OPERATING INSTRUCTIONS

TYPE 1000-P6
CRYSTAL DIODE MODULATOR

1 INTRODUCTION.

1.1 PURPOSE. The Type 1000-P6 Crystal Diode Modulator (Fig. 1) is a simple device for amplitude modulation of the output of an r-f generator over the carrier range of 20 to 1000 Mc. It is especially useful for wide-band modulation (such as is required for television) or for radio receiver tests where incidental fm must be negligible.

1.2 DESCRIPTION. The modulator consists of a crystal diode between input and output terminals, an output filter to prevent appreciable modulating voltage from appearing in the output, and a means of isolating and applying modulating and bias voltages.

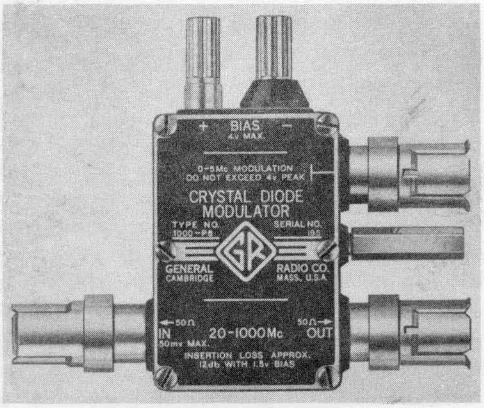

Figure 1. Type 1000-P6 Crystal Diode Modulator

2 PRINCIPLES OF OPERATION.

(See Fig. 3.) The crystal-diode resistance, as a function of the voltage across the diode, can be modulated by a varying voltage. The unit is therefore equivalent to an impedance that can be modulated and that can be placed in series with an r-f generator and its load, thereby affording a means of producing amplitude modulation.

3 OPERATION.

3.1 GENERAL. The resistance of the r-f source should be 50 ohms or less from the carrier frequency down to dc, so that the bias and modulation will be properly applied to the crystal. If necessary, insert a 50-ohm, 10- or 20-db pad between the r-f source and the modulator. The load presented to the output should be 50 ohms for a good modulation characteristic. Higher resistance loads should be shunted by suitable resistances, or a 50-ohm, 10- or 20-db pad can be inserted between output and load if the additional attenuation can be tolerated. Type 874-G10 (10 db) and Type 874-G20 (20 db) Attenuators are recommended. The applied r-f input should not exceed 50 millivolts.

3.2 BIAS. A convenient bias supply for sine-wave modulation is a 1.5-v battery connected across the bias terminals with polarity as indicated on the nameplate. This reduces the crystal resistance from the high unbiased condition to a value about in the center of an average crystal characteristic. Increasing the bias increases the output. A variable bias supply (e.g. a 3-v battery in series with a 10,000-ohm rheostat) may improve the modulation characteristic. With an asymmetrical modulating signal an adjustable bias - not to exceed 4 volts - is recommended if means are available for observing the modulation characteristic. Since dc can be applied through the modulation terminals, the bias can be included as part of the modulating voltage instead of being applied at the bias terminals. If bias is applied in this way, negative bias is required at the high modulation terminal. With no bias applied, the modulator will function on the negative cycles of the modulating voltage, producing a chopped output. Of course, no bias is necessary if the applied modulation consists only of negative pulses.

3.3 MODULATION. Modulation from 0 to 5 Mc can be applied with connection of a Type 874 Cable or Type 274-M Plug at the modulation terminals. Negative modulation increases r-f output. The voltage required for a given percent modulation depends on the 1N21-B diode used and on the bias applied. For sine-wave modulation under specified terminal conditions and 1.5-v bias, the average crystal requires about 0.2 v rms for 30-percent modulation. The crystal supplied with the Type 1000-P6 was selected so that required modulating voltage is within 20% of the stated value and the envelope distortion is low at 30% modulation.

Every modulator, with a fixed value of d-c bias and fixed values of generator and load impedance, can be calibrated at various carrier frequencies in terms of applied modulating voltage. There are two ways to determine percent modulation in terms of applied modulating voltage and to determine the optimum bias. In the conventional a-c method, an oscilloscope is connected to the i-f output of a receiver supplied with a modulated signal from the Type 1000-P6. (It is unlikely that an oscilloscope will have either the sensitivity or the frequency range to work directly with the Type 1000-P6.) The r-f input voltage to the receiver should be kept at a minimum to prevent receiver nonlinearity. The modulating frequency should be kept low enough so that there is no possibility of sideband cutting in the receiver. A trapezoidal display of the modulation envelope, obtained by use of the modulating voltage for horizontal deflection, is best for observing modulation linearity, for determining optimum bias, and for measuring percent modulation.

The second method is to determine the static modulation characteristic of the Type 1000-P6 by application of various values of positive and negative d-c voltage applied to the modulation terminals, with the variation of r-f plotted against d-c voltage. Peak ac required for a given percent modulation is easy to determine from this plot. To measure r-f output of the Type 1000-P6, use either a receiver with a carrier meter, a d-c vtvm across the diode load resistor, or a microammeter in series with the load resistor. To eliminate errors due to receiver nonlinearity, keep the receiver output indicator at a fixed reference level at each value of d-c modulating voltage by adjusting the signal-generator output. Since the change in signal-generator output with a fixed modulator is inversely proportional to the change in modulator output with a fixed r-f input, the percent modulation, linearity, and effect of bias changes can be determined from plots of signal-generator output vs applied d-c modulating voltage.

For t-v picture modulation (Fig. 2), the synchronizing pulses of the composite video

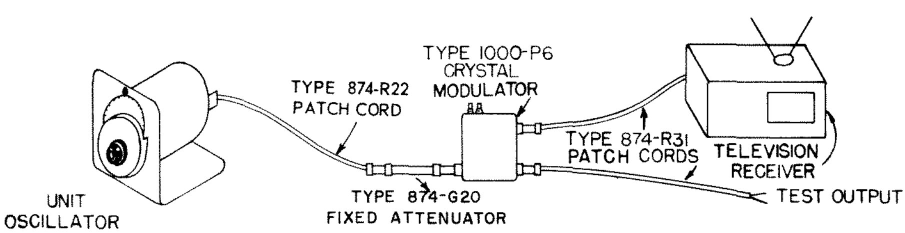

Figure 2. Interconnection Diagram of Unit Oscillator and Video Modulator Used as a Television Signal Generator

signal applied must be negative for standard modulation. A suitable source of video signals for test purposes is a t-v receiver tuned to a local station. The output can be taken from the plate circuit of the last video amplifier through a large coupling capacitor and a suitable compensated voltage divider. The video-signal polarity at this point is correct for application to the modulator, and a large voltage division is possible, permitting a minimum disturbance of the receiver circuit conditions. The exact modulating and bias voltages required are best determined experimentally. A 60-to-1 voltage divider at the t-v receiver output has been found satisfactory.

3.4 CRYSTAL REPLACEMENT. To remove the crystal diode: Turn clockwise the threaded ring bearing the words "General Radio Co. Type 874" at the input connector until the ring falls free. Then lift off the input connector and invert the modulator, allowing the crystal cartridge to fall out. If means are available for observing the modulation envelope, select replacement crystals that give 30% modulation with 1.5-v bias and 0.2-v rms modulation applied at a carrier frequency of 100 Mc. (R2 may be shunted or replaced to give the required characteristics, if desired.) As a rough guide, crystals should have a d-c forward resistance of from 200 to 300 ohms with 0.25 v applied, and a back resistance of over 10,000 ohms with 1.5 v applied.

3.5 CONNECTORS. A complete line of Type 874 coaxial elements is available, including tees, ells, rigid lines, patch cords, attenuators, filters, etc. Write for information or consult the General Radio Catalog.

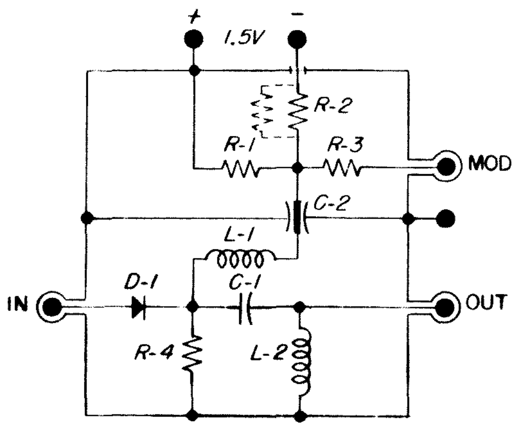

Figure 3.
Schematic Diagram of
Type 1000-P6 Crystal
Diode Modulator

PARTS LIST

C1	CAPACITOR, 47 $\mu\mu$f ±10% (ERIE)	N750-A
C2	CAPACITOR, 300 $\mu\mu$f ±10%	COU-8-2
D1	DIODE	1N21-B
L1	CHOKE, 7.6 μh	ZCHA-19
L2	CHOKE, 0.5 μh	CHA-18
R1	180Ω ±5%, ½w	REC-20BF
R2	600-1500Ω (lab adj) ±10%, ½w	REC-20BF
R3	510Ω ±5%, ½w	REC-20BF
R4	560Ω ±5%, ½w	REC-20BF

SPECIFICATIONS

Carrier Frequency Range: 20-1000 Mc. Insertion loss increases approx 10 db at 10-Mc carrier frequency due to output filter.

Modulating Frequency Range: 0-5 Mc. Response approx 2 db down at 5 Mc, with gradual roll-off to prevent serious phase distortion of video signals.

Impedance: Looking into either input or output terminals, impedance is a function of bias and modulating voltages. Unit designed for use with a 50-ohm source and 50-ohm load. Impedance at modulation terminals approx 600 ohms.

Modulation: With no more than 50 mv r-f input, 30% amplitude modulation is available at carrier frequencies from 20-1000 Mc. For optimum sine-wave modulation, an average crystal requires 1.5 v at the bias terminal. Insertion loss under these conditions is approx 12 db, and approx 0.2 v rms at modulation terminals will produce 30% modulation. Max percent modulation is a function of carrier frequency, and at 1000 Mc is limited to about 30%. Peak modulation voltage with respect to ground should not exceed 4 v.

Terminals: Type 874 Coaxial Connectors used for r-f and modulation terminals. Modulation terminals accept 874 Connector or Type 274-M Plug.

Accessories Supplied: One Type 274-MB Plug.

Accessories Required: Proper connectors; 1.5-v battery for fixed bias or 3-v battery and 10-Ω rheostat for adjustable bias.

Dimensions: Width 5, height 4, depth 1-1/6 inches (130 by 105 by 30 mm), over-all.

Weight: 1 lb (0.5 kg).

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