



tion and are accurate to $\pm 1\%$. The 10^9 , 10^{10} and 10^{11} resistors are carbon, have been treated to prevent adverse humidity effects and are accurate to $\pm 5\%$. A switch position permits quick checking of the higher resistance standards in terms of the wire-wound units.

Input Resistance: The input resistance is determined by the setting of the resistance standards switch. In the infinity position, it is approximately 10^{14} ohms.

Drift: Less than 2 mv per hour after one-hour warmup.

Output: Voltage, current and resistance are indicated on a panel meter. Terminals are available for connecting a recorder (such as the Esterline-Angus 5-ma or 1-ma graphic recorder). The recorder can have a resistance of up to 1500 ohms.

Frequency Characteristic: With a 1500-ohm load at the OUTPUT terminals, the frequency characteristic is flat within 5% from zero to 10, 30, 100, 300, 1000 and 3000 cycles at the 30-, 100-, 300-millivolt, 1-, 3-, and 10-volt ranges respectively.

Terminals: The input is connected through an 874-type coaxial terminal assembly. In addition, there are three "low" terminals to provide versatility in guard and ground connections, as required, for example, in three-terminal network measurements.

Input Switch: A panel switch permits disconnection of the unknown without transient electrical disturbances in either the unknown or the measuring circuit.

Input Insulation: Entirely teflon or silicone-treated glass.

Temperature, Humidity, Line Voltage Effects: Negligible.

Tube Complement: One 5886 electrometer, one CK6418, one 6AN5, one 6AL5, one 6627, and three 0B2.

Accessories Supplied: One TYPE 874-411 Adaptor, one TYPE 1230-P1-300 Panel Adaptor Assembly, two TYPE 274-MB Plugs, one TYPE 274-SB Plug, spare fuses and TYPE CAP-35 Power Cord.

Accessories Available: TYPE 1230-P1 Component Shield.

Mounting: Aluminum front and rear panels finished in black-crackle lacquer and encased in an aluminum black-wrinkle-finished sleeve-like cabinet. The instrument is also available mounted inside a recorder case.

Power Supply: 105 to 125 (or 210 to 250) volts, 50 to 60 cycles. Power input is approximately 85 watts at 115 volts.

Dimensions: (height) $13\frac{1}{4}$ \times (width) $7\frac{5}{8}$ \times (depth) 9 inches, over-all.

Net Weight: $15\frac{1}{4}$ lbs.

Type		Code Word	Price
1230-A	D-C Amplifier and Electrometer.....	MASON	\$440.00
1230-AE	D-C Amplifier and Electrometer in Esterline-Angus Case.....	MISTY	502.00
1230-P1	Component Shield.....	MANOR	40.00

A LOW-COST MICROWAVE SIGNAL SOURCE

One of the most frequently needed instruments in the electronics laboratory is a simple, convenient, and inexpensive signal source. General Radio Unit Oscillators were developed in an-

swer to this need, and their constantly increasing popularity is conclusive evidence of how well they perform their tasks.

Unit Oscillators have been available

Figure 1. Panel view of the Type 1220-A Unit Klystron Oscillator with a Type 1201-A Unit Regulated Power Supply.



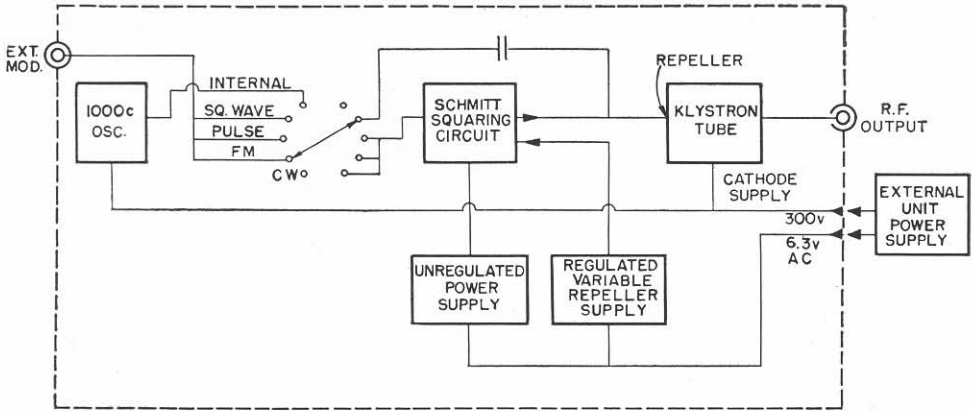


Figure 2. Block diagram showing the elements of the oscillator.

covering all frequencies from 20 cps to 2000 Mc, but there has been an obvious need for a unit to operate at still higher frequencies. The new TYPE 1220-A Unit Klystron Oscillator shown in Figure 1 meets this need for applications where frequent changes in frequency are not required.

It produces a c-w, square-wave-, pulse-, or frequency-modulated signal at frequencies between 2700 and 7450 megacycles by means of eight plug-in reflex klystrons. Each tube has a self-contained resonant cavity, which can be tuned over a range of the order of 500 megacycles. Tube changing can be accomplished quickly and simply. The oscillator is available either without tubes or with any number of the tubes in the available series.

Tuning is accomplished by flexing a copper diaphragm in the resonant cavity by means of a screw which is accessible from the rear of the instrument.

For testing on the production line, for measurements in the laboratory, and for demonstrations in the classroom, the TYPE 1220-A Unit Klystron Oscillator offers the advantages of low cost, small size, and convenient adaptability to the problem at hand.

Circuit

As shown in the block diagram of Figure 2, the TYPE 1220-A Unit Klystron Oscillator contains a variable regulated voltage supply for the repeller electrode of the klystron, a Schmitt squaring circuit for square-wave and pulse modulation of the repeller, a power supply for the Schmitt circuit, a 1000-cycle R-C oscillator, and a socket and output connections for the reflex klystron tube.

The cathode current for the klystron is supplied by an external Unit Power Supply. For maximum frequency stability, a TYPE 1201-A Unit Regulated Power Supply is recommended, although in less critical applications a TYPE 1203-A Unit Power Supply can be used. For field work, where only 6 or 12 volts d-c power is available, the instrument can be operated from a Type 1202-A Unit Vibrator Power Supply.

Klystron Oscillator

The reflex klystron is an excellent microwave oscillator. It produces a substantial amount of r-f power, operates on reasonably low voltages and can be modulated easily. Klystrons used in this instrument are completely self-



contained oscillators and are similar in appearance and size to conventional metal-shell receiving tubes. The tuning ranges for the various tube types are given in the specifications at the end of this article.

As shown in Figure 3, the tubes plug into an octal socket in the instrument and the repeller voltage connection is made by means of a grid cap at the top of the tube. The r-f output lead from the tube is a coaxial line which extends through the tube socket and connects to the TYPE 874 Coaxial Connector on the panel of the instrument by means of a short length of coaxial cable with an adaptor for the tube line on one end.

Tuning is accomplished by means of a tuning screw, permanently attached to the side of the metal envelope, which controls the flexing of one end of the resonator and thus changes the capacitance across the resonant cavity in the oscillator. A special tool is supplied for making tuning adjustments through a hole in the back of the dust cover. The frequency thus can be adjusted without removing the dust cover, although no frequency calibration is provided.

Since the diaphragm will not stand an indefinite number of flexings without fatiguing, these tubes are not recommended for applications where continual frequency changing is required.

The repeller voltage must also be set at a level which produces oscillations at the resonant frequency of the cavity. For this purpose a calibrated repeller voltage control is provided on the front panel.

One of these tubes, TYPE 6043 Kly-

stron, covering frequencies between 2950 and 3275 Mc, differs physically from all the other tubes. Its output connection is made near the top of the tube and tuning is accomplished by adjusting a series of screws in the outer wall of the cavity. This tube can be tuned indefinitely without damage but the dust cover must be removed to make the tuning adjustments. A special output lead is supplied for use with this tube. Both types of output lead are supplied with each instrument.

R-F Output

The power output obtainable varies from tube to tube and over the frequency range of each tube. The average power output for all tubes into a 50-ohm load is of the order of 75 milliwatts. A table showing the average power output of each tube type is included in the specifications appearing at the end of this article. This figure is the average of the power output over the frequency range for a typical tube. The output is usually a maximum at the center of the tuning range.

In most applications an isolating pad should be used between the oscillator and the load. One of the following pads is recommended:

TYPE 874-G6	6 db Pad
TYPE 874-G10	10 db Pad
TYPE 874-G20	20 db Pad

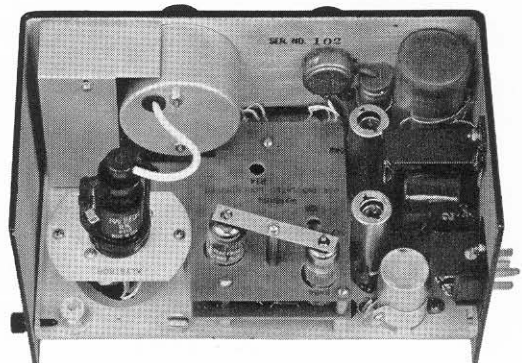


Figure 3. Top view of the oscillator with shield cover removed, showing the klystron tube.

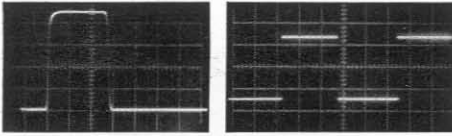


Figure 4. Oscillograms of modulation waveforms at 3800 Mc, as recovered by a Type 874-VR detector. Left, 1- μ sec pulse; right, 1000-cycle square wave.

Modulation

The klystron can be square-wave, pulse, or frequency modulated by modulating the repeller voltage. The Schmitt squaring circuit provides a voltage which switches the repeller voltage between the normal oscillating level and a non-oscillating level for 100% amplitude modulation. In order to make the klystron oscillate at exactly the same frequency when modulated as when unmodulated, the Schmitt circuit is d-c coupled to the repeller, and the whole circuit floats at the repeller potential. Since the klystron oscillates when the output stage of the Schmitt circuit is cut off, the repeller voltage (and hence the oscillating frequency) in the modulated condition is the same as the frequency in the unmodulated condition. A modulation voltage control is included in the plate circuit of the Schmitt circuit so that the klystron can be prevented from oscillating in other modes on the off part of the modulating cycle.

The Schmitt squaring circuit can be driven by a sine-wave, square-wave, or pulse signal. An internal R-C oscillator is provided for producing a 1000-cycle signal for square-wave modulation. The frequency of this oscillator is adjustable to any frequency between 985 and 1015 cycles so that maximum sensitivity can be obtained when very sharply tuned 1000-cycle amplifiers are used in the detector circuit. Square-wave modulation at frequencies between 50 cycles and 200 kc can be obtained from external sine- or square-wave sources, producing inputs of at least 15 volts rms.

The TYPE 1210-B Unit R-C Oscillator is a satisfactory external modulator.

The klystron oscillator can be satisfactorily modulated by an external pulse generator with pulses having lengths from 1 μ s to 10,000 μ s and repetition rates between 50 cycles and 200 kc. The peak input voltage should

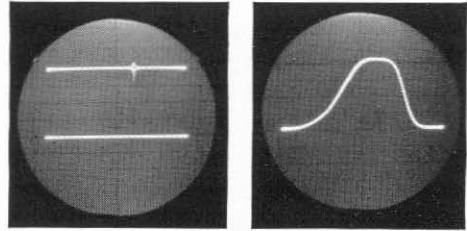


Figure 5. Left, frequency modulated output of the klystron; total swing, 8Mc; modulating frequency, 60 cycles; carrier, 3800 Mc. The marker pip was introduced by an external oscillator. Base line added.

Right, band-pass characteristic of an f-m receiver with signal shown at left applied to receiver input. Signal was recovered from second detector.

be at least 25 volts. The rise and decay times of the r-f pulses are less than 0.2 μ s. The TYPE 1217-A Unit Pulser is an excellent modulator.

Frequency modulation can be produced by the application of a small modulating voltage to the repeller electrode. The frequency deviation obtainable varies from tube to tube, but at least a 15 Mc total excursion is obtainable with a maximum change of 3 db in amplitude of the r-f signal. The amplitude variation decreases rapidly as the excursion is decreased. Provision is made for applying a frequency-modulating voltage from an external source. Approximately 10 volts, rms, across 47 kilohms is required for maximum frequency modulation.

Power Supply

The cathode current for the klystron is obtained from a Unit Power Supply. The TYPE 1201-A Unit Regulated Power Supply is recommended for maxi-



Figure 6. Unit Klystron Oscillator and Type 874 Coaxial equipment set up for the measurement of cable attenuation at 3000 megacycles.



imum frequency stability. A jack is provided for measuring the current and a rheostat is included for adjusting it.

The repeller voltage is obtained from a well-filtered, regulated, internal power supply derived from the 6.3v a-c output of the Unit Power Supply. A calibrated potentiometer, adjustable from the panel, is used to control the voltage from 30 to 300 volts below the cathode potential.

The power supply for the Schmitt circuit is also derived from the 6.3 a-c volt input from the Unit Power Supply.

Typical Applications

The TYPE 1220-A Unit Klystron Oscillator is well adapted to measurement applications in which the frequency does not have to be changed frequently.

On the production line, these relatively inexpensive units can be set up for measurements at specified frequencies on impedance, VSWR, attenuation, bandwidth, for adjusting circuits

to a specified frequency, and for many other types of measurements.

In the laboratory the unit is a suitable signal source for driving a slotted line.

In the classroom, the low cost, small size, ruggedness, and high power output makes the oscillator ideal for supplying r-f power for various classroom demonstrations and student exercises.

Cable Attenuation Measurements

The oscillator is an excellent source of r-f power for making attenuation measurements on coaxial cable at the 3000 Mc frequency specified in Military Specification JAN C17A. One method of making this measurement is described in an article by W. R. Thurston entitled "The Measurement of Cable Characteristics." Figure 6 shows a typical setup for this measurement.

Measurement of VSWR of Fixed Attenuators at 4000 Mc

The klystron oscillator makes a good

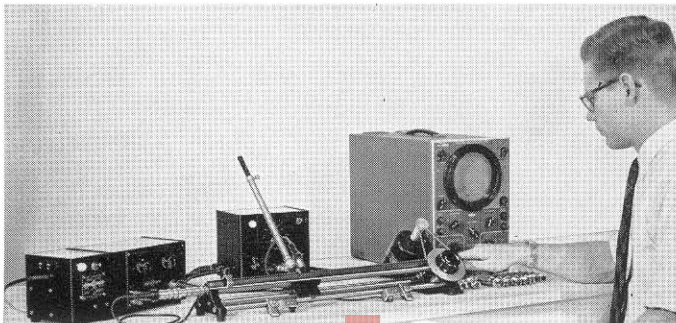


Figure 7. Unit Klystron Oscillator and Type 874-LBA Slotted Line with Motor Drive, set up for measurements of standing-wave ratio on coaxial attenuators.

source of power for VSWR measurements at one frequency on a number of elements. Figure 7 shows a setup for VSWR measurements on a group of fixed Attenuators at 4000 Mc, using a TYPE 874-LBA Slotted Line with a TYPE 874-MD Motor Drive and an oscilloscopic display of standing-wave ratio.

The oscillator can be used to excite waveguide circuits through a standard waveguide-to-coaxial adaptor. Adaptors to connect between the TYPE 874 output connector of the oscillator and the

waveguide adaptor (and to other types of connectors) are listed in the price table.

— BENEDICT O'BRIEN
— R. A. SODERMAN

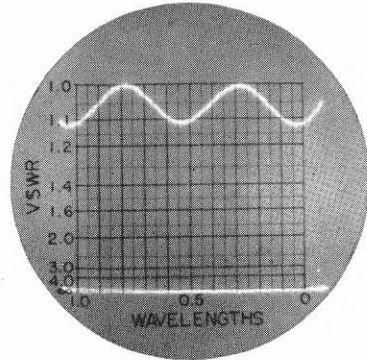


Figure 8. Oscilloscope display of VSWR of a Type 874-G20 Coaxial Attenuator at 4000 Mc, as measured with the equipment shown in Figure 7.

SPECIFICATIONS

Frequency Range: Depends on klystron tube used (see price table below); all units are identical except for klystron tube — frequency range of any unit can be changed to that of any other by inserting the appropriate klystron tube.

Frequency Calibration: None

Modulation:

Internal 1-ke square wave, adjustable \pm 15 cycles.

External

Square wave, 50 c to 200 kc; sine or square-wave modulating signal of at least 15v, rms required — TYPE 1210-B R-C Oscillator recommended modulator.

Pulse, 1 to 10,000 μ s duration, less than 0.2 μ s rise and fall time, 50 c to 200 kc repetition rate; at least 20v peak pulse voltage required — TYPE 1217-A Unit Pulser recommended modulator.

Frequency Modulation, at least 15 Mc excursion obtainable with less than 3 db change in output — at 60 c, an rms input of the order of 10 v is suitable.

Output Connector: 50-ohm TYPE 874-Coaxial Connector. Adaptors to other connector types available.

Tube Complement: Klystron, as specified, for TYPES 1220-A1 through A-8; one 6AB4, one 5963, two OA2.

Accessories Required: Unit Power Supply; see price table below.

TYPE 1201-A Unit Regulated Power Supply recommended for high stability and minimum incidental fm.

TYPE 1203-A Unit Power Supply, for less critical applications where cost is an important factor.

TYPE 1202-A Unit Vibrator Power Supply, for use in the field from 6 v to 12 v, d-c power.

Accessories Recommended: Fixed attenuator pad for isolating oscillator from load; adaptors to other coaxial connectors. See price table below.

Dimensions: 9 $\frac{7}{8}$ \times 5 $\frac{3}{4}$ \times 6 $\frac{1}{4}$ inches, not including plugs, knobs, and terminals.

Net Weight: 6 pounds, with klystron.

Type	Klystron Oscillator with klystron, for	Nominal Power Output in Milliwatts	Code Word	Price
1220-A1	2700-2960 Mc.....	100	KAWUN	\$254.65
1220-A2	2950-3275 Mc.....	90	KATOO	272.90
1220-A3	3400-3960 Mc.....	90	KATRE	265.75
1220-A4	3840-4460 Mc.....	75	KAFOR	312.15
1220-A5	4240-4910 Mc.....	100	KAFIN	261.45
1220-A6	5100-5900 Mc.....	80	KASIX	301.45
1220-A7	5925-6450 Mc.....	100	KASET	272.90
1220-A8	6200-7425 Mc.....	90	KALOC	272.90
1220-A	Without Tube.....		KANOT	205.00



ACCESSORIES

KLYSTRON TUBES

Type		Code Word	Price
726-C	Klystron, 2700-2960 Mc.....	KLYSTRONAY	\$49.65
6043	Klystron, 2950-3275 Mc.....	KLYSTROBEE	67.90
2K29	Klystron, 3400-3960 Mc.....	KLYSTROSEE	60.75
2K56	Klystron, 3840-4460 Mc.....	KLYSTRODEE	107.15
2K22	Klystron, 4240-4910 Mc.....	KLYSTRONEE	56.45
6115	Klystron, 5100-5900 Mc.....	KLYSTRONEF	96.45
QK404	Klystron, 5925-6450 Mc.....	KLYSTROGEE	67.90
5976	Klystron, 6200-7425 Mc.....	KLYSTROJAY	67.90

The following klystron tubes can also be used in the instrument, but are not stocked by the General Radio Company: 2K25 (8500-9660 Mc), 2K26

(6250-7060).

All klystron tubes in these oscillators except for the 6043 are designed for relatively infrequent tuning.

POWER SUPPLIES (One required)

Type		Code Word	Price
1201-A	Unit Regulated Power Supply.....	ASSET	\$80.00
1203-A	Unit Power Supply.....	ALIVE	40.00
1202-A	Unit Vibrator Power Supply.....	AURAL	125.00

PADS

Type		Code Word	Price
874-G6	Attenuator Pad, 6 db.....	COAXNODDER	\$25.00
874-G10	Attenuator Pad, 10 db.....	COAXBELLER	25.00
874-G20	Attenuator Pad, 20 db.....	COAXNEPPER	25.00

ADAPTORS

Type	Contains Type 874 Connector and	Fits	Code Word	Price
874-QBJ	Type BNC Jack	Type BNC Plug	COAXBIGGER	\$4.75
874-QBP	Type BNC Plug	Type BNC Jack	COAXBUNNER	4.75
874-QCJ	Type C Jack	Type C Plug	COAXCOGGER	4.75
874-QCP	Type C Plug	Type C Jack	COAXCUFFER	6.25
874-QHJ	Type HN Jack	Type HN Plug	COAXHAWSER	6.50
874-QHP	Type HN Plug	Type HN Jack	COAXHANGER	6.50
874-QLJ	Type LC Jack	Type LC Plug	COAXLITTER	17.50
874-QLP	Type LC Plug	Type LC Jack	COAXLUGGER	17.50
874-QNJ	Type N Jack	Type N Plug	COAXNAGGER	3.75
874-QNP	Type N Plug	Type N Jack	COAXNUTTER	4.50
874-QUJ	Type UHF Jack	Type UHF Plug	COAXYUNDER	4.00
874-QUP	Type UHF Plug	Type UHF Jack	COAXYUPPER	4.25