THE GENERAL RADIO

EXPERIMENTER

VOLUME 37 No. 1 JANUARY, 1963

IN THIS ISSUE

New

- Standard Sweep-Frequency Generator
- Vibration Meter in Metric Units
- Single-Pulse Trigger

THE GENERAL RADIO

EXPERIMENTER

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COVER

Engineers at Tapetone Electronics Laboratories, manufacturers of frequency converters for ham radio and for telemetry, are shown with the Type 1025-A Standard Sweep-Frequency Generator in aligning a converter. In this application, the stability and versatility of the generator save time and assure accurate alignment.

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GENERAL RADIO COMPANY (OVERSEAS), ZURICH, SWITZERLAND
REPRESENTATIVES IN PRINCIPAL OVERSEAS COUNTRIES

A STANDARD SWEEPING-FREQUENCY SIGNAL GENERATOR

The General Radio Company has for many years manufactured standard-signal generators, the word standard denoting that certain characteristics (usually the frequency, amplitude, and modulation) of the output signal provided are accurately indicated, or standardized. With the introduction of the Type 1025-A Standard Sweep-Frequency Generator, the *standard* concept has been extended to the sweeping-frequency signal generator.

This generator has been designed to be as universally applicable as possible, but is particularly useful for sweep-frequency measurements on wide-band devices where a multiplicity of adjustments must be set to secure the desired characteristics.

In this instrument, the frequency of the sinusoidal output is varied in a smooth, continuous manner over a frequency band in repetitive cycles by means of a motor-driven tuning capacitor. By this means, the amplitude response of a network or device as a func-

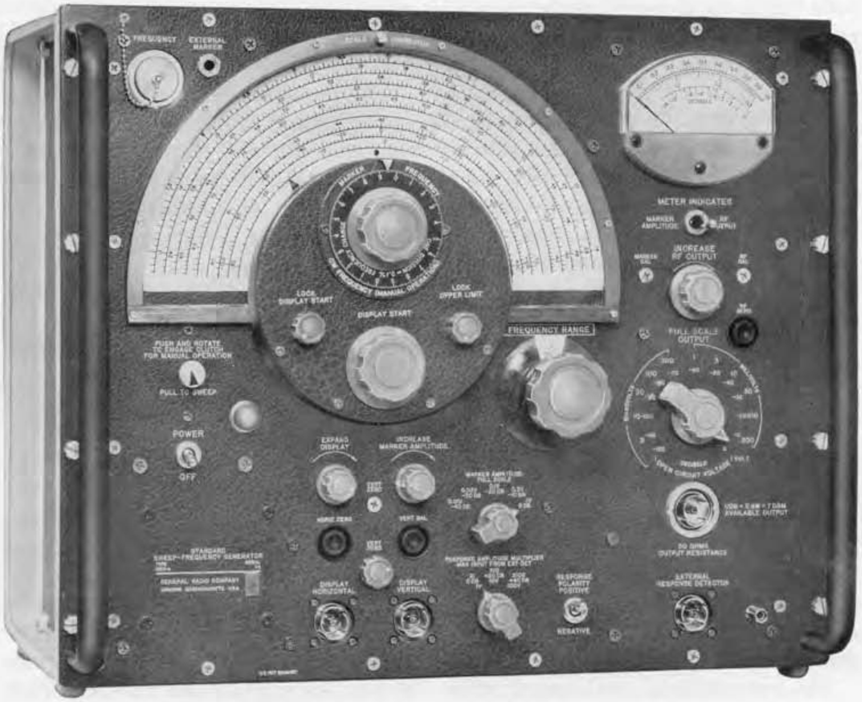

Figure 1. Panel view of Type 1025-A Standard Sweep-Frequency Generator.

tion of frequency can be displayed automatically on an oscilloscope. A synchronously varying horizontal deflection is provided for the oscilloscope. The large dial on the instrument indicates the frequency of a manually positioned marker on the display. The amplitude of the marker is adjustable and is monitored by a panel meter, thus providing complete frequency and amplitude calibration of the displayed response.

An automatic amplitude-control circuit holds the rf output behind an accurate 50-ohm resistance at a manually preset level, independent of frequency, line voltage, and load variation. The rf output level is accurately indicated by the panel meter and is adjustable over a wide range by a continuously variable control and step attenuator.

The generator can also be quickly switched to cw operation, in which function it is as stable as a non-swept signal generator, so that it can be used with an external digital frequency meter for really precise measurements of a response after a preliminary sweep presentation shows that such detailed measurements are justified. This is not possible with the usual sweep generator, so that often both a sweep generator and a cw signal generator are necessary.

Frequency Ranges

The oscillator coils for the various frequency ranges are mounted on a 12-sector turret which is designed to permit individual sectors to be readily replaced for special ranges. The instrument is normally supplied with ten octave ranges covering from 0.7 to 230 Mc with generous overlaps.

The two positions on the FREQUENCY RANGE control beyond the ten required for 0.7 to 230 Mc are normally supplied with bandspread sectors of 400 to 500 kc and 10.7 ± 0.3 Mc. Additional bandspreads can be had at the sacrifice of general-coverage ranges up to the 12-sector capacity of the turret. The bandspread ranges have an essentially linear frequency distribution on the display, while the octave ranges have a logarithmic distribution. In order to make use of a single pre-calibrated multi-scale dial, the available bandspreads have been quantized to fit a zero center ±30 scale, a zero center ±100 scale, and a 40 to 50 scale. For the general-coverage octave ranges there are four nearly logarithmic scales which are used for 0.4 to 80 Mc and two quasi-logarithmic scales for the 65- to 140-Mc and 100- to 230-Mc ranges.

Automatic Sweeping

The frequency is swept by a motor-driven tuning capacitor. The capacitor rotates continuously at 1200 rpm and is balanced both mechanically and electrically, so that no balancing weights or sliding contacts are required. This is accomplished by a split-stator design with the rotor plates divided equally about the axis of rotation.

The entire frequency range selected is swept in 1/45 of a second, and there are 20 sweeps per second. The oscillator output is blanked off between sweeps to permit the capacitor to return to the low-frequency end of the range; the sweeping is always from low to high frequencies. A sawtooth voltage is generated in synchronism with the frequency sweeping for horizontal deflection of a cathode-ray oscilloscope. The entire range is swept, but, by means of EXPAND DISPLAY and DISPLAY START controls, as little as one-tenth of any octave range can be set to occupy the full screen width of the display oscilloscope. Where additional resolution is required, bandspread ranges can be provided on special order covering as little as 5% in frequency for the full-range sweep, and this, too, can be reduced by expansion of the display to one-tenth of the full range.

Manual and Slow-Speed Sweeping

In addition to the normal sweep mode of operation, the sweep motor can be stopped and a clutch engaged to connect the marker control and frequency indicator directly to the tuning capacitor for manual control of the frequency. In this mode, the frequency indicated on the dial is the cw frequency generated. The generator still functions as a sweep generator since a dial potentiometer provides a display sweep voltage proportional to frequency-indicator travel. In fact, the dial potentiometer is arranged to duplicate operation in the normal sweep mode, so that the DISPLAY START and DISPLAY EXPANSION controls continue to function. Thus, an XY plotter can be connected to replace the oscilloscope used with the high-speed sweep, and a plot of the response obtained by slow rotation of the frequency knob.

The manual drive provides a test method for determining whether the automatic sweeping speed is excessive for the device under test and, if it is, for plotting the true response. In addition, two dial drives are available, and can be attached to the dial in place of the manual-drive knob. The TYPE 908-P2 Synchronous Dial Drive is used for slow-speed sweeping (10 seconds to sweep the full range of the dial) for display on an oscilloscope with a long-persistence phosphor. The TYPE 908-P3 Dial Drive provides a single sweep (1¼ minutes) for use with an XY plotter.

Marker Generation

The heart of this instrument, which makes it unique among sweeping generators, is the system used to provide

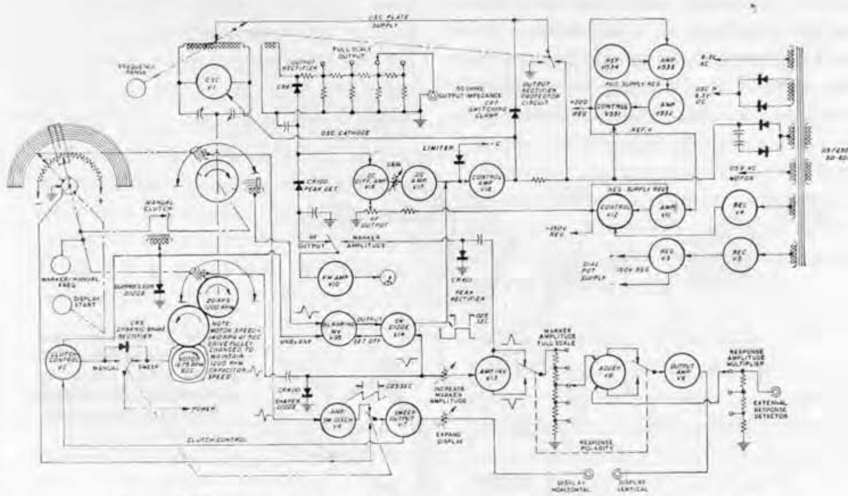

Figure 2. Elementary schematic diagram of standard sweep-frequency generator.

frequency markers in the normal sweep mode of operation. Figure 2 is an elementary schematic. The angular position of the variable capacitor can obviously be calibrated in terms of frequency generated for any particular range. The position of the capacitor is used as an indication of frequency, but in the sweep mode it is done instantaneously. Figure 3 is a cutaway drawing showing how this is accomplished. The capacitor drive drum carries a thin iron vane, which generates a pulse as it passes a magnetic pickup device. The pickup's angular position is indicated on a dial and can be adjusted to coincide with the capacitor vane at any position of the capacitor within its active range. For each setting of the marker pickup dial, the pulse generated occurs at a particular position of the tuning capacitor and consequently at a particular frequency. The dial therefore can be calibrated in frequency existing at the instant the pulse occurs. If this pulse is displayed as a vertical deflection on an oscilloscope whose horizontal deflection is a time-varying voltage in synchronism with the frequency variation of the oscillator, the position of the pulse represents the frequency at that point on the display, regardless of any nonlinearities that may be present in the display horizontal deflection.

Since the response is presented as a vertical deflection on the display, the superposition of the marker could distort the picture. To avoid this, we take advantage of the fact that the tuning capacitor is useful for only 180 degrees of its range. Figure 4 is a timing diagram showing the relationship of events in the sweep cycle.

The oscillator is blanked off for the second 180 degrees of capacitor rotation and, since the rotating capacitor with its drive drum is a very good flywheel, the angular speed of the second 180 degrees is the same as that of the first 180 degrees of rotation. Consequently, the time relationships in the two half-revolutions are identical for all practical purposes. The marker vane is positioned 180 degrees from the position to be identified, so that the marker is generated while the oscillator is blanked off. The blanking is controlled by pulses from a fixed magnetic pickup. Two vanes, 180 degrees apart on a separate track from the marker vane, produce pulses at the beginning and end of the active tuning range of the capacitor. These are used

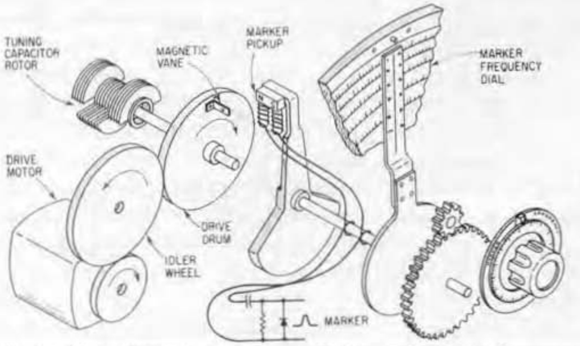

Figure 3. Magnetic vane induces marker voltage in pickup when capacitor rotor position corresponds to preselected frequency.

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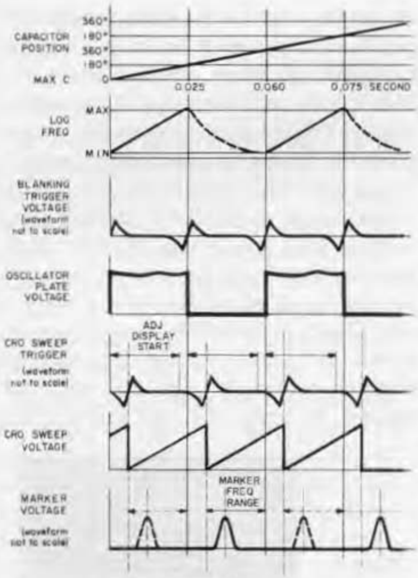


Figure 4.
Timing diagram of one complete sweep cycle.

to complement a bi-stable blanking multivibrator. The proper phasing of the blanking is obtained by use of the marker pulse to set the multivibrator to the blanked state if it is out of step.

A sawtooth waveform voltage is generated for the display horizontal deflection, two cycles occurring per revolution of the tuning capacitor. The response and marker are displayed on alternate sweeps of the display so there is no interference, one with the other. The dotted marker-voltage pulse on the timing diagram of Figure 4 shows the position to be identified, but the generated pulse actually occurs exactly 180 degrees later while the oscillator is blanked off.

Display Expansion

The display horizontal sawtooth voltage is generated by an electronic sweep circuit triggered by pulses from the DISPLAY START magnetic pickup. This pickup operates with the same rotating vanes used for the blanking, and thus two equally-spaced pulses are produced per revolution of the tuning capacitor. The angular position of the pickup can be varied by the DISPLAY START control to set the point at which the display sawtooth starts. This, in conjunction with the EXPAND DISPLAY control, permits any part of a frequency range to be expanded on the display. About 10 to 1 is the practical limit of expansion, so that 1/10 of any tuning range can be made to occupy full scale of this display. This requires a 10-volt full-scale display horizontal sensitivity, since the maximum peak-to-peak amplitude of the sawtooth is 100 volts. The start of the sawtooth is clamped to zero, so that with a direct-coupled oscilloscope the start of the display remains fixed and the excess voltage deflects the trace-off scale to the right. The base width of the marker is less than 1% of the unexpanded display, and, since it occurs when the oscillator is blanked off, the base line on which it sets is the zero reference level of the response. The response appears as a separate line on the display, except when it is zero, owing to presentation of the marker and response on alternate display sweeps. The triangular marker waveform permits the indication to be read to about 1/10 of the base width, so that resolution is about 0.1% of the unexpanded display or 1% with a 10 to 1 expansion.

Marker-Amplitude Calibration

The output of an external response detector is brought back to the signal generator, in order that the marker can be added to the vertical display voltage. About 18 db of direct-coupled amplification is provided. A polarity-reversing switch permits a right-side-up display with a response detector of either output polarity. Step attenuators and the metering of the adjustable marker amplitude provide means of calibrating the vertical scale of the display.

Detector

When the device under test includes a detector, its dc output can be fed directly into the EXTERNAL RESPONSE DETECTOR terminals of the generator.

Where there is no built-in detector, the TYPE 1025-P1 Detector Probe, supplied with the generator, will be found satisfactory for most uses. Its high input impedance imposes no appreciable load on the device under test.

For 50-ohm systems, the TYPE 874-VQ Voltmeter Detector and TYPE 874-WM 50-ohm Termination are recommended.

Generator Output Calibration

The rf output voltage is provided as a true zero-impedance generator voltage in series with an accurate 50-ohm resistance. The maximum value of the voltage is one volt and is adjustable down to a fraction of one microvolt by means of a 10-db-per-step attenuator and a continuously adjustable output control. The output is indicated on a meter with a multiplying factor determined by the attenuator setting. A db calibration relative to the one-volt output is provided in addition to a voltage calibration.

Applications

One of the important fields of application for this generator is, as pointed out previously, in measurements on wide-band devices where many adjustments are necessary to get the desired response. A good example of this use is in the alignment of a wide-band i-f amplifier for a radar receiver in which the desired passband is obtained by staggering the tuning of interstage coupling networks. Figure 5 shows the response of a properly aligned 30-Mc i-f preamplifier for a radar receiver. This is an unexpanded presentation covering exactly the full 24- to 48-Mc range of the TYPE 1025-A. The vertical scale within the first two centimeters down from the peak in this and the following photographs is 2 db per cm. Figure 6 shows the same response shown in Figure 5, but the EXPAND DISPLAY control setting has been increased to make the horizontal scale

Figure 5.

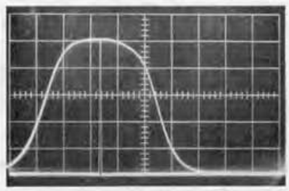


Figure 6.

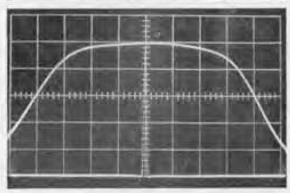


Figure 7.

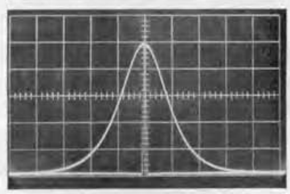
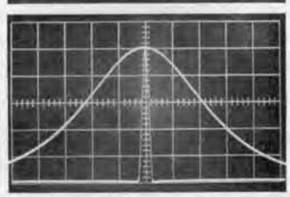


Figure 8.



Figures 5-8.
Response characteristics of 30-Mc i-f amplifier for various alignment and sweep conditions (see text).

1 Mc per centimeter, and the DISPLAY START control has been set to make 30 Mc occur on the center line of the display.

Figure 7 is an oscillogram of a much sharper response characteristic for the same amplifier when the interstage tuning is reset to a common 30-Mc frequency. The horizontal scale is the same as in Figure 6, but the input level to the amplifier had to be reduced about 20 db to compensate for the increased gain resulting from this adjustment.

Figure 8 shows how the response display of Figure 7 can be further expanded and centered by an increased setting of the EXPAND DISPLAY control with the DISPLAY START control reset. The horizontal scale in this photograph is 400 kc per centimeter.

In all these oscillograms the marker is at 30 Mc, but it may be used to calibrate both horizontal and vertical scales of the display. Incidentally, the amplifier whose characteristics are shown was designed to work from a 300-ohm source shunted by a 10-pf capacitance, representing the output impedance of the crystal-diode-microwave mixer in the radar receiver. A dummy network, consisting of a 250-ohm series resistor in a TYPE 874-X Insertion Unit with a 10-pf capacitor across the output connector, can be quickly assembled to provide the proper source impedance for testing this amplifier. Similarly, other impedances may be provided for testing devices requiring source impedances differing from the 50-ohm output of the generator.

— W. F. BYERS

CREDITS

The design and development of the TYPE 1025-A Standard Sweep-Frequency Generator was carried out by W. F. Byers, supported by E. Karplus, Group Leader; E. Favre, designer; D. Foss, production engineering; W. Montague, design drafting; and W. Poté, test engineering; plus many others in Engineering who contributed to the details of the design.

— EDITOR

SPECIFICATIONS

FREQUENCY

Range: 0.7 to 230 Mc in 10 ranges (0.7 to 1.4, 1.3 to 2.6, 2.4 to 4.8, 4 to 8, 7 to 14, 13 to 26, 24 to 48, 40 to 80, 65 to 140, and 100 to 230 Mc) and bandspread ranges of 400 to 500 kc and 10.7 ± 0.3 Mc.

Alternate range sectors can be substituted in the range-selector turret. Those presently available are: 0.4 to 0.8 Mc, 2 ± 0.1 Mc, 2.8 ± 0.1 Mc, 4 to 5 Mc, 16 ± 0.3 Mc, and 40 to 50 Mc. Special bandspread ranges can be provided according to the following schedule:

Specified Center Frequency	*Bandwidth*
Between 0.4 and 0.5 Mc	±0.01 Mc
0.45 and 1.6 Mc	±0.03 Mc
1.4 and 5 Mc	±0.1 Mc
4.5 and 16 Mc	±0.3 Mc

Control: 11-inch semicircular dial; scales are logarithmic for octave ranges up to 80 Mc, quasi-logarithmic between 65 and 230 Mc, essentially linear for all bandspread ranges. Slow-motion vernier drive dial is provided. One division on the vernier dial represents approximately 0.1% frequency difference on the octave frequency ranges.

Calibration Accuracy: At output voltages less than 0.3 volt, frequency is indicated to within ±0.5% when scale corrector is set to bring dial to index line. At output voltages above 0.3 volt, an external load on the output can produce frequency changes as large as ±0.5%. With an external frequency meter, scale corrector can be used to bring dial into agreement, for frequency resolution within ±0.1%.

Drift: Not greater than 0.3% for five hours after one-hour warmup.

Sweeping Rate: Frequency is swept from low-frequency end to high-frequency end of range in 22.2 milliseconds 20 times per second. Output is blanked off for return sweep.

Sawtooth Sweep Voltage: Adjustable in amplitude up to 100 volts, peak-to-peak. Also adjustable in starting point in the frequency range.

Marker: Internally generated marker of half-sinusoidal waveform is adjustable in amplitude from 3 millivolts to 1 volt; response amplitude multiplier effectively extends range up to 100 volts. Amplitude is indicated to an accuracy of ±10%.

RF OUTPUT

Voltage: Adjustable from 0.3 microvolt to 1

SPECIFICATIONS (*Continued*)

volt behind 50 ohms (−123 to 7 dbm power into 50 ohms).

Over-all Voltage Accuracy: ±14% up to 100 Mc, due to maximum voltmeter and attenuator errors listed below. Above 100 Mc, harmonics may add additional error of ±3%.

Voltmeter Error: 2% + 2% of full scale.

Attenuator Error: 1% per step to maximum of 6%.

Stability: Output is held at preset level to within ±1% (0.1 db) up to 100 Mc and within ±3% (0.25 db) up to 230 Mc. Changes due to line-voltage variations and range switching will not exceed ±3% (0.25 db). A Type 874-R22A Patch Cord will reduce output 5% (0.4 db) at 230 Mc.

Impedance: 50 ohms resistive with a vswr of less than 1.01 at the panel jack. With a Type 874-R22A Patch Cord, vswr at the output of the cable will be less than 1.1 over the frequency range.

Leakage: External rf field produces negligible interference with measurements down to the lowest levels provided by the generator.

RESPONSE AMPLIFIER

Maximum Input Voltage: 1, 10, or 100 volts as selected by the response-amplifier multiplier switch. Noise level is less than 1 millivolt peak-to-peak referred to the input at the ×1 (1 v) position of the multiplier switch, 10 millivolts at the ×10 (10 v) position, and 100 millivolts at the ×100 (100 v) position.

Input Impedance: 1 megohm in parallel with 30 to 45 pf.

Gain: Dc amplification between external response input connector and vertical display output connector is ×8 (18 db) at the ×1 position of the multiplier, ×0.8 at the ×10 multiplier position, and ×0.08 at the ×100 multiplier position.

Bandwidth: Greater than 10 kc. Sufficient for passing all details of any response that can be resolved at the maximum sweep rate of the generator.

Polarity: A polarity-reversing switch is provided to give a positive display vertical output voltage with either positive or negative inputs from the external response detector.

DISPLAY OUTPUT VOLTAGES

Vertical: Up to +8 volts into 100-kilohm load, consisting of marker plus response to be displayed.

Horizontal: Up to +100 volts dc or sawtooth peak into 100-kilohm load.

GENERAL

Frequency Output Voltage: 0.1 to 0.3 volt behind 50 ohms for operating external frequency meter or external marker generator.

External Marker Input Voltage: 1 volt peak-to-peak into 50 kilohms. Birdie-type markers can be applied which are controlled in amplitude and added to the response displayed.

Power Requirements: 105 to 125 (or 210 to 250) volts, 60 (or 50) cps. Maximum input power is 145 watts.

Terminals: Recessed Type 874 Locking Connectors, except for EXTERNAL MARKER input connector, which is a standard phone jack.

Accessories Supplied: Type 1025-P1 Detector Probe, three Type 874-R22A Patch Cords, three Type 874-R33 Patch Cords, three Type 874-C58A Cable Connectors, six Type 838-B Alligator Clips, Type CAP-22 Power Cord, spare fuses.

Accessories Available: Type 874-VQ Voltmeter Detector, Type 874-WM 50-ohm Termination, Types 908-P2 and -P3 Synchronous Dial Drives, locking adaptors to all standard coaxial connectors.

Cabinet: Aluminum, with aluminum panel, in both relay-rack and bench models.

Dimensions: Bench model — width 19, height 16, depth 13¾ (485 by 410 by 350 mm), over-all; rack model — panel, width 19, height 15¾ inches (485 by 400 mm), depth behind panel, 11⅛ inches (290 mm).

Net Weight: 73 pounds (34 kg.)

Shipping Weight: 108 pounds (50 kg), approximately.

TYPE 1025-P1 DETECTOR PROBE (supplied with instrument)

Input Impedance: 1.5 pf, in parallel with 25 kilohms up to 10 Mc decreasing to 6 kilohms at 250 Mc.

Maximum RF Voltage: 3 volts rms.

Frequency Characteristic: Flat within 5% (0.4 db) from 0.4 to 250 Mc.

Output Polarity: Positive.

Transfer Characteristic: Dc output voltage equals the rms rf voltage above 0.5-volt input; essentially square-law characteristic below 50 millivolts rms rf input.

Fall Time: Less than 150 μsec, sufficiently short to follow all details of any response that can be resolved at the maximum sweep rate of the Type 1025-A.

Type		*Code Number*	*Price*
1025-AM	**Standard Sweep-Frequency Generator, Bench Model**	1025-9801	**$3250.00**
1025-AR	**Standard Sweep-Frequency Generator, Rack Model**	1025-9811	**3250.00**

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

VIBRATION METER WITH METRIC CALIBRATION

To meet the requirements of those who prefer to use the metric system, the TYPE 1553 Vibration Meter[1] can now be supplied with a metric calibration. The TYPE 1553-A Vibration Meter which is calibrated in mils displacement, in/sec velocity, in/sec² acceleration, and in/sec³ jerk, is still available. A new model, the TYPE 1553-AK is direct reading in mm displacement, m/sec velocity, m/sec² acceleration, and m/sec³ jerk.

Both instruments will be supplied with the new TYPE 1560-P52 PZT Ceramic Vibration Pickup.[2] The basic frequency response is now 2-2000 cps with the full 2-20,000 cps band available for acceleration measurements with auxiliary wide-range pickups. Other than the difference in units and numbers appearing on the FUNCTION and METER FULL SCALE dials, the specifications for the two instruments are identical. Tabulated below are the ranges and corresponding units for the two instruments.

In the table below MIN refers to 1/10 full-scale reading on the meter with scale selector switch in the most sensitive position (max clockwise). MAX refers to full-scale reading on the meter with the scale selector switch in the least sensitive position. (This is determined by rotation of the scale selector knob counterclockwise as far as possible before CAL appears in the METER FULL SCALE window or before the knob pointer is at CAL engraved on the panel.)

—E. E. GROSS

[1] E. E. Gross, "Type 1553-A Vibration Meter," *General Radio Experimenter*, 35, 11, November, 1962.

[2] E. E. Gross, "New PZT Ceramic Vibration Pickup and Control Box for Vibration Measurements," *General Radio Experimenter*, 36, 11, November, 1962.

TYPE NO.	QUANTITY	PK TO PK INDICATION MIN	PK TO PK INDICATION MAX	AVE INDICATION MIN	AVE INDICATION MAX	UNITS	FREQUENCY RANGE (cps)
1553-A	Acceleration	0.3	300,000	0.1	100,000	in/sec²	2-2000
1553-AK	Acceleration	0.01	10,000	0.003	3,000	m/sec²	2-2000
1553-A	Velocity	0.03	30,000	0.01	10,000	in/sec	2-2000
1553-AK	Velocity	0.001	1,000	0.0003	300	m/sec	2-2000
1553-A	Displacement	3	300,000	1	300,000	mils	2-2000
1553-AK	Displacement	0.1	10,000	0.03	10,000	mm	2-2000
1553-A	Displacement	0.03	30,000	0.01	10,000	mils	20-2000
1553-AK	Displacement	0.001	1,000	0.0003	300	mm	20-2000
1553-A	Jerk	30	300,000	10	300,000	in/sec³	2-20
1553-AK	Jerk	1	10,000	0.3	10,000	m/sec³	2-20

Type		*Code Number*	*Price*
1553-AK	**Vibration Meter** (Metric Units)..............	1553-9817	**$740.00**

U. S. Patent No. 2,966,257

A SINGLE-PULSE TRIGGER FOR THE TYPE 1217-B UNIT PULSE GENERATOR

When the new Type 1217-B Unit Pulse Generator[1] was in design, we considered adding a panel pushbutton to permit a single pulse to be produced manually. There are some serious disadvantages to a panel-mounted pushbutton; it may be hard to reach, and even if it can be reached it may be awkward and tiresome to push. A more comfortable method, and one which is more economical for users who do not need manual operation, is to make the pushbutton a hand-held device; hence the Type 1217-P2 Single-Pulse Trigger.

The trigger assembly consists of a Microswitch, battery, and bounce filter. The circuit arrangement applies a clean dc pulse (normally negative-going) to the input terminals of the Type 1217-B Unit Pulse Generator, which is set up to accept a negative-going external trigger. It will produce its single output pulse when the button is released. When the trigger input plug is reversed, a pulse will be produced when the button is first pushed.

There are myriad applications for a pulse generator which will produce a single pulse upon manual command. For example, in design of complex systems that are intended to operate at any high repetitive rates, it is often desired to cycle them slowly (to permit voltages to be read, for example). With a manual system the user can rapidly skip unwanted conditions, and then slow down and stop at the desired condition. The pushbutton, which in no way alters the pulse specifications of the generator, will also permit a pulse of given duration and amplitude to be injected into a working system at random times, thus approximating a controlled noise impulse.

[1] R. W. Frank, "More and Better Pulses from the Unit Pulse Generator," *General Radio Experimenter*, 36, 1 & 2, January-February, 1962.

SPECIFICATIONS

Pulse Output Amplitude: −1.2 to −1.5 volts depending on battery used, behind 200 kilohms.

Upon switch closure: Rise to zero volts in approximately 0.02 second.

Upon switch opening: Fall to between −1.2 and −1.5 volts in approximately 0.02 second with output terminals open-circuited.

Battery: 1.5-volt penlite cell.

Battery Life: Shelf life of battery used.

Weight: 6 ounces (0.2 kg).

Dimensions: Diameter 1¼, length 4½ inches (32 by 115 mm), over-all.

Type		*Code Number*	*Price*
1217-P2	**Single-Pulse Trigger**........................	1217-9602	**$25.00**

General Radio Company

PRINTED IN U.S.A.