\frac{3}{4}$ " wide, $13\frac{1}{2}$ " high, 12" deep.
- WEIGHT:** Net 65 lbs.; shipping weight 105 lbs.
- ACCESSORIES FURNISHED:** (a) M to X Band wave guide adapter, WR-75 to WR-90 guide. (b) M to P Band wave guide adapter, WR-75 to WR-62 guide. (c) Power cord.
- PRICE:** -hp- Model 626A SHF Signal Generator, 10-15.5 kmc, \$3,250.00 f.o.b. Palo Alto, California.
- Data subject to change without notice.

³B. P. Hand, A Precision Wave Guide Attenuator Which Obey's a Mathematical Law, *Hewlett-Packard Journal*, Volume 6, No. 5, January, 1955.

A Simple 0-500 Volt Metered Power Supply



Fig. 1. *hp Model 711A Regulated Power Supply has many operating features such as overload relay, voltage vernier that suit it to everyday use.*

The *hp* Model 711A Regulated Power Supply has been designed as a medium-priced general-purpose supply suitable for the majority of typical bench work. It is intended to meet the need presently existing below the specialized, high-performance type of supply currently emphasized for a utility supply suited to use as standard bench equipment. A number of electrical and mechanical features are included to make the supply convenient for such everyday use.

The supply provides d-c currents up to 100 ma over the range from 0 to 500 volts. Both output current and voltage are metered. As a special feature to facilitate low-power work the meter sensitivities can be independently increased 10 times with panel push-switches, i.e., to 10 ma full scale for the current meter and 50 volts full scale for the voltmeter. The panel voltmeter is arranged so that it reads when the d-c switch is off, a feature that permits the output voltage to be accurately set before it is applied to the load. A vernier is provided for the output voltage to facilitate incremental voltage changes and precise voltage settings.

To avoid the inconvenience of replacing fuses whenever accidental overloads occur, the d-c output circuit is protected by an overload relay instead of a fuse. Use of a relay over other arrangements has a number of advantages. It is fast-acting since no thermal lag is involved. It can withstand even a sustained short circuit at the supply terminals without damage to the supply. And finally, the supply is immediately operative without need of resetting when the short is removed.

In keeping with the utility nature of the supply, care has been taken to maintain circuit simplicity. Only five tubes are used including the 5651 reference tube. Power rectification is accomplished with selenium rectifiers. To minimize weight and bulk, an automatically-tracked multi-pole switch is used at the out-

put of the power transformer instead of an autotransformer. As a result of these precautions, component failure probability is unusually low. Further, the weight of the supply is only 20 pounds—less than half the weight of most supplies.

Electrical performance of the unit is suited to typical day-in day-out bench use. The 0-500 volt range of the output enables the supply to be used with loads ranging from low-voltage relays and transistors to 50-watt power stages. On the occasions where additional d-c power may be required, the load can be split among two of the supplies. Two of the supplies can also be operated in series to provide extra-high voltages or both + and - voltages. The latter type of operation has the advantage over most supplies that a significant amount of power is available

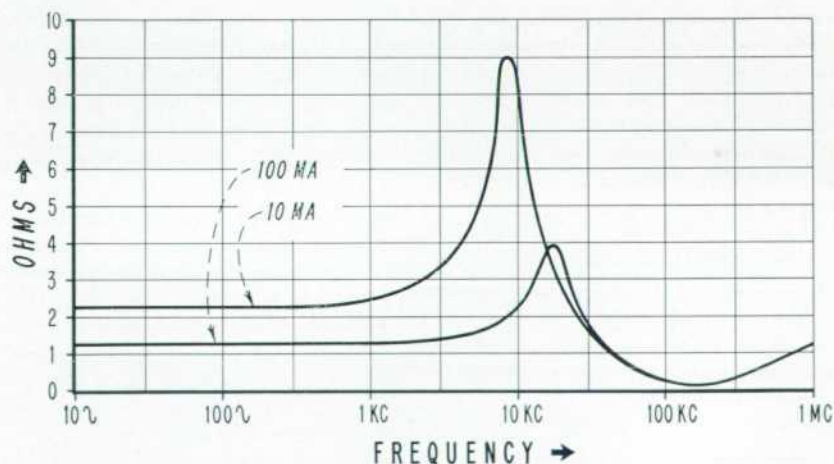


Fig. 2. *Typical internal impedance characteristic of hp Model 711A Power Supply.*

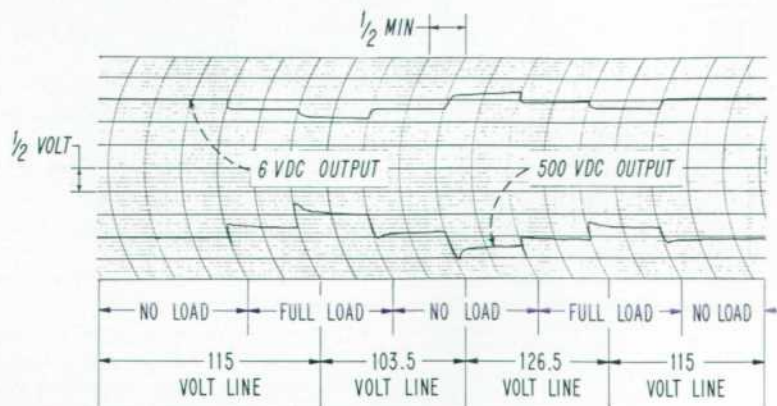


Fig. 3. *Typical stability characteristic of hp Model 711A under severe line voltage and load shifts.*

from the negative source to power below-ground circuits. Two separate 6.3-volt 3-ampere outputs are provided to power the filaments of either 6.3- or 12.6-volt tubes.

One of the important characteristics of the supply is its relatively low hum and noise level of less than 1 millivolt. This level is less than that found in more sophisticated designs and is a feature of some value to the user since it permits the supply to be used with low-level stages.

The internal impedance of the supply is shown in Fig. 2 and the stability with line voltage and load changes in Fig. 3. The peak shown in Fig. 2 can, if desired, be substantially reduced by connecting a 5- or 10-microfarad capacitor across the supply's output terminals. The data in Fig. 3 are shown for full output

current at full voltage (lower curve) and for full current at 6 volts (upper curve). The data represent the effect on the output voltage of unusually severe conditions, i.e., changes from no load to full load, from one line-

voltage extreme to the other, etc. Even so, it will be seen that the output changes seldom exceed $\frac{1}{2}$ volt at a 500 volt level and are less at the lower levels.

—Brunton Bauer

SPECIFICATIONS
-hp-
MODEL 711A POWER SUPPLY

OUTPUT VOLTAGES: Dc Regulated High Voltage: 0 to 500 volts (without switching), 100 ma maximum load. Ac Unregulated: 6.3 volts, 6 amps maximum load; 12.6 volts CT, 3 amps maximum load.

REGULATION: For line voltage 115/230 volts $\pm 10\%$, less than 0.5% change or 1.0 volt change, whichever is greater; from no load to full load, change of less than 0.5% or 1.0 volt, whichever is greater.

RIPPLE: Less than 1.0 mv.

METERING: Current Meter: 0 to 100 ma; 0 to 10 with push-button. Voltage Meter: 0 to +500 volts; 0 to +50 volts with push-button.

TERMINALS: Either positive or negative dc regulated high voltage terminal may be grounded.

OVERLOAD PROTECTION: Ac line fused. Overload relay prevents dc output from greatly exceeding current rating of output milliammeter thus protecting instrument from overload conditions including short circuit output.

POWER: 115/230 volts $\pm 10\%$, 50/1000 cps. Approximately 150 watts depending on load and line voltage.

SIZE: Cabinet Mount: 7 $\frac{1}{2}$ " wide, 11 $\frac{1}{2}$ " high, 12 $\frac{3}{4}$ " deep. Rack Mount: 19" wide, 7" high, 13 $\frac{3}{4}$ " deep.

WEIGHT: Net 20 lbs.; shipping weight 26 lbs.

PRICE: -hp- Model 711AR Power Supply, Rack Mount, \$230.00. -hp- Model 711A Power Supply, Cabinet Mount, \$225.00. All prices f.o.b. Palo Alto, California.

Data subject to change without notice.

Balanced Output from the -hp- Square Wave Generator

The -hp- Model 211A Square Wave Generator provides fast-rise square waves over a frequency range from 1 cps to 1 megacycle. These square waves are available from two independent outputs on the instrument. One output provides 7 volts open circuit from a 75-ohm source; the other provides 55 volts open circuit from a 600-ohm source. Both outputs are single-ended and negative with respect to ground.

The instrument is also valuable, however, when it is desired to apply square waves to a balanced load. For these cases the Model 211A can be converted to a balanced source without modifying the instrument in any way.

Fig. 1 shows the basic arrangement of the output circuit in the Model 211A. The output tubes themselves are in push-pull but have unequal loads as shown. A balanced voltage can thus be obtained by equalizing the tube loads. This can be done directly at the terminals on the panel.

In Fig. 2 the upper terminal represents the 75-ohm output on the Model 211A and the lower terminals represent the 600-ohm output. To equalize the source impedances at the two outputs, a resistance of 86 ohms can be connected across the lower terminals as shown in Fig. 2. This additional resistance will reduce the source impedance at the lower terminals to about 75 ohms and will also reduce the voltage available from the lower terminals to approximately the same amount available at the upper terminal. At the same time the additional resistance will form a more favorable time constant with the stray capacity C_0 at the lower terminals and thus speed up the normally slower rise time at those terminals until it is comparable to that of the 75-ohm output.

Fig. 2 suggests the use either of two 75-ohm cables or a balanced 150-ohm cable for connecting to the load. In either of these cases it is normally unnecessary to terminate the cables, so that they can be connected directly to the load. The arrangement has the advantage that it can be used with any load impedance. If cables of other impedances are used, they should be terminated in the characteristic im-

pedance of the cable. This will involve a consideration of the load impedance in some cases.

The output voltage can be selected most conveniently if the 75-ohm attenuator is first set to zero. The two amplitude controls will then have about the same voltage range and each should be set as necessary to obtain one-half of the desired output voltage. This will occur when both controls are at about the same angular position. If desired, both line-to-ground voltages can be measured with a voltmeter or oscilloscope.

The generator will provide as much as 14 volts peak-to-peak when unterminated cables are used. With terminated 75-ohm cables, a maximum of about 7 volts peak-to-peak is available.

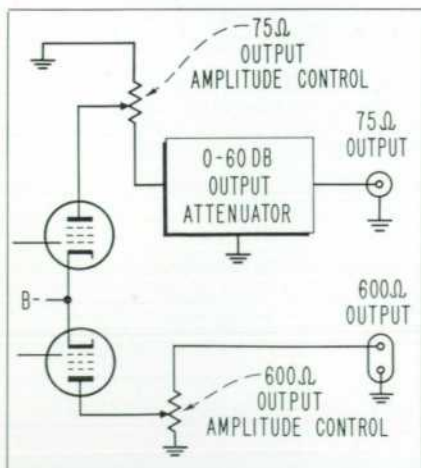


Fig. 1. Basic arrangement of -hp- Model 211A output circuit.

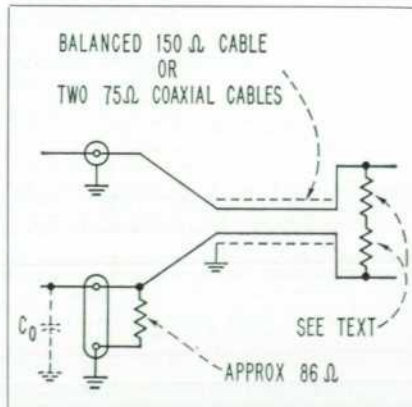


Fig. 2. Method for obtaining balanced output from -hp- Model 211A.