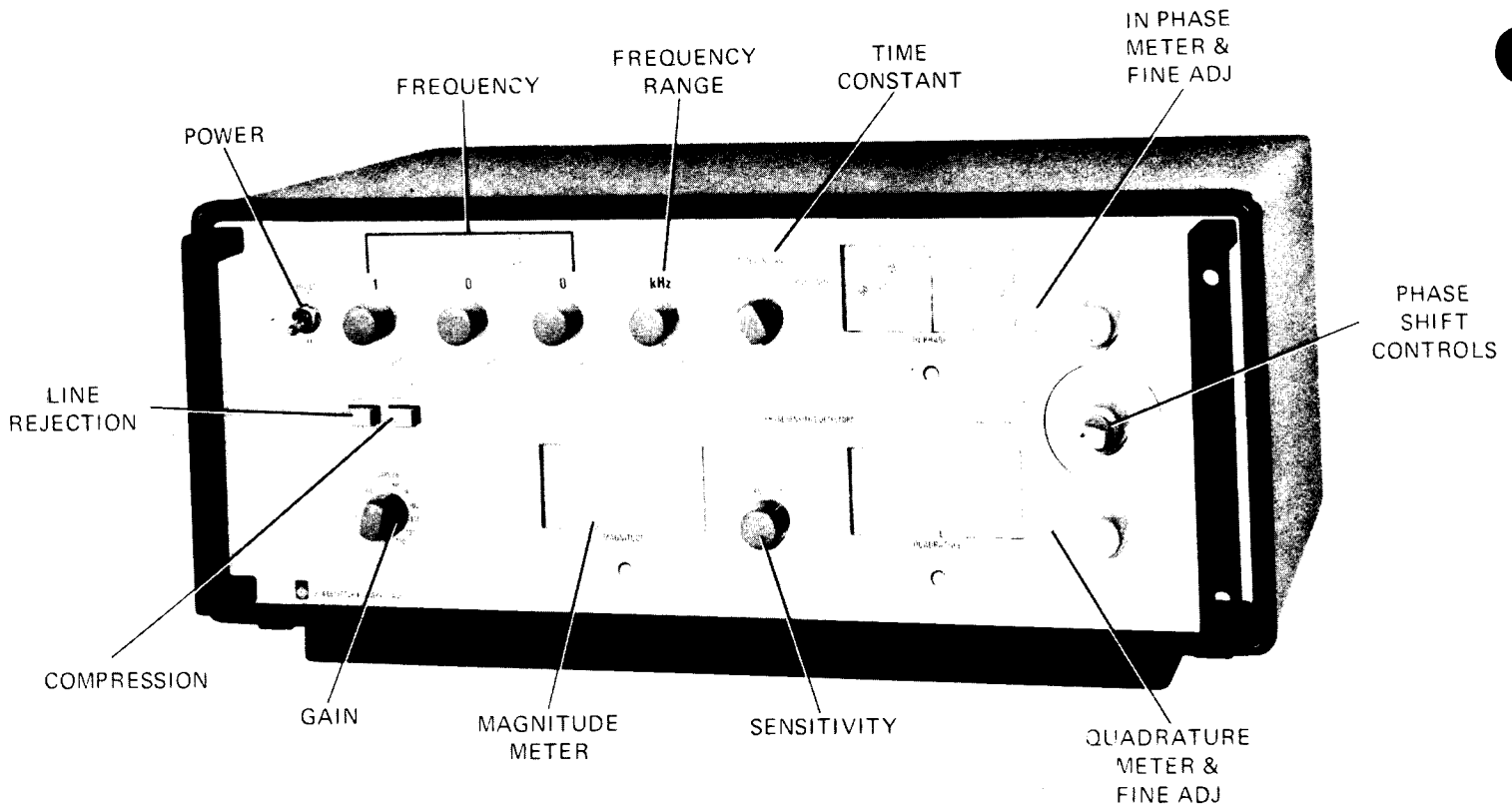
Contents

Type 1238 Detector

Concord, Massachusetts, U.S.A. 01742
November, 1983



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Condensed Operating Instructions

POWER.

a. Set the line-voltage switch (rear panel) to correspond with the available power (100-125 or 200-250 V).

b. If power-line frequency is 50 Hz, but the instrument was sold (or previously readjusted) for 60 Hz, ***or the converse***, make the jumper change and readjustment described in para. 5.5.

UNTUNED MAGNITUDE DETECTOR.

a. Provide the signal to be detected via shielded cable to rear-panel BNC connector INPUT SIGNAL. Normal levels: 2 μV to 1 V; limit: 200 V rms max.

b. Set controls as follows:

FREQUENCY – any
FREQUENCY range – FLAT
TIME CONSTANT – 1 s
FINE ADJUST – midrange
PHASE SHIFT – 0°
SENSITIVITY – minimum (ccw)
GAIN – 20 dB (ccw)
COMPRESSION – push button out
LINE REJECTION – push button out
POWER – ON.

c. Turn the GAIN control for MAGNITUDE meter reading between 20 and 100 – relative voltage level (not volts). For comparisons requiring GAIN-control change, note: 2 steps are a factor of 10 (1 step, factor of 3.16).

d. Take the amplified signal from rear-panel BNC connector AMPLIFIER OUTPUT to a scope, recorder, or other instrument if you wish to.

e. Set COMPRESSION push button in, if you want a quasi logarithmic function, making the 5-100 span of the meter response a factor of 100 in voltage (instead of 20).

f. Set LINE REJECTION push button in, if you want attenuation of the input-signal component at power-line frequency (by a factor of 100).

TUNED MAGNITUDE DETECTOR.

a. Set the controls as above, except:

FREQUENCY – frequency of desired signal
FREQUENCY range – decimal point and units.

b. Adjust source frequency or Detector FREQUENCY controls carefully for maximum response (best tuning).

c. Use the instrument as above, except that signal components and noise outside the 3% bandwidth are rejected. Tuned gain is 25 dB (factor of 18) greater than the FLAT gain. Normal input-signal levels: 1 μV to 400 mV.

DUAL-PHASE-SENSITIVE DETECTOR

a. Connect 2-phase reference signal from oscillator (GR 1316 recommended) to rear-panel BNC jacks REFERENCE INPUTS. Reference must be coherent with input signal; QUADRATURE leading, 90° ahead of IN PHASE.

b. Set the controls as above, except: *

- PHASE-SHIFT - set to make QUADRATURE meter zero and IN PHASE meter deflect to the right when input-signal phase is any initial angle Ø.
- FINE ADJ (QUADRATURE) -- fine control of above.
- FINE ADJ (IN PHASE) -- set to make INPHASE meter zero when input signal is Ø ±90°. If 90° phase shift is not available, leave control at midrange.

c. Use instrument as above except IN PHASE and QUADRATURE meters now indicate relative voltages and senses of input-signal components at Ø and Ø + 90° respectively. Phase-sensitive detection provides very effective rejection of input-signal components not coherent with the reference.

d. Increase SENSITIVITY (cw) if necessary to measure small signals (approx 100 nV) even though MAGNITUDE meter deflection is very small. Range of this control: 16 dB (factor of 6).

e. Increase TIME CONSTANT if necessary to help in reducing noise (jumpy meters) with small input signals.

f. Avoid GAIN setting that makes MAGNITUDE meter deflect offscale, otherwise indications of IN PHASE and QUADRATURE meters may be invalid.

***The phase Ø of the initial signal should be significant in your test system. For example, in a capacitance bridge, obtain this signal by unbalancing the bridge with *only* C or G, *not* an arbitrary combination.**

Specifications

Frequency: 10 Hz to 100 kHz, flat or tuned. *Flat*, ±5 dB from 10 Hz to 100 kHz. *Tuned*, controlled by 4 in-line readout dials with ±5% of reading accuracy, 2 to 4% bandwidth, and second harmonic ≥30 dB down from peak. *Line-rejection filter*, reduces line level by ≥40 dB while signal is down 6 to 10 dB at 10 Hz from line frequency; filter can be switched out.

Signal Input from bridge or other source: Applied to rear BNC connector. *Sensitivity*, also see curve; 100 nV rms typical for full-scale deflection at most frequencies, compression can be switched in to reduce full-scale sensitivity by 20 dB. *Impedance*, 1 GΩ//20 pF. *Maximum input*, 200 V rms. *Voltage gain*, ≈105 dB in flat mode, ≈ 130 dB in tuned mode, controlled by 12-position switch. *Spot noise voltage* <30 nV × $\sqrt{\text{bandwidth}_{Hz}}$ at 1 kHz with input impedance of 70 MΩ//500 pf. *Monitored* by magnitude, in-phase, and quadrature meters; phase-sensitive detectors contain time-constant variable from 0.1 to 10 s in 5 steps.

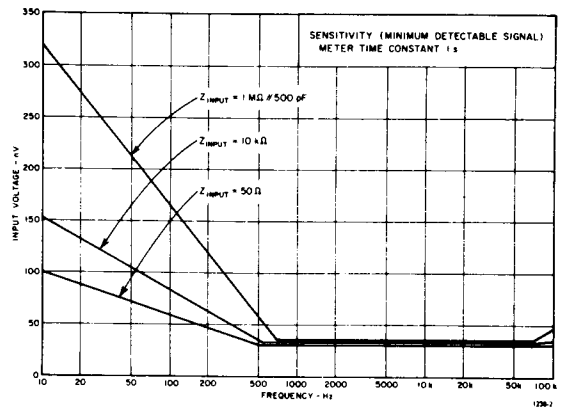
Reference Inputs from oscillator: Applied to rear BNC connectors. Two ≥1-V rms reference signals required, with 90° phase difference between them. *Phase shifter* rotates both references continuously from 0 to 360° and two verniers rotate each reference individually ≈ 10°.

Outputs: ***Main amplifier***, 4 V rms (approx 2.3 V for full scale on Magnitude meter) available at rear BNC connector. ***Magnitude***, 6 V dc for full scale deflection; ***phase detectors***, up to 1 V dc each for full scale deflection (depending on Sensitivity setting); available at rear 5-pin connector.

Required: Oscillator with 0 and 90° outputs; the 1316 Oscillator is recommended.

Power: 105 to 125 and 210 to 250 V, 50 to 60 Hz, 15 W.

Mechanical: Bench or rackmount. Dimensions (w X h X d): Bench, 19.75 X 6.66 X 12.93 in. (502 X 169 X 329 mm); rack, 19 X 5.22 X 13.1 in. (483 X 133 X 332 mm). Weight: Bench 27 lb (12 kg) net, 40 lb (18 kg) shipping; rack, 21 lb (10 kg) net, 34 lb (16 kg) shipping.



Catalog Number	Description
	1238 Detector
1238-9700	60-Hz Bench Model
1238-9701	60-Hz Rack Model
1238-9703	50-Hz Bench Model
1238-9704	50-Hz Rack Model

Also included in each 1621 Precision Capacitance Measurement System.

Introduction—Section 1

1.1 PURPOSE.

The 1238 Detector is a sensitive, low-noise, analog instrument particularly suited for null detection in a highly precise bridge system such as the GR 1621. As you bring the bridge to balance, this detector continuously provides an indication of the remaining unbalance. You are also provided with the relative magnitudes and senses of its quadrature components. If, for example, the bridge measures C and G, separate zero-center phase-sensitive meters conveniently indicate the C and G components of unbalance. Also, these meters will resolve signals so small as to be "lost in the noise" of a magnitude-only detector.

To handle the great range of signal levels characteristic of bridges, this detector has manually selected gain, optional rejection of noise and harmonics by tuning, optional compression of the linear response characteristic, and a choice of 5 time constants for the phase-sensitive meters. Automatic protection circuitry saves the instrument from damage even if the input signal reaches 200 V while you have the gain set for 100 nV, full scale. The digital, in-line frequency controls match those of the companion 1316 Oscillator (used in the 1621 Precision Capacitance-Measurement System). Both instruments cover the frequency range of 10 Hz to 100 kHz with 3-digit resolution.

In addition to its prime purpose as a bridge detector, the 1238 is well suited as a low-noise amplifier with the very high input impedance of 1 GΩ in parallel with 20 pF. The filters may be switched out for a flat frequency characteristic. With the tuning filter in, the 1238 serves as an analyzer having about 3% bandwidth, better than 30 dB rejection of the 2nd harmonic, and a dynamic range (with the gain control) of at least 130 dB.

1.2 DESCRIPTION. **Figure 1-1.**

The 1238 Detector is a high-gain, solid-state, tunable, metered amplifier with a pair of phase-sensitive detectors. They can be set to respond to any 2 quadrature (i.e., orthogonal) components of the input signal, if a pair of quadrature-related reference signals is provided, generally by the oscillator that drives the measurement system.

Figure 1-1 shows the 1238 circuitry by an elementary block diagram. The high-input-impedance preamplifier is well shielded and isolated; it has a separate power supply and all its control functions are handled by solid-state relays (insulated-gate field-effect transistors). Its first stage, a field-effect transistor, is diode protected against high-volt-

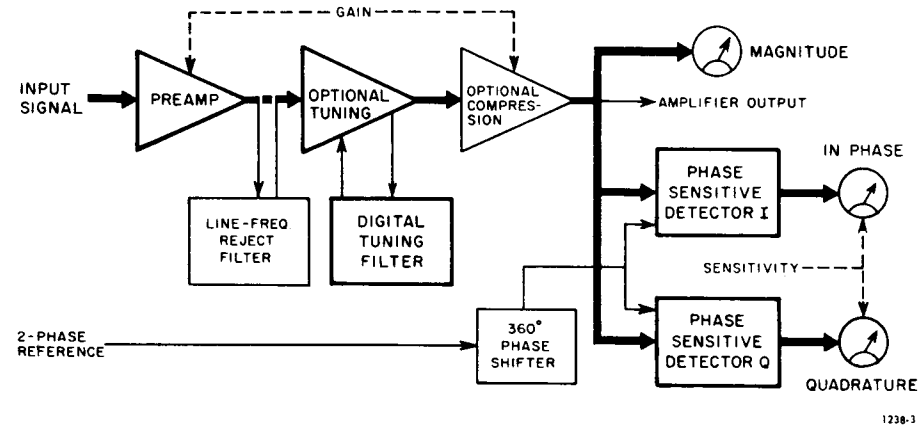


Figure 1-1. Elementary block diagram.

age input signals. The digital tuning filter, 360° phase shifter, meters, and sensitivity control are components of the front-panel assembly. Each phase-sensitive detector is a separate plug-in board. Amplifier and power supply circuits are on the mother board, which is easily accessible from above and below for adjustment and servicing.

1.3 CONTROLS, INDICATORS, AND CONNECTORS.

Tables 1-1 and 1-2 list and describe the front and rear panel controls, indicators, and connectors. Refer to the illustrations of Figures 1-2 and 1-3.

1.4 ACCESSORIES.

Table 1-3 lists the accessories supplied with the 1238 Detector. Table 1-4 lists connectors and patch cords suitable for connecting to the instrument and the recommended companion oscillator, which is shown in Figure 1-4.

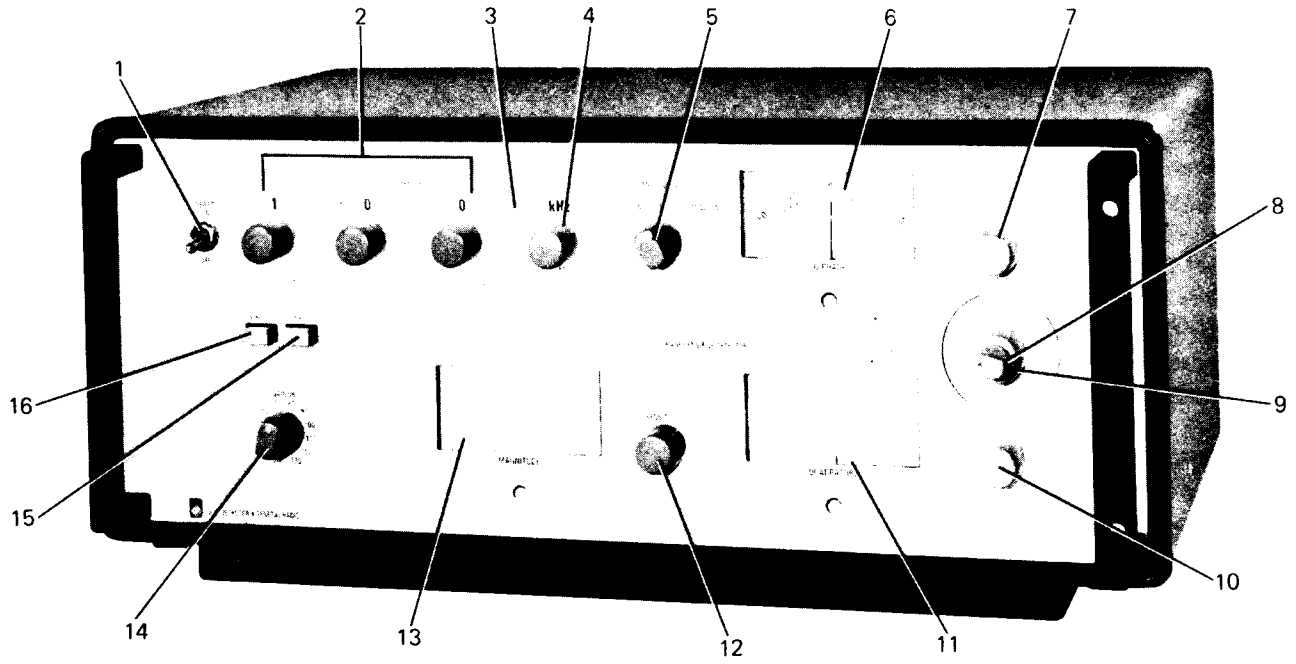


Figure 1-2. Front-panel controls and indicators.

Table 1-1

FRONT-PANEL CONTROLS AND INDICATORS

Fig. 1-2 Item	Name	Description	Function
1	POWER Switch	Toggle switch, up: ON; down: OFF.	Turns detector on and off.
2	FREQUENCY selector	Set of 3 rotary switches with decimal steps, 0 . . . 10.	Selects and indicates frequency to which detector is tuned (unless "FLAT"). With item 4, controls the digital tuning filter.
3	Decimal point	Set of 3 small, round, recessed lamps, one to the right of each digit in item 2.	Indicates proper location of decimal point in item-2 readout, as determined by item 4. Pilot-light indication: power is on.

Table 1-1 Cont.

FRONT-PANEL CONTROLS AND INDICATORS

Fig. 1-2 Item	Name	Description	Function
4	Frequency range	Rotary switch with 5 positions: FLAT, Hz, Hz, kHz, kHz.	Selects flat amplifier characteristic or frequency range of tuned response. Indicates frequency units for item 2. Controls its decimal point, item 3.
5	TIME CONSTANT	Rotary switch with 5 positions: 0.1, 0.3, 1, 3, 10 SECONDS.	Controls the smoothing (integration) of detected signals and hence, effectively, the damping of items 6 and 11, but not 13.
6	IN-PHASE meter	Zero-center meter graduated 50-0-50; has mechanical zero-adjustment screw.	Indication of one component of input signal (such as C unbalance in 1621 system).
7	FINE ADJUST (IN-PHASE)	Stepless rotary pot.	Trims the phase of item-6 reference so the quadrature component is rejected.
8	PHASE SHIFT (smaller knob)	Rotary switch with 4 positions: 0°, 90°, 180°, 270°.	Selects phase shift of 2-phase reference in 90° steps, supplemented by items 7, 9, and 10.
9	PHASE SHIFT (larger knob)	Stepless rotary control, calibrated -50° to +50°	Adjusts phase shift of 2-phase reference, over 100° centered on the indication of item 8. Set so items 6 and 11 respond to desired components of input signal.
10	FINE ADJUST (QUADRATURE)	Stepless rotary pot.	Trims the phase of item 11 reference so the in-phase component is rejected.
11	QUADRATURE meter	Zero-center meter graduated 50-0-50; has a mechanical zero-adjustment screw.	Indication of the input-signal component in quadrature with item 6 (Example: G unbalance in 1621 system).
12	SENSITIVITY control	Stepless rotary pot.	Fine control; used to keep IN-PHASE and QUADRATURE meters reading on scale (does not affect items 13 or 1R). Range 6:1.
13	MAGNITUDE meter	Meter, calibrated 0 to 100; has a mechanical zero-adjustment screw.	Indication of relative magnitude of input-signal (item 5R) components in pass band set by items 2, 16. Linearity depends on item 15.
14	GAIN, dB	Step attenuator, 12 positions: 20 . . . 130 dB.	Coarse gain control; used to keep MAGNITUDE meter reading on scale. (Turn cw if meter reads less than 30.)
15	COMPRESSION	Push-button switch (push to engage; push again to release).	Out: linear response, full gain. In: 20-dB-compressed response, 10 times-larger signal can be handled with MAGNITUDE meter on scale.
16	LINE REJECTION	Push-button switch (push to engage; push again to release).	Out: normal. In: 40 dB attenuation of line-frequency component of input signal. (Circuit can be adapted to either 50 or 60 Hz.)

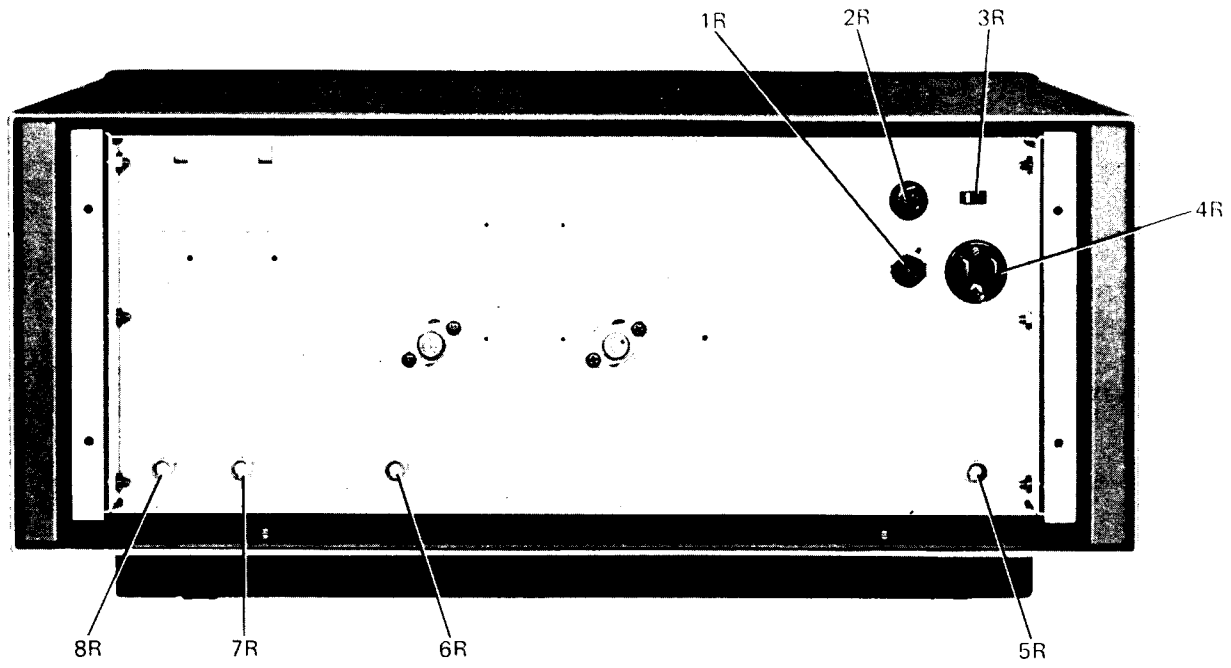


Figure 1-3. Rear-panel controls and connectors.

Table 1-2

REAR-PANEL CONTROLS AND CONNECTORS

Fig. 1-3 Item	Name	Description	Function
1R	DC METER OUTPUTS	5-pin socket (Figure 2-6).	Outputs for remote metering. Full-scale dc levels: MAGNITUDE, 6 V; IN-PHASE and QUADRATURE, 0.25-1.5 V, depending on item 12 (which does not affect ratio: dc out/signal in).
2R	1/2 AMP fuse	Fuse in extractor post holder	Protection against damage from short circuit
3R	Line-voltage switch	Slide switch (labeled 50-60 Hz) 2 positions: 100-125 V, 200-250 V.	Accomodates power supply to either range of line voltage.
4R	Power plug	3-pin power plug	Connection from power line and earth ground.
5R	INPUT SIGNAL	BNC Jack*	Main input. Impedance: 1 GΩ//20 pF for normal signal levels. Max level: 200 V rms.
6R	AMPLIFIER OUTPUT	BNC Jack*	Output for remote instrumentation. Level: 0-4 V rms (2.25 V at FS on item 13).
7R	IN-PHASE REFERENCE INPUT	BNC Jack*	One of two quadrature references required for phase-sensitive detection. See item 8R.
8R	QUADRATURE REFERENCE	BNC Jack*	The other – see item 7R. Required levels: 1 V rms min, each. Phase: Item 8R normally leads 7R by 90° ±5°

*BNC jack accepts Amphenol "BNC" plug or military connector No. UG-88/U.

1-4 INTRODUCTION

Table 1-3

ACCESSORIES SUPPLIED

Name	Description or Function	GR Part No.
Power cord	Stackable hammerhead dual connector (one end) and socket (other end) each molded integrally to plastic jacket of 3-wire AWG number 18 type SVT cable, rated at 7A, 230 V. The connectors, designed for 125-V operation, conform to the Standard for Grounding Type Attachment Plug Caps and Receptacles, ANSI C73.11-1963. Length: 7 ft.	4200-9625 (4200-0220)
Plug	For DC METER OUTPUTS socket; 5-pins; Amphenol No. 126-217.	4220-5401

Table 1-4

COMPANION OSCILLATOR, CONNECTORS AND PATCH CORDS

Name	Description or Function	GR Part No.
Oscillator	Stable, synchronizable, transformer-coupled, metered, sine-wave source. **Frequency**: 10 Hz to 100 kHz; **Stability**: 0.001% in 10 min; **Calibration accuracy**: ±1%; **Distortion**: < 0.2%; **Power**: 0-1.6 W (up to 5A or 125 V rms); **Reference outputs – phase**: 0° and 90° leading main output; **level**: 1.25 V rms; **distortion**: < 0.4%; **min load**: 47 kΩ.	(Type 1316) 1316-9700 (Bench) 1316-9701 (Rack)
Patch Cords	Shielded cable with BNC plugs at each end; **Length**: 3 ft. (Type 776-C).	
	Shielded cable with BNC plug and GR874® connector at opposite ends; **Length**: 3 ft.	(Type 776-B)
Adaptor	BNC plug to 874 connector (Fits BNC jack).	(Type 874-QBPA)

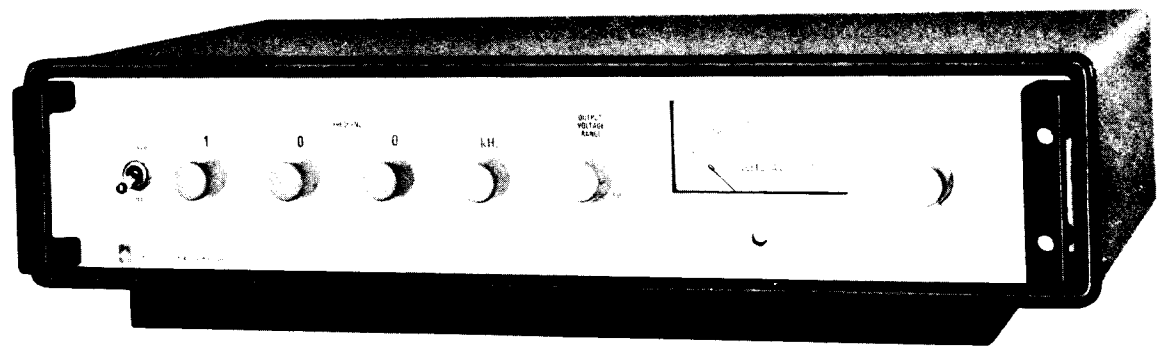


Figure 1-4. A recommended companion instrument, the 1316 Oscillator.