

PRECISION INSTRUMENTS

FOR

UHF

MEASUREMENTS



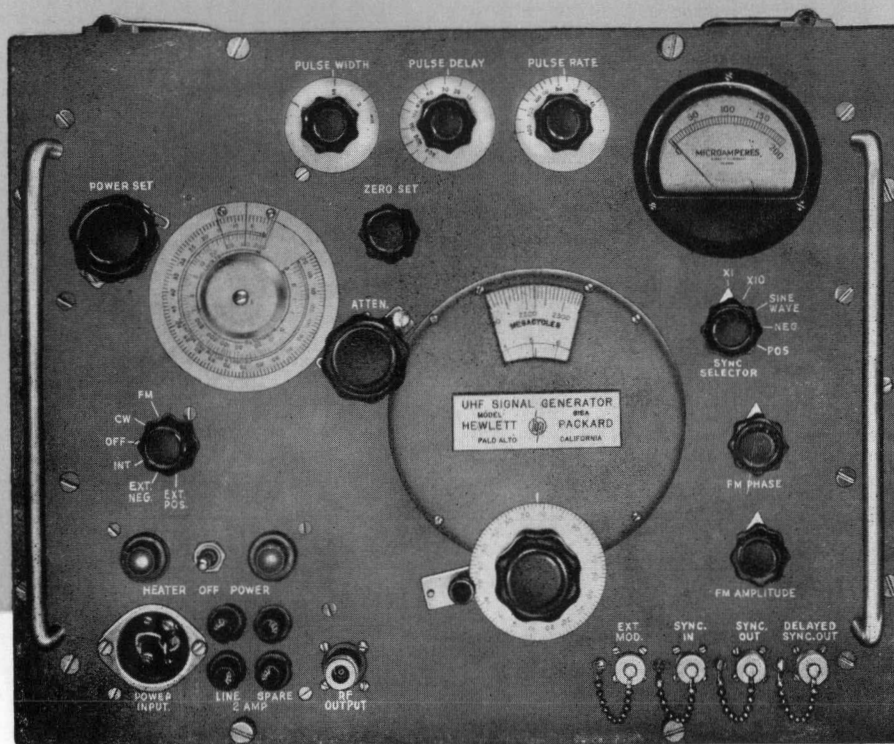
HEWLETT-PACKARD COMPANY

395 PAGE MILL ROAD • PALO ALTO, CALIFORNIA



MODEL 616A

UHF SIGNAL GENERATOR



ADVANTAGES:

- Direct frequency control
- Direct voltage readings
- C-w, f-m, or pulsed output
- Variable pulse rate
- Synchronized pulsing
- Wide frequency range
- Great stability
- Rugged, compact

USE IT TO MEASURE:

- Receiver sensitivity
- Signal-noise ratio
- Conversion gain
- Standing wave ratios
- Antenna gain
- Transmission line characteristics

FAST DIRECT READINGS 1800 TO 4000 MC

EASE of operation, direct reading without reference to calibration charts, one-dial frequency control, great stability, and precision accuracy between 1800 and 4000 mc—those are but a few of the advantages of this new *-hp-* Model 616A Signal Generator.

Operation of the new *-hp-* 616A is extremely simple. For example, carrier frequency in mc may be directly set and read on the large tuning dial. No voltage adjustments are necessary during operation, because the unique, *-hp-* developed coupling device causes oscillator repeller voltage to automatically track frequency changes. R-f output from the reflex klystron oscillator is directly set and read on a simplified output dial. It may be continuous or pulsed, or frequency modulated at power supply frequency. Pulse modulation may be provided externally or supplied internally. Internal pulsing may be synchronized with either positive or negative external pulses, or sine waves. R-f pulse may be delayed 3 to 300 microseconds with respect to external synchronizing pulse.

The oscillator portion of the new -hp- 616A Signal Generator is of the reflex klystron type, with an external resonant cavity. Frequency of oscillation is determined by a movable plunger which varies the parameter of the cavity. Oscillator output is monitored by a temperature-compensated thermistor bridge circuit which operates virtually unaffected by ambient temperature conditions. Voltage beyond the monitored output level is passed through a piston attenuator which is so designed that attenuation is linear over a range of 120 db or more. Voltage output is directly read on the scale.

Because of its wide range and great stability, the -hp- 616A UHF Generator is ideal for almost any precision uhf application. It is easy to use, compact to save bench space, and ruggedly-built of finest components for long, trouble-free service.

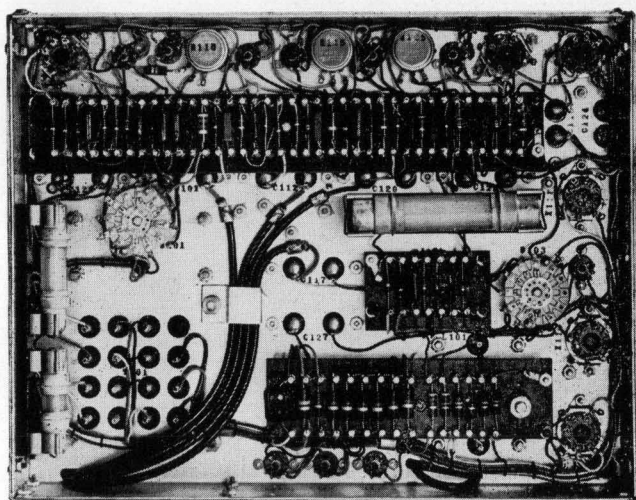


Fig. 1 — Rear view of -hp- 616A UHF Signal Generator, showing compact arrangement and ready accessibility of all components.

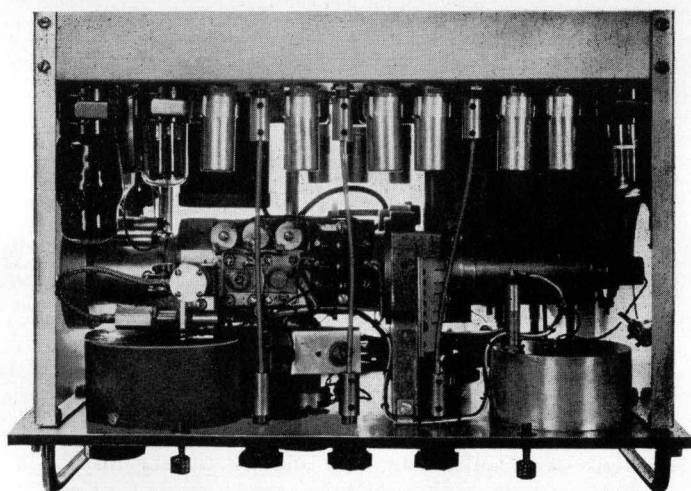


Fig. 2 — Top view of signal generator showing klystron oscillator cavity and bolometer circuits. Aperture at right permits easy replacement of oscillator tube.

S P E C I F I C A T I O N S

Frequency Range: 1800 to 4000 megacycles.

Selection is made by means of a single directly-calibrated control covering the entire range. No charts are necessary.

Frequency Calibration Accuracy: $\pm 1\%$.

Frequency Stability: 0.005% per degree centigrade change in ambient temperature; line voltage changes of ± 10 volts cause less than 0.01% frequency change.

Output Range: 1 milliwatt or .223 volts to 0.1 microvolt (0 dbm to -127 dbm). Directly calibrated in microvolts and db; continuously monitored.

Attenuator Accuracy: Within ± 1 db without correction charts. A correction chart is provided when greater accuracy is desired.

Output Impedance: 50 ohms, nominal.

Modulation: Internal or external pulse or f-m.

Internal Pulse Modulation: Repetition rate variable from 40 to 4000 per second; pulse length variable from 1 to 10 microseconds; and delay variable from 3 to 300 microseconds (between synchronizing signal and r-f pulse).

Trigger Pulses Out:

1. Simultaneous with r-f pulse.
2. In advance of r-f pulse, variable 3 to 300 microseconds. (Both approximately 0.5 microsecond rise time, height 25-50 volts.)

External Sync Pulse Required: Amplitude from 10 to 50 volts of either positive or negative polarity and 1 to 20 microseconds width. May also be synchronized with sine waves.

FM Modulation: Oscillator frequency sweeps at power line frequency. Phasing and sweep range controls provided. Maximum deviation approximately ± 5 mc.

Power Source: The instrument operates from a 105-125 volt 50/60 cycle, single phase source.

Approximate Size: 17" long, 13 $\frac{1}{4}$ " high and 13 $\frac{1}{2}$ " deep.

Data subject to change without notice.



MODEL 610B

UHF SIGNAL GENERATOR



SPECIFICATIONS

Frequency Range: 450-1200 mc directly calibrated.

Attenuator: Mutual inductance piston type, directly calibrated in db below 0.1 volts in 50 ohms; 120 db maximum attenuation.

Output: Accurately known voltages from 0.1 microvolt to 0.1 volt supplied through 50-ohm coaxial cable terminated in type "N" connector. Internal impedance 50 ohms. Accuracy better than ± 1 db over entire range.

Modulation: Internal pulse, external pulse, external square wave, external amplitude.

Internal Pulser: Pulse length variable 2 to 50 microseconds. Repetition rate variable 60 to 3000 cps. Pulse delay variable 3 to 300 microseconds (between externally supplied synchronizing pulse and beginning of r-f pulse).

Leakage: Sufficiently low to permit measurement of sensitivities as low as 1 microvolt.

Size: Panel 8" x 11"; depth 22".

Net Weight: 44 pounds. Shipping Weight: 85 pounds.

Data subject to change without notice.

GENERAL PURPOSE UHF SIGNAL GENERATOR, 450 TO 1200 MC

THE *hp*- Model 610B Signal Generator provides a general purpose laboratory standard for measurements between 450 and 1200 mc. It supplies an accurately known voltage throughout this range, from 0.1 microvolt to 0.1 volt. Output voltage and frequency are directly selected and read without reference to calibration charts.

The *hp*- 610B includes a high-frequency oscillator, and an attenuator for accurately controlling output beyond a measured level. Also included is an internal pulser and modulator, and a regulated power supply to provide oscillator plate voltage. The oscillator employed is of the concentric type, utilizing a "lighthouse" tube, and is adjusted by the positioning of the shorting plungers in the concentric lines. Output voltage is derived through a mutual inductance type attenuator, coupled to the oscillator cavity. R-f voltage at attenuator input is measured by a thermistor bolometer.

Internal pulsing circuits provide rectangular, r-f, pulsed output of variable lengths and repetition rates. The pulse rate may be synchronized from an outside source. An external synchronizing pulse is provided. R-f signal may also be externally amplitude modulated.

hp MODEL 614A

UHF SIGNAL GENERATOR



SPECIFICATIONS

Frequency Range: 800-2,100 mc directly calibrated. Accurate within $\pm 1\%$.

Output Range: 1 milliwatt or .223 v to 0.1 μ v. (0 dbm to -127 dbm) Directly calibrated in μ v and db; continuously monitored.

Output Impedance: 50 ohms. SWR 3 db (VSWR 1.4).

External Modulation: By external pulses, pos. or neg. peak amplitude 40 to 70 v., 0.5 microseconds to square wave.

FM Modulation: Oscillator frequency sweeps at power line frequency. Phasing and sweep range controls provided. Max. deviation approx. ± 5 mc.

Internal Modulation: Pulse repetition rate variable from 40 to 4,000 per second; pulse length variable from 1 to 10 μ sec. Pulse rise and decay approx. 0.1 μ sec.

Trigger Pulses Out: (1) Simultaneous with rf pulse. (2) In advance of rf pulse, variable 3 to 300 μ sec. (Both approx. 1 μ sec. rise time, height 10 to 40 v.)

External SYNC Pulse Needed: Amplitude from 10 to 50 v. of either pos. or neg. polarity; and 1 to 20 μ sec width. May also be synchronized with sine waves.

Size: 17" long; 13 $\frac{1}{4}$ " high; 13 $\frac{1}{2}$ " deep.
Net Weight: 65 lbs. Shipping weight: 115 lbs.

Data subject to change without notice.

DIRECT READING, DIRECT CONTROL GENERATOR, 800 TO 2,100 MC

THIS new *hp*-UHF Signal Generator is similar in design to the *hp*-616A generator, but offers such additional advantages as faster rise time of pulsed output, more constant internal impedance and higher output accuracy.

Like the 616A, the new 614A can save hours of time and work in making UHF measurements. It offers direct reading output and accuracy of ± 1 db; constant internal impedance with a standing wave ratio of 3 db; external modulation of half-microsecond pulses to square waves; a choice of CW, FM or pulsed output, and many other time-saving conveniences.

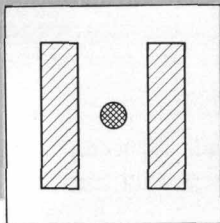
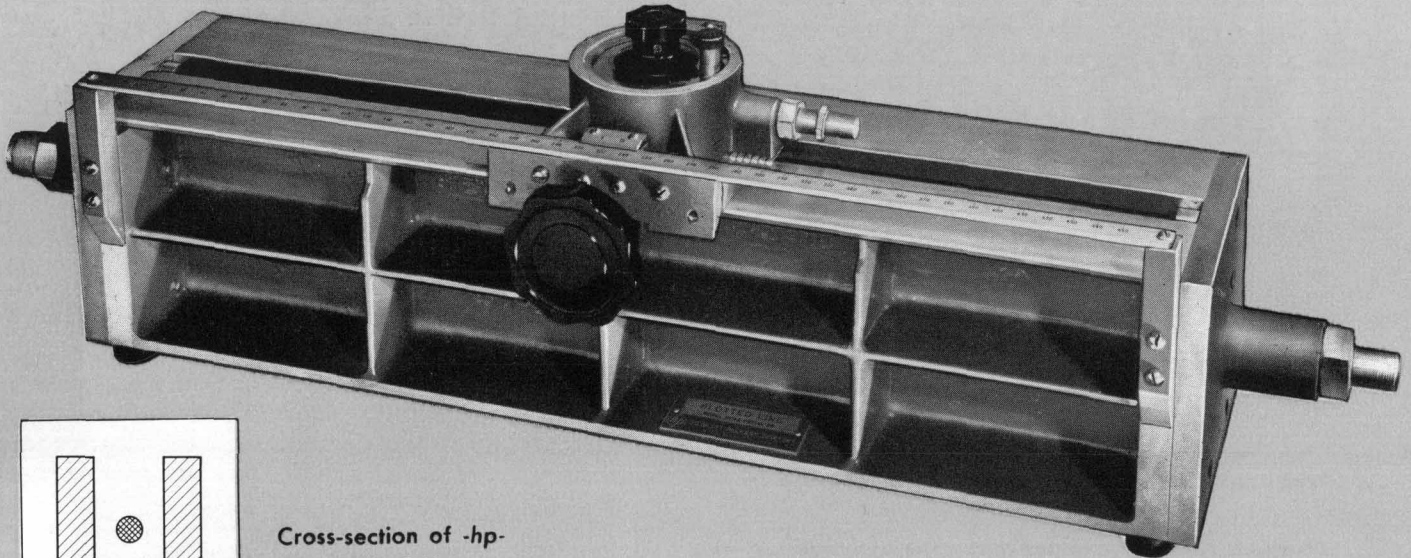
For example, carrier frequency in mc can be set and read directly on the large central tuning dial. Rf output from the klystron oscillator is also directly set and read, in microvolts or db. No calibration charts or tedious interpolations are necessary; and no voltage adjustments are required during operation. Output may be continuous, pulsed, or frequency modulated at power supply frequency. The instrument can be modulated internally or externally; and may be synchronized with positive or negative pulses or sine waves.

With this instrument you can quickly, easily and accurately measure receiver sensitivity and alignment, signal-to-noise ratio, conversion gain, standing wave ratios, antenna gain, and transmission line characteristics—to name but a few readings essential to UHF work.



MODEL 805

SLOTTED LINE



Cross-section of -hp-
805 Slotted Line

ADVANTAGES:

Parallel plane design: provides higher accuracy, greater stability, negligible slope, rigid central conductor. Ball-bearing probe carriage. Low residual VSWR.

USE IT TO MEASURE:

- Load Impedance
- System Flatness
- Connector Reflection
- Antenna Match
- % of Reflected Power
- Standing Wave Magnitude
- Standing Wave Phase

NEW "PARALLEL-PLANE" DESIGN GIVES UTMOST ELECTRICAL STABILITY

THE new -hp- 805 Slotted Line incorporates a radically new structural design with precision manufacture, resulting in an instrument of unvarying accuracy for the measurement of microwave circuits.

GREATER INHERENT ACCURACY

This new instrument employs two parallel planes and a rigid central conductor in place of the conventional co-axial arrangement. This configuration has several important advantages over the standard slotted section.

For example, it permits the parallel planes to be made mechanically rigid; thus insuring greater accuracy and providing a rigid probe carriage. The central conductor is proportionately larger and more rigid, with less tendency to bow. Depth of probe penetration is inherently less critical, and therefore carriage inaccuracies are minimized. Leakage is also low because the effective slot opening is small. This new design permits VSWR of the basic section to be held to less than 1.02.

In the construction of the *-hp-* 805 Slotted Line, every effort has been made to achieve complete mechanical stability. The flat sections or planes are of cast, normalized aluminum alloy, ribbed to combine strength and light weight. The central conductor is a selected brass rod, centerless ground and silver plated.

CALIBRATION

Calibration of the scale is in millimeters and centimeters, and the probe position can be read to 0.1 millimeters. The probe carriage traverses the slot length on ball bearings, and is free-moving to facilitate quick setting of the probe position. Close setting is made by means of a vernier control knob. The probe circuit is tunable over the instrument's entire frequency range, 500 to 4,000 megacycles. Depth of probe penetration can be quickly and easily adjusted by means of a knob on top of the probe carriage.

The *-hp-* 805 Slotted Line is supplied complete with a specially designed steel-and-dural carrying case. The case includes sponge rubber shock-mountings to guard the instrument against damage, and is fitted with steel snap fastenings and carrying handle.

SPECIFICATIONS

-hp- 805A Slotted Line

Frequency Range: 500 mc to 4,000 mc (minimum frequency determined by usable length of $17\frac{1}{2}$ inches).

Characteristic Impedance: 50 ohms. (For use with such flexible coaxial cables as RG: 8/U, 9/U, 10/U, 14/U, 17/U, 18/U, 21/U.)

Connections: TYPE N. (One male; one female). Special fittings designed to mate with Type N connectors provide a minimum VSWR. Connectors compensated so that either end may be connected to the load. Also included are shorting connectors, male and female, for use in making phase measurements.

Residual VSWR: 1.04.

Slope: Negligible.

Calibration: Metric, calibrated in cm and mm. Vernier permits reading to 0.1 mm.

Detector: Circuit tunable, uses standard crystal (1N21B or 1N23); Sperry Barretter Model 821; or 1/100 ampere instrument fuse.

Size: Length 27". Height 8". Width 6". Weight 18 lbs. In case: Length 28". Height $9\frac{1}{4}$ ". Width $9\frac{3}{4}$ ". Weight 33 lbs. Shipping weight 75 lbs.

-hp- 805B Slotted Line

Characteristic Impedance: 46.3 ohms. For use with RG 44/U stub supported coaxial cable. $\frac{7}{8}$ " outside diameter.

Connections: (One male, one female UG 45/U and UG 46/U.)

Residual VSWR: 1.02.

(Other specifications same as *-hp-* 805A)

Data subject to change without notice.



-hp- Model 415A

STANDING WAVE INDICATOR

THE new *-hp-* 415A Standing Wave Indicator is designed for use with the *-hp-* 805A Slotted Line. It may also be used as a null indicator, or for bridge measurements, and provides a 75,000 ohm input circuit for this application.

The *-hp-* 415A consists of a high gain amplifier with very low noise level, operating at a fixed audio frequency. Amplifier output is measured with a Square-Law calibrated vacuum tube voltmeter. This meter reads direct in VSWR and in db, eliminating the need for laborious computations. A 60 db attenuator adjustable in 10 db steps provides a calibrated range of 70 db for readings of SWR. A gain control adjusts the instrument to a convenient level. Input circuits are provided both for use with a crystal rectifier or bolometer.

SPECIFICATIONS

Frequency: Normally 1,000 cps $\pm 2\%$. Plug-in units for other frequencies, 300 to 2,000 cps are available. Request unit 41A-42, and specify frequency. Amplifier "Q" is 20 ± 5 .

Sensitivity: 0.3 μ v. gives full scale deflection. Equivalent noise level referred to input is 0.04 μ v.

Calibration: For use with Square-Law detector. 60 db level covered in 6 ranges. Accuracy ± 0.1 db per 10 db step.

Gain Control: Adjusts meter to convenient level. Range is approx. 30 db.

Input: Connects to crystal rectifier or bolometer. Bias of 8 v. $\pm .5$ v. delivers approx. 8.75 ma. to a 200 ohm bolometer or 1/100 ampere instrument fuse. 75,000 ohms for null measurement. One terminal at ground.

Size: 12" long, 9" wide, 9" high. Weight 17 lbs. Shipping weight 30 lbs.

Data subject to change without notice.

hp MODEL 430A

MICROWAVE POWER METER



SPECIFICATIONS

Power Range: Full scale readings of: .1, .3, 1, 3 and 10 mw. Also calibrated in db to give continuous reading from -20 dbm to +10 dbm. (0 dbm = .001 watt). Power range can be extended with attenuators or directional couplers in microwave system.

External Bolometer: Frequency Range depends on bolometer mount. Bolometer must be 200 ohms at power level of approximately 15.3 mw and have positive temperature coefficient. Suitable bolometers include: 1/100 ampere instrument fuse; Sperry barretter 821. (Bolometer and mount not supplied.)

Accuracy: $\pm 5\%$ of full scale reading.

Size: 12" wide, 9" deep, 9" high. 4" meter.

Weight: 17 lbs. Shipping weight 32 lbs.

Power: 115 v., 50/60 cps, 60 watts.

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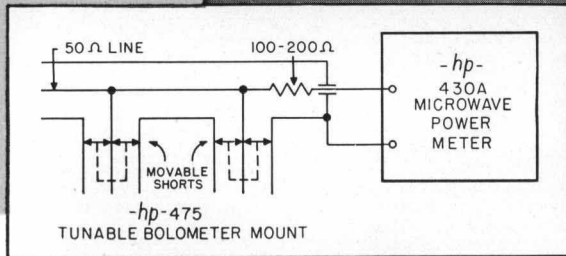
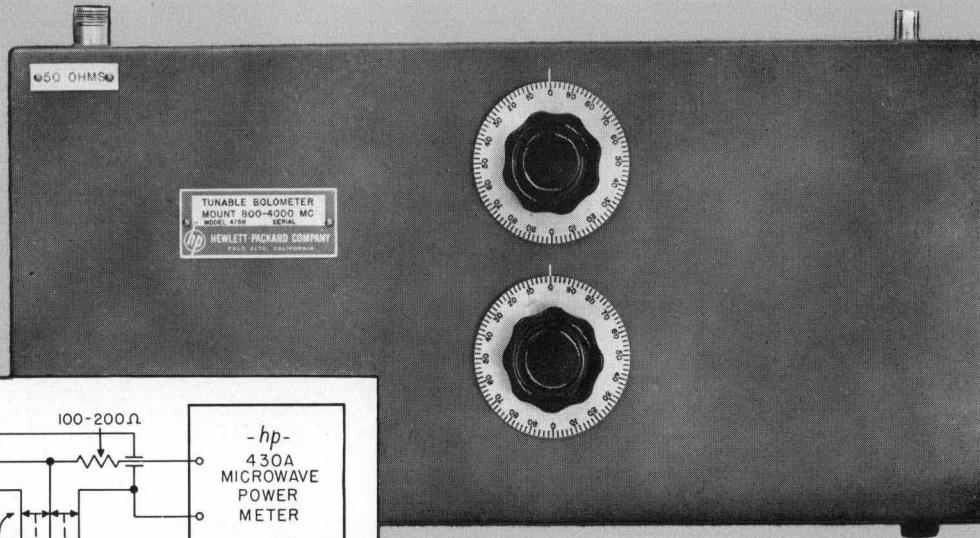
DIRECT, AUTOMATIC, INSTANTANEOUS POWER READINGS IN MW OR DBM!

HERE at last is Microwave Power Meter that offers you completely automatic, instantaneous power readings direct in decibels or milliwatts. No tedious calculations, no troublesome adjustments. And it can be used at any microwave frequency you desire!

The *-hp-* 430A consists of an audio bridge, one arm of which is a power sensitive element. The bridge is initially balanced with no rf power in the element. As rf power is applied, an equivalent in audio power is automatically removed, so that the bridge remains in balance. The change in audio power level indicates directly on the front panel vacuum tube voltmeter. This meter, calibrated in milliwatts and dbm, then gives direct indication of the rf power in the sensitive bridge arm.

The outstanding feature of this new *-hp-* instrument is its automatic operation. Measuring an unknown rf is as simple as connecting the *-hp-* 430A to the 200-ohm bolometer in your system. After initial balancing, the instrument does the rest. Power can be read directly in milliwatts from .02 to 10 mw, or dbm from -20 to +10 dbm. Higher powers can be measured by adding attenuators or directional couplers to the microwave system. Any of 5 ranges are quickly selected on a front panel switch.

TUNABLE BOLOMETER MOUNTS



SPECIFICATIONS

-hp- 475A Tunable Bolometer Mount

Frequency: Approx. 300 to 1,000 mc. (Varies with VSWR, phase of source and value of bolometer load.)

Fittings: Type N female (UG23/U) (Incoming power) BNC Type (UG89/U) bolometer dc connection. Output will accept Type N connector fitting so mount may be used as a conventional double-stub transformer.

Power Range: 0.1 mw to 10 mw full scale (with -hp- 430A).

Power Sensitive Element: 1/100 ampere instrument fuse, Sperry Barretter 821, Western Electric Type D166382 Thermistor*
(*Not usable with -hp- 430A.)

Size: 9 $\frac{3}{4}$ " x 34". 2" deep.

-hp- 475B Tunable Bolometer Mount

Frequency: Approx. 800 to 4,000 mc. (Varies with VSWR, phase of source and value of bolometer load.)

Size: 7 $\frac{1}{2}$ " x 15". 3 $\frac{1}{2}$ " deep.

(Other specifications same as -hp- 475A.)

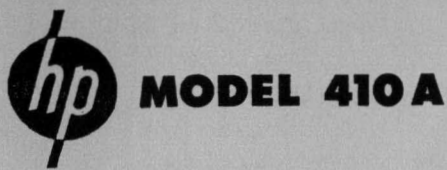
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NEW WIDE-BAND MATCHING SYSTEM FOR MEASUREMENT OF MICROWAVE POWER

THESE new -hp- tunable bolometer mounts set a new standard of accuracy and convenience for making microwave power measurements. Since these mounts are *tunable* over a broad band, they have universal application.

Both the -hp- 475A and 475B are essentially double stub tuners, designed to couple energy from a 50 ohm coaxial microwave system into a 200 ohm bolometer. The rf energy absorbed by the bolometer is measured by means of a bolometer bridge; or by using a self-balancing bridge such as the -hp- 430A Microwave Power Meter. With this combination of equipment, microwave power may be measured directly at frequencies from 300 to 1,000 mc (-hp- 475A) or 800 to 4,000 mc (-hp- 475B).

Both instruments are similar in construction. Two shorting stubs are rigidly positioned in shunt with a transmission line section, and are spaced $\frac{1}{2}$ wave apart at a frequency above the transmission range. Shorting stubs are varied by two controls actuating sliding contact fingers. The transmission line section terminates in a power-sensitive element which may have resistance values ranging from 100 to 200 ohms.



HIGH FREQUENCY VACUUM TUBE VOLTMETER



ADVANTAGES:

- Range: 20 cps to 700 mc
- Input capacity, approximately 1.3 μmf
- High input impedance
- Few controls. High stability
- Rugged meter movement
- Excellent overload protection

USE IT TO MEASURE:

- Audio frequency, supersonic, r-f, and VHF voltages
- Antenna voltage, current, and power
- Transmission line characteristics
- Standing waves
- Audio, video and VHF amplifiers
- DC voltage in high impedance circuits

ALL-PURPOSE TEST INSTRUMENT MEASURES TO 700 MC

BECAUSE of the tremendous number of tasks it will perform, the 410A High Frequency Vacuum Tube Voltmeter can play a uniquely valuable role in any laboratory, broadcast station, or production test department. It combines in one instrument an ac voltmeter covering the frequency range from audio to radar frequencies, a dc voltmeter with 100 megohms input impedance, and an ohmmeter capable of measuring resistance from 0.2 ohms to 500 megohms. In addition, it is easy to use, compact, portable, and light in weight.

A special probe, employing a new, radically different diode especially designed by Eimac for Hewlett-Packard, is used for making ac measurements. The resonant frequency of the diode is approximately 2000 mc, and the shunt capacity is extremely low. Mounted in the probe, it places a capacity of

approximately 1.3 μfd across the circuit under test. Total input impedance at low frequencies for ac measurements is 10 megohms shunted by this capacity.

The 410A employs a high impedance dc voltmeter having a special circuit developed by *-hp-* engineers. Its outstanding feature is low drift and maintenance of calibration over long periods of time. Only one zero adjustment is necessary for all voltage ranges, and once set it rarely needs readjustment. This circuit permits the use of a 1 ma meter movement which together with certain features of the circuit itself makes it impossible to damage the meter by overloads. Input impedance for dc measurements is 100 megohms for all ranges.

USES

The versatility of the 410A is so great that the number of uses to which it may be put is almost endless. As an ohmmeter it will accurately measure resistance over a much wider range than is ever ordinarily encountered. As a dc voltmeter, its extremely high input impedance permits its use on almost any equipment without any appreciable loading of the circuit.

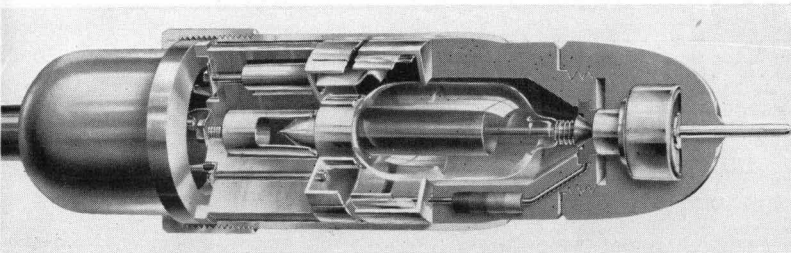


Figure 1. Construction details of new *-hp-* diode probe

As an ac voltmeter, its combination of high input impedance with great frequency range sets altogether new standards of performance. The probe can be inserted in almost any audio, supersonic, radio, or VHF amplifier without detectable loading of the circuit. It can be used to measure antenna and transmission-line voltage, current, and power with as much ease and convenience as if the circuits carried dc. Special adaptors can be supplied for use with the probe to connect to standard transmission lines.

Finally, the fact that all these functions are combined in one instrument means that where previously a whole battery of equipment might be required to test a given piece of apparatus, the 410A, in one small, convenient, and highly portable instrument, does the whole job. Leads are provided for all functions so that to change from one to another it is necessary only to throw a switch.

SPECIFICATIONS

Ranges: 1 to 300 volts in 6 ranges full scale: 1, 3, 10, 30, 100, and 300 volts ac or dc and 0-1000 volt range dc. Resistance 0.2 ohm to 500 megohms in seven ranges. Mid-scale reading of 10, 100, 1000, 10,000, 100,000 ohms, 1 megohm, and 10 megohms.

Accuracy: $\pm 3\%$ of full scale on all ranges on sinusoidal ac voltages and on dc voltages. The ac portion of the instrument is a peak-reading device, calibrated in rms volts.

Frequency Response: Frequency response is flat within ± 1 db up to 700 mc and drops off less than 1 db at 20 cps. Probe resonant frequency is about 2000 mc, and an indication can be obtained up to 3000 mc. See Fig. 2.

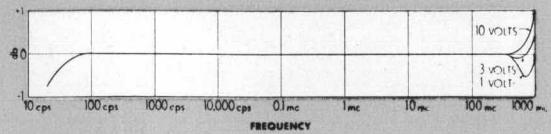


Figure 2. Frequency response

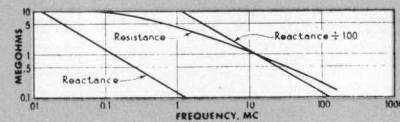


Figure 3. Input characteristics

Input Impedance: Input capacity is 1.3 μfd ; input resistance is 10 megohms at low frequencies. At high frequencies resistance drops off due to dielectric losses. (See Fig. 3.) Dc input resistance is 100 megohms for all ranges.

Probe: The probe is approximately 1" diameter and 4 1/2" long. It is equipped with a ground clip, and the connector may be soldered to the point under test. For operation at lower frequencies the probe can be mounted in the storage compartment and connections made to binding posts on the panel. Adapting connectors are available to measure voltages in coaxial transmission lines.

Power Supply: 115 volts, 50/60 cycles, 40 watts. Two 1 1/2 volt flashlight cells provide ohmmeter circuit voltage.

Mounting: Gray panel. Wrinkle gray finished metal case. Size 12 1/8" x 7 5/8" x 6 1/4".

Net Weight: 16 pounds. Shipping Weight: 23 pounds.

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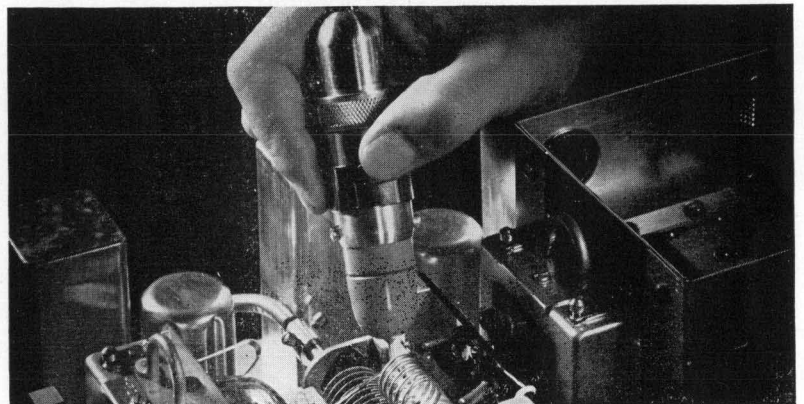
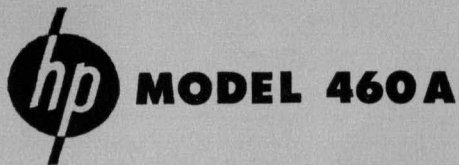
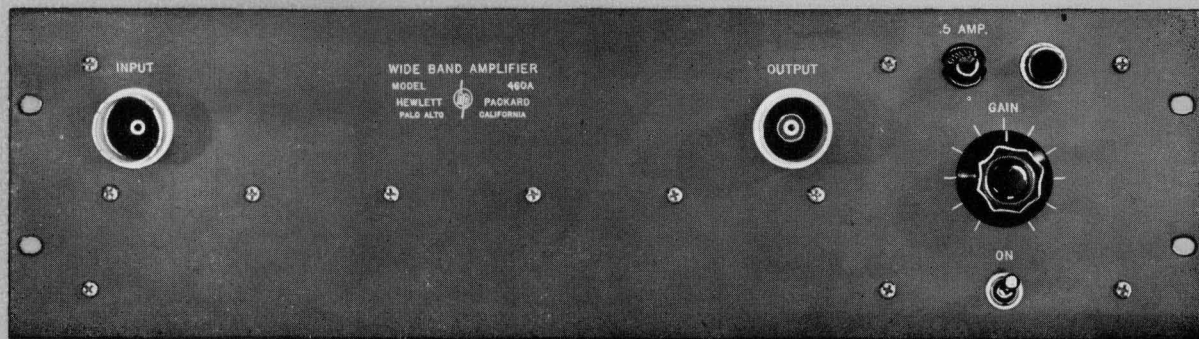


Figure 4. Probe is compact for greater ease in reaching components



WIDE BAND AMPLIFIER



ADVANTAGES

- True amplification of very short pulses
- Rise time .0026 μ sec
- No ringing or overshoot
- Response matches Gaussian curve
- 20 db gain; can be cascaded
- Increases VTVM sensitivity 10 times
- Flat response to 200 mc

USES

- Amplify extremely short pulses
- Increase voltmeter sensitivity
- Accurately measure small outputs
- General laboratory amplifier
- Increase oscilloscope gain
- For TV, UHF or nuclear work

SETTING A NEW STANDARD FOR FAITHFUL PULSE AMPLIFICATION

THIS new *hp*-460A Wide Band Amplifier is the first instrument of its kind to offer you *faithful amplification* of extremely short pulses without objectionable ringing or overshoot. The rise time of the amplifier itself is only .0026 microseconds; and the high frequency response matches the Gaussian curve (established ideal of pulse transmission) more closely than any other instrument offered.

OPERATION

The *hp*-460A is a new type of amplifier with a very wide transmission band (approximately 200 mc). It has two stages with five tubes in each stage. Tube grids are connected along one transmission line to form the input circuit. Tube plates are connected along a second transmission line, forming the output circuit. A wave, travelling along the input line, excites the grids in succession; and half of the corresponding wave (generated in the plate circuit) travels down the plate line toward the output. This wave is reinforced at each successive plate.

The part of the wave in the plate line which travels in the reverse direction is absorbed by a termination at the opposite end of the line. By the time the wave in the plate line reaches the output, it has been amplified by about 10 db. The second stage of the amplifier also increases the gain by approximately

10 db, making a total approximate gain of 20 db for the unit. Several amplifiers can be cascaded to achieve a stable, flat gain up to 100 db.

TRUE AMPLIFICATION

The precise accuracy with which the new *-hp-* 460A amplifies very short pulses can be seen in Figure 1. The top view shows a .01 microsecond pulse applied direct to the plates of a 5XP11A cathode ray tube. At bottom in Figure 1, the same pulse after passing through the *-hp-* 460A. Note the very short rise time (less than .003 μ sec) and the complete absence of ringing or overshoot.

The response of the new *-hp-* 460A is shown in Figure 2. Note how closely the curve of the *-hp-* 460A follows the Gaussian ideal, even to a point beyond 200 mc. Figure 2 also shows graphically how this new *-hp-* instrument can be combined with the *-hp-* 410A Vacuum Tube Voltmeter to increase the voltmeter's sensitivity up to 10 times. In this combination, accurate readings of voltages as small as .01 volts from 200 kc to 200 mc are quickly and easily made.

200 OHM COAXIAL SYSTEM

Since the optimum interconnecting impedance level for this amplifier is 200 ohms, *-hp-* has designed a complete 200 ohm coaxial system of connectors and cables. These include leads with fittings, panel jacks and plugs, adapters to connect a 50 ohm Type N system into the amplifier; and a special adapter for use with the *-hp-* 410A Vacuum Tube Voltmeter. (See Specifications for details.)

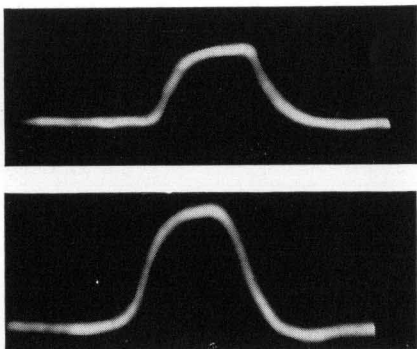
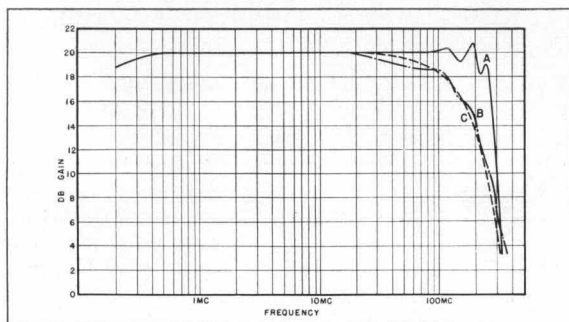


Fig. 1. Actual photo of oscillograph trace showing 0.01 μ sec pulse (above) applied direct to plates of cathode ray tube; and (below) same trace applied through *-hp-* 460A Amplifier.



★ Fig. 2. Typical response of *-hp-* 460A Amplifier working into (A) resistive load (B) using *-hp-* 410A Voltmeter (C) Gaussian curve.

★ ERRATA: In caption above—(A) should be (B)
(B) should be (A)

SPECIFICATIONS

Frequency Response: *High frequency*—closely matches Gaussian curve when operating into a 200 ohm resistive load. 3 db point is 140 mc.

Low frequency—when operating from a 200 ohm source and .01 blocking condenser, response off 3 db at 3 kc into an open circuit or succeeding amplifier. When operating into a 200 ohm load, off 3 db at 100 kc.

With *-hp-* 410A VTVM: ± 1 db, 200 kc to 200 mc.

Gain: Approximately 20 db into 200 ohm load. Gain control has range of 6 db. 5 amplifiers may be cascaded.

Output: Approx.: 8 v. peak open circuit.
Output impedance, 330 ohms.

Input Impedance: 200 ohms.

Noise Factor: Less than 10 db.

Delay Characteristics: Approx. .012 μ sec.

Rise Time: Approx. .0026 μ sec (10% to 90% amplitude).
No appreciable overshoot.

Mounting: Relay rack. 5 1/4" x 19", panel 6" deep.

Weight: 11 lbs. Shipping weight 22 lbs.

Power Supply: 115 v. 50/60 cps, self-contained.

ACCESSORIES

-hp- 46A-16A Patch Cord: 2-foot length, 200 ohm cable, with plugs, for interconnecting two *-hp-* 460A Amplifiers.

-hp- 46A-16B Patch Cord: Same as above but 6' long.

-hp- 46A-95A Panel Jack: Low capacitance jack designed for 200 ohm cables. Mates with other accessories. Requires 1 1/8" dia. mounting hole.

-hp- 46A-95B Cable Plug: Low capacitance plug designed for use with 200 ohm system. Mates with other accessories.

-hp- 812-52 Cable: 200 ohm cable available in lengths to your requirements.

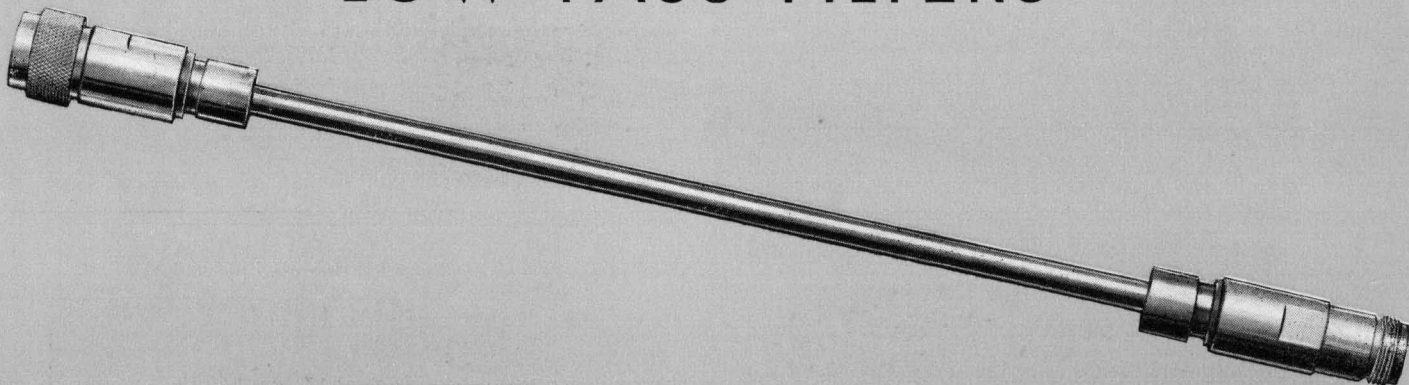
-hp- 46A-95C 50 ohm Adapter: Provides Type N connection for coupling 50 ohm transmission line to input of *-hp-* 460A Amplifier. Includes terminating resistor.

-hp- 46A-95D Adapter for -hp 410A Voltmeter Probe: Comprising bayonet type sleeve fitting directly to diode probe of *-hp-* 410A Voltmeter. Includes proper compensating LC components.

-hp- 46A-95E Connector Sleeve: For joining two *-hp-* 46A-95B Cable Plugs to interconnect two lengths of 200 ohm cable.

Data subject to change without notice.

LOW PASS FILTERS



SPECIFICATIONS

Cut-off Frequency:

Model	Cut-off
-hp- 360A	700 mc
-hp- 360B	1,200 mc
-hp- 360C	2,200 mc
-hp- 360D	4,100 mc

Insertion Loss: Not over 3 db throughout pass band.

Rejection: 50 db or more attenuation at 1.4 x (Cut-off Frequency).

Nominal Impedance: 50 ohms through pass band. Should be matched for optimum performance.

Fittings: 1 Type N Male (UG 21/U)
1 Type N Female (UG 23/U)

Data subject to change without notice.

ELIMINATE HARMONICS. TRANSMIT ENERGY AT A SINGLE MICROWAVE FREQUENCY

THE -hp- Model 360 Low Pass Filters are designed to facilitate microwave measurements by eliminating harmonics and permitting the transmission of energy at a single known frequency. Such isolation of a single frequency is of particular importance in the making of slotted line measurements, in checking filter characteristics, in determining receiver response and other applications where harmonics are objectionable.

NO SPURIOUS RESPONSES

The new -hp- filters consist of brass tubes fitted with a multi-section coaxial type filter. The ends are terminated in Type N fittings, one male and one female. Attenuation in the pass bands less than 3 db; and attenuation in the rejection band is more than 50 db. There are no spurious responses up to 3 times cutoff frequency.

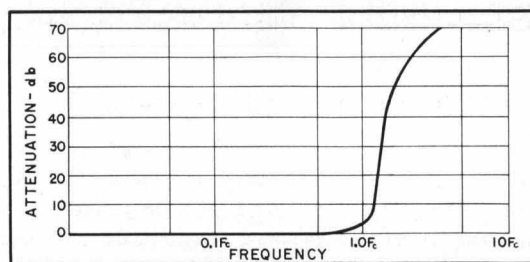
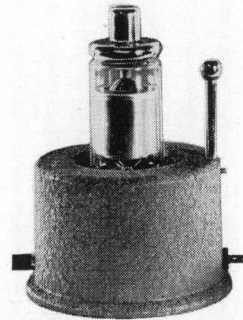


Fig. 1. Typical transmission and frequency cut-off characteristics.

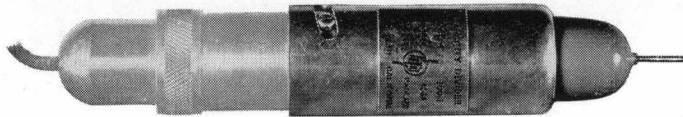
-hp- VOLTMETER ACCESSORIES

EXTEND the usefulness of your present -hp- voltmeters with these new precision built -hp- accessories. Custom-designed for use with -hp- Models 400A, 400C or 410A Vacuum Tube Voltmeters. Save time and work, simplify tedious jobs. Make fast, accurate measurements far beyond the original range of your instruments.



-hp- 452A Capacitive Voltage Divider

For -hp- 400A, 400C and 410A Voltmeters. Safely measure power, supersonic and dielectric heating voltages to 25 kv. Accuracy $\pm 3\%$. Frequency range, 25 cps to 20 mc. Division ratio 1,000:1. Input capacity 15 μf .



-hp- 453A Capacitive Voltage Divider

For -hp- 410A Voltmeter. Increases range so transmitter voltages can be measured quickly, easily. Accuracy $\pm 1\%$. Division ratio, 100:1. Input capacity approx. 2 μf . Max. voltage 2,000 v. For frequencies 10 kc and above.

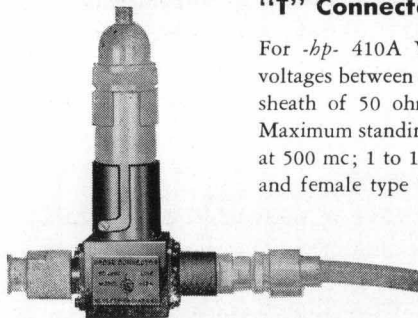


-hp- 458A Probe Coaxial "N" Connector

For -hp- 410A Voltmeter. Measures volts at open end of 50 ohm transmission line. (No terminating resistor.) Uses female Type "N" fitting.

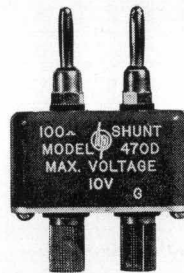
-hp- 455A Probe Coaxial "T" Connector

For -hp- 410A Voltmeter. Measures voltages between center conductor and sheath of 50 ohm transmission line. Maximum standing wave ratio 1 to 1.1 at 500 mc; 1 to 1.2 at 1,000 mc. Male and female type "N" fittings.

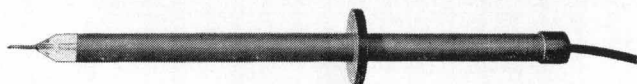


-hp- 470A-470F Shunt Resistors

For -hp- 400A or 400C Voltmeters, to measure currents as small as 1 μa full scale. Accuracy $\pm 1\%$ to 100 kc, $\pm 5\%$ to 2 mc. Max. power dissipation 1 watt.



Instrument	Value
-hp- 470A	0.1 Ω
-hp- 470B	1.0 Ω
-hp- 470C	10.0 Ω
-hp- 470D	100 Ω
-hp- 470E	600 Ω
-hp- 470F	1,000 Ω

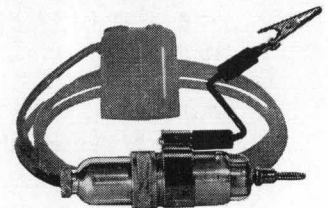


-hp- 459A DC Resistive Voltage Multiplier

For -hp- 410A Voltmeter. Gives maximum safety and convenience for measuring high voltages as in television receivers, etc. Accuracy $\pm 5\%$. Multiplication ratio 100:1. Input impedance 12,000 megohms. Max. voltage 30 kv. Max. current drain 2.5 microamperes.

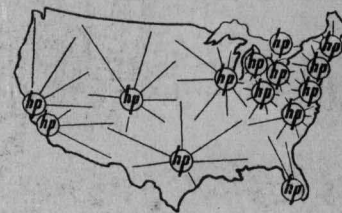
-hp- 454A Capacitive Voltage Divider

For -hp- 400C Voltmeters. Safely measure power, audio, supersonic and rf voltages. Accuracy $\pm 3\%$. Division ratio, 100:1. Input impedance 50 megohms, resistive shunted with 2.75 μf capacity. Max. voltage, 1,500 v.



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