A TEST OSCILLATOR FOR S-BAND MEASUREMENTS

With the TYPE 1360-A Microwave Oscillator, the frequency range of General Radio continuously tunable oscillators is extended to 4 Gc. Although not itself one of the Unit Instruments, it supplements this popular line of test equipment that provides the user with versatility and quality at a reasonable price.

Every effort has been made to give this new oscillator, within the design limitations dictated by tube choice and price, maximum usefulness as a driver for slotted lines, as the local oscillator in a heterodyne detector, and as a general-purpose power source for measurements on components and systems at microwave frequencies.

The frequency range of the oscillator is 1.7 to 4.1 Gc. Output power is 100 milliwatts or more over most of the frequency range. Internal 1-kc square-wave modulation is provided, as is also a narrow-band sweep at both 1-kc and the power-line frequency. Modulation from external sources can be fm, square-wave, or pulse.

RF CIRCUIT

The microwave oscillator in the TYPE 1360-A is a TYPE 5836 Reflex Klystron in a coaxial cavity with a noncontacting tuning plunger. The frequency range is split in order to obtain a maximum range of interference-free operation and, at the same time, to provide maximum output power. For the higher frequency range (2.6-4.1 Gc), the cavity length is $\frac{3}{4}$ wavelength and the klystron is operating in its $2\frac{3}{4}$ repeller mode. In the lower frequency range (1.7-2.8 Gc), the numbers are $\frac{1}{4}$ and $1\frac{1}{4}$ respectively. The range switching is controlled automatically by the main frequency dial (center of panel, Figure 1), and, since the higher frequency range requires the longest cavity, the lower frequency range starts at the top end of the higher one. The two ranges are separated on the dial by different colored scales, and a

Figure 1. Panel view of the Microwave Oscillator.

pilot lamp indicates which scale is to be read. The tuning law of the repeller is matched to that of the cavity by a specially shaped, high-resolution potentiometer, and the final adjustment is made by trimmer rheostats. In series with the repeller potentiometer is also a small rheostat for fine frequency adjustment ($\triangle$F knob), with a range of approximately 1 Mc. However, since adjustment of this rheostat may seriously harm the tracking of repeller voltage and cavity tuning when the oscillator is square-wave modulated, the $\triangle$F control is disabled under that condition.

OUTPUT CIRCUIT

The output control is at the lower right of the panel. The output power is a function of frequency, as shown in Figure 2, and is more than 100 milliwatts over most of the frequency range. At the very low-frequency end of the range, it may be as low as 20 milliwatts, which corresponds to 1 v into a 50-ohm load. At the upper end of each frequency range, it is possible to overload the klystron oscillator, and an output monitor is provided to warn against this condition. The monitor enables the user to extract the maximum output power at any setting of the frequency dial. The output power is controlled by a retractable pick-up loop in the oscillator cavity. The dial plate on the attenuator (pick-up loop) knob is calibrated in arbitrary units (maximum coupling is 100), but the divisions are equivalent to decibels except in the nonlinear range of the attenuator where the output power is greatest. The area where over-coupling is possible at some frequencies, even with a 50-ohm load, is indicated on the attenuator dial by the legend WATCH OUTPUT MONITOR. The output monitor is fed from a directional coupler in such a manner that it is quite insensitive to load changes. A variable resistor in series with the meter serves as a sensitivity control.

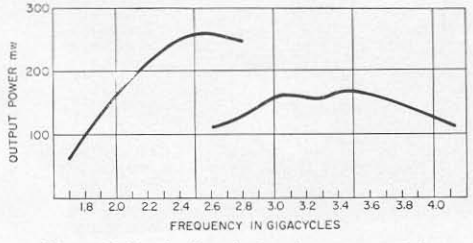

Figure 2. Typical variation in output with frequency.

The output connector is a 50-ohm TYPE 874 Locking Connector which will permit a semipermanent attachment of a cable or an adaptor to some other type of coaxial connector.

MODULATION

Since the most-used type of operation (other than CW) for a test oscillator at these frequencies is 1-kc square-wave modulation, this is provided internally. To facilitate matching the frequency to the filter in the detector system, a screwdriver adjustment on the front panel can vary the modulation frequency approximately $\pm 5\%$. In the STANDBY position of the modulation switch, between the CW and 1-KC square-wave positions, the rf energy is shut off.

Narrow-band, linear sweep is provided at power-line frequency and 1 kc. This can be used for checking receivers and other narrow-band devices, and is also very useful for realigning the klystron oscillator after a change of klystron tube. When the klystron is being swept internally, oscilloscope synchronization can be obtained through negative trigger pulses from the oscillator.

Square waves for modulation at other

frequencies can be applied by an external source. Recommended sources are the TYPE 1210-C Unit RC Oscillator and the TYPE 1217-B Unit Pulse Generator. The latter is also recommended for pulse modulation. For external frequency modulation, the modulating signal is applied across a series resistor in the repeller lead.

The three block diagrams in Figure 3 illustrate how modulation is accomplished, and it should be noted that different methods are used for pulse modulation and square-wave modulation. For pulse modulation (Figure 3b), the klystron beam current is interrupted by application of a negative voltage to the normally positive biased grid. During the first couple of hundreds of milliseconds after the current is turned on

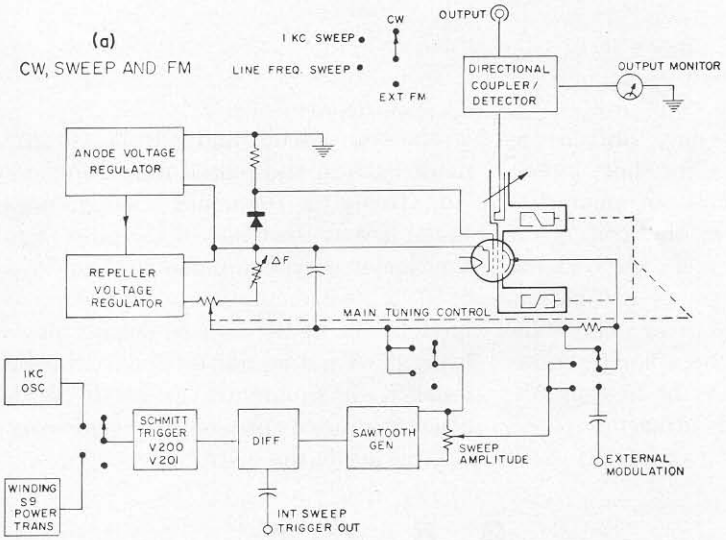

Figure 3a. Schematic for CW, sweep, and frequency modulation.

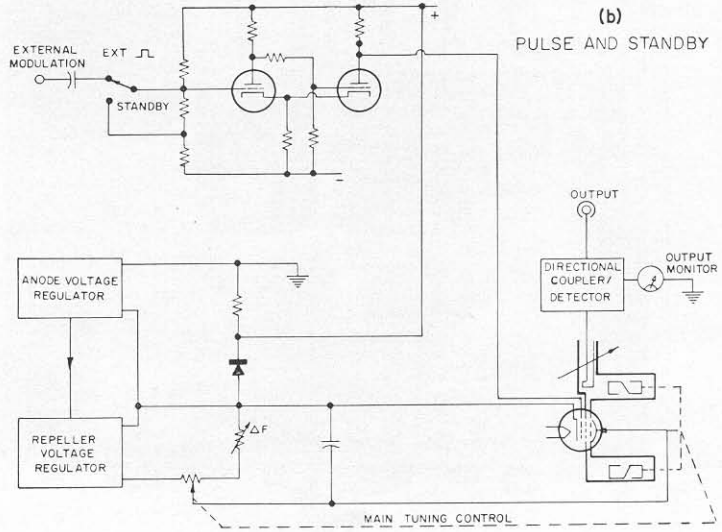

Figure 3b. Schematic for pulse modulation and standby operation.

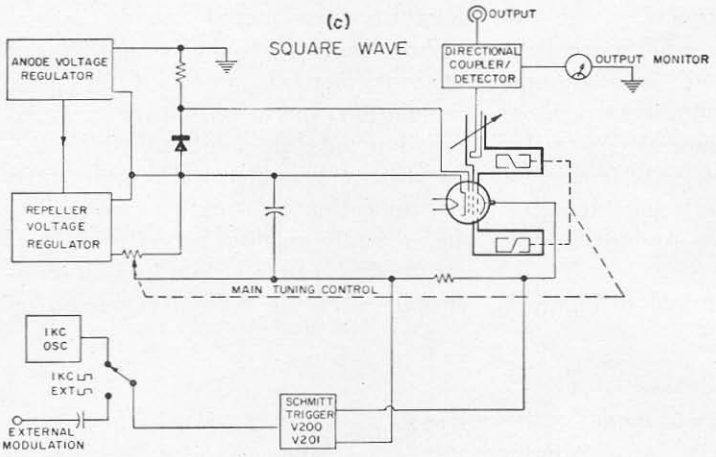

Figure 3c. Schematic for square-wave modulation.

again, the frequency may shift by as much as a megacycle. For short pulses, the frequency shift does not amount to very much, and, since the grid is the pulsing member that gives the best rise time, it is used for pulse modulation. For square waves, however, where the on-period may last for a longer time, the frequency shift may be undesirable, and it was found advantageous to repeller-modulate the klystron. The tube is tracked outside and parallel to the mode pattern and pulsed into the mode. Admittedly, a frequency change does take place at the edges of the pulse, but the time is short compared to the period of the most commonly used square-wave modulation. If the user so desires, however, short pulses can be applied to the repeller, or square waves to the grid, after readjustments of the symmetry control inside the instrument.

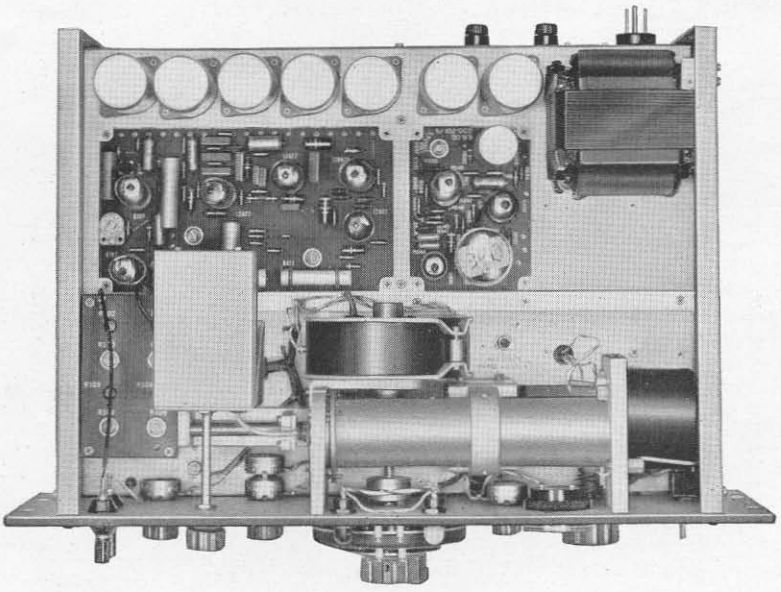

Figure 4. Interior view.

The internal narrow-band sweep at line-frequency or 1-kc rates is produced by application of an internally generated sawtooth voltage to the repeller. Owing to the inherent characteristics of the klystron, the sweep is practically linear in frequency.

External modulation voltage for fm is applied to the repeller through a 0.047-μf capacitor. The input impedance is 400 kilohms shunted with 70 pf.

POWER SUPPLIES

Both the cathode and repeller of the klystron are fed from well-regulated supplies. The repeller heater is fed from a dc supply, which, like the power supply for the modulator circuit, is unregulated but adequately filtered. The bias voltage for the klystron grid is taken from a Zener diode in order to make the voltage constant and independent of the grid current, which varies considerably from tube to tube.

MECHANICAL FEATURES

The TYPE 1360-A is packaged in a 7-inch relay-rack cabinet and can be obtained either with end frames for bench use or with support fittings for rack mount. Figure 4 shows the instrument with the cabinet removed. Almost all the electronic components are mounted on etched boards which are easily accessible from both sides. Tube replacements, including the klystron, do not require any tools, and precautions have been taken to prevent service personnel from accidentally touching high-voltage terminals.

The noncontacting tuning plunger is supported by a carriage with long-life reinforced Teflon bearings, and the rack and pinion drives for the tuning plunger and attenuator require a minimum of lubrication.

—PER A. BERGSTAD

CREDITS

The TYPE 1360-A Microwave Oscillator was developed by Per A. Bergstad, author of the foregoing descriptive article. William G. Cooper, Eduard Karplus, Charles S. Kennedy, Benedict O'Brien and Robert A. Soderman have all contributed to the final design. George A. Clemow was responsible for the mechanical design.

— EDITOR

SPECIFICATIONS

FREQUENCY

Range: 1.7 to 4.1 Gc in two ranges, 1.7 to 2.8 Gc and 2.6 to 4.1 Gc.

Fine Frequency Control ($\triangle$F): Order of 1 Mc, but not functioning for square-wave modulation.

Accuracy: $\pm 1\%$.

Stability: Warm-up drift is approximately 0.15% during the first hour, total drift approximately 0.25%. After warm-up, frequency is stable within approximately 5 ppm.

Residual FM: Approximately 0.5 ppm in the lower frequency range and 0.2 ppm in the higher. Dominant frequencies are 60 and 120 cps (with 60-cycle line frequency).

OUTPUT POWER

Typically more than 100 mw above 2 Gc. Total variation in maximum output with frequency is 20 to approximately 300 mw.

Attenuator: Relative calibration only.

INTERNAL MODULATION

Narrow-Band Sweep: 1 to 3 Mc maximum at 1 kc and power-line frequency. Negative trigger pulse supplied.

Square-Wave: 1 kc, adjustable approximately $\pm 5\%$.

EXTERNAL MODULATION

FM: Sensitivity approximately 0.2 Mc per volt, input impedance, 400 kilohms and 70 pf (ac only).

Square-Wave: 50 cps to 200 kc, 12-v (rms) sine wave or 20-v (peak-to-peak) square wave; 20% minimum duty cycle from external source. Input impedance greater than 100 kilohms.

Pulse: Rise and fall times approximately 0.2 μsec, minimum length approximately 0.5 μsec, jitter may be 0.2 μsec. Input impedance 100 kilohms; driving-pulse amplitude, 20 v (peak-to-peak); maximum duty cycle 20%.

SPECIFICATIONS (Cont.)

GENERAL

Terminals: RF output, TYPE 874 Locking Connector. Modulation, binding posts.

Mounting: Bench or relay rack.

Power Input: 105 to 125 (or 210 to 250) volts, 50 to 60 cps, 85 watts. Instrument will operate satisfactorily (except for line-frequency sweep) at power-line frequencies up to 400 c.

Tube Complement: Two each 6197 and 12AT7, one each 6AN8, 6AV5GA, 12AX7, 12BH7A, 5651, 5836 (Reflex Klystron), 5965.

Accessories Supplied: TYPE 874-R22 Patch Cord, TYPE 874-C58 Cable Connector, TYPE CAP-22 Power Cord, and spare fuses.

Dimensions: Width 19, height 7½, depth 15½ inches (485 by 195 by 395 mm), over-all; panel, 19 by 7 inches (485 by 180 mm).

Net Weight: 38 pounds (17.5 kg).

Type		*Code Word*	*Price*
1360-AM	**Microwave Oscillator, Bench Mount**	BURLY	**$1100.00**
1360-AR	**Microwave Oscillator, Rack Mount**	BASSO	**1100.00**

U.S. Patent No. 2,548,457

MORE AND BETTER PULSES FROM THE UNIT PULSE GENERATOR

The TYPE 1217-A Unit Pulser[1] was, like its companion instruments in the unit line, designed for maximum utility, minimum complexity, and low cost. The thousands of these compact, high performance devices that are now in use have shown that the design was indeed a successful blend of these often conflicting factors. Time has made available new circuits and components, and experience has shown where improvements would be both desirable and practical. In the redesign the goals set were simple: to make every possible improvement compatible with the two conditions of no increase in price and no increase in power supply requirements.

[1] R. W. Frank, "Pulses in a Small Package — A Pulse Generator for the Unit Line," *General Radio Experimenter*, 28, 10, March, 1954.

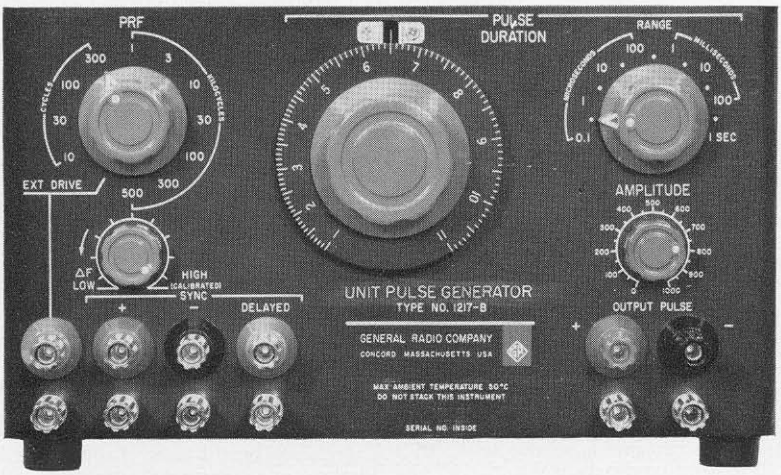

Figure 1. Panel view of the Unit Pulse Generator.