Greater Flexibility in the
-hp- 3800-7600 Mc Signal Generator

TWO years ago the Hewlett-Packard Company introduced the Model 618A 3800-7600 megacycle signal generator. This instrument generated a full milliwatt of power over its frequency range, was direct-reading both in frequency and in power output, had an internal square-wave generator to provide square-wave modulation of the r-f output, and included provision for pulse or frequency modulation from externally-applied voltages. The instrument was thus nicely suited both to laboratory and production applications.

More recently, there has been need for a signal generator similar to the 618A but with the addition of an internal pulse-generating system that would minimize the equipment necessary for field-testing of pulse receivers. As a result, the Model 618A has now been modified to include such a pulser. At the same time, it has been possible to make several advances in the basic design.

The modified instrument is known as the -hp- Model 618B. The 618B is currently being supplied on all orders calling for the Model 618A. The 618A has been discontinued.

The r-f oscillator in the Model 618 consists of a reflex klystron operating in a parallel-plane type resonator. The parallel-plane resonator was selected for its ease of straight-forward suppression of undesired modes of oscillation. Briefly, this design was such that undesired modes were suppressed through special manipulation of parasitic resonances in the resonator.*

To cover the complete 3800-7600 megacycle range in the 618A, the klystron was operated in the $1\frac{3}{4}$ reflector mode at the lower frequencies and in the $2\frac{3}{4}$ mode at frequencies above approximately 4200 megacycles. However, the relative instability which is characteristic of the $1\frac{3}{4}$ mode led to need for careful selection of tubes at the factory and complicated field replacement of tubes.

From the standpoint of klystron characteristics, greater latitude would result if the klystron were operated in a single mode. Originally, the klystron characteristics were not suitable for single mode operation over the complete 3800-7600 megacycle range. However, through cooperation of the tube manufacturer, the klystron design has now been modified to permit operation over this range in the $2\frac{3}{4}$ mode. In addition, the specifications for this modified klystron require satisfactory operation in a resonator identical to that used in the Model 618B. The modified klystron has been assigned the RTMA number 6236.

Fig. 1. *New -hp- Model 618B operates from 3800-7600 mc and includes flexible new pulser.*
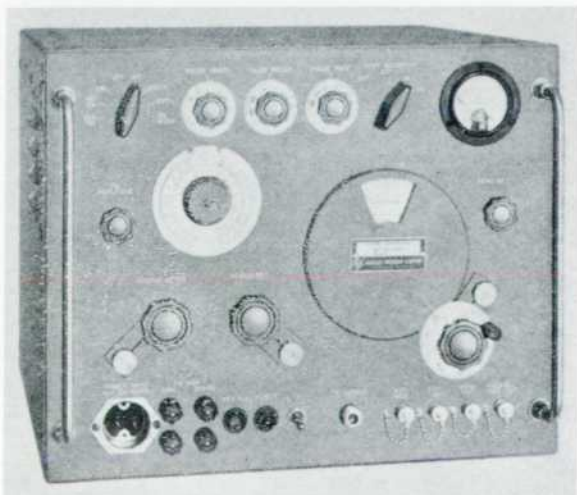
*See Myers, W. D., "A 3800-7600 Mc. Signal Generator Using a Parallel-Plane Type Resonator," Hewlett-Packard Journal, Vol. 2, No. 1, September, 1950.

Other advances in the new Model 618B include a substantial reduction of zero drift of the power monitor circuit and forced-air cooling of the klystron to provide a several-fold increase in tube life.

PULSER

The pulser in the Model 618B is designed to generate (a) square waves, (b) pulses whose duration is adjustable from at least 0.5 to 10 microseconds, and (c) sawtooth waves for sawtooth frequency modulation of the r-f output. Fig. 2 indicates the basic pulser circuitry.

Fig. 3. *Typical (a) 0.25-microsecond and (b) 1-microsecond r-f output pulses (detected). Most instruments generate pulses as short as 0.25 microsecond, although specified minimum width is 0.5 microsecond.*

The repetition-rate multivibrator (Fig. 2) can be operated either free-running or synchronized with external voltages. The rate of this multivibrator determines the repetition rate for pulse, square-wave, and sawtooth operation of the equipment. The multivibrator design is of the balanced type which generates square waves and which inherently has good stability. The rate of the multivibrator in the free-running condition is adjustable from 40 to 4000 pps by a calibrated panel control.

For square-wave modulation, the output of the rate multivibrator is applied directly to the modulator circuit for the klystron. For pulse modulation, the output of the rate multivibrator is applied through a delay circuit to the pulse-width-generating multivibrator. A calibrated panel control adjusts the width of the modulating pulse between approximately 0.5 and 10 microseconds. Care is taken to achieve a fast rise and decay for the modulating pulses. The quality of the pulsed r-f output is illustrated in Fig. 3, which
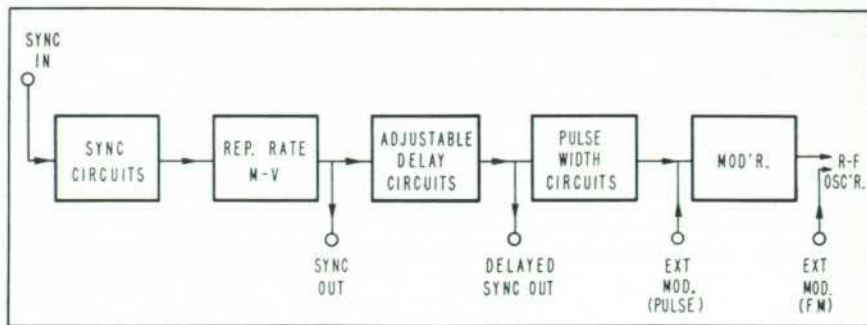

Fig. 2. *Block diagram of basic pulser circuitry.*

shows oscillograms of detected 0.25 and 1 microsecond r-f output pulses. Although specified minimum width for the instrument is 0.5 microsecond, pulses as short as 0.25 microsecond can usually be obtained.

The pulser is further arranged to accommodate modulation by external pulses or square waves. Provision is also made for frequency modulation from external sawtooth or sine-wave voltages. External modulating frequencies as high as 500 kc can be used. Maximum obtainable deviation is approximately ±5 megacycles.

The pulser provides a sync out and a delayed sync out video pulse for use with external equipment. These pulses are of at least 25 volts peak amplitude when applied to loads of 1,000 ohms shunted by 500 micro-microfarads.

The rise of the delayed sync out pulse is approximately coincident with the rise of the r-f output pulse. The position of both pulses is determined by the delay circuits, which are adjustable by means of a calibrated panel control from 3 to 300 microseconds following the sync out pulse.

The pulser circuit is relatively insensitive to changes in tube characteristics. Where tolerances in tube characteristics are likely to modify the pulser performance, simple internal controls are provided for compensation purposes.

—*W. D. Myers*

Measuring Large Resistances With the -hp- 410 VTVM

A PROBLEM that occurs in laboratory and production work is measuring the value of large resistances in the order of a hundred megohms and larger. Typical examples of this type of measurement include measuring leakage resistance of transformers, insulation resistance, large fixed resistances, etc.

When these values are beyond the range of an ordinary ohmmeter, the measurements can be made very simply with the -hp- Model 410 voltmeter. The Model 410 is usually considered in terms of its 700-megacycle high-frequency response, but the instrument is also valuable as a wide-range d-c voltmeter having a resistance of 122 megohms and a range from 0 to 1,000 volts d-c.

The set-up for measuring large resistances with the 410 is indicated in Fig. 1. This set-up is essentially a variation of the common ohmmeter circuit. The resistance to be measured is connected in series with the Model 410. The combination is then fed from a d-c source.

To determine the unknown resistance, it is first necessary to know the voltage of the d-c source. The source voltage can be measured and adjusted by connecting the Model 410 directly across the source before making the resistance measurement.

Once the voltage of the d-c source is known, the reading of the voltmeter can be translated into the resistance of the unknown by referring to the curve in Fig. 2. This curve is direct-reading for source voltages of 10 volts, but it is also useful for other voltages. When a different source voltage is used, the voltmeter reading should be multiplied by the factor

$$\frac{\text{voltage of curve (i.e., ``10'')}}{\text{actual source voltage}}$$

Using the product of this multiplication, the unknown resistance can be obtained directly from the curve in Fig. 2. For example, if a 30-volt
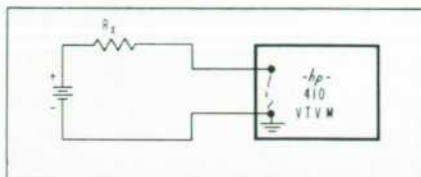

Fig. 1. *Set-up for measuring large resistances with -hp- Model 410 VTVM.*

source is used, the multiplying factor would have a value of $\frac{1}{3}$. Therefore, the reading obtained on the voltmeter should be multiplied by $\frac{1}{3}$ and the resulting value referred to Fig. 2 to determine R_x.

The voltmeter method of measuring resistance lends itself to a number of different types of measurements. For example, the method can be used to measure insulation resistances both of low-voltage and high-voltage devices. Also, resistance as a function of applied voltage can readily be investigated.

A number of different d-c sources can be used for these measurements. Any of the -hp- series of regulated power supplies is useful, especially where higher source voltages are desired. Where small source voltages are desired, batteries can be used.

The accuracy of the method is adequate for most high-resistance measurements. The calibration of the 410 is accurate within 3%, while its input resistance of 122 megohms is also accurate within approximately 3%. The voltage of the d-c source should be known accurately, and if the source is measured with the 410 the accuracy will be within 3%. The measurements can thus be made with an overall accuracy of within approximately 10%. If higher accuracy is desired, the setup can be calibrated with a known resistance of suitable value, in which case only the 3% scale error of the voltmeter will be obtained.
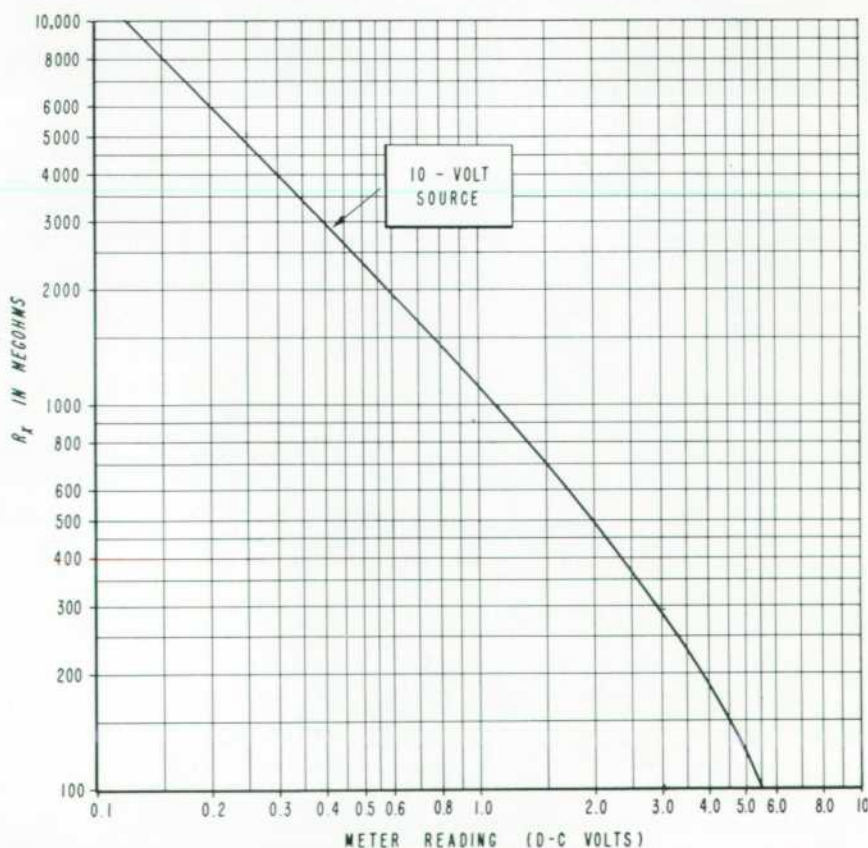

Fig. 2. *Curve for determining unknown resistance from reading of -hp- Model 410 VTVM. See text for procedure when source voltage is different from 10 volts.*

Checking Klystron Linearity with -*hp*- Equipment

IN SHF communications applications where klystrons are frequency-modulated from voice channels, a high degree of linearity is desired for the klystron reflector modulation characteristic in order to minimize distortion. During development work on such klystrons at Varian Associates in San Carlos, California, it was desired to measure reflector modulation linearity in order to establish tangible specifications.

Under project leader Theodore Moreno of Varian Associates, an interesting arrangement was devised for making these measurements with a group of standard -*hp*- instruments available in the Varian laboratory. The equipment arrangement is shown in Fig. 1. The klystron to be measured is frequency-modulated from an -*hp*- Model 206A Audio Signal Generator to have a swing of ±1 megacycle. The 206A is operated at a convenient frequency such as 1000 cps. The output of the modulated klystron is mixed with the output of a c-w klystron to give a difference frequency of 4 megacycles which contains the 1 mc modulation swing.

The 4-megacycle difference frequency from the mixer is amplified in an -*hp*- Model 460A Wide Band Amplifier and further amplified and displayed by a wide-band oscilloscope. The amplified signal is applied to an -*hp*- Model 524A 10-megacycle frequency counter. In this application the frequency counter is used as a 20:1 frequency divider. To use the counter as a divider, the output is taken from the first binary stage of the second decade divider of the counter. This output consists of a 200 kc voltage containing an f-m swing of ±50 kc.

The 200 kc voltage is introduced into the i-f section of an -*hp*- Model 335B FM Frequency and Modulation Monitor, an instrument developed for monitoring standard f-m broadcast stations. The monitor normally operates with a 200 kc voltage in its i-f section; therefore, the output of the counter can be introduced into the i-f section of the monitor without circuit modification.

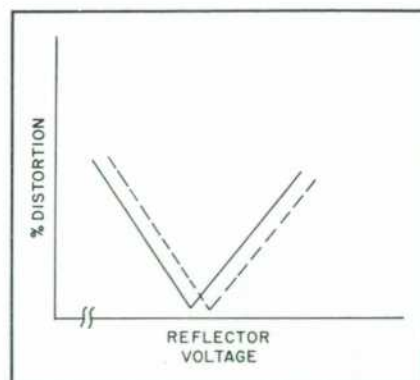The monitor is designed to measure and indicate modulation swings up to 100 kc so that the swing in the

Fig. 2. *Curve of second harmonic distortion obtained with arrangement of figure 1.*

200 kc voltage can be read directly on the monitor's per cent modulation meter. This meter was used in setting the modulation level. The monitor also detects the f-m modulation in a low-distortion pulse-counter type f-m detector. The percentage of the individual harmonics in this detected signal is measured with an -*hp*- Model 300A Harmonic Wave Analyzer.

A typical curve of second harmonic vs. reflector voltage measured with this arrangement is shown in Fig. 2. As would be expected, the distortion is smallest near the point of inflection of the reflector modulation characteristic.

As an interesting sidelight, it was found that this distortion curve was somewhat displaced when the frequency of the c-w klystron was shifted to operate on the opposite side of the center frequency of the modulated klystron. This effect was caused by the slight distortion in the circuits of the monitor and provides an independent method for checking the residual distortion in the monitor. The results showed monitor distortion to be less than 0.1%. This compares with the value of 0.25% which is specified as maximum distortion in the monitor for modulation swings of ±75 kc (100% modulation for standard f-m broadcast stations).
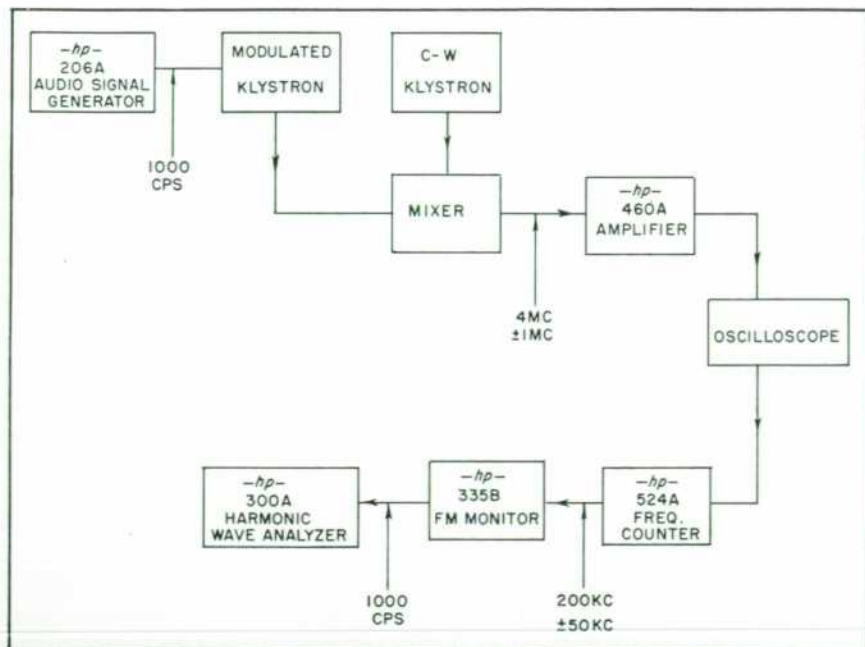

Fig. 1. *Equipment arrangement for measuring klystron reflector modulation linearity.*