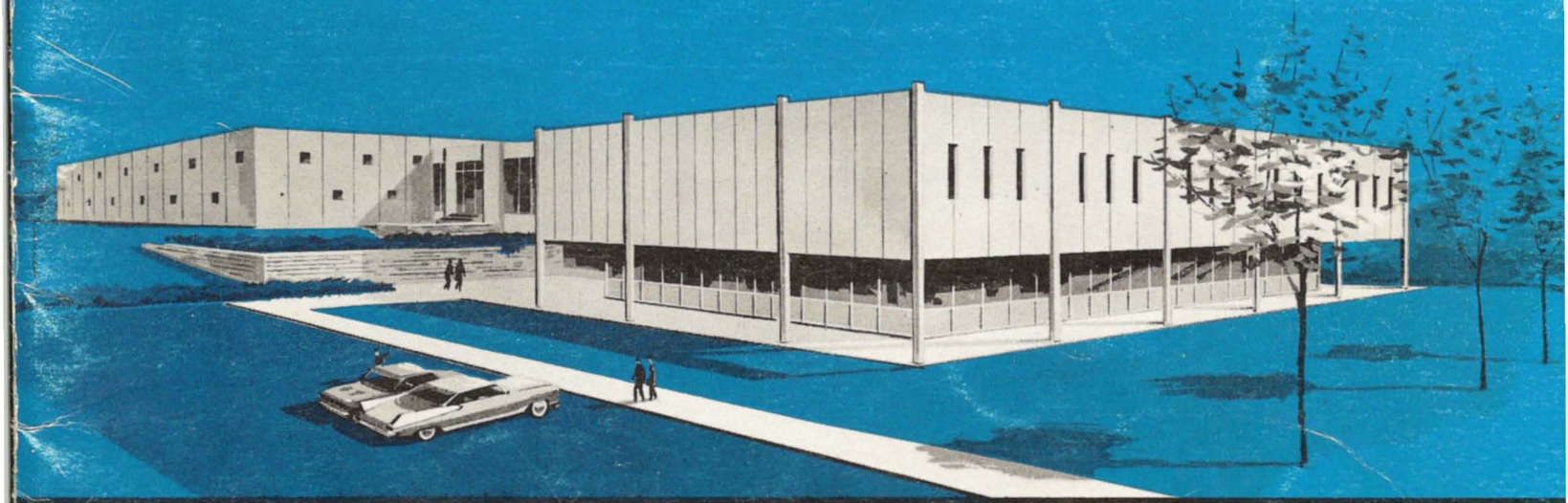
CATALOG 0 1963-64

PRECISION TEST EQUIPMENT



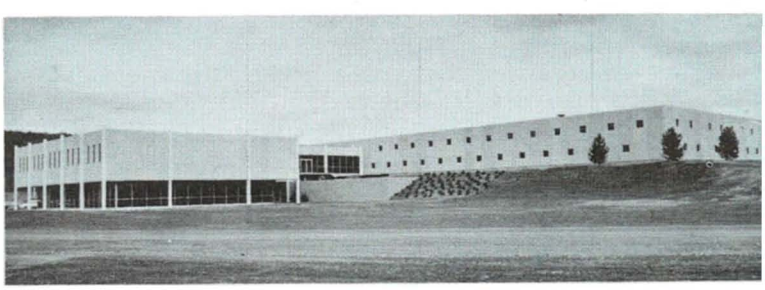
Precision Electronic Instruments Since 1934

BOONTON RADIO COMPANY

A Division of Hewlett-Packard Company

GREEN POND ROAD, ROCKAWAY, NEW JERSEY, U.S.A.
TELEPHONE: OAKWOOD 7-6400 (AREA CODE 201)
TWX: 201-627-3912 • CABLE: BOONRACO

The New BRC Plant...



Boonton Radio Company's new ultra-modern plant occupies a 70 acre site that will permit an ultimate expansion to five times present capacity. Complete research and development facilities, combined with fully-equipped engineering and production departments are geared to meet the increasingly critical requirements of the electronic industry.

BOONTON RADIO COMPANY
DIVISION OF HEWLETT-PACKARD COMPANY
Precision Electronic Instruments since 1934
GREEN POND ROAD, ROCKAWAY, NEW JERSEY
PHONE: 201-627-6400
TWX: 201-627-3912

November 1, 1963

To Our Customers:

Boonton Radio, a subsidiary of the Hewlett-Packard Company since 1959, assumed divisional status in 1962 to achieve greater flexibility and to further improve and expand services to our customers.

Since its founding in 1934, Boonton Radio has shared the basic -hp- objective - to make significant contributions to the specialized field of electronic instrumentation and has concentrated its efforts in the areas of impedance measurement, FM signal generators, and specialized instrumentation for the calibration of aircraft navigation systems. This catalog includes new improved designs of many basic instruments and also a unique instrument for the measurement of peak RF power.

To fulfill the varying needs of its many thousands of customers, Hewlett-Packard employs a large staff of factory-trained field engineers. These engineers, whose primary responsibility is to provide technical data and assistance to customers, are backed by customer service groups at each manufacturing division. They assure Boonton Radio customers of prompt, efficient service on the application, maintenance, and calibration of our products. A complete listing of these local -hp- field offices, located throughout the Free World, may be found on the back pages of this catalog.

Your comments and suggestions as to how we may better serve you are always welcome.

Sincerely,

William D. Myers

WDM/Mcl

William D. Myers
General Manager

A message to our customers...

Table of Contents

Ordering

Orders should specify the type number of the equipment, together with other identifying details, such as the powerline voltage and frequency from which equipment is to be operated.

Prices and Shipments

Prices are subject to change without notice. Price quotations and estimated shipping schedules are based on acceptance within 30 days.

Terms

Domestic Commercial Orders: Net 30 days, f.o.b. Rockaway, New Jersey. No additional charges are made for domestic packing. Unless credit has been established shipments will be made C.O.D. east of and C.I.A. west of the Mississippi River. Export Orders: Net cash in advance of shipment in U.S.A. funds or payment in the form of irrevocable sight letter of credit on the part of a prime New York bank.

Discounts

Our sales are made directly to customers. No trade, educational or quantity discounts.

Taxes

Federal, State, or local taxes (except Income Taxes), if any, upon the services, supplies and products or the production, manufacture, sale, or transportation thereof will be for account of BUYER, and if paid or required to be paid by SELLER, the amount thereof will be added to and become a part of the price payable by BUYER.

Specifications

We reserve the right to change specifications at any time without notice and without incurring any obligation to incorporate new features in instruments previously sold.

Modifications

Prices for operation on special powerline voltages and frequencies or other special modifications will be given on request.

Repairs

Instruments should be returned to us prepaid with papers indicating the nature of difficulties experienced. Instruments under warranty will be shipped prepaid to the customer by Boonton Radio Company.

New or repaired instruments damaged in transit should not be returned to the manufacturer without first obtaining specific handling instructions.

Replacement Parts or Spares

The type number and serial number of the instrument in which these are to be used should be supplied.

General Information

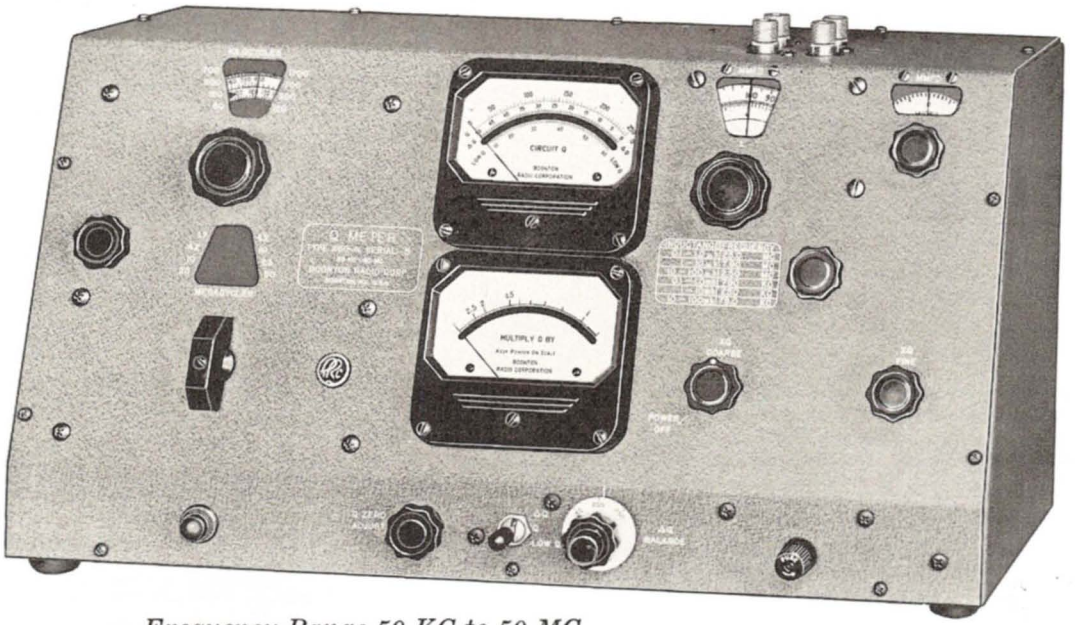
Warranty

We warrant each new instrument manufactured and sold by us to be free from defects in material, workmanship and design. Under this warranty, our obligation is limited to the original purchaser and to the extent of repairing or replacing any instrument or any part proved to be defective by our inspection within one year after the original sale. All instruments returned under this warranty should be sent to us with charges prepaid. After repairs have been completed we will return the instrument with all charges prepaid. This warranty shall not apply to tubes, or any instrument which shall have been repaired or altered outside of our plant so as, in our judgment, to affect its stability or reliability, or which has been subject to misuse, negligence or accident.

Patents

Many of our instruments are manufactured and sold under United States Letter Patents owned by the Boonton Radio Company and Radio Corporation of America.

Q METER TYPE 260-A



Frequency Range 50 KC to 50 MC

Description

The Q Meter was first designed and introduced in 1934 as a means of measuring the Q or "Figure of Merit" of coils. Improved models and broadened applications have kept pace with a rapidly growing industry, and the Q Meter is recognized as a flexible general purpose device with a large number of uses. The Q Meter consists of a self-contained, continuously variable, stable oscillator, whose controlled and measured output is applied in series with a series-tuned, resonant circuit. A vacuum tube volt-meter with high input impedance is connected across the internal variable capacitor portion of the tuned circuit to measure the reactive voltage in terms of circuit Q. The coil portion of the tuned circuit is connected externally and represents the unknown to be measured. By inserting low impedances in series with the coil or high impedances in parallel with the capacitor, the parameters of unknown circuits or components can be measured in terms of their effect on the circuit Q and resonant frequency. Because of the high quality components used in the manufacture of the Q Meter, coupled with a design engineered to minimize unwanted inherent residuals, the instrument is extremely sensitive.

Features

As a result of our studies, field information and suggestions received from our customers, we have incorporated in our present Q Meters those modifications and additions which it was felt would increase the usefulness of the instrument. Except where noted, the following features apply to both the 190-A and the 260-A:

1. "Lo Q" Scale. Direct reading expanded scale permits the measurement of Q down to 10.

2. "Δ Q Scale." Also direct reading expanded scale to permit the reading of very small changes in Q resulting from the variation of test circuit parameters.

3. Thermocouple Protection. The Type 260-A utilizes a rugged thermocouple operating at ½ rated power, and the output of the oscillator is adjusted at the factory to avoid overload. Both of these features guard against accidental thermocouple overload.

4. Power Supply Regulation. Through the use of an internal regulating transformer and an electronically regulated power supply, the operation of the instruments is not affected by normal power line voltage fluctuations.

5. Teflon insulation has been provided for the terminals of the 260-A, providing mechanical stability and low electrical loss. The oscillator output is con-

trolled by varying the screen grid voltage of the oscillator tube to obtain smooth operation as well as good waveshape. A 0.02 ohm annular insertion resistor is used to improve Q meter accuracy. Provision is made for the use of an external oscillator to supply the Q Meter through a matching transformer (Type 564-A) to provide operation below 50 kc. down to 1000 cycles per second. A scale is also provided to read inductance directly at selected frequencies. Paragraph 5 applies 260-A only.

6. Meter scales with mirror reflectors are used to eliminate error due to parallax.

7. The instrument has been designed to minimize internal residual inductance and resistance.

8. The thermocouple as well as all tubes can be replaced by the customer without returning the instrument to the factory.

Uses

Coils: Circuit Q is read directly from a parallax-free meter. From the measurements made on coils, the distributed capacity, effective inductance, and self-resonant frequency can be determined.

Capacitors: Capacitance from 0.1 pf to 100 μfd, and Q from 10 to 10,000 can be evaluated from measurements made on the Q Meter with and without the component connected. The self-resonant frequency of capacitors can be determined within the range of the instrument.

Resistors: The effective rf resistance, inductance or capacitance, and Q of resistors over a wide range can be determined.

IF and RF Transformers: Measurements can be made of effective impedance, Q, coefficient of coupling, mutual inductance, and frequency response.

Dielectrics: The Q Meters measure dielectric constant and dissipation factor, power factor, etc., of various grades of insulating materials and ceramics, including very low loss types. Samples with foils applied can be measured in a Hartshorn-Ward type of holder, or mounted directly on the Q Meter using a simple flat ground plate and connecting clip. Liquids held in a suitable container can also be measured.

Miscellaneous: The resistance, reactance, Q, and impedance of miscellaneous passive circuits, networks, filters, etc., can be determined with dc bias voltages applied if desired. Measurements can be made of antennas and coupling networks. Transmission line parameters necessary to compute characteristic impedance, attenuation, and velocity of propagation can be evaluated.

Specifications

Radio Frequency Characteristics

RF RANGE: Total Range: 50 Kc. to 50 Mc.
1 Kc. to 50 Kc.*
*With external oscillator

No. Bands: 8

Band Ranges:		
50 — 120 Kc.	1.7 — 4.2 Mc.
120 — 300 Kc.	4.2 — 10 Mc.
300 — 700 Kc.	10 — 23 Mc.
700 — 1700 Kc.	23 — 50 Mc.

RF ACCURACY: ±1% approximately.

RF CALIBRATION: Increments of approximately 1%.

Q Measurement Characteristics

Q RANGE: Total Range: 10 to 625
Low Range: 10 to 60
Δ Range: 0 to 50

Q ACCURACY: ±5%* 50 Kc. to 30 Mc.
±10%* 30 Mc. to 50 Mc.
*For circuit Q of 250 read directly on indicating meter.

Q CALIBRATION:
Main Scale: Increments of 5 from 40 to 250
Low Scale: Increments of 1 from 10 to 60
Δ Scale: Increments of 1 from 0 to 50
XQ Scale: Increments of 0.1 from 1 to 1.5
Increments of 0.5 from 1.5 to 2.5

Inductance Measurement Characteristics

L RANGE:
0.09 μh to 130 mh (effective inductance)*
*Direct reading at six specific frequencies.

L ACCURACY: ±3%*
*For resonating capacitance > 100 μμf and inductance > 5 μh.

Resonating Capacitor Characteristics

CAPACITOR RANGE:
Main: 30 to 460 μμf
Vernier: —3.0 to +3.0 μμf

CAPACITOR ACCURACY:
Main: ±1% or 1 μμf whichever is greater
Vernier: ±0.1 μμf

CAPACITOR CALIBRATION:
Main: 1 μμf increments 30 to 100 μμf
5 μμf increments 100 to 460 μμf
Vernier: 0.1 μμf increments

Accessories

FURNISHED: None

AVAILABLE: Type 103-A Inductors (Page 8).
Type 513/518A Q Standards (Page 9).
Type 564-A Coupling Unit (Page 8).

Tube Complement

1 — OA2	1 — 535-A
1 — OB2	1 — 5763
	1 — 6X4

Mechanical Characteristics

MOUNTING: Sloping front cabinet, for bench use.

FINISH: Gray wrinkle, engraved panel (Other finishes available on special order).

DIMENSIONS: Height: 12½" Width: 20" Depth: 8½"

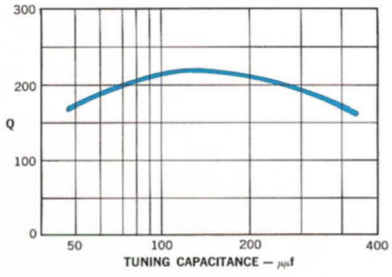
WEIGHT: Net: 40 lbs. Gross Export: 98 lbs.
Gross Domestic: 55 lbs. Legal Export: 50 lbs.

Power Requirements

260-A: 95-130 Volts, 60 Cps, 65 Watts
260-AP: 95-130 Volts, 50 Cps., 65 Watts

Price: 260-A: $990.00 260-AP: $990.00

INDUCTORS TYPE 103-A



Illustrating construction, also relationship between Q and tuning capacitance for typical inductor

These inductors are designed specifically for use in the Q circuit of the Type 160-A and 260-A Q-Meters, for measuring the radio-frequency characteristics of condensers, insulating materials, resistors, etc.

Each Type 103-A Inductor consists of a high Q coil mounted in a convenient shield and provided with plug terminals which plug directly into the coil terminals of the Q-Meter to facilitate the quick interchange of inductors for measurements at various frequencies.

Type	Inductance	Approx. resonant frequency for tuning capacitance of: 400μμf	100μμf	50μμf	Approx. Q	Capacitance μμf
103-A1	1 μh	8	16	20 mc	180	6
103-A2	2.5 μh	5	10	14 mc	200	6
103-A5	5 μh	3.5	7	10 mc	200	6
103-A11	10 μh	2.5	5	7 mc	200	6
103-A12	25 μh	1.5	3	4.5mc	200	6
103-A15	50 μh	1.1	2.2	3 mc	200	6
103-A21	100 μh	800	1600	2000 kc	200	6
103-A22	250 μh	500	1000	1400 kc	200	6
103-A25	500 μh	350	700	1000 kc	170	7
103-A31	1 mh	250	500	700 kc	170	7
103-A32	2.5 mh	150	300	450 kc	170	8
103-A35	5 mh	110	220	300 kc	160	8
103-A41	10 mh	80	160	200 kc	140	9
103-A42	25 mh	50	100	140 kc	110	9
		100 μμf		35 μμf		
103-A50	0.5 μh	20 mc		35 mc	225	5.5
103-A51	0.25 μh	30 mc		50 mc	225	5.5
103-A52	0.1 μh	45 mc		75 mc	225	3.5

Complete shielding eliminates errors in measurement due to coupling between the inductor and the test component and again with nearby objects, which coupling might alter the Q circuit constants during a measurement. Perfect shielding provides the desired stability.

The Q of the majority of the Type 103-A Inductors is in the region of 200, over the normal range of tuning capacitance of from 50 to 400 micro-microfarads. The approximate variation in Q with tuning capacitance of a typical 103-A Inductor is shown in the above curve. A few of the higher inductance inductors have a Q of less than 200. The approximate Q of each inductor is listed.

The true inductance of types A1 through A42 is adjusted to within 2 per cent of their nominal value. Tolerance on other coils is slightly wider. The total distributed capacitance varies as indicated.

For convenience in selecting the correct inductance, the approximate frequencies at which each inductor resonates with two or three different tuning capacitances is included in the list at the left.

Price: $17.75 each. Set of 16 Inductors for 260-A: $255.00 Set of 17 Inductors for 160-A: $270.00

COUPLING UNIT TYPE 564-A

The Coupling Transformer Unit Type 564-A is designed to couple the output of an external oscillator into the Q-Meter Type 260-A or 160-A for the purpose of extending the operation range of the Q-Meter to the low frequency region. By means of the Coupling Unit and an auxiliary oscillator, the Q-Meter may be operated down to a low frequency limit of 1 kilocycle. The oscillator should supply a variable voltage of 22 volts max. into an impedance of 500 ohms. **Price: $39.75**

Dimensions: Approx. 1¼" x 2½" x 3¾"

Q-STANDARDS

0.5 MC-1.5 MC
Type 513-A
1.5 MC-4.5 MC
Type 518-A3
5 MC-15 MC
Type 518-A2
15 MC-45 MC
Type 518-A1
50 KC-150 KC
Type 518-A5
150 KC-450 KC
Type 518-A4

Type 513-A

The Q-Standard Type 513-A is a shielded reference inductor which has accurately-measured and highly-stable inductance and Q characteristics. Specifically designed for use with Q-Meters Type 260-A and 160-A, the Q-Standard is particularly useful as a check on the overall operation and accuracy of these instruments, as well as for providing precisely-known supplementary Q-circuit inductance desirable for many impedance measurements by the parallel method. The Q-Standard consists of a specially-designed, high-Q coil of Litz wire, wound on a low-loss Steatite form. The coil is hermetically sealed inside a copper shield can which is filled with an inert gas under pressure. The desired Q-versus-frequency characteristics are provided by a carbon film resistor shunted across the coil. Two replaceable banana plug connectors mounted on the base serve to connect the unit to the Q-Meter circuit. The Q-Standard is supplied in a convenient wooden carrying and storage case. Each unit is individually calibrated and marked with its true inductance (L), distributed capacity (C_d), and effective Q (Q_e) and indicated Q (Q_i) at 0.5, 1.0 and 1.5 mc, respectively. Tolerance: L ±1% — C_d ±2% — Q_e ±3% measured at 73° F. Q_i is an average Q-Meter reading. Any instrument deviating more than ±7% from the marked value is not operating in accordance with original specifications.

Nominal Values for Type 513-A

L - 250 μh		Cd - 8 μμf	
	0.5 mc	1.0 mc	1.5 mc
Q_e	190	250	220
Q_i	183	234	200

Actual values of all these quantities are marked on the name plate of the Q-Standard.

With the unit in the Q-circuit, approximate resonant frequencies of 500, 1000 and 1500 kc are obtained with tuning capacitances of 400, 100 and 50μμf, respectively.

Temperature Coefficients:

L and C_d — Negligible

Q_e — freq.	%ΔQeff/°F
0.5 mc	—0.128
1.0	—0.083
1.5	—0.042

Overall Q-Standard Dimensions:
3" diam. x 4½" h. (approx.)

Net Weight (including case):
28 oz. (approx.)

Price: Type 513-A: $97.00 ea.

Types 518-A1 to 518-A5

Q Standards Types 518-A1 to 518-A5

Supplementing the Q-Standard Type 513-A, BRC has designed five additional Q-Standards Type 518-A. Similar in construction and performance to the 513-A, these Standards, in conjunction with the 513-A, provide frequency coverage from 50 KC to 50 MC — the entire range of Q-Meter Type 260-A. The units are useful as precision inductors and as a fast, convenient method for checking the overall operating accuracy of Q Meters.

Each model is supplied in a convenient wooden carrying and storage case and is individually calibrated and marked with its indicated Q and resonating capacitance (C) at each of three (3) discrete frequency points.

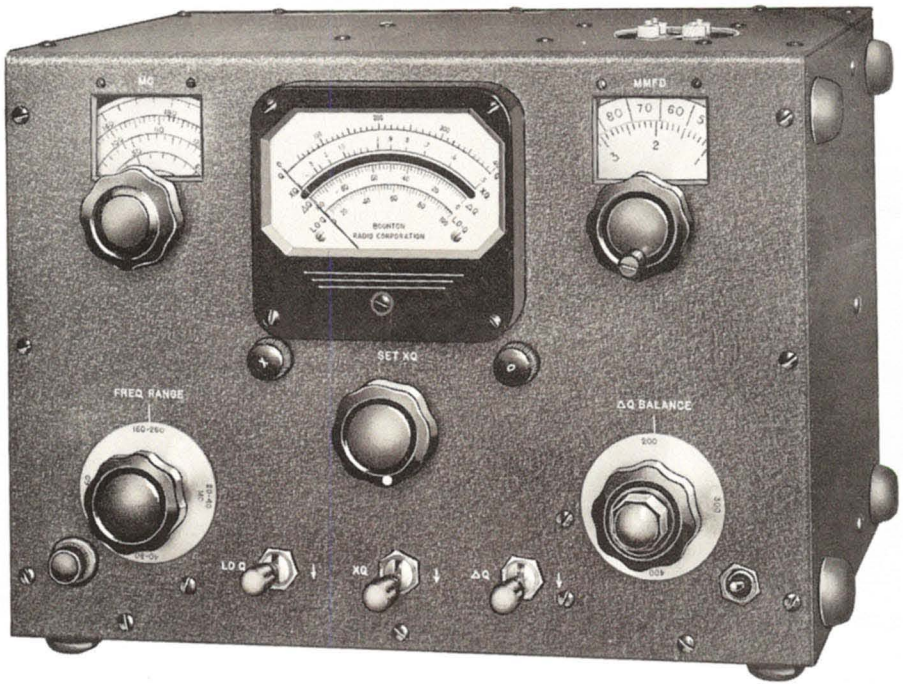
"Indicated Q" is an average Q-Meter reading — any instrument deviating from the marked value by more than ±8% from 50 KC to 30 MC, increasing to ±13% at 50 MC, is not operating in accordance with original specifications. Resonating capacitance accuracy: ±0.5% ±0.5 μμf.

	518-A1	518-A2	518-A3	518-A4	518-A5
INDUCTANCE	0.25 μh	2.5 μh	25 μh	2.5 mh	25 mh
Low Freq. Data:					
Frequency	15 MC	5 MC	1.5 MC	150 KC	50 KC
Resonating C	420 μμf	395 μμf	440 μμf	440 μμf	400 μμf
Indicated Q	175	195	175	170	90
Middle Freq. Data:					
Frequency	30 MC	10 MC	3 MC	300 KC	100 KC
Resonating C	100 μμf	95 μμf	105 μμf	100 μμf	85 μμf
Indicated Q	235	235	225	180	130
High Freq. Data:					
Frequency	45 MC	15 MC	4.5 MC	450 KC	150 KC
Resonating C	40 μμf	40 μμf	45 μμf	40 μμf	35 μμf
Indicated Q	225	205	230	135	125

(Table shows nominal values)

Price: Type 518-A: $97.00 ea.
Set of five Type 518-A and one 513-A: $525.00

Q METER TYPE 190-A



Frequency Range 20 to 260 MC

Description

The Q Meter Type 190-A finds applications similar to those described for the 260-A Q Meter, shown on page 6, but in the VHF range of frequencies. This instrument does not have a thermocouple, but employs a special coupling impedance to introduce voltage across the series-tuned, resonant circuit. This voltage, as well as the reactive voltage developed across the internal Q capacitor, is measured by two high impedance, low input capacitance vacuum tube voltmeters and indicated on a single front panel parallax-free meter.

This instrument also features an expanded scale to allow readings of low Q down to 5 and "delta Q" down to very small changes. The series tuned circuit includes the coupling impedance, a precision variable condenser of low loss and low inductance, and binding posts for attachment of an external inductance. Careful design has resulted in a low minimum capacitance in the Q measuring circuit, which permits measurement of coils designed to operate in low capacitance circuits. Internal residual impedance in the Q measuring circuit has been kept to a minimum so that correct measurement of higher values of Q can be made. The instrument has an internally regulated power supply which assures stability of readings under voltage source variation.

Specifications

Radio Frequency Characteristics

RF RANGE: Total Range: 20 to 260 Mc.
No. Bands: 4
Band Ranges: 20 — 40 Mc. 80 — 160 Mc.
40 — 80 Mc. 160 — 260 Mc.

RF ACCURACY: ±1%

RF CALIBRATION: Increments of approximately 1%.

Q Measurement Characteristics

Q RANGE: Total Range: 5 to 1200
Low Range: 10 to 100
Δ Range: 0 to 100

Q ACCURACY: ±7%* 20 to 100 Mc.
±15%* 100 to 260 Mc.
*For circuit Q of 400 read directly on indicating meter.

Q CALIBRATION
Main Scale: Increments of 10 from 50 to 400
Low Scale: Increments of 2 from 10 to 100
Δ Scale: Increments of 2 from 0 to 100
XQ Scale: Increments of 0.1 from 0.5 to 1.5
Increments of 0.5 from 1.5 to 3.0

Resonating Capacitor Characteristics

CAPACITOR RANGE: 7.5 to 100 μμf

CAPACITOR ACCURACY: ±0.2 μμf 7.5 to 20 μμf
±0.3 μμf 20 to 50 μμf
±0.5 μμf 50 to 100 μμf

CAPACITOR CALIBRATION: 0.1 μμf increments.

Accessories

FURNISHED: None

AVAILABLE: Type 590-A Inductors (See below).

Tube Complement

1 — OB2 1 — 538-A
1 — 537-A 2 — 5718
1 — 537-B

Physical Characteristics

MOUNTING: Cabinet for bench use.

FINISH: Gray wrinkle, engraved panel (other finishes available on special order).

DIMENSIONS: Height: 10½" Width: 13⅛" Depth: 9½"

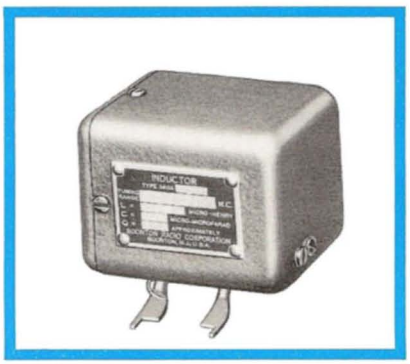
WEIGHT:
Net: 25 lbs. Gross Export: 55 lbs.
Gross Domestic: 32 lbs. Legal Export: 30 lbs.

Power Requirements

190-A: 95-130 Volts, 60 Cps, 55 Watts
190-AP: 95-130 Volts, 50 Cps., 55 Watts

Price: 190-A: $995.00 190-AP: $995.00

INDUCTORS TYPE 590-A



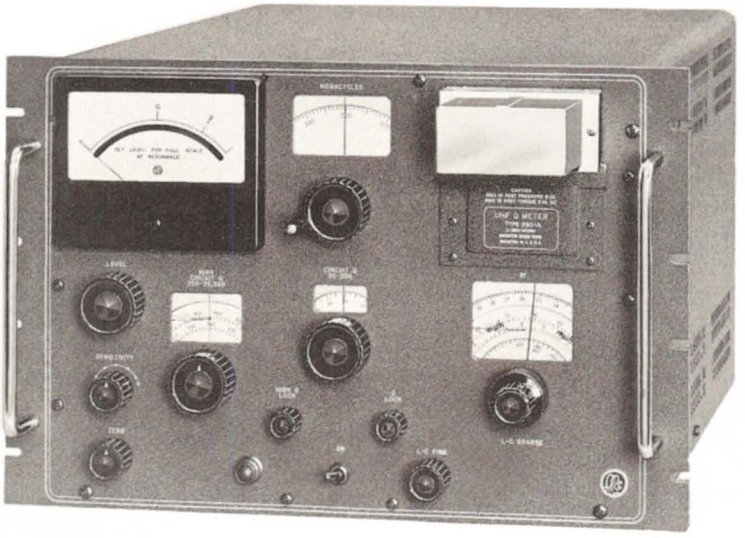
Price: $17.75 each.
$95.00 for complete set of six.

Inductors Type 590-A are designed specifically for use in the Q Circuit of the Q Meters Type 170-A and 190-A for measuring the radio-frequency characteristics of condensers, resistors, and insulating materials. They have general usefulness as reference coils and may also be used for periodic checks to indicate any considerable change in the performance of the Q Meters.

Each inductor Type 590-A consists of a high Q coil mounted in a shield and is provided with spade lugs for connection to the coil terminals of the Q Meters. The shield is connected to the lugs which connect to the Low Coil terminal in order to minimize any changes in characteristics caused by stray couplings to elements or to ground.

Type	Inductance μh	Capacitance μμf	Approximate Resonant Freq. mc.	Approximate Q	Approximate Distributed C μμf
590-A1	0.05	95.0 — 7.5	70 — 230	350	1.5
590-A2	0.1	95.0 — 7.5	50 — 160	320	1.7
590-A3	0.25	100 — 7.5	30 — 100	380	2.3
590-A4	0.5	80 — 7.5	25 — 70	360	2.3
590-A5	1.0	60.0 — 7.5	20 — 50	350	2.9
590-A6	2.5	15.0 — 8.0	20 — 30	330	2.9

UHF Q METER TYPE 280-A



Frequency Range
210 to 610 MC

Description

The UHF Q Meter Type 280-A is a completely self-contained instrument for measuring the RF characteristics of components and systems in the frequency range of from 210 to 610 MC. The instrument directly reads circuit Q over a total range from 10 to 25,000. Measurements may be made either by connection to the reference plane and resonating with the internal capacitor or, by coaxial connection to external self-resonant devices.

The instrument consists of a specially designed stable oscillator, whose output is either applied to a parallel resonant circuit, consisting of the internal resonating capacitor and a ground plane for connection of external devices, or is available directly for injection into external self-resonant circuits.

All Q measurements are made by measuring the percentage bandwidth of the resonance curve; the direct-reading Q dials mechanically compute the equation $Q = f/\Delta f$, where f = resonant frequency and Δf = bandwidth between the ½ power or 3db points on the resonance curve. Two Q reading dials, covering the ranges of 20 to 200 and 200 to 25,000 are provided. The low-Q dial is a gear driven vernier on the main oscillator frequency control, which rotates the oscillator capacitor rotor. The high-Q dial activates a specially designed torsion-spring system through a micrometer screw drive, which rotates the oscillator capacitor stator in precise, minute increments with negligible backlash.

The internal resonating capacitor is specially designed to provide direct readout of true UHF capacitance at the operating frequency. The capacitor is a translational, split-stator design with a constant resonant frequency (LC product), independent of capacitance setting over the range from 4 to 25 pf. Capacitance varies exponentially with dial rotation; constant-percentage correction for internal inductance as a function of frequency is automatically applied. An inductance computer is also included, which permits direct-readout of true UHF inductance over the range from 2.5 to 146 muh at the operating frequency.

A specially designed voltmeter, employing a photoconductive chopper with synchronous detection, is either connected across the internal resonating capacitor or an external diode probe and functions as a resonance indicator. Voltmeter sensitivities of 25 to 250 mv. RF are available for measurements employing the internal resonating capacitor, permitting small signal measurement of level-sensitive devices. Lumped-parameter devices may be directly mounted on the RF reference plane of the Q circuit; a removable shield is provided to minimize radiation loss. External self-resonant devices may be readily connected through coaxial BNC jacks on the rear of the cabinet. An electronically regulated power supply, employing both tubes and semi-conductors, furnishes all power requirements.

Features

1. The UHF Q Meter Type 280-A measures Q by measuring the actual percentage bandwidth of the resonance curve over the range 10 to 25,000.

2. The RF voltage level (at resonance) may be reduced to 25 mv. for the measurement of level-sensitive devices.

3. The Q and resonant frequency of external self-resonant devices may be readily measured.

4. The resonating capacitor is completely and automatically self-correcting and reads out the true UHF capacitance at the operating frequency in the plane of reference. A direct reading inductance scale is also provided.

5. The specially-designed connection terminals permit direct connection to a defined RF reference plane.

6. The RF voltage level (at resonance) is variable in five steps from 25 to 250 mv. and is independent of the Q of the component under test.

7. A specially designed diode voltmeter employing a photo-conductive chopper amplifier with synchronous detection permits extremely light coupling of the measuring diode to the circuit under test.

8. A specially-designed injection system, employing a precision waveguide-below-cutoff attenuator, provides a constant and negligible generator loss over the entire range.

Specifications

Radio Frequency Characteristics

RF RANGE: 210 to 610 Mc.
RF ACCURACY: ± 3%
RF CALIBRATION: Increments of approximately 1%
RF MONITOR OUTPUT: 10 mv. minimum into 50 ohms*
*At frequency monitoring jack.

Q Measurement Characteristics

Q RANGE: Total Range: 10 to 25,000*
High Range: 200 to 25,000*
Low Range: 10 to 200
*10 to approx. 2,000 employing internal resonating capacitor.
Q ACCURACY: ±20% of indicated Q.
Q CALIBRATION: High Q Scale: Increments of 1 — 5% up to 2,000
Low Q Scale: Increments of 3 — 5%

Inductance Measurement Characteristics

L RANGE: 2.5 to 146 muh*
*Actual range depends upon measuring frequency.
L ACCURACY: ±11 to 15%*
*Accuracy depends upon resonating capacitance.
L CALIBRATION: Increments of approx. 5%

Resonating Capacitor Characteristics

CAPACITOR RANGE: 4 to 25 $\mu\mu$f
CAPACITOR ACCURACY: ± (5% + 0.2 $\mu\mu$f)
CAPACITOR CALIBRATION: 0.05 $\mu\mu$f increments, 4-5 $\mu\mu$f
0.1 $\mu\mu$f increments, 5-15 $\mu\mu$f
0.2 $\mu\mu$f increments, 15-25 $\mu\mu$f

Measurement Voltage Level

RF LEVELS: 25, 40, 80, 140, 250 mv. nominal*.
*Across measuring terminals.

Accessories

FURNISHED: Type 530-A Component Shield
No. 307510 Mounting Screws (18)
No. 307584 Mounting Posts (6)
No. 307649 Mounting Clamp (3)
AVAILABLE: Type 580-A Probe Kit

Tube Complement

11 — 1N1763 Diode	2 — 2N554 Transistor	1 — 5751
2 — 1N536 Diode	1 — 31G-7H Diode	1 — 6080
1 — 1N82 Diode	2 — G31A-7H Diode	1 — 6CL6
1 — 12AT7	1 — 31G-12L Diode	1 — DET-22
3 — 12AX7	1 — 5651	1 — NE-2 Lamp

Physical Characteristics

MOUNTING: Cabinet for bench use: by removal of end covers, suitable for 19" rack mounting.
FINISH: Gray wrinkle, engraved panel (other finishes available on special order).
DIMENSIONS: Height: 12 7/32"; Width: 19"; Depth: 17"
WEIGHT: Net: 72 lbs. Gross Export: 140 lbs.
Gross Domestic: 90 lbs. Legal Export: 85 lbs.

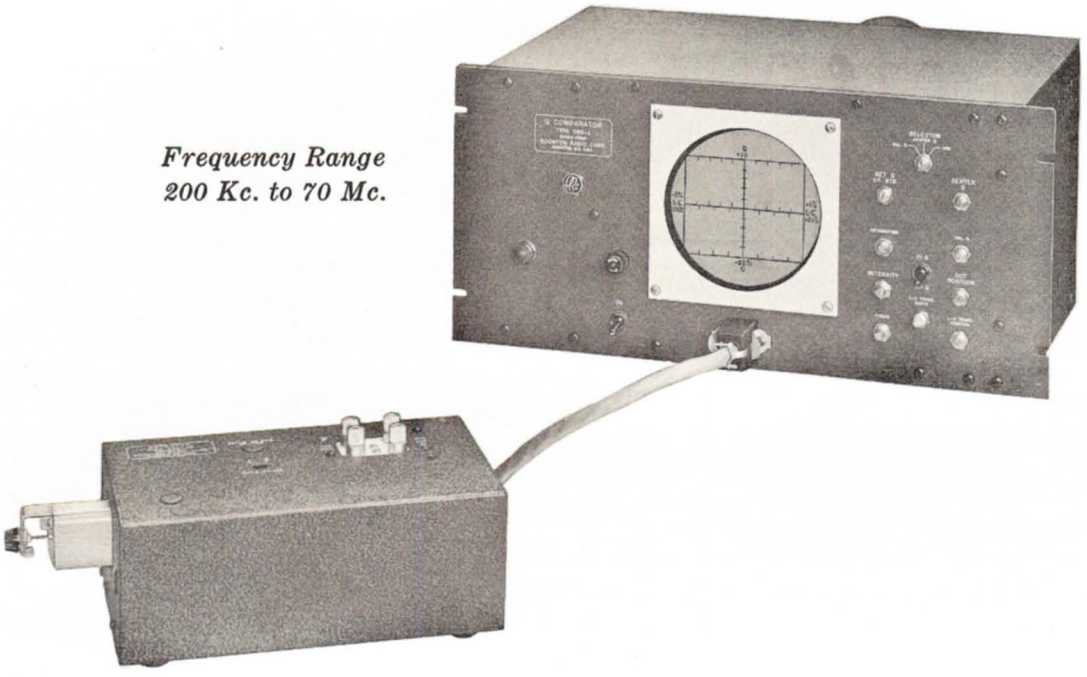
Power Requirements

280-A: 105-125/210-250 volts, 60 cps, 140 watts.
280-AP: 105-125/210-250 volts, 50 cps, 140 watts.

Price: 280-A: $2610.00 280-AP: $2610.00

Q COMPARATOR TYPE 265-A

Frequency Range
200 Kc. to 70 Mc.



The Q Comparator Type 265-A is designed for the rapid production inspection of coils, capacitors, and resistors for both Q and L-C. Through the use of plug-in Type 520-B Oscillator Inductors, measurements may be made over the frequency range from 200 Kc. to 70 Mc.

Description

The Q Comparator consists of two units; the detector unit which is designed for bench mounting in front of the operator and the indicator unit which is designed for either bench or standard rack mounting. The instrument consists essentially of a swept-frequency oscillator, Q meter-type measuring circuit with detector, vertical amplifier, differentiator, spot generator, horizontal amplifier with blanking circuit, cathode ray tube indicator and power supply.

In operation, the instrument is first adjusted and calibrated against a known standard component. Production components for inspection are then successively connected to the test terminals and the Q and L-C of the component under test is read directly on the CRT in % departure from the standard. The CRT presentation is a dot which reads directly against the vertical axis, calibrated in %Q, and the horizontal axis, calibrated in %L-C.

Specifications

Radio Frequency Characteristics

RF RANGE:

Total Range: 200 Kc. to 70 Mc.*
*Through use of plug-in Type 520-B Oscillator Inductors.

RF ACCURACY:
May be set to within ±0.5% with external standard.

Q Measurement Characteristics

Q RANGE: 30 to 500

% Q RANGE: ±25% of standard.

% Q ACCURACY: ±5% on 25% range.

% Q CALIBRATION: Increments of 5%.

Inductance Capacitance Measurement Characteristics

L RANGE: 0.15 μh to 15 mh*

C RANGE: 5 μμf to 0.01 μf*

R RANGE: 500Ω to 20 meg Ω*
*Actual range depends upon test frequency.

% L-C RANGE: ±5% or ±20% of standard, full scale.

% L-C ACCURACY:

Direct reading to ±20% of % L-C range*
*For L between 1μh and 15 mh and C between 500 μμf and 0.01 μf.

Comparison to ±10% of limit standards*

*For L between 0.15 μh and 15 mh and C between 5 μμf and 0.01 μf.

% L-C CALIBRATION: 1% increments on ±5% range.
5% increments on ±20% range.

Accessories

FURNISHED:

(1) Type 520-B Oscillator-Inductor. (Specify range).

AVAILABLE:

Type 103-A Inductors (Page 8).
Type 520-B Oscillator Inductors. (See below).

Tube Complement

3 — 0A2	2 — 6AU8A	6 — 12AX7
4 — IN55A	1 — 6C4	4 — M150 Rectifier
1 — 5ABP1	2 — 12AU7A	2 — NE2

Physical Characteristics

MOUNTING:

Indicator Unit — Cabinet for bench use, for 19″ rack mounting.
Oscillator-Detector Unit — Cabinet for bench mounting.

FINISH: Gray wrinkle, engraved panel.
(Other finishes available on special order.)

DIMENSIONS:

Indicator Unit	Oscillator-Detector Unit
Height: 9 11/32″	Height: 5 11/64″
Width: 19″	Width: 10 13/16″
Depth: 10¼″	Depth: 8⅛″

WEIGHT:

Net:	40 lbs.	Gross Export:	82 lbs.
Gross Domestic:	50 lbs.	Legal Export:	46 lbs.

Power Requirements

265-A: 105-125 volts, 60 cps., 115 watts.

Price: 265-A: $975.00* **265-AP: $975.00***

*Includes a choice of one (1) Type 520-B Oscillator-Inductor. Please specify required operating frequency range.

Features

The Q Comparator provides instantaneous and simultaneous readout of both Q and L-C; no tuning or adjustment is required for production testing.

The instrument is designed to provide an accurate, legible readout on the CRT screen eliminating operator measurement error.

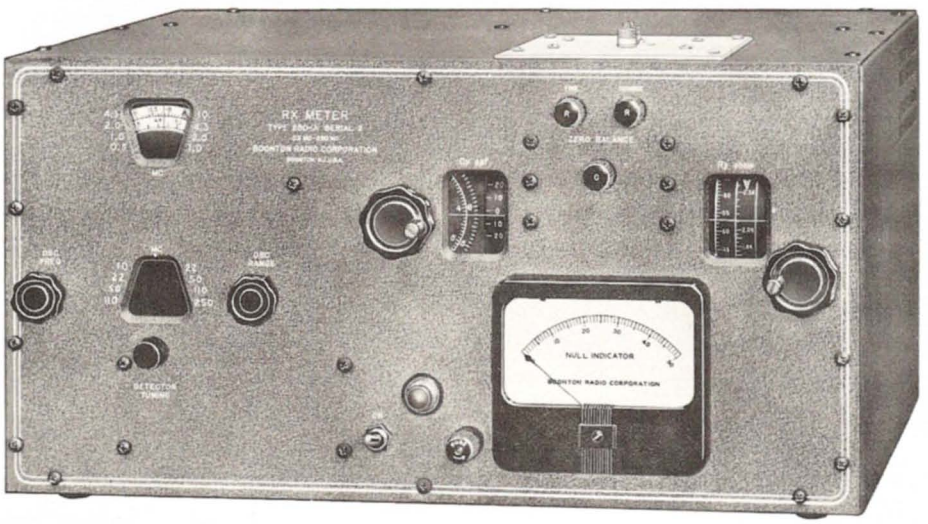
The instrument is extremely rapid and simple to use, saving valuable inspection time and minimizing operator training.

OSCILLATOR INDUCTORS TYPE 520-B

Oscillator Inductors Type 520-B are designed specifically for use with the Type 265-A Q Comparator. A total of eight (8) inductors is required to cover the entire operating frequency range.
Price: $28.50 each

Coil Number	Range Desig.	Frequency Range
520-B1	Range A	50-70 mc
520-B2	Range A	30-50 mc
520-B3	Range A	15-30 mc
520-B4	Range A	8-16 mc
520-B5	Range A	4- 8 mc
	Range B	2- 4 mc
520-B6	Range A	1- 2 mc
	Range B	.55- 1 mc
520-B7	Range B	300-550 kc
520-B8	Range B	200-300 kc

RX METER TYPE 250-A



Frequency Range
0.5 to 250 MC

Description

The RX Meter Type 250-A is a completely self-contained instrument for use in measuring the equivalent parallel resistance and capacitance or inductance of two terminal networks. The instrument's design includes an accurate, continuously tuned oscillator, high frequency bridge, amplifier-detector, and null indicating meter.

The oscillator, which is carefully designed to minimize temperature effects, is mounted inside a rigid casting in order to obtain a high degree of accuracy, stability, and low leakage. A long life subminiature triode is used, and the unit is carefully shielded to avoid any leakage of signal to the amplifier-detector by any path other than through the bridge. The high frequency bridge is also mounted inside a casting, and is specially designed to minimize the effects of coupling between arms. All calibrated variable elements of the bridge are special low inductance high quality variable capacitors driven by anti-backlash gears. Connections to the unknown impedance are arranged for almost zero lead length. Convenient, easily adjusted bridge balance controls are available.

The amplifier-detector null indicator has high, automatically controlled gain and a very low noise level. The power supply is internally regulated.

Features

The RX Meter is self-contained and requires no external units for its operation. This feature permits an integrated design and eliminates difficulties arising from leakage, hand effects, or improper matching which can occur when several different units must be interconnected in the laboratory. The instrument is always ready for use, and the assembly of several laboratory units is avoided.

The range of measurement of equivalent parallel resistance, capacitance or inductance over the frequency range (0.5 to 250 mc.) is as follows: 15 to 100,000 ohms for parallel resistance (0 to 15 ohms by indirect methods); 0.1 to 120 mmfd. for capacitance; and 0.001 microhenries to 100 millihenries for inductance. Resistance values are indicated directly, and no corrections are necessary over the entire frequency range. Small corrections at the higher frequencies, as indicated in the instruction book, are necessary in order to obtain the highest accuracy in the measurement of capacitance and inductance.

The capacitance dial is calibrated in 0.1 mmf. increments, and the resistance dial has good readability over a 28 inch scale length. The automatic gain control on the null indicator avoids meter damage and permits indication at all times of the correct direction for adjusting to balance. The low noise, high gain characteristics of the amplifier-detector result in high sensitivity near the balance point.

Uses

Measure equivalent effective parallel resistance and capacitance (or inductance) of components, networks, and miscellaneous circuits.

Resistors: Measures net effective resistance and reactance. Q can be calculated to a very low value.

Capacitors: Measures net capacitance and effective parallel resistance.

Inductors: Measures effective inductance and parallel resistance, self-resonant frequency, and distributed capacity.

Tubes and Semi-Conductors: Measurements can be made of the parameters of vacuum tubes, transistors, germanium diodes, etc., under selected conditions of dc bias and operating levels. The bridge can be arranged to effect measurements with a minimum rf level of 20 millivolts applied to test circuit.

Antennas: Antennas and antenna systems can be measured in terms of equivalent parallel resistance and reactance which can be readily converted to series equivalents or V.S.W.R.

Transmission Lines: Measures characteristic impedance, attenuation, and velocity of propagation of transmission lines.

Specifications

Radio Frequency Characteristics

RF RANGE:

Total Range: 500 Kc. to 250 Mc.
No. Bands: 8

Band Ranges:		
	.5 — 1 Mc.	9 — 21 Mc.
	1 — 2 Mc.	21 — 48 Mc.
	2 — 4 Mc.	48 — 110 Mc.
	4 — 9 Mc.	110 — 250 Mc.

RF ACCURACY: ± 1%.

RF CALIBRATION: Increments of approximately 1%.

Resistance Measurement Characteristics

RESISTANCE RANGE: 15 to 100,000 Ω.

RESISTANCE ACCURACY: $\pm\left[2+\frac{F^*}{200}+\frac{R^*}{5000}+\frac{Q^*}{20}\right]\% \pm 0.2\Omega$

*F = frequency (Mc) ; R = RX Meter R_p reading (Ω) ;

$Q = \omega CR \times 10^{-12}$, where C = RX Meter C_p reading ($\mu\mu$f)

RESISTANCE CALIBRATION: Increments of approximately 3% throughout most of range.

Capacitance Measurement Characteristics

CAPACITANCE RANGE: 0 to 20 $\mu\mu$f*

*May be extended through use of auxiliary coils.

CAPACITANCE ACCURACY:

$\pm\ (0.5 + 0.5\ F^2 * C * \times 10^{-5})\ \% \pm 0.15\ \mu\mu f$

*F = frequency (Mc) ; C = RX Meter C_p reading ($\mu\mu$f).

CAPACITOR CALIBRATION: 0.1 $\mu\mu$f increments.

Inductance Measurement Characteristics

INDUCTANCE RANGE: 0.001 μh to 100 mh*

*Actual range depends upon frequency; auxiliary resistors employed.

INDUCTANCE ACCURACY: Basic accuracy is capacitance accuracy given above.

Measurement Voltage Level

RF: 0.05 to 0.75 Volts approximately*, depending upon frequency.

*May be reduced to 20 mv by installation of auxiliary potentiometer.

DC: 0.* volts.

*External DC current up to 50 ma. may be passed through RX Meter terminals.

Accessories

FURNISHED: None.

AVAILABLE: Type 515-A Co-Ax Adapter Kit (See below).

Tube Complement

1 — OD3	1 — 542-A	2 — 6AG5
1 — 5Y3GT	2 — 5718	1 — 6H-6 Ballast

Physical Characteristics

MOUNTING: Cabinet for bench use.

FINISH: Gray wrinkle, engraved panel (other finishes available on special order).

DIMENSIONS: Height: 10″ Width: 20″ Depth: 12″

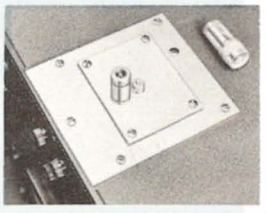
WEIGHT: Net: 40 lbs. Gross Export: 82 lbs.
Gross Domestic: 50 lbs. Legal Export: 46 lbs.

Power Requirements

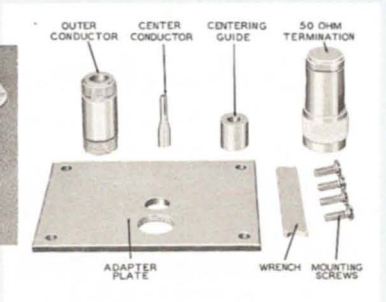
250-A : 105-125 volts, 50-60 cps., 60 watts

Price: TYPE 250-A: $1695.00

CO-AX ADAPTER KIT TYPE 515-A



Co-ax Adapter Kit Type 515-A adapts RX Meter for coaxial connections



Designed to permit connection to the RX Meter bridge circuit of any coaxial transmission line or fixture fitted with a type "N" male connector.

SPECIFICATIONS

A. ADAPTER

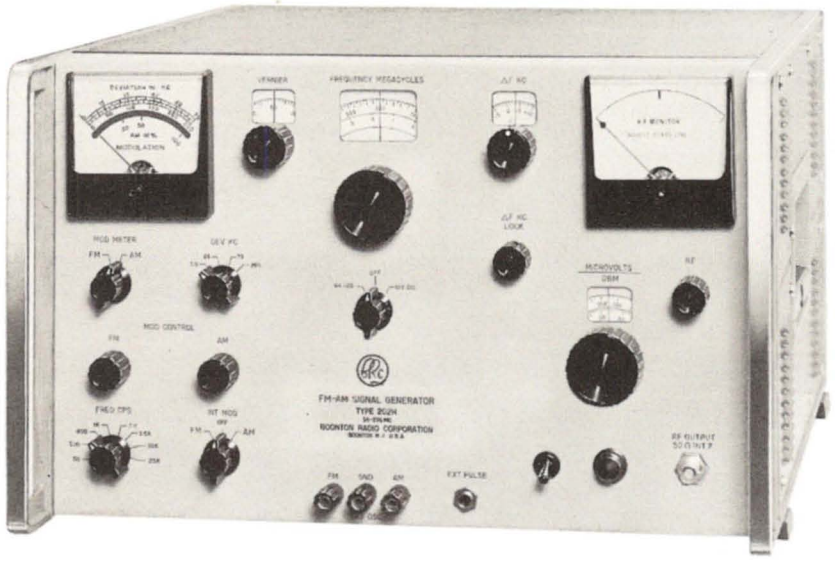
1. Connector: Type "N" female
2. Characteristic impedance: 50 ohms
3. Finish: Silver plate with rhodium flash

B. TERMINATION Type 516-A

1. Connector: Type "N" male
2. Characteristic impedance: 50 ohms
3. DC Resistance: 50 ohms, ±1%
4. Maximum parallel capacitance (mounted on adapter): ±0.2$\mu\mu$f
5. VSWR: Less than 1.10 up to 800 mc.
6. Maximum Power: ½ Watt

Price: 515-A ADAPTER KIT: $49.50

FM-AM SIGNAL GENERATOR TYPE 202-H



Frequency Range 54 Mc. to 216 Mc.

Description

The Type 202-H FM-AM Signal Generator covers the frequency range from 54 to 216 Mc. and is designed for the testing and calibration of FM receiving systems in the areas of broadcast FM, VHF, TV, mobile, and general communications. The generator consists of a three-stage RF unit, together with a modulating oscillator and power supply, all housed in a single cabinet which may be readily adapted for rack mounting.

The RF unit consists of a variable oscillator, a reactance tube modulator, a doubler, and an output stage. The modulator is specially designed for minimum distortion and operates in conjunction with the electronic vernier to provide incremental changes in RF output frequency as small as 1 Kc. The RF output is fed through a precision, waveguide-below-cutoff variable attenuator; automatic RF level set is incorporated which maintains "red line" on the RF monitor meter over the entire band. The entire RF unit is shock-mounted for minimum microphonism.

An internal audio oscillator provides a choice of eight frequencies which may be used for either FM or AM modulation. A modulation meter indicates either FM deviation or % AM and is calibrated for sine-wave modulation.

A completely solid-state power supply furnishes all necessary operation voltages and may be switched for inputs of either 105-125 or 210-250 volts, 50-60 cps.

Features

Type 202-H provides less than 1% T.H.D. at 75 Kc. deviation. A calibrated electronic tuning vernier permits relatively small calibrated changes in output frequency. The Unit is compatible for FM stereo.

Specifications

Radio Frequency Characteristics

RF RANGE:
Total Range: 54 to 216 Mc.
No. Bands: 2
Band Ranges: 54-108 Mc. 108-216 Mc.

RF ACCURACY:
Main Dial: ±0.5%.*
Electronic Vernier: ± (10% + 1 Kc.).*
*After one hour warm-up.

RF CALIBRATION:
Main Dial: Increments of 0.5 Mc. (54-108 Mc.). Increments of 1.0 Mc. (108-216 Mc.).
Mechanical Vernier: 2300 divisions through range.
Electronic Vernier: Increments of 1 Kc. over ±30 Kc. range*.
*Total range ±40 Kc.; provision for slipping dial to place "0" at a specific frequency.

RF STABILITY: <0.01% per hour*.
*After two hour warm-up.

RF OUTPUT:
Range: 0.1 μv to 0.2 volts*. *Across external 50 ohm load at panel jack.
Accuracy: ±10%, 0.1 μv to 50 K μv. ±20%, 50 K μv to 0.2 volts.
Auto Level Set: Holds RF monitor meter to "red line" over band.
Impedance: 50 ohms.
VSWR: < 1.2.
Spurious Output: All spurious RF output voltages are at least 30 db below desired fundamental.

RF LEAKAGE:
Sufficiently low to permit measurements at 0.1 μv.

Amplitude Modulation Characteristics

AM RANGE: Internal: 0-50%. External: 0-100%.
AM ACCURACY: ±10% of reading at 400 cps. at 30% and 50% AM.
AM CALIBRATION: 30, 50, 100%.
AM DISTORTION: < 5% at 30%. < 8% at 50%. < 20% at 100%.
AM FIDELITY: ±1 db, 30 cps. to 200 Kc.
EXTERNAL AM REQUIREMENTS: Approx. 60 volts RMS into 500 ohms for 100% AM.

Frequency Modulation Characteristics

FM DEVIATION RANGE: Internal: 0-250 Kc. in 4 ranges. External: 0-250 Kc. in 4 ranges.
FM DEVIATION ACCURACY: ±5% of full-scale*.
*For 400 cps. sine-wave.
FM CALIBRATION: 0—7.5 Kc. in increments of 0.5 Kc. 0—25 Kc. in increments of 1 Kc. 0—75 Kc. in increments of 5 Kc. 0—250 Kc. in increments of 10 Kc.
FM DISTORTION (At 400 cps. mod. freq.):
< 0.5% at 75 Kc. (100 Mc.).
< 1% at 75 Kc. (54-216 Mc.).
< 10% at 250 Kc. (54-216 Mc.).
FM FIDELITY: ±1 db, 5 cps. to 200 Kc.
SIGNAL-TO-NOISE RATIO: > 60 db below 10 Kc.
MICROPHONISM: Extremely low; shock-mounted RF unit.
EXTERNAL FM REQUIREMENTS:
< 3 volts RMS into 2K ohms for 250 Kc. deviation.

Pulse Modulation Characteristics

PM SOURCE: External.
PM RISE TIME: < 0.25 μsec.
PM DECAY TIME: < 0.8 μsec.

Modulating Oscillator Characteristics

OSC FREQUENCY:		
	50 cps.	7.5 Kc.
	400 cps.	10 Kc.
	1000 cps.	15 Kc.
	3000 cps.	25 Kc.

OSC ACCURACY: ±5%.
OSC DISTORTION: < 0.5% at FM terminals.

Accessories

FURNISHED: Type 502-B Patching Cable.
AVAILABLE: Type 207-H Univerter (Page 20).
Type 501-B Output Cable (Page 42).
Type 504-A Adapter (Page 42).
Type 505-B Attenuator (Page 42).
Type 506-B Patching Cable (Page 42).
Type 507-B Adapter (Page 42).
Type 508-B Adapter (Page 43).
Type 509-B Attenuator (Page 43).
Type 510-B Attenuator (Page 43).
Type 514-B Output Cable (Page 43).
Type 517-B Output Cable (Page 43).
Type 523A-1 Adapter (Provides rear input/output connections).
Type 523A-2 Adapter (Provides rear input/output connections).

Tube Complement

TUBES	TRANSISTORS	DIODES
3 — 6688	1 — 2N1136	2 — 1N660
1 — 6AF4A	3 — 2N1379	2 — 1N1763
2 — 6AW8A	1 — 2N1533	4 — 1N1764
3 — 6AU6A		2 — 1N1581
1 — 6BK7A		1 — S1029
1 — 6AQ5A		
1 — 6DJ8		

Physical Characteristics

MOUNTING: Cabinet for bench use; readily adaptable for 19" rack mounting.
FINISH: Gray engraved panel; green cabinet. (Other finishes available on special order).
DIMENSIONS: Height: 10⅜" Width: 16¾" Depth: 18⅜"
WEIGHT:

Net:	45 lbs.	Gross Export:	100 lbs.
Gross Domestic:	60 lbs.	Legal Export:	55 lbs.

Power Requirements

202-H: 105-125/210-250 volts, 50-60 cps, 100 watts.

Price: 202-H: $1365.00

UNIVERTER TYPE 207-H

Frequency Range 100 Kc. to 55 Mc.

Features

- PROVIDES EXTENDED FREQUENCY COVERAGE FOR EITHER 202-H OR 202-J SIGNAL GENERATOR
- LOW NOISE OUTPUT FOR PRECISION RECEIVER MEASUREMENTS
- IMPROVED FREQUENCY STABILITY—0.001% (5 MINUTES)

Description

The Type 207-H Univerter, a frequency converter with unity gain, is designed for use with the Type 202-H FM-AM Signal Generator and the Type 202-J Telemetering Signal Generator to provide additional frequency coverage from 100 Kc. to 55 Mc., including commonly used intermediate frequencies.

The Univerter consists essentially of a semi-fixed frequency, 200 Mc. heterodyne oscillator, a wide band amplifier, and a self-contained regulated power supply. In operation, the internal heterodyne oscillator beats with the output signal of the 202-H (199.9 to 145 Mc.) or 202-J (200.1 to 255 Mc.) and the difference frequency is passed through the wide band amplifier to the output system.

The output frequency of the Univerter is easily determined by subtracting 200 Mc. from the frequency dial reading of the 202-J or subtracting the 202-H frequency dial reading from 200 Mc. In addition, a front panel incremental frequency control, calibrated in 5 Kc. increments provides continuous control over a ±300 Kc. range. External adjustments are provided for setting the overall gain of the in-

Specifications *(When used with Signal Generators Types 202-H & 202-J)*

Radio Frequency Characteristics

RF RANGE: 100 Kc. to 55 Mc.*
*With 199.9 to 145 Mc. Input from 202-H.
With 200.1 to 255 Mc. Input from 202-J.

RF CALIBRATION:
Incremental Range: ±300 Kc.
Incremental Calibration: Increments of 5 Kc.
Incremental Accuracy: ± (3% +1 Kc.).

RF STABILITY:
Short Term: <0.001% * (5 minutes).
Long Term: <0.005% * (1 hour).
Line Voltage: <400 cps/volt.
*After one hour warmup.

RF OUTPUT:

Range:
(A) 1μv to 0.1 volts* (X1).
(B) 0.01μv to 1 mv* (X.01).
(C) >1 volt** (High output).
*Across external 50 ohm load at panel jack.
**With 0.1 volt input and 300 ohm output load.

Accuracy:
(A) Reproduces output of 202-H or 202-J ±1 db.
(B) Reproduces output of 202-H or 202-J ±2 db.

Impedance:
(A) 50 ohm nominal.
(B) 50 ohm nominal.
(C) 300 ohm nominal.

Spurious Output: All spurious output voltages are better than 25 db* below desired output. Spurious output of 207-H alone consists of random noise and 200 Mc. local oscillator. At X.01 output, noise power essentially equivalent to 50 ohm resistor at room temperature.
*For input levels <0.05 volts.

Modulation Characteristics

RANGE: Duplicates FM and AM modulation of 202-H or 202-J.

DISTORTION:
FM: No appreciable distortion.
AM: No appreciable distortion for input levels <0.05 volts.

Accessories

FURNISHED: Type 524-A Patching Cable.
High Output Plug.

AVAILABLE: Type 501-B Output Cable (Page 42).
Type 502-B Patching Cable (Page 42).
Type 506-B Patching Cable (Page 42).
Type 514-B Output Cable (Page 43).

Tube Complement

1 — 6AF4A 2 — 6AK5 1 — 6ER5 1 — 6688

Physical Characteristics

MOUNTING: Cabinet for bench use; readily adaptable for 19" rack mounting.

FINISH: Gray engraved panel; green cabinet. (Other finishes available on special order).

DIMENSIONS: Height: 5 33/64" Width: 16¾" Depth: 18⅜"

WEIGHT:

Net:	26 lbs.	Gross Export:	68 lbs.
Gross Domestic:	38 lbs.	Legal Export:	43 lbs.

Power Requirements

207-H: 95-130 volts, 60 cps., 50 watts.
207-HP: 95-130/190-260 volts, 50 cps., 50 watts.

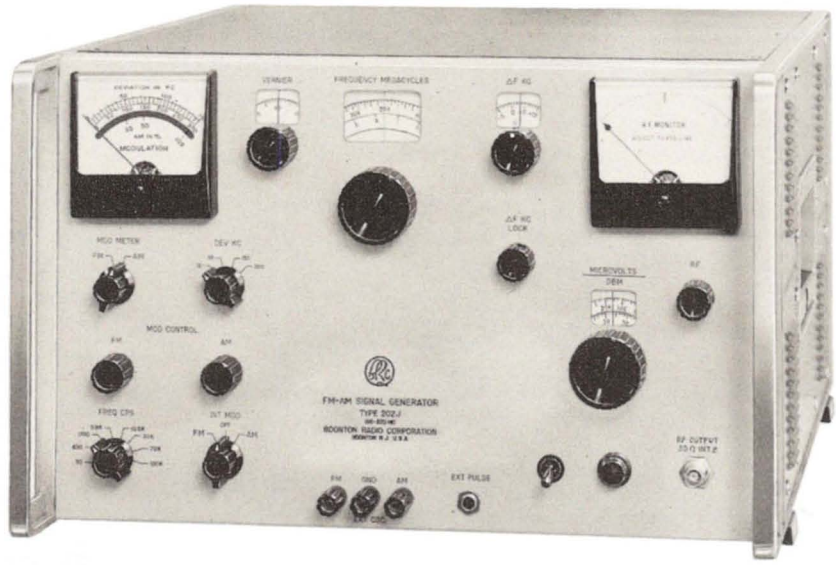
Price: 207-H: $525.00
Price: 207-HP: $525.00

strument to unity, and for adjusting the center frequency of the local oscillator to zero beat with the 200 Mc. dial calibration of the 202-H or 202-J Signal Generator.

To use the Univerter, it is only necessary to connect the RF output of the associated 202-H or 202-J Signal Generator to the input of the Univerter; three separate outputs are provided. The X1 output provides unity gain, under the control of the signal generator attenuator, and is suited for most general purpose applications. The X.01 output attenuates the input signal level as well as the random noise power output 40 db and is specifically provided for receiver measurements in the low microvolt region. An uncalibrated, high-level output provides a minimum of 1 volt with 0.1 volt input. The Univerter operates from a power source of 95-130 volts, 60 cps. (207-H) or 95-130/190-260 volts, 50 cps. (207-HP).

The instrument is housed in a modular cabinet which may be stacked with a 202-H or 202-J Signal Generator or, by use of the mounting brackets furnished, may be adapted for standard 19" rack mounting.

TELEMETERING SIGNAL GENERATOR TYPE 202-J



Frequency Range 195 Mc. to 270 Mc.

Description

The Type 202-J Telemetering Signal Generator covers the frequency range from 195 to 270 Mc. and is designed for the testing and calibration of FM telemetering receiving systems in the 215 to 260 Mc. band. The generator consists of a three-stage RF unit, together with a modulating oscillator and power supply, all housed in a single cabinet which may be readily adapted for rack mounting.

The RF unit consists of a variable oscillator, a reactance tube modulator, a doubler, and an output stage. The modulator is specially designed for maximum linearity and operates in conjunction with the electronic vernier to provide incremental changes in RF output frequency as small as 1 Kc. The RF output is fed through a precision, waveguide-below-cutoff variable attenuator; automatic RF level set is incorporated which maintains "red line" on the RF monitor meter over the entire band. The entire RF unit is shock-mounted for minimum microphonism.

An internal audio oscillator provides a choice of eight frequencies which may be used for either FM or AM modulation. A modulation meter indicates either FM deviation or % AM and is calibrated in terms of the peak-to-peak value of the modulating signal. The FM modulating system provides a bandwidth of 1 Mc.

A completely solid-state power supply furnishes all necessary operating voltages and may be switched for inputs of either 105-125 or 210-250 volts, 50-60 cps.

Features

The 202-J is carefully designed to simplify the testing and calibration of FM telemetering systems in that a choice of eight standard RDB audio modulating frequencies are available for internal modulation.

Simultaneous FM and AM modulation may be obtained for checking the performance of telemetering receivers in the presence of amplitude modulation.

The unit provides less than 1.5% FM non-linearity. An electronic tuning vernier permits relatively small calibrated changes in output frequency.

Specifications

Radio Frequency Characteristics

RF RANGE: 195-270 Mc.

RF ACCURACY:
Main Dial: ±0.5%*.
Electronic Vernier: ± (10% + 1 Kc.)*
*After one hour warm-up.

RF CALIBRATION:
Main Dial: Increments of 0.5 Mc.
Mechanical Vernier: 2200 divisions through range.
Electronic Vernier: Increments of 1 Kc. over ±30 Kc. range*.
*Total range ±40 Kc; provision for slipping dial to place "0" at a specific frequency.

RF STABILITY: < 0.02% per hour*.
*After two hour warm-up.

RF OUTPUT:
Range: 0.1 μv to 0.2 volts*.
*Across external 50 ohm load at panel jack.
Accuracy: ±10%, 0.1 μv to 50 K μv.
±20%, 50 K μv to 0.2 volts.
Auto Level Set: Holds RF monitor meter to "red line" over band.
Impedance: 50 ohms.
VSWR: <1.2
Spurious Output: All spurious RF output voltages are at least 25 db below desired fundamental.

RF LEAKAGE:
RF Leakage: Sufficiently low to permit measurements at 0.1 μv.

Amplitude Modulation Characteristics

AM RANGE: Internal: 0-50%. External: 0-100%.

AM ACCURACY: ±10% of reading at 400 cps. at 30% and 50% AM.

AM CALIBRATION: 30, 50, 100%.

AM DISTORTION: < 5% at 30%.
< 8% at 50%.
< 20% at 100%.

AM FIDELITY: ±1 db, 30 cps. to 200 Kc.

EXTERNAL AM REQUIREMENTS: Approx. 50 volts RMS into 7500 ohms for 100% AM.

Frequency Modulation Characteristics

FM DEVIATION RANGE: Internal: 0-300 Kc. in 4 ranges.
External: 0-300 Kc. in 4 ranges.

FM DEVIATION ACCURACY: ±5% of full-scale*.
*Indication proportional to peak-to-peak modulating waveform at 400 cps.

FM CALIBRATION: 0-15 Kc. in increments of 0.5 Kc.
0-30 Kc. in increments of 1 Kc.
0-150 Kc. in increments of 5 Kc.
0-300 Kc. in increments of 10 Kc.

FM NON-LINEARITY*: < 1.5% at 150 Kc. < 5% at 300 Kc.
*"Least squares" departure from straight line passing through origin.

FM FIDELITY: ±1 db, 5 cps. to 500 Kc.
±3 db, 3 cps. to 1 Mc.

SPURIOUS FM: Total RMS spurious FM from 60 cps. power source is at least 60 db below 150 Kc. (less than 150 cps.).

MICROPHONISM: Extremely low; shock-mounted RF unit.

EXTERNAL FM REQUIREMENTS:
< 1 volt RMS into 100K ohms for 150 Kc. deviation.

Pulse Modulation Characteristics

PM SOURCE: External.

PM RISE TIME: < 0.25 μsec.

PM FALL TIME: < 0.8 μsec.

Modulation Oscillator Characteristics

OSC FREQUENCY:

50 cps.	10.5 Kc.
400 cps.	30 Kc.
1730 cps.	70 Kc.
3900 cps.	100 Kc.

OSC ACCURACY: ±5%.

OSC DISTORTION: <0.5%.

Accessories

FURNISHED: Type 502-B Patching Cable (Page 42).

AVAILABLE: Type 207-H Univerter (Page 20).
Type 501-B Output Cable (Page 42).
Type 504-A Adapter (Page 42).
Type 505-B Attenuator (Page 42).
Type 506-B Patching Cable (Page 42).
Type 507-B Adapter (Page 42).
Type 508-B Adapter (Page 43).
Type 509-B Attenuator (Page 43).
Type 510-B Attenuator (Page 43).
Type 514-B Output Cable (Page 43).
Type 517-B Output Cable (Page 43).
Type 523A-1 Adapter (Provides rear input/output connections).
Type 523A-2 Adapter (Provides rear input/output connections).

Tube Complement

TUBES	TRANSISTORS	DIODES
3 — 6688	1 — 2N1136	2 — 1N660
1 — 6AF4A	3 — 2N1379	2 — 1N1763
1 — 6AW8A	1 — 2N1533	4 — 1N1764
3 — 6AU6A		2 — 1N1581
1 — 6BK7A		1 — S1029
1 — 6AQ5A		1 — 1N34A
1 — 12AU7A		
1 — 6DJ8		

Physical Characteristics

MOUNTING: Cabinet for bench use; readily adaptable for 19" rack mounting.

FINISH: Gray engraved panel; green cabinet.
(Other finishes available on special order).

DIMENSIONS: Height: 10⅜" Width: 16¾" Depth: 18⅜"

WEIGHT:

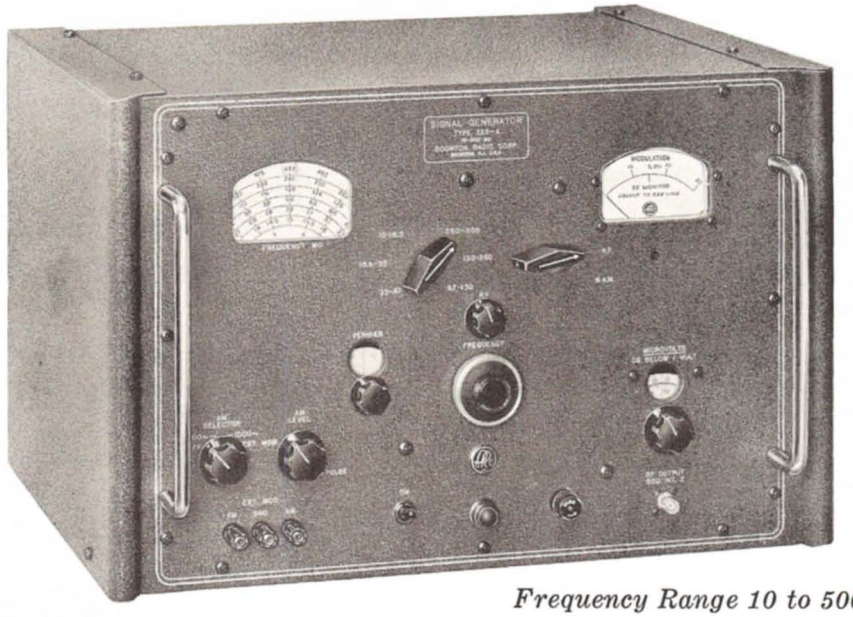
Net:	45 lbs.	Gross Export:	100 lbs.
Gross Domestic:	60 lbs.	Legal Export:	55 lbs.

Power Requirements

202-J: 105-125/210-250 volts, 50-60 cps, 100 watts.

Price: 202-J: $1475.00

SIGNAL GENERATOR TYPE 225-A



Frequency Range 10 to 500 Mc.

Description

The Signal Generator Type 225-A is designed for general purpose laboratory use in connection with the development and testing of receivers and associated circuits in the frequency range from 10 to 500 Mc.

The instrument incorporates an MOPA circuit in which the oscillator and power amplifier are mounted in separate rugged aluminum castings affording maximum isolation and extremely low leakage. A precision backlash-free gear train is incorporated for adjusting output frequency. A waveguide-below-cutoff piston attenuator provides a continuous adjustment of RF output level which is monitored on a "set to line" meter. The cabinet is designed for bench use; by simple removal of the cabinet end bells, the instrument may be mounted into a standard 19" rack.

AM modulation is available, indicated on a panel meter, from either the internal audio oscillator or an external source. FM and pulse modulation may be obtained from an external source.

Features

The 225-A is carefully designed for maximum RF stability. Short term (5 minute) stability is better than 0.001%; long term (1 hour) stability is better than 0.01%. The change in frequency for a 5 volt line change is less than 0.001%.

Through the use of a precision backlash-free gear train, RF settability is better than 0.05%.

As a result of maximum isolation between the oscillator and amplifier and careful circuit design, incidental FM at 30% AM is 0.001% or 1,000 cps, whichever is greater, throughout the entire frequency range.

FM modulation is available, from an external oscillator, in the range from 130 to 500 Mc.

Specifications

Radio Frequency Characteristics

RF RANGE:

Total Range: 10 to 500 Mc.
No. Bands: 6

Band Ranges:	10 — 18.5 Mc.	67 — 130 Mc.
	18.5 — 35 Mc.	130 — 250 Mc.
	35 — 67 Mc.	250 — 500 Mc.

RF ACCURACY: ±0.5% (after two hour warmup).

RF SETTABILITY: ±0.05%.

RF CALIBRATION:

Main Dial: Increments of approximately 1%.
Vernier: 1000 divisions through each range.

RF STABILITY:

Short Term: ±0.001%* (5 minutes)
Long Term: ±0.01%* (1 hour)
Line Voltage: ±0.001%* (5 volts)

*After two hour warmup—67-500 Mc.
and three hour warmup—10-67 Mc.

RF OUTPUT:

Range: 0.1 μv to 0.1 volts*.
*Across external 50 ohm load.
Accuracy: ±10% 0.1 to 50 K μv, 10 to 250 Mc.
±15% 0.1 to 50 K μv, 250 to 500 Mc.
±20% 0.05 to 0.1 v, 10 to 500 Mc.
Impedance: 50 ohms*.
*25 ohms at terminals of Type 501-B Output Cable.
VSWR: 1.2

RF LEAKAGE: Sufficiently low to permit measurements at 0.1 μv.

Amplitude Modulation Characteristics

AM RANGE: Internal: 0 to 30%
External: 0 to 30%

AM ACCURACY: ±10% at 30% AM, 10 to 250 Mc.
±15% at 30% AM, 250 to 500 Mc.

AM CALIBRATION: 10, 20, 30%

AM DISTORTION: 5% 10 to 250 Mc.
7% 250 to 500 Mc.

AM FIDELITY: ±1 db 40 cps. to 20 Kc.

INCIDENTAL FM: 0.001% or 1000 cps., whichever is greater, at 30% AM.

EXTERNAL AM REQUIREMENTS: Approximately 10 volts RMS into 4000 ohms for 30% AM.

Frequency Modulation Characteristics

FM RANGE:

External: 0 to between 5 Kc. and 60 Kc., depending upon frequency in the range 130 to 500 Mc.

FM CALIBRATION: Deviation sensitivity vs. frequency nomograph.

INCIDENTAL AM: 10%.

EXTERNAL FM REQUIREMENTS: Approximately 10 volts RMS into 1000 ohms.

Pulse Modulation Characteristics

PM SOURCE: External.

PM RISE TIME: 5 μsec 10 to 40 Mc.
3 μsec 40 to 80 Mc.
2 μsec 80 to 500 Mc.

PM OVERSHOOT: 10% 10 to 100 Mc.
25% 100 to 500 Mc.

EXTERNAL PM REQUIREMENTS: 10 volts peak negative pulse, 20 ma. peak short-circuit capability.

Modulating Oscillator Characteristics

OSC FREQUENCY: 400 and 1000 cps.

OSC ACCURACY: ±10%

Accessories

FURNISHED: Type 501-B Output Cable.
Type 502-B Patching Cable.

AVAILABLE: Type 504-A Adapter (Page 42).
Type 506-B Patching Cable (Page 42).
Type 508-B Adapter (Page 43).
Type 514-B Output Cable (Page 43).
Type 517-B Output Cable (Page 43).

Tube Complement

1 — OC3	2 — 6AU8A
2 — 2AF4A	1 — 12-3H Ballast
1 — 5Y3GT	1 — 545A (Selected 3S6/5)
1 — 6AN4	

Physical Characteristics

MOUNTING: Cabinet for bench use; by removal of end bells, suitable for 19" rack mounting.

FINISH: Gray wrinkle, engraved panel (other finishes available on special order).

DIMENSIONS: Height: 13" Width: 19⅛" Depth: 15"

WEIGHT:

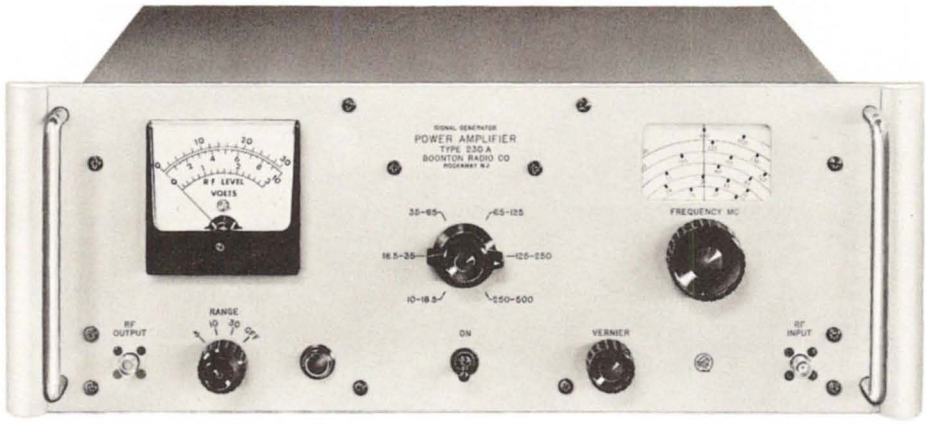
Net:	57 lbs.	Gross Export:	112 lbs.
Gross Domestic:	69 lbs.	Legal Export:	66 lbs.

Power Requirements

225-A: 105 — 125 volts, 60 cps., 80 watts.
225-AP: 105 — 125 volts, 50 cps., 80 watts.

Price: 225-A: $1050.00 225-AP: $1050.00

SIGNAL GENERATOR
POWER AMPLIFIER TYPE 230-A



Frequency Range 10 Mc. to 500 Mc.

Description

The new Signal Generator Power Amplifier Type 230-A is the ideal solution to your high RF power requirements including receiver testing, wattmeter calibration, antenna testing, filter and component testing, and attenuation measurements.

The amplifier may be conveniently driven with any conventional signal generator and is designed to reproduce AM, FM, and pulse modulation characteristics of the driving generator with minimum distortion.

The new Signal Generator Power Amplifier Type 230-A employs three tuned, cascaded stages of grounded-grid amplification fed from a regulated power supply. An RF output voltmeter is also included and the unit is designed for either standard 19" rack or cabinet mounting.

Applications

Areas of Application

The instrument has numerous applications in the entire communications spectrum, including such FCC frequency allocations as:

AMATEUR RADIO
TELEMETRY
R & D
NAVIGATIONAL
COMMERCIAL FM AND TV
FIXED PUBLIC
COMMUNICATIONS

Aviation	Scatter	Maritime	Industrial
Military	Relay	Mobile	Scientific

Typical Applications

HIGH LEVEL DRIVER

Bridges	Slotted Lines
Counters	Computers

RECEIVER TESTING

Adjacent Channel	Intermodulation	Cross Modulation
Desensitization	Image Rejection	IF Rejection

WATT AND VOLTMETER CALIBRATION
ANTENNA TESTING
ATTENUATION MEASUREMENTS
HIGH LEVEL TUNED VOLTMETER
DOWNSTAGE TESTING
TRANSISTORS AND DIODES
DISTRIBUTION AMPLIFIER
SCREEN ROOM TESTING
FILTER AND COMPONENT TESTING
HARMONIC AMPLIFIER

Specifications

Radio Frequency Characteristics

RF RANGE:

Total Range: 10 to 500 Mc.

No. Bands: 6

Band Ranges: 10-18.5 Mc. 65-125 Mc.
18.5-35 Mc. 125-250 Mc.
35-65 Mc. 250-500 Mc.

RF CALIBRATION:
Increments of approximately 10%, accurate to ± 10%.

RF OUTPUT:
Range: Up to 15 volts*.
*Across external 50 ohm load.

Calibration: 0.2 to 3 volts f.s.; increments of approx. 5%.
1.0 to 10 volts f.s.; increments of approx. 5%.
2.0 to 30 volts f.s.; increments of approx. 5%.
Accuracy: ±1.0 db of f.s. (10-250 Mc.).
±1.5 db of f.s. (250-500 Mc.).

Impedance: 50 ohms.

Leakage: Effective shielding is greater than 40 db.

RF BANDWIDTH:*
>700 Kc. (10-150 Mc.).
>1.4 Mc. (150-500 Mc.).
*Frequency interval between points 3 db down from max. response.

RF INPUT:

Level: ⩽0.316 volts* (30 db gain) (10-125 Mc.).
⩽0.446 volts* (27 db gain) (125-250 Mc.).
⩽0.630 volts* (24 db gain) (250-500 Mc.).
*For 10 volts output into 50 ohms.

Amplitude Modulation Characteristics

AM RANGE: Reproduces modulation of driving signal generator 0-100%*.

AM DISTORTION: <10% added to distortion of driving Signal Generator*.
*Up to 5 volt max. carrier output for up to 100% AM.

Frequency Modulation Characteristics

FM RANGE: Reproduces modulation of driving Signal Generator except as limited by the RF bandwidth.

INCIDENTAL AM: 10%* added to modulation of driving Signal Generator.
*At 150 Kc. deviation.

FM DISTORTION: Negligible distortion added to distortion of driving Signal Generator for deviations and modulation frequencies <150 Kc.

Accessories

FURNISHED: None.
AVAILABLE: Type 225-A Signal Generator (Page 24).

Tube Complement

3 — 2C39A	1 — OA2
1 — 5U4	1 — 6923/EA52
1 — 3TF4	1 — 12AU7
1 — 6AS7	3 — 1N1763
1 — 6AU6	1 — 1N54A

1 — Lamp, No. 47

Physical Characteristics

MOUNTING: Cabinet for bench use; by removal of extruded strips suitable for 19-inch rack mounting.

FINISH: Gray wrinkle, engraved panel.
(Other finishes available on special order.)

DIMENSIONS: Height: 7 3/16" Width: 19 1/2" Depth: 17 11/16".

WEIGHT:

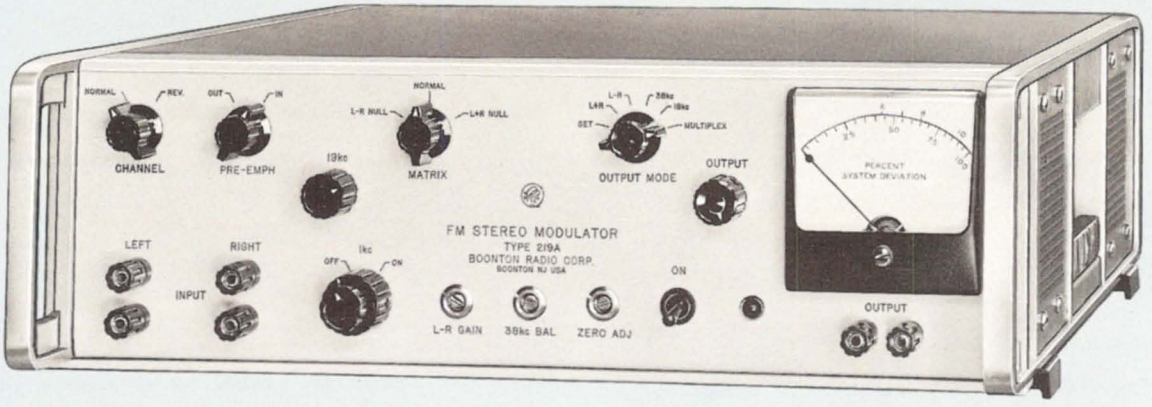
Net:	37 lbs.	Gross Export:	75 lbs.
Gross Domestic:	45 lbs.	Legal Export:	43 lbs.

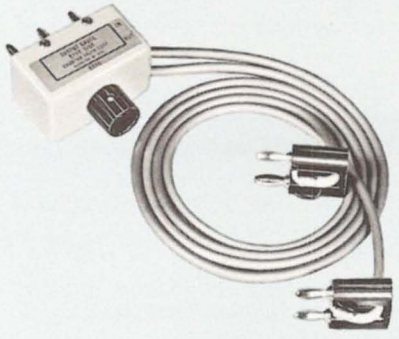
Power Requirements

230-A: 105-125/210-250 volts, 50-60 cps, 150 watts.

Price: 230-A: $1200.00

FM STEREO MODULATOR
TYPE 219-A





Frequency Range 50 cps. to 15 Kc.

Description

The FM Stereo Modulator Type 219-A is designed to provide a multiplex output signal in accordance with FCC Docket 13506 when fed with Left (L) and Right (R) audio stereo channel inputs and/or subsidiary communications FM sub-carriers (SCA). The output of the modulator may be switched to provide either (L+R), (L−R), 19 Kc. pilot carrier, 38 Kc. residual carrier or the complete multiplex signal which can then be used to modulate a suitable FM Signal Generator.

When used with the BRC Type 202-H, no external audio oscillator or other equipment is required, since the seven fixed 202-H modulating oscillator test frequencies may be fed directly into either the left (L) or right (R) input of the 219-A.

The Type 519-A Output Cable (available as an optional accessory) provides a convenient means of interconnecting the FM Stereo Modulator with the 202-H signal generator. Direct connection is provided between the output of the 219-A and the external FM modulation input of the 202-H.

A peak reading metering system, calibrated in % of system deviation, is provided for setting and monitoring the levels of the individual sub-carriers. The internal matrix may be switched from the normal condition to provide either (L+R) or (L−R) null for checking the matrix in the receiver under test. The modulator is completely self-contained and housed in a single cabinet which may be adapted for standard rack mounting.

Input Characteristics

LEFT (L) & RIGHT (R) INPUTS

FREQUENCY RANGE: 50 cps. to 15 Kc.

Level: 1.7 ±0.3 volts rms*.
*For 90% peak multiplex output with either a Left (L) or Right (R) input.

Impedance: 10 K ohms shunted with 30 $\mu\mu$f.

Preemphasis: 75 μsec preemphasis switchable in or out of circuit.

SUBSIDIARY COMMUNICATIONS (SCA) INPUT

FREQUENCY RANGE: 20-75 Kc.

Level: 1.0 volts rms*.
*For approx. 10% peak multiplex output.

Impedance: 10 K ohms.

Modulating Oscillator Characteristics

OSC FREQUENCY: 1 Kc.

OSC ACCURACY: ±10%.

OSC OUTPUT: Switchable into either (L) or (R) input.

OSC DISTORTION: <1%.

Output Characteristics

LEVEL: 0-7.5 volts peak (multiplex output).

LOAD IMPEDANCE: >1500 ohms shunted with <200 $\mu\mu$f.

RESIDUAL HUM & NOISE: >60db below 100% output.

CROSSTALK: * >40db below 100% output.
*(L − R) into (L + R).

METERING:
Range: 0-10%* (19 Kc. and 38 Kc. only).
0-100%*.
*Multiplex output; output adjustable 0-7.5 volts peak for 100% meter indication.

Calibration: 0-10% in increments of 1%, 6-10%, 0-100% in increments of 5%.

Accuracy: ±2% f.s.*.
*±1% relative accuracy at 45% for (L+R) and (L − R) and at ½ of 90% for multiplex signal.

MATRIX: Normal, L + R null, L − R null.

OUTPUT MODES: Switchable for L + R, L − R, 19 Kc. pilot carrier, 38 Kc. residual carrier or multiplex signal.

PILOT CARRIER: Frequency: 19 Kc.
Accuracy: ±0.01%.

Level: 0-30%*.
*Multiplex output.

MONAURAL (L + R): Output Level: 0-100%*.
*Multiplex output with either an L or R signal.

Fidelity: 50 cps. −15 Kc. ±1db*.
*±0.2db and ±1.5° relative to (L − R).

Distortion: <1%*.
*At 45% composite output.

DOUBLE SIDEBAND SUPPRESSED CARRIER (L-R)

FREQUENCY: 38 Kc.

FREQUENCY ACCURACY: ±0.01%.

CARRIER LEVEL: <0.5% (Composite output).

OUTPUT LEVEL: 0-100%*.
*Composite output with either an L or R signal.

FIDELITY: 50 cps. −15 Kc. ±1 db*.
*±0.2 db and ±1.5° relative to (L + R).

DISTORTION: <1%*.
*At 45% composite output.

SUBSIDIARY COMMUNICATIONS (SCA)

OUTPUT LEVEL: 0-20% (Composite output).

FIDELITY: 20-75 Kc. ±0.5 db.

DISTORTION: <1%*.
*At 10% composite output.

OSCILLOSCOPE SYNCHRONIZING SIGNAL

FREQUENCY: 19 Kc.

OUTPUT LEVEL: 0.5 volts rms nominal.

IMPEDANCE: 25 ohms nominal.

Accessories

FURNISHED: None.

AVAILABLE: Type 202-H Signal Generator (Page 18).
Type 207-H Univerter (Page 20).
Type 519-A Output Cable.

Tube Complement

1 — 6AU8A	4 — 12AU7A	4 — 1N1764
3 — 6DR7	2 — 12AT7	1 — 1N662
3 — 7199	2 — Ballast	4 — 1N34A
4 — 7543	1 — OG3	1 — 1.5M82Z10
		1 — 6X4

Physical Characteristics

MOUNTING: Cabinet for bench use; readily adaptable for 19" rack mounting.

FINISH: Gray engraved panel, green cabinet. (Other finishes available on special order).

DIMENSIONS: Height: 5$\frac{7}{32}$"; Width 16$\frac{3}{4}$"; Depth: 16$\frac{3}{8}$"

WEIGHT:

Net:	35 lbs.	Gross Export:	75 lbs.
Gross Domestic:	45 lbs.	Legal Export:	40 lbs.

Power Requirements

219-A: 105-125/210-250 volts, 50/60 cps, 130 watts.

Price: 219-A: $975.00

SWEEP SIGNAL GENERATOR TYPE 240-A

Frequency Range 4.5 to 120 MC

Description

The Sweep Signal Generator Type 240-A has been designed for use in the development and testing of radio frequency pass-band amplifiers over the frequency range of 4.5 to 120 mc. It consists of (1) a precision CW Signal Generator which may be amplitude modulated, (2) a Sweep Frequency Generator providing linear frequency deviation over the range from ±1% of center frequency to ±30% of center frequency or ± 15 mc. whichever is smaller.

Features

Features include a Marker System producing (a) crystal-referenced birdie-type markers, (b) adjustable pip interpolation markers, and (c) a composite signal containing the markers added to the response of the system under test. A precision output attenuator system operates on both CW and swept outputs. Provisions are included for sweeping from an external source of sweeping voltages and for providing to an oscilloscope the synchronized sweep voltage.

Uses

The Type 240-A Sweep Signal Generator finds use in (1) the determination of selectivity and sensitivity of test circuits, (2) the study of band-pass characteristics, (3) the adjustment of stagger tuned circuits, (4) the study of cable characteristics, (5) determination of linearity of FM discriminators, and (6) the study of crystal modes.

Specifications

Radio Frequency Characteristics

RF RANGE: Total Range: 4.5 to 120 Mc.
No. Bands: 5
Band Ranges: 4.5 — 9 Mc. 35 — 75 Mc.
9 — 18 Mc. 75 — 120 Mc.
18 — 35 Mc.

RF ACCURACY: ±1%* (after four hour warmup).
*May be standardized against internal crystal to ±0.005%.

RF CALIBRATION: Increments of approximately 1%.

RF OUTPUT:
Range: 1 μv to 0.3 volts* (sweep).
1 μv to 0.1 volts* (CW & AM).
*Across external 50 Ω load.
Accuracy: ±20% of full scale RF level meter reading.
Impedance: 50 Ω*
*25 Ω at terminals of Type 501-B Output Cable.

Swept Frequency Characteristics

SWEEP RANGE:
Internal: ±1% to ±15 Mc. or ±30% of center frequency, whichever is smaller.
External: ±1% to ±12 Mc. or ±24%* of center frequency, whichever is smaller, (20 to 200 cps. repetition rate).
*Decreases to ±0.75 Mc. or ±1.5% at 1000 cps. repetition rate.

SWEEP LINEARITY:
±10% over central ±80% of sweep excursion.
±20% over outer 20% of sweep excursion.

OUTPUT FLATNESS: Flat within <7%.

REPETITION RATE:
Internal: 20 to 70 cps.*
External: 20 to 1000 cps.
*Provision for synchronization with line frequency.

BLANKING: Internal blanking of RF output provides zero base line display during return cycle of internal sweep.

SWEEPING VOLTAGE OUTPUT: 20 volts P-P (triangular waveform) available at front panel posts.

Marker Characteristics

CRYSTAL BIRDIE MARKERS: Frequency: 0.1, 0.5, and 2.5 Mc.
Accuracy: ±0.005%

PIP MARKERS:
No. of Markers: 2
Position: Continuously adjustable to any position on sweep excursion.

INTERNAL MIXER:
Function: Adds markers to output of circuit under test. Markers do not pass through circuit under test.
Gain: Approximately 10*.
*For input level range 0.1 to 5 volts P-P.

Amplitude Modulation Characteristics

AM LEVEL: Approximately 30% from internal 1000 cps. oscillator.

Accessories

FURNISHED: Type 501-B Output Cable.

AVAILABLE: Type 203-B Univerter (Page 32).
Type 502-B Patching Cable (Page 42).
Type 506-B Patching Cable (Page 42).
Type 509-B Attenuator (Page 43).
Type 514-B Output Cable (Page 43).

Tube Complement

1 — OA3	1 — 6AL5	1 — 6N030 Relay
1 — 5U4G	2 — 6AQ5	1 — 6U8
1 — 545-A	2 — 6AS7G	1 — 12AT7
1 — 5651	1 — 6AU6	6 — 12AU7
2 — 5718	1 — 6BJ7	5 — 12AX7
1 — 6AK5	1 — 6BK7A	

Price: 240-A: $1995.00* **240-AP: $1995.00***

Physical Characteristics

MOUNTING: Cabinet for bench use (19" rack mount available on special order).

FINISH: Gray wrinkle, engraved panel (other finishes available on special order).

DIMENSIONS: Height: 18" Width: 14½" Depth: 19¼"

WEIGHT:

Net:	76 lbs.	Gross Export:	168 lbs.
Gross Domestic:	100 lbs.	Legal Export:	92 lbs.

Power Requirements

240-A: 105-125 volts, 60 cps., 280 watts.
240-AP: 105-125 volts, 50 cps., 280 watts.

*For rack mount add $25.00.

UNIVERTER TYPE 203-B

Frequency Range 0.1 Mc. to 25 Mc.

Description

The Type 203-B Univerter, a frequency converter accessory with unity gain, is designed for use with the Type 240-A Sweep Signal Generator to provide additional frequency coverage from 0.1 Mc. to 4.5 Mc. Since the 240-A Sweep Signal Generator covers a frequency range of 4.5 to 120 megacycles, the 203-B Univerter provides a convenient method of obtaining the additional coverage.

This instrument also enables the swept frequency and amplitude modulation features of the 240-A instrument, as well as the attenuator calibration feature of the 240-A, to be utilized at these lower frequencies without causing any appreciable distortion.

The Univerter requires that the frequency of the 240-A Sweep Signal Generator be used from 70 Mc. to 95 Mc. The output frequency of the Univerter is easily determined by subtracting 70 Mc. from the frequency dial reading of the 240-A Sweep Signal Generator. The heterodyne oscillator may be continuously varied over a narrow frequency range of ±250 Kc. by means of a front panel incremental frequency control calibrated at 10 Kc. intervals, thereby enabling selectivity measurements to be made.

Adjustments are provided for setting the overall gain of the instrument to unity, and for adjusting the center frequency of the local oscillator to zero beat with the 70 Mc. dial calibration of the 240-A Sweep Signal Generator.

Specifications

Radio Frequency Characteristics

RF RANGE: 100 Kc. to 25 Mc.*
*With 70 to 95 Mc. input from 240-A.

RF CALIBRATION: Incremental frequency control provides range of ±250 Kc. calibrated in increments of 10 Kc.

RF OUTPUT:

Range	
(A)	Calibrated: 1 μv to 0.1 volts*. *Across external 50 ohm load.
(B)	High Level: 2 volts approximately.
Accuracy	
(A)	Calibrated: Reproduces output of 240-A ±2db.
Impedance	
(A)	Calibrated: 50 Ω
(B)	High Level: 470 Ω approximately.

RF LEAKAGE: Sufficiently low to permit measurements at 0.1 μv.

Modulation Characteristics

RANGE: Duplicates AM and sweep modulation of 240-A.

DISTORTION:
FM: No appreciable distortion.
AM: No appreciable distortion for output levels <0.1 volts.

Accessories

FURNISHED: High Output Jack.

AVAILABLE: Type 501-B Output Cable (Page 42).
Type 502-B Patching Cable (Page 42).
Type 506-B Patching Cable (Page 42).
Type 509-B Attenuator (Page 43).
Type 514-B Output Cable (Page 43).

Tube Complement

1 — 4-25 Ballast	3 — 548A
1 — 547A	1 — 6X5

Physical Characteristics

MOUNTING: Cabinet for bench use.

FINISH: Gray wrinkle, engraved panel. (Other finishes available on special order).

DIMENSIONS: Height: 11½" Width: 7⅜" Depth: 10½"

WEIGHT:

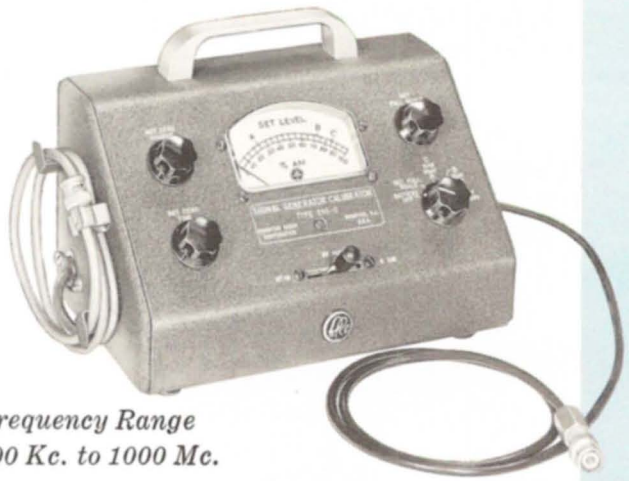
Net:	12 lbs.	Gross Export:	45 lbs.
Gross Domestic:	16 lbs.	Legal Export:	15 lbs.

Power Requirements

203-B: 105-125 volts, 50-60 cps, 50 watts.

Price: 203-B: $445.00

SIGNAL GENERATOR CALIBRATORS TYPES 245-C & D



Frequency Range
500 Kc. to 1000 Mc.

The Signal Generator Calibrators, Types 245-C and D were designed to provide a rapid and convenient means for checking and calibrating the RF output and AM modulation of signal generators operating in the frequency range from 500 Kc. to 1000 Mc. They will also provide a calibrated low-level RF output voltage for the precision testing of receiver sensitivity. The instrument consists of a precision fixed attenuator with an attenuation ratio of either 2,500:1 (245-C) or 25,000:1 (245-D), a transistorized metering circuit which monitors the RF input level to the attenuator, and a transistorized demodulator circuit which senses the %AM on the RF carrier. The metering circuit may be switched to directly read either the input or output RF voltage level.

Features

The 245-C/D features complete portability for "on the spot" calibration checks of signal generators in the laboratory, on the production line, or in the field. All necessary power is furnished by internal mercury batteries which essentially provide "shelf life" against the low drain from the completely transistorized circuits.

The instrument is extremely simple to use in that only two balance adjustments are required. All circuits are frequency compensated over the entire range, completely eliminating the need for correction curves.

The ability of instrument to accurately measure "both ends" of the signal generator attenuator permits a complete check of the output system for calibration accuracy, level, and leakage.

The direct-reading %AM scale permits rapid and accurate measurement of signal generator modulating systems.

Specifications

Radio Frequency Measurement Characteristics

RF RANGE: 500 Kc. to 1000 Mc.

RF VOLTAGE MEASUREMENT LEVELS:
Input: 0.025, 0.05, 0.1 volts.
Output: 5, 10, 20 μv. (245-C).
0.5, 1, 2 μv. (245-D).

RF VOLTAGE ACCURACY:
Input: ±10% 500 Kc. to 500 Mc.*
±15% 500 Mc. to 1000 Mc.*
*When supplied from a 50 ohm nominal source, with a VSWR <2.
Output: ±10% 500 Kc. to 500 Mc.*
±20% 500 Mc. to 1000 Mc.*
*Measured at the 245 output jack.

RF IMPEDANCE:
Input: 50 ohms.
Output: 50 ohms.*
*At output jack on instrument and at output connector of Type 517-B Output Cable.

RF VSWR:
Input: <1.3 500 Kc. to 500 Mc.
<1.6 500 Mc. to 1000 Mc.
Output: <1.05 500 Kc. to 100 Mc.*
<1.07 100 Mc. to 500 Mc.*
<1.1 500 Mc. to 1000 Mc.*
*At output connector of Type 517-B Output Cable.

Amplitude Modulation Measurement Characteristics

AM RANGE: 10 to 100%.

AM ACCURACY: ±10%* 30 cps. to 15 Kc. (Modulating freq.)
±15%* 20 cps. to 20 Kc. (Modulating freq.)

*Of full scale.

AM FREQUENCY RANGE: 20 cps. to 20 Kc.

RF INPUT REQUIREMENTS: 0.1 volts.

Accessories

FURNISHED: Type 517-B Output Cable.
AVAILABLE: None.

Tube Complement

2 — 1N34A Diode	2 — 2N109 Transistor
1 — 1N415B Diode	1 — 2N647 Transistor

Physical Characteristics

MOUNTING: Cabinet for bench use.

FINISH: Gray wrinkle, engraved panel (Other finishes available on special order).

DIMENSIONS: Height: 6½" Width: 9¾" Depth: 6"

WEIGHT:

Net: 5 lbs.	Gross Export: 25 lbs.
Gross Domestic: 7 lbs.	Legal Export: 6 lbs.

Power Requirements

245-C & D: No external requirements; all necessary power furnished by internal mercury batteries.

Price: 245-C: $460.00 245-D: $455.00

PEAK POWER CALIBRATOR
TYPE 8900-B

- MEASURES TRUE PEAK POWER ±0.6 db ABSOLUTE.
- MEASUREMENTS COMPLETELY INDEPENDENT OF REPETITION RATE AND PULSE WIDTH ($>0.25\ \mu$sec).
- READILY STANDARDIZED AGAINST EXTERNAL BOLOMETER OR CALORIMETER.
- INCORPORATES WIDE-BAND (7 Mc.) DETECTOR OUTPUT FOR PULSE MONITORING.

Frequency Range 50 to 2000 Mc.

Description

The need for accurate measurements of peak RF power of pulsed sources, while having existed for over a score of years, has prompted surprisingly little in the way of simple reliable commercial equipment for performing the task. Today with the increasing number of electronic systems such as radar, air navigation, telemetry, communications, command and control, television, radiosonde, and many others depending on pulsed RF signals, the need is greater than ever. Yet, in many instances, the systems engineer must devise his own method of peak power measurement. While some of these systems are fairly accurate, they are generally time consuming and expensive and often completely unsuitable for high volume or production line measurements. The time factor is an important one, not only from the viewpoint of time efficiency, but from the viewpoint of accuracy, for it is axiomatic in this type of measurement that time and error are quite directly related. Other criticisms of current methods have been that they exhibit a high degree of temperature sensitivity and a rather unwieldy procedure for recalibration.

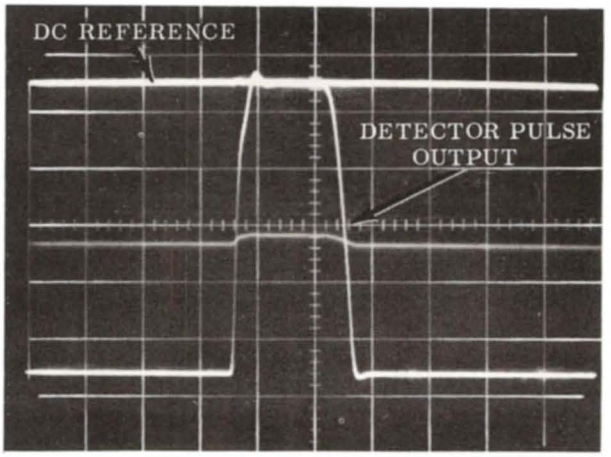
The Type 8900-B Peak Power Calibrator provides a convenient means for measuring the peak RF power of pulses in the range from 50 to 2000 Mc. The power level is read out directly on the panel meter and is completely independent of repetition rate and pulse width ($>0.25\mu$sec). The instrument consists basically of a precision terminated input circuit, diode detector, dc reference supply, meter, and a chopped video output system.

In operation, the RF signal is applied to the input circuit, which, through a power splitter, feeds the diode detector. The demodulated diode output and the output of the dc reference supply are simultaneously fed to the video output through a mechanical chopper. In making a measurement, a suitable external oscilloscope is connected to the video output and the dc reference voltage is adjusted so that it is exactly equal to the peak value of the demodulated pulse. The level of the required dc reference voltage is then indicated on the panel meter, calibrated to read peak RF power. The diode is operated in a biased condition for maximum stability of calibration. Provision is made, however, for readily standardizing the instrument against an external bolometer or calorimeter by simply connecting to a rear panel output in place of a standard termination.

The Peak Power Calibrator is completely self-contained and housed in a modular cabinet which may be readily rack mounted.

The detector output is also available directly through a 2-stage emitter follower for pulse monitoring.

A basic factor in the philosophy of the 8900-B is that of actual observation of the pulse waveform during the measurement. While this requires the use of a suitable auxiliary oscilloscope, it was considered important in the reduction of subtle errors; some of which are variations in pulse width, rate, or shape. It has an inherent advantage, however, in permitting measurement of intermediate levels of power in a complex waveshape. The operator may ignore characteristics, such as overshoot, if they contribute nothing to the effectiveness of his system or he may measure them as he chooses. In some applications, the user may be monitoring the effectiveness of a system at the time the measurement is made in an effort to correlate system performance to peak RF power. It then becomes important that he verify the



Typical Oscilloscope Display—Type 8900-B

output power has not changed by even a few tenths of a db at the time of the reading. Some frequently useful methods of peak power measurement have the disadvantage that the operator stops looking at the waveform at the precise moment of measurement, which is the most important time of all.

While the specified accuracy of the BRC 8900-B Peak Power Calibrator is ±0.6 db, when frequency correction is applied, it should be explained that utilization to a higher degree of accuracy, by virtue of its inherent stability, is both practical and recommended. Without frequency correction, overall accuracy is conservatively rated at ±1.5 db over the specified frequency range.

Specifications

Radio Frequency Measurement Characteristics

RF RANGE: 50 to 2000 Mc.

RF POWER RANGE: 200 mw* peak full scale.

*May be readily increased through use of external attenuators or directional couplers.

RF POWER ACCURACY: ±1.5 db*.

*±0.6 db with custom calibration curve.

RF POWER PRECISION: 0.1 db.

RF PULSE WIDTH: >0.25 μsec.

RF REPETITION RATE: 1.5 Mc. maximum.

RF IMPEDANCE: 50 ohms.

RF VSWR: <1.25.

Monitor Output

LEVEL: 0.2 volt for 20 mw input.

IMPEDANCE: 150 ohms nominal.

BANDWIDTH: >7 Mc.

Physical Characteristics

MOUNTING: Cabinet for bench use; readily adaptable for 19" rack mounting.

FINISH: Gray engraved panel; green cabinet. (Other finishes available on special order.)

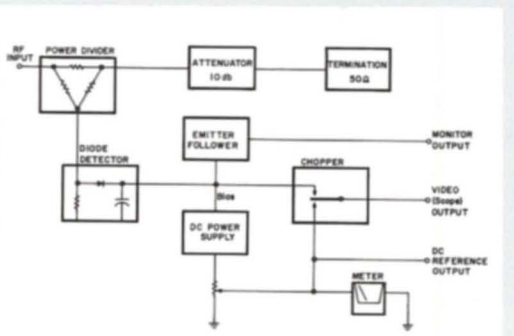
DIMENSIONS: Height: 6⅛" Width: 7¾" Depth: 11"

WEIGHT: Net 10 lbs.

Power Requirements

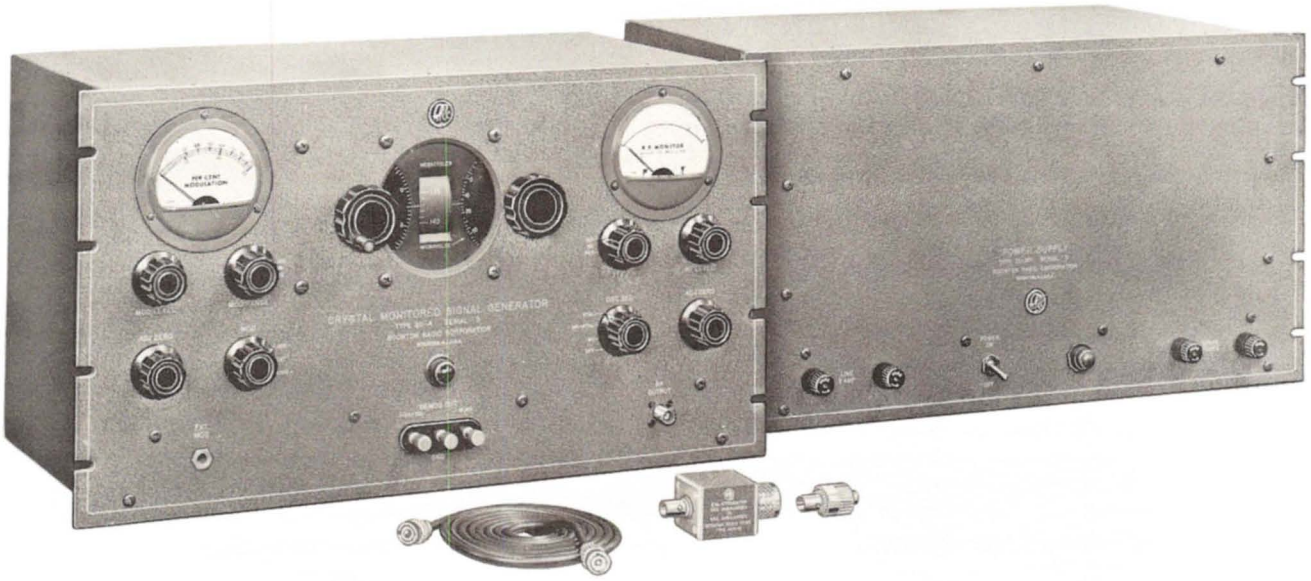
8900-B: 105-125/210-250 volts, 50-60 cps.

Price: 8900-B: $485.00
Custom Calibration Curve: $75.00



Block Diagram—Type 8900-B

CRYSTAL MONITORED SIGNAL GENERATOR TYPE 211-A



Description

The Type 211-A Signal Generator is specifically designed for the testing and calibrating of omni-range radio receiving equipment operating within the frequency range of from 88-140 megacycles. It may also be used for laboratory and development work where a precision type amplitude modulated R.F. signal source is required.

A conventional master oscillator, doubler, and doubler-output arrangement is employed to cover continuously the frequency range from 88-140 megacycles. In addition, a crystal oscillator is incorporated within the instrument which may be switched on in place of the master oscillator to provide output frequencies of 110.100 or 114.900 mc., each accurate to ±.0035%. If desired, the master oscillator and crystal oscillator may be operated simultaneously permitting the output frequency of the master oscillator to be standardized to an accuracy approaching that of the crystal itself at numerous beat points which occur throughout the tuning range of the instrument.

A demodulator stage is included within the 211-A Signal Generator which supplies to front panel binding posts a portion of the demodulated RF carrier. This feature permits checking the actual modulation process within the instrument and enables the identification of beat points by the use of earphones in standardizing the master oscillator against harmonics of the crystal frequencies.

An internal audio oscillator provides two modulation frequencies, 400 and 1000 cycles, each of which may be selected by means of a front panel switch. If desired, an external audio oscillator may be plugged in at the front panel to obtain amplitude modulation at various other frequencies. Two amplitude modulation ranges are available, 0-30% and 0-100%, each continuously variable from a front panel control.

A calibrated piston type of RF attenuator is used, the range of which is 0.1 microvolt to 0.2 volt. Direct settings in microvolts are made by means of the front panel attenuator dial after the output level has been standardized by adjusting the pointer of the output meter to a single calibration line on the meter scale.

The unit is finished in grey wrinkle enamel with engraved panel and is supplied complete with power supply, tubes, and standard output cable.

Specifications

Radio Frequency Characteristics

RF RANGE:
Master Oscillator: 88 to 140 Mc. in one range.
Crystal Oscillator: 110.1 and 114.9 Mc.

RF ACCURACY: ±0.1%*
*May be standardized to crystal accuracy.

RF CALIBRATION: Main Dial: Increments of 1 Mc.
Vernier: Increments of 10 Kc.

RF STABILITY:
Master Oscillator: <0.005% per °C.
Crystal Oscillator: <±0.0035% 10° — 50°C.

RF OUTPUT:
Range: 0.1 μv to 0.2 volts*
*Across external 50 Ω load.
Impedance: 50 Ω
Spurious Output: All spurious RF output voltages are better than 40 db below desired output.

RF LEAKAGE: Sufficiently low to permit measurements at 0.1 μv.

Amplitude Modulation Characteristics

AM RANGE: Internal: 0 to 100% in two ranges.
External: 0 to 100% in two ranges.

AM CALIBRATION: Increments of 2% 0 — 30%
Increments of 5% 30 — 100%

AM DISTORTION: <5% at 90% AM.

AM FIDELITY:
Frequency: ±0.5 db 30 cps. to 11 Kc.
±0.1 db 90 cps. to 150 cps.
±0.1 db 9.5 Kc. to 10.5 Kc.
Phase Shift: <0.25° at 30 cps.
Approximately 10° at 11 Kc.

INCIDENTAL FM: <2.5 Kc. at 100% AM.

EXTERNAL AM REQUIREMENTS: Approximately 2 volts RMS into 100 K Ω.

DEMODULATED OUTPUT:
Approximately 4.6 volts RMS at "+20V DC" posts at 50% AM.
Approximately 3.0 volts RMS at "4μf" posts at 50% AM.

Modulating Oscillator Characteristics

OSC FREQUENCY: 400 and 1000 cps.

OSC DISTORTION: <1%

Accessories

FURNISHED: Type 211-AP1 Power Supply
Type 504-A Adapter.
Type 505-B Attenuator.
Type 506-B Patching Cable.

AVAILABLE: Type 213-A Phase Test Set (See at right).
Type 502-B Patching Cable (Page 42).
Type 507-B Adapter (Page 42).
Type 509-B Attenuator (Page 43).
Type 510-B Attenuator (Page 43).

Tube Complement

1 — OA3	4 — 543-B	1 — 6V6GT
2 — 2C51	1 — 545-A	1 — 6X5GT
1 — 5R4GY	2 — 6AU6	2 — 12AX7
1 — 543-A	2 — 6AS7G	1 — 6N030 Relay

Physical Characteristics

MOUNTING: Designed for standard 19" rack mounting.
FINISH: Gray wrinkle, engraved panel (other finishes available on special order).

DIMENSIONS:	211-A	211-AP1
Height:	10½"	10½"
Width:	19½"	19½"
Depth:	9½"	9½"

WEIGHT:
Net: 63 lbs. Gross Export: 170 lbs.
Gross Domestic: 86 lbs. Legal Export: 78 lbs.

Power Requirements

211-A: 105-125 volts, 50-60 cps., 150 watts

Price: 211-A: $1990.00

PHASE TEST SET TYPE 213-A

The Phase Test Set was developed to provide a simple and precise method of measuring and adjusting overall phase shift in the Type 211-A Crystal Monitored Signal Generator. It is furnished complete with all interconnecting cables, but requires the use of an auxiliary audio oscillator and oscilloscope.

Specifications

(Accessory for use with 211-A)

A. "30 Cycle Bridge" Operation

1. Sensitivity such that a phase shift of 1° can be made to produce at least 2" deflection on the oscilloscope screen for modulation percentages of the 211-A of 30% or greater.

2. Self calibrating for measurements of phase shift with a calibration error of less than 0.1° when the 1° BRIDGE CALIB Position is used.

B. "Direct" Measurements

Useful at any modulation frequency between 20 and 11,000 cycles per second (must be phased and have gain adjusted at each modulation frequency at which phase shift is checked).

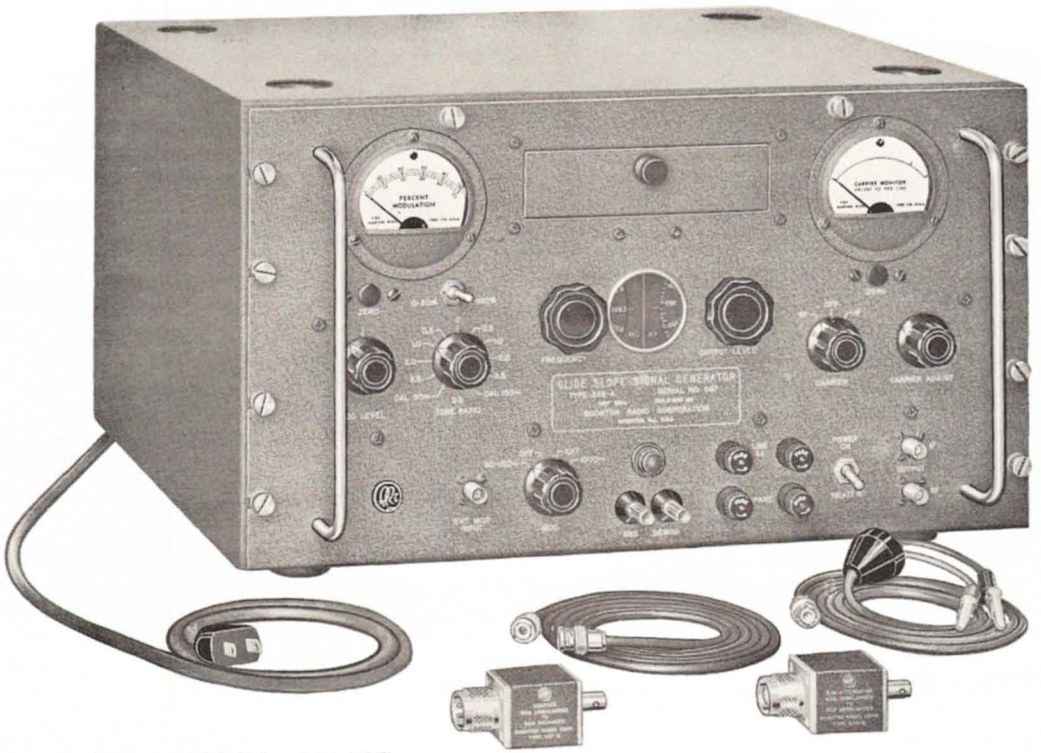
Accessories Furnished: 5 Cables, 3 ft. long, mating with microphone jacks on test set at one end and terminating in clip leads for 4 cables and a phone plug for one cable.

Weight: 11 lbs.

Dimensions: 7¼" x 7¼" x 5¼".

Price: $230.00

GLIDE SLOPE SIGNAL GENERATOR TYPE 232-A



Frequency Range 329.3 to 335 MC

Description

The **FAA** Instrument Landing System for aircraft includes a Glide Slope Receiver for indicating the proper rate of descent. The Glide Slope Signal Generator Type 232-A was designed for use in testing and calibrating these Glide Slope Receivers.

The Type 232-A includes two complete generators: an RF generator; and an IF generator. Each is capable of being modulated to a depth of 100% by self-contained modulation sources or by an external modulation source. Both generators use a common carrier monitor meter to indicate output level and a Percent Modulation meter to indicate percent modulation. The output of each generator is adjusted by a common knob and indicated in microvolts on a common Attenuator Dial. The RF Generator supplies twenty crystal controlled frequencies from 329.3 mc. to 335 mc. in 0.3 mc. steps and the IF Generator supplies one crystal controlled frequency. The IF frequency is 20.7 mc., but can be changed to other frequencies from 15 to 30 mc. by a change of crystals and internal adjustments. The power supply is internally regulated.

The Glide Slope Receiver in an aircraft receives two carriers of the same frequency: one is modulated with 90 cps audio; and the other is modulated with 150 cps audio. The airplane's position is indi-

Specifications

Radio Frequency Characteristics

RF RANGE: (A) 329.3 to 335.0 Mc. in increments of 0.3 Mc.
(B) 20.7 Mc.*
*Other frequencies between 15 and 30 Mc. available on special order.

RF ACCURACY: ±0.0065% (crystal controlled).

RF OUTPUT: Range: 1 μv to 0.2 volts*
*Across external 50 ohm load
Accuracy: ±10% approximately
Impedance: 50Ω

RF LEAKAGE: Sufficiently low to permit measurement at 1 μv.

Amplitude Modulation Characteristics

AM RANGE: Internal: 0 to 100% in two ranges
External: 0 to 100% in two ranges

AM CALIBRATION: Increments of 2% 0-50%
Increments of 10% 0-100%

DEMODULATED OUTPUT: Available at front panel posts through 2 mfd. capacitor.

Modulating Oscillator Characteristics

OSC FREQUENCY: (A) 1000 cps.
(B) 90/150 cps in the following tone ratios:

0 db	±2.0 db
±0.5 db	±3.3 db
±1.0 db	±infinite db (calibrate)

Accessories

FURNISHED: Type 505-B Attenuator
Type 506-B Patching Cable
Type 507-B Adapter
Type 514-B Output Cable

AVAILABLE: Type 502-B Patching Cable (Page 42).
Type 504-A Adapter (Page 42).
Type 509-B Attenuator (Page 43).
Type 510-B Attenuator (Page 43).

Tube Complement

1 — OB2	1 — 6AS7G
5 — 538-B	4 — 6AU6
2 — 546-A	1 — 6173
1 — 545-A	1 — 17-3 Ballast
1 — 6AL5W/5726	1 — 6AQ5W/6005

Physical Characteristics

MOUNTING: Cabinet for bench use; when removed, suitable for 19" rack mounting.

FINISH: Gray wrinkle, engraved panel
(Other finishes available on special order).

DIMENSIONS: Height: 10½" Width: 20⅞" Depth: 12"

WEIGHT:

Net:	64 lbs.	Gross Export:	115 lbs.
Gross Domestic:	75 lbs.	Legal Export:	70 lbs.

Power Requirements

232-A: 105-125 volts, 60 ±1 cps, 150 watts.

Price: 232-A: $2175.00

cated at the output of the receiver by the relative levels of these two modulations. The RF carrier from the 232-A can be internally modulated with 90 and 150 cps audio simultaneously, and the relative amounts of modulation can be varied by a front panel switch. This provides a test of the sensitivity and course correctness of the receiver under test.

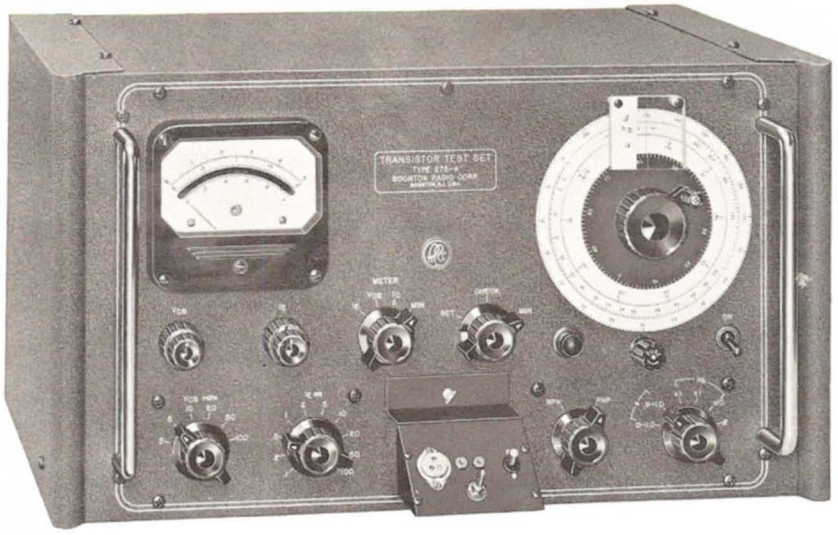
Features

The Glide Slope Generator Type 232-A provides twenty crystal controlled RF output frequencies and one crystal controlled IF output frequency. An internal alternator driven by a synchronous motor modulates either the RF or IF Generator simultaneously with 90 and 150 cps audio. The modulation depth resulting from each tone can be independently adjusted to equality and the relative levels subsequently varied. A 1000 cps audio oscillator is included for general purpose work. A continuously variable attenuator calibrated in microvolts controls the output of the RF or IF generator. Demodulated output from the RF or IF Generator is available at front panel terminals.

Uses

The Glide Slope Generator Type 232-A is designed for use in calibrating and testing Glide Slope Receivers used in Aircraft Instrument Landing Systems. It provides calibrated signals for measuring the sensitivity and for aligning the RF and IF section of the receiver. The sensitivity and centering of the receiver system for indicating vertical course position of the airplane can also be measured and calibrated. General study of the receiver characteristics can be made by use of the 1000 cps modulated carriers.

TRANSISTOR TEST SET
TYPE 275-A



Description

The Type 275-A Transistor Test Set is a completely self-contained instrument for the precise measurement of basic transistor parameters over a wide range of operating conditions. The Test Set may also be used to measure the characteristics of diodes and other semi-conductor devices. Direct read-out alpha (short-circuit current gain, grounded base, h_{fb}), beta (short-circuit current gain, grounded emitter, h_{fe}), and input resistance (output shorted, grounded base, h_{ib}) is provided with variable emitter current and collector voltage from the internal supplies.

The Test Set consists of a specially designed measuring circuit, test oscillator, detector, emitter and collector power supplies, and a multi-function precision meter. The entire instrument is housed in an aluminum cabinet which is designed for both bench and rack mounting.

The specially designed measuring circuit incorporates precision resistance elements arranged to provide direct read-out of all parameters on a large, calibrated dial. Measurements are completely independent of signal level fluctuation and calibration is essentially permanent. The circuit may be switched to accept either PNP or NPN types and a test circuit is provided to insure that the polarities of the operating potentials are correctly applied.

The test oscillator, which feeds the measuring circuit, is of the conventional R-C type. The detector, which amplifies the unbalance output from the measuring circuit, is fed to the multi-function meter which may be switched to operate as a null indicator. Provision is also made for the use of an external detector.

Separate power supplies are provided for emitter current and collector voltage. Both supplies are regulated against line voltage changes and are continuously variable over wide range. Ripple has been held to a minimum and special attention has been given to provide a suitably low source impedance from the collector supply. The output of both supplies is monitored by the multi-function meter which may be switched to read either current or voltage. Complete meter protection is provided through automatic meter range switching.

Features

The unique null-type measuring circuit employed in the Type 275-A Transistor Test Set is completely independent of signal level fluctuations and permits measurement of alpha to 3 significant figures and down to extremely low emitter currents. Consisting of passive elements, calibration is essentially permanent.

Readout of all parameters is direct on a large, easy-to-read dial; no correction or interpolation of any kind is required. Multi-ranges provide maximum readability and accuracy.

The built-in collector and emitter power supplies operate over an extremely wide range, 0 to 100 volts and 100 ma. respectively and their outputs are indicated to an accuracy of 1½% on the front panel meter. Provision has been made to accept emitter currents up to 5 amps. from an external source.

Specifications

Alpha (h_{fb}) Measurement Characteristics

RANGE: (a) 0.100 to 0.999
(b) 0.9001 to 0.9999

ACCURACY: (a) $\pm \left(0.1 + \frac{0.09}{h_{fb}} \right)$ % *
(b) ± 0.2% *

*For $f\alpha \geqslant 500$ Kc.

Beta (h_{fe}) Measurement Characteristics

RANGE: 7 to 200

ACCURACY: $\pm \left(0.6 + \frac{30}{h_{fe}} \right)$ % *

*For $f\alpha \geqslant 500$ Kc.

Input Resistance (h_{ib}) Measurement Characteristics

RANGE: (a) 0.30 to 30 ohms
(b) 3.0 to 300 ohms
(c) 30.0 to 3000 ohms

ACCURACY: (a) ± 3% *
(b) ± 3% * (above 30 ohms)
(c) ± 3% *

*For linear resistance.

Internal Test Oscillator

FREQUENCY: 1000 cps.

ACCURACY: ± 5%

DETECTOR:
Internal: Null-meter
External: Connection jack provided

Collector Voltage (V_{CB}) Supply Characteristics

RANGE:
Internal: 0 to 100 volts D.C.
External: 0 to 100 volts D.C.

RIPPLE: < 20 mv. (115 v. line input)

REGULATION: ± 2% or ± 0.25 volt whichever is greater for ± 10 volts input line voltage

LOAD REGULATION: ± (0.2 v + 0.5%) volts

METERING:
Ranges: 0 to 2, 5, 10, 20, 50, 100 volts
Accuracy: ± 1.5% f.s.

Emitter Current (I_E) Supply Characteristics

RANGE:
Internal: 0 to 100 ma. D.C.
External: 0 to 5 amps. D.C.* (intermittent operation)
0 to 2 amps. D.C.* (continuous operation)

*h_{fb} only; $I_b \leqslant 100$ ma. D.C.; I_E & I_C metered externally.

RIPPLE: < 1%

REGULATION: < ± 5% for ± 10% input line voltage

SOURCE IMPEDANCE: > 15 K ohms

METERING:
Ranges: 0 to 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100 ma.
Accuracy: ± 1.5% f.s.

Base Current (I_b) Characteristics

RANGE: 0 to 100 ma. D.C.

METERING: Connection terminals provided for external meter.

Accessories

FURNISHED: Type 575-A Transistor Test Jig
Cinch-Jones P-312-FHT Plug

AVAILABLE: None

Tube Complement

1 — OA2	1 — 6C4
3 — OG3	2 — 6DQ6A
1 — 6AH6	1 — 12AT7
2 — 6BA6	1 — 12AX7
	1 — 6N030 Relay

Physical Characteristics

MOUNTING: Cabinet for bench use; by removal of end bells, suitable for 19" rack mounting.

FINISH: Gray wrinkle, engraved panel (other finishes available on special order).

DIMENSIONS: Height: 10⅞" Width: 19⅝"
Depth: 12¹³⁄₁₆"

WEIGHT:

Net:	46 lbs.	Gross Export:	95 lbs.
Gross Domestic:	55 lbs.	Legal Export:	52 lbs.

Power Requirements

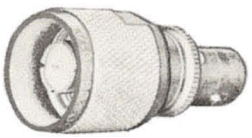
275-A: 105-125/210-250 volts, 50-60 cps. 90 watts

Price: 275-A: $975.00

SIGNAL GENERATOR ACCESSORIES

Output Cable Type 501-B

Consists of shielded coaxial cable with a characteristic impedance of 50 ohms terminated at one end with a plug type BNC connector. The other end is terminated in a 50 ohm resistor mounted in a moulded holder, connected across two binding post connectors. Open circuit impedance across the binding posts, with the BNC connector connected to a 50 ohm Signal Generator is 25 ohms. Overall length is 3'3". Connects Signal Generators to Receivers. **Price: $15.50**



Type 504-A Adapter

Consists of an interconnected jack type BNC connector and plug type N connector. Intended for adapting plug type BNC connectors on Types 502-B and 506-B Patching Cables to receivers with jack type N input connectors.

Price: $3.75

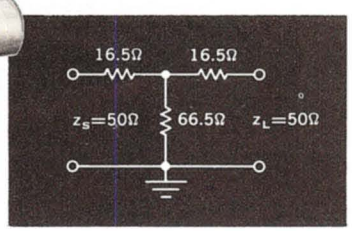
Patching Cables Type 502-B & Type 506-B

Consists of shielded coaxial cable with a characteristic impedance of 50 ohms terminated at each end by a BNC plug type connector. Overall length of Type 502-B is 3', of Type 506-B is 6'. These cables are intended for connecting signal generators to the Attenuators and Adapters listed on these pages.

Prices: Type 502-B, $6.50 Type 506-B, $6.50

Attenuator Type 505-B

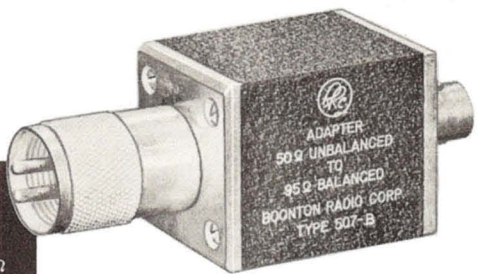
This unit includes an unbalanced "T" type resistive attenuator inserted between a jack type BNC and plug type N connector. It produces an attenuation of 6 db between the input voltage and the terminated output voltage when the input voltage is connected to the attenuator input through a 50 ohm source impedance. Under these conditions the impedance looking back into the output is 50 ohms. This unit is used for isolating receiver and signal generator and as a dummy antenna. **Price: $34.00**

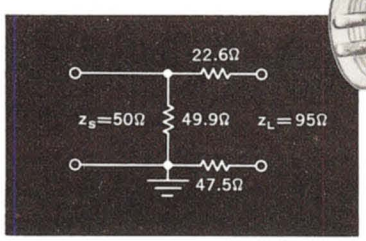


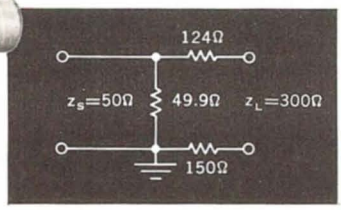
Adapter Type 507-B

This Adapter is used for connecting a 95 ohm balanced load to a 50 ohm unbalanced source. It produces an attenuation of 6 db between the input voltage and the terminated output voltage when the input voltage is connected to the attenuator input through a 50 ohm source impedance. Under these conditions the impedance looking into the output is 95 ohms. The input connector is a jack type BNC and the output connector is a plug type small twin connector.

Price: $35.25







Adapter Type 508-B

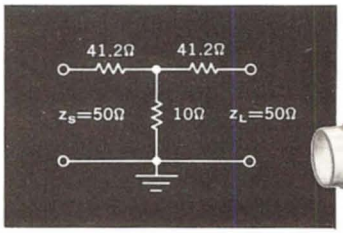
This unit adapts 300 ohm balanced loads to 50 ohm unbalanced sources. It produces an attenuation of 6 db between the input voltage and the terminated output voltage when the input voltage is connected to the attenuator input through a 50 ohm source impedance. Under these conditions the impedance looking into the output is 300 ohms. The input connector is a jack type BNC connector and the output connection is to two binding posts.

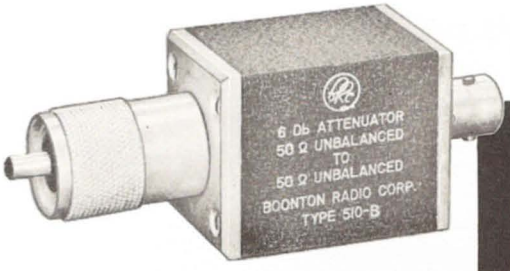
Price: $35.00

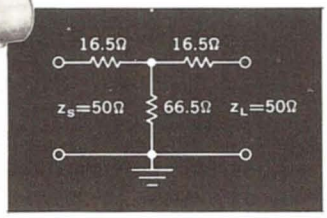
Attenuator Type 509-B

This unit includes an unbalanced "T" type resistive attenuator inserted between two jack type BNC connectors. It produces an attenuation of 20 db between the input voltage and the terminated output voltage when the input voltage is connected to the attenuator input through a 50 ohm source impedance. Under these conditions the impedance looking into the output is 50 ohms. This attenuator is used for isolating the receiver from the signal generator and as a dummy antenna.

Price: $33.00







Attenuator Type 510-B

Unit includes an unbalanced "T" type resistive attenuator inserted between a jack type BNC and plug type UHF connector. Produces an attenuation of 6 db between the input voltage and the terminated output voltage when the input voltage is connected to the attenuator input through a 50 ohm source impedance. Under these conditions the impedance looking back into the output is 50 ohms. This unit is used for isolating receiver and signal generator and as a dummy antenna.

Price: $35.25

◀ Output Cable Type 514-B

Consists of a shielded coaxial cable with a characteristic impedance of 50 ohms terminated at one end in a plug type BNC connector. The other end is terminated in a 50 ohm resistor, mounted in a moulded housing, connected across to alligator clips. Overall length is 6 feet. This cable is used generally at IF frequencies to connect signal generators to terminals within a receiver.

Price: $15.50

Output Cable Type 517-B ▶

Consists of a coaxial cable with a characteristic impedance of 50 ohms terminated at one end in a jack type BNC connector. The other end is terminated in a coaxially mounted 50 ohm metalized disc resistor followed by a 25 ohm series coaxial center conductor resistor to a plug type BNC connector. It produces a 6 db attenuation between a voltage, when connected by a 50 ohm source impedance to the cable input, and the terminated output voltage. Under these conditions the impedance looking into the open circuit output is 50 ohms.

Price: $24.75

REACTANCE CHART DATA

Refer to Chart on Page 45

The reactance chart provides a quick, convenient means of determining (a) the reactance of a given inductance or capacitance at a given frequency, and (b) the resonant frequency of a given inductance-capacitance combination.

To Find Inductive Reactance

1. Locate the given value on the inductance scale.
2. Follow the sloping inductance line until it crosses the vertical line corresponding to the given frequency.
3. From the point of intersection, project horizontally to the left and read the inductive reactance in ohms on the left-hand scale.

To Find Capacitive Reactance

1. Locate the given value on the capacitance scale.
2. Follow the sloping capacitance line until it crosses the vertical line corresponding to the given frequency.
3. From the point of intersection, project horizontally to the left and read the capacitive reactance in ohms on the left-hand scale.

To Find Resonant Frequency of L-C Combination

1. Locate the given values of inductance and capacitance on the appropriate scales, as described above.
2. Follow the sloping lines to the point of intersection.
3. From this point, project vertically downward and read the resonant frequency (or wave length) on the scale at the bottom of the chart.

SERIES-PARALLEL CONVERSION CHART DATA

Refer to Chart on Page 46

It is frequently necessary to convert a given impedance from the series form ($Z = R_s + jX_s$) to the equivalent parallel form ($Z = R_p + jX_p$) or vice versa. This chart makes it possible to convert readily from one form to the other without resorting to tedious computation.

The rectangular coordinates of any point on the chart represent the series resistance (R_s) and reactance (X_s) components of an impedance. The equivalent parallel values of this impedance (R_p and X_p) are indicated by the two mutually-perpendicular circular arcs passing through the point. (NOTE: Since the chart is constructed symmetrically about the axis X= R, the reactance and resistance axes may be reversed, if convenient, as long as the reversal is consistent throughout the conversion. An impedance having values of resistance and reactance which exceed the printed scale values may be divided by a convenient factor, such as 10. The results obtained from the chart must then be multiplied by this same factor to yield the correct answer.)

To Convert from Series to Parallel Form

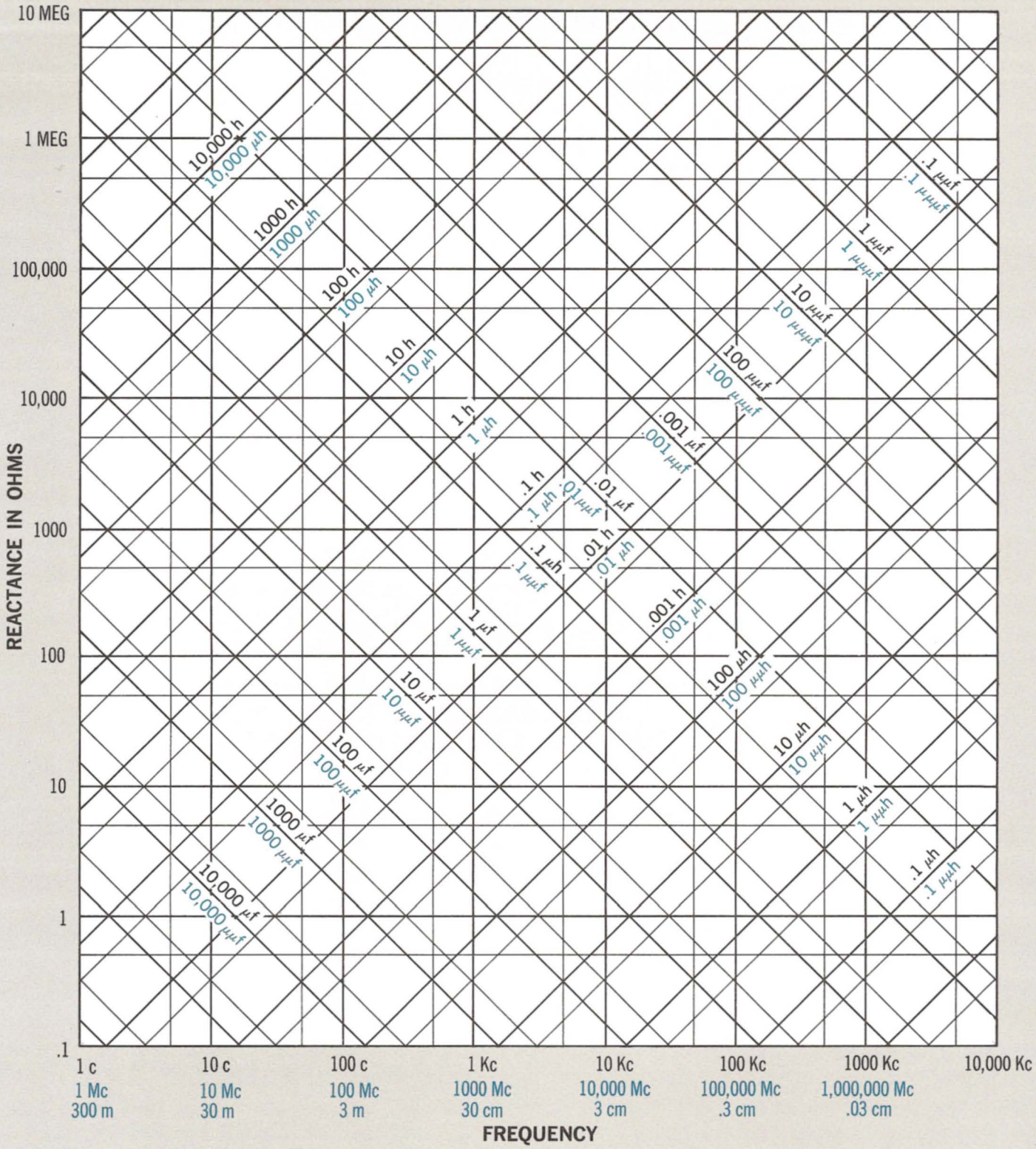
1. Locate the given series resistance (R_s) in ohms, on the scale at the bottom edge of the chart, and the given series reactance (X_s), in ohms on the scale along the left-hand edge of the chart.
2. Enter the chart vertically from the series resistance value, and horizontally from the series reactance value to the point of intersection.
3. Determine the values of the two arcs passing orthogonally through this point (interpolating visually between arcs, if necessary). The arc curving upward to the right from the origin represents the parallel resistance component (R_p) whose value is determined by the point at which the arc intersects the series resistance axis (or an extension thereof). Similarly, the arc curving upward to the left from the origin represents the parallel reactance component (X_p) whose value is determined by the intersection of this arc with the series reactance axis.

To Convert from Parallel to Series Form

1. Locate the parallel resistance arc (curving to the right from the origin) and the parallel reactance arc (curving to the left from the origin) corresponding to the given values of R_p and X_p, respectively.
2. Follow both arcs into the chart to their point of intersection.
3. From this point, project vertically downward to read the equivalent series resistance (R_s) in ohms, on the scale at the bottom of the chart; project horizontally to the left to read the equivalent series reactance (X_s) on the scale at the left-hand edge of the chart.

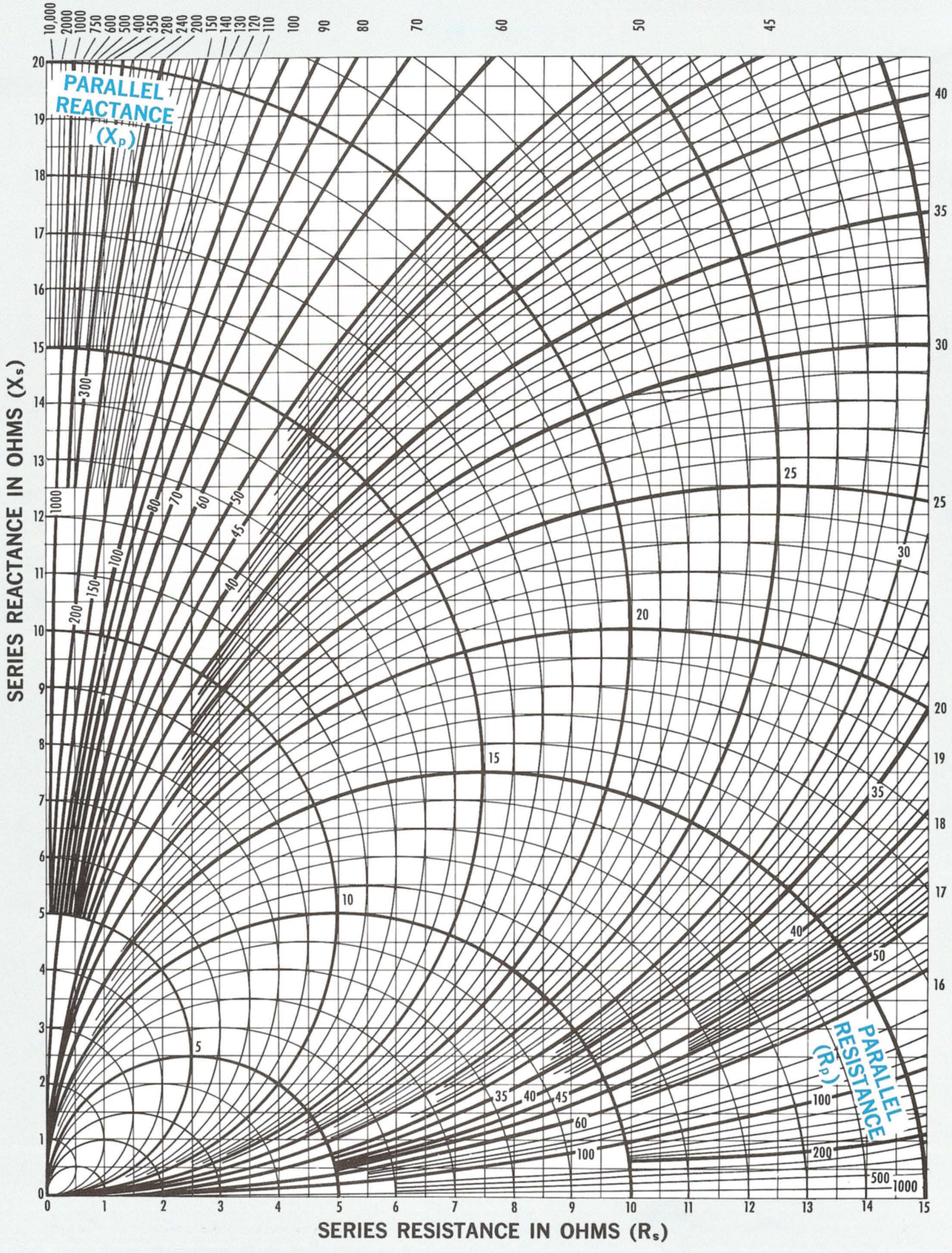
REACTANCE CHART

For Data, Refer to Page 44



For Data, Refer to Page 44

SERIES-PARALLEL CONVERSION CHART



PRICE SUMMARY

Instruments

TYPE	DESCRIPTION	UNIT PRICE F.O.B. ROCKAWAY, N. J.
190-A	Q METER	$ 995.00
202-H	FM-AM SIGNAL GENERATOR	1,365.00
202-J	TELEMETERING SIGNAL GENERATOR	1,475.00
203-B	UNIVERTER	445.00
207-H	UNIVERTER	525.00
211-A	CRYSTAL MONITORED SIGNAL GENERATOR	1,990.00
213-A	PHASE TEST SET	230.00
219-A	FM STEREO MODULATOR	975.00
225-A	SIGNAL GENERATOR	1,050.00
230-A	SIGNAL GENERATOR POWER AMPLIFIER	1,200.00
232-A	GLIDE SLOPE SIGNAL GENERATOR	2,175.00
240-A	SWEEP SIGNAL GENERATOR	1,995.00 (A)
245-C	SIGNAL GENERATOR CALIBRATOR	460.00
245-D	SIGNAL GENERATOR CALIBRATOR	455.00
250-A	RX METER	1,695.00
260-A	Q METER	990.00
265-A	Q COMPARATOR	975.00
275-A	TRANSISTOR TEST SET	975.00
280-A	UHF Q METER	2,610.00
8900-B	PEAK POWER CALIBRATOR	485.00 (B)

Note: (A) For rack mount add $25.00
(B) For custom calibration chart add $75.00

Accessories

103-A	INDUCTORS	17.75 (C)
513-A	Q STANDARD	97.00 (D)
515-A	COAX ADAPTER KIT	49.50
516-A	TERMINATION	22.75
518-A	Q STANDARDS	97.00 (D)
520-B	OSCILLATOR INDUCTORS	28.50
530-A	COMPONENT SHIELD	31.00
564-A	COUPLING UNIT	39.75
575-A	TRANSISTOR TEST JIG	24.75
580-A	PROBE KIT	94.50
590-A	INDUCTORS	17.75 (E)

NOTES:
(C) Complete set of sixteen (16) for 260-A Q Meter 255.00
Complete set of seventeen (17) for 160-A Q Meter 270.00
(D) Complete set of five (5) 518-A plus one (1) 513-A for 260-A and 160-A Q Meters 525.00
(E) Complete set of six (6) 590-A for 190-A and 170-A Q Meters 95.00

RF Output Fittings

501-B	OUTPUT CABLE	15.50
502-B	PATCHING CABLE	6.50
504-A	ADAPTER	3.75
505-B	ATTENUATOR	34.00
506-B	PATCHING CABLE	6.50
507-B	ADAPTER	35.25
508-B	ADAPTER	35.00
509-B	ATTENUATOR	33.00
510-B	ATTENUATOR	35.25
514-B	OUTPUT CABLE	15.50
517-B	OUTPUT CABLE	24.75
519-A	OUTPUT CABLE	17.75
523A-1	ADAPTER	100.00
523A-2	ADAPTER	100.00
521-A	OUTPUT CABLE	24.75
522-A	PATCHING CABLE	8.50

Replacement Thermocouples

107-A	THERMOCOUPLE UNIT (for 100-A Q Meter)	42.75 (F)
165-A	THERMOCOUPLE UNIT (for 160-A Q Meter)	43.50 (F)
565-A	THERMOCOUPLE UNIT (for 260-A Q Meter)	65.75 (F)

Note: (F) Serial number of Q Meter required. TERMS—Net 30 days; All prices subject to change without notice.

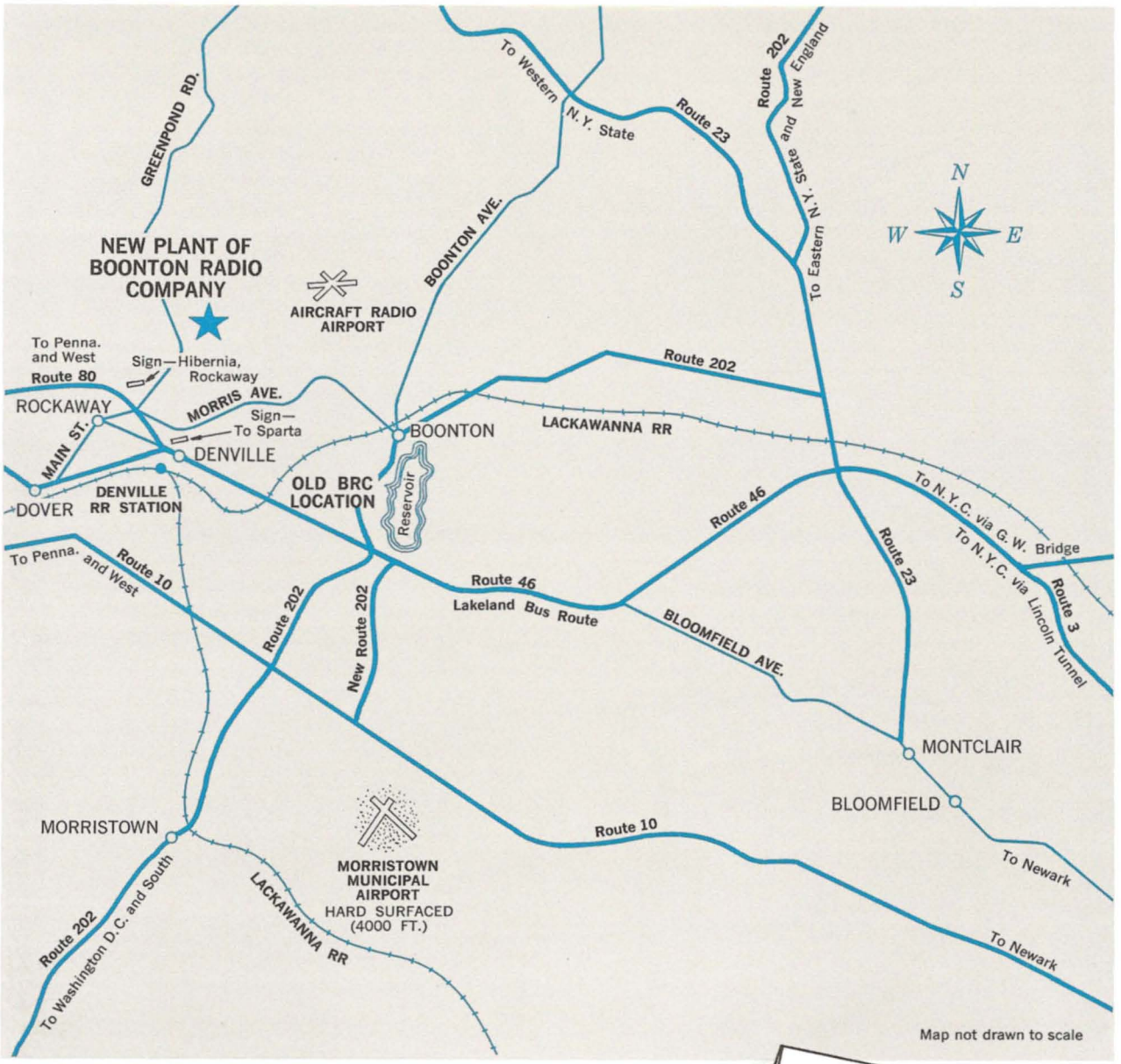
Special Replacement Tubes

TUBE TYPE	QTY/INST.	UNIT PRICE F.O.B. ROCKAWAY, N. J.
Type 100-A & 160-A Q Meter		
535-A (105-A) (1)	1	$35.00
536-A (102-A) (1)	1	4.25
Type 170-A Q Meter		
539-A (Q-VM-955) (1)	1	8.75
539-B (OS-VM-955) (1)	1	8.75
540-A (Selected 9002) (1)	1	10.25
Type 192-A G Meter		
549-A (Selected 6AL5) (1)	1	3.75
550-A (Selected 5691) (1)	1	14.50
Type 203-B Univerter		
547-A (Selected 6AG7) (2)	1	4.50
548-A (Selected 6J6) (2)	3	3.00
4-25 Ballast	1	5.25
Type 211-A Signal Generator		
543-A (Selected 6AK5) (2)	1	9.25
543-B (Selected 6AK5) (2)	4	9.25
545-A (Selected 3S6/5) (1)	1	.75
6N030 Relay	1	5.50
Type 240-A Sweep Signal Generator		
545-A (Selected 3S6/5) (1)	1	.75
6NO3O Relay	1	5.50
Type 242-A Signal Generator		
5NO45T Relay	2	5.50
16-4 Ballast	1	3.75
Type 260-A Q Meter		
535-A (105-A) (1)	1	35.00

TUBE TYPE	QTY/INST.	UNIT PRICE F.O.B. ROCKAWAY, N. J.
Type 110-A QX Checker		
541-A (101-C) (1)	1	$ 3.25
Type 225-A Signal Generator		
545-A (Selected 3S6/5) (1)	1	.75
12-3H Ballast	1	5.25
Type 190-A Q Meter		
537-A (Q-VM-9005) (1)	1	8.75
537-B (OS-VM-9005) (1)	1	8.75
538-A (Selected 12AT7) (1)	1	2.50
Type 202-B, C, D, E, F, G Signal Generator		
543-A (Selected 6AK5) (2)	2	9.25
543-B (Selected 6AK5) (2)	1	9.25
544-A (Selected 6C4) (2)	1	2.00
545-A (Selected 3S6/5) (1)	1	.75
6H-6 Ballast	1	3.50
Type 206-A Signal Generator		
543-A (Selected 6AK5) (2)	2	9.25
543-B (Selected 6AK5) (2)	1	9.25
544-A (Selected 6C4) (2)	1	2.00
545-A (Selected 3S6/5) (1)	1	.75
6N030 Relay	1	5.50
Type 250-A RX Meter		
542-A (Selected 6AB4)	1	2.25
6H-6 Ballast	1	3.50
Type 232-A Signal Generator		
538-B (Selected 12AT7) (1)	2	2.50
545-A (Selected 3S6/5) (1)	1	.75
546-A (Selected 6X4W) (1)	2	3.00
16-4 Ballast	1	3.75

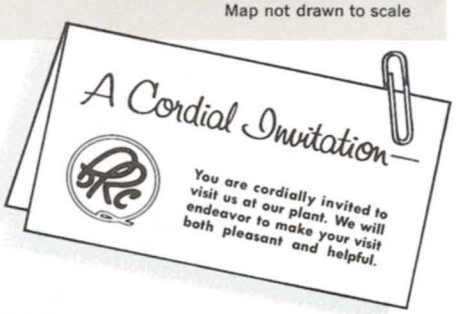
Notes: (1) Specially Selected. (2) Specially calibrated for each individual instrument.

Directions from New York City

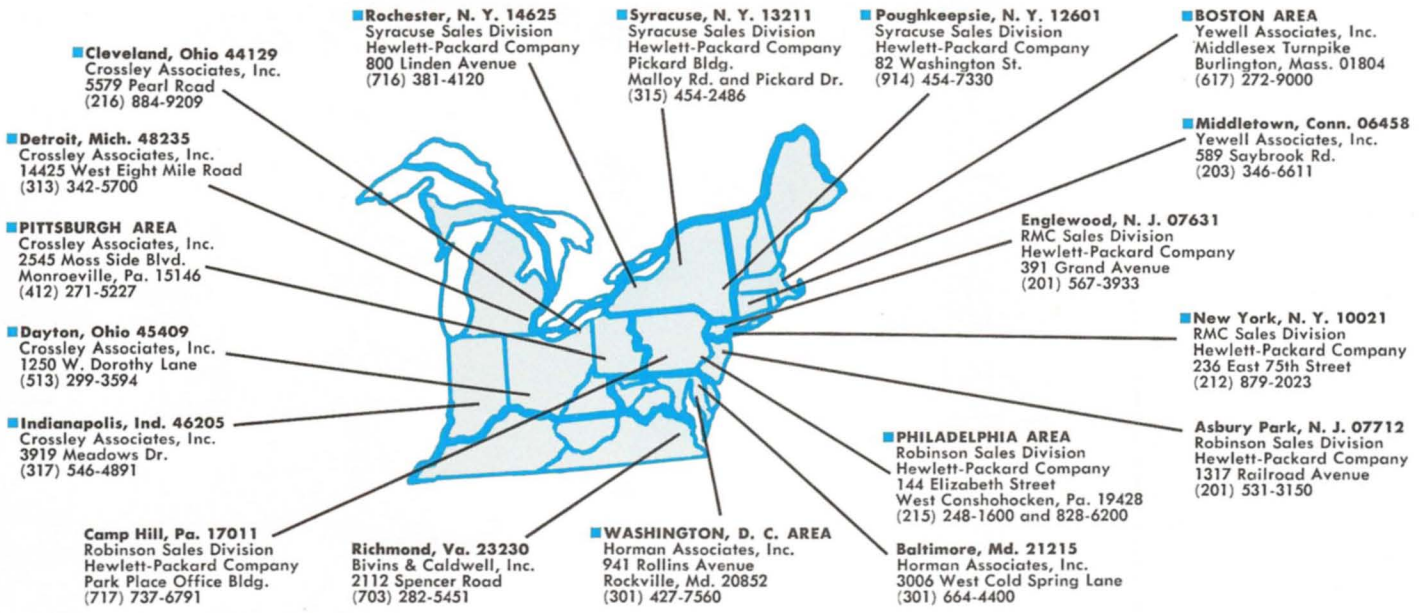


VIA BUS—Take LAKELAND Bus from New York Port of Authority Bus Terminal, 40th St. & 8th Ave., NYC, to Denville Bus Stop. By car to BRC plant.

VIA CAR—Take Lincoln Tunnel, drive west on Route 3 to Route 46, continue west on Route 46 to Route 80, drive north on Route 80 to "Hibernia-Rockaway" exit, turn left after exit toward Hibernia 1.9 miles to BRC plant.



SALES AND SERVICE OFFICES IN NORTH AMERICA



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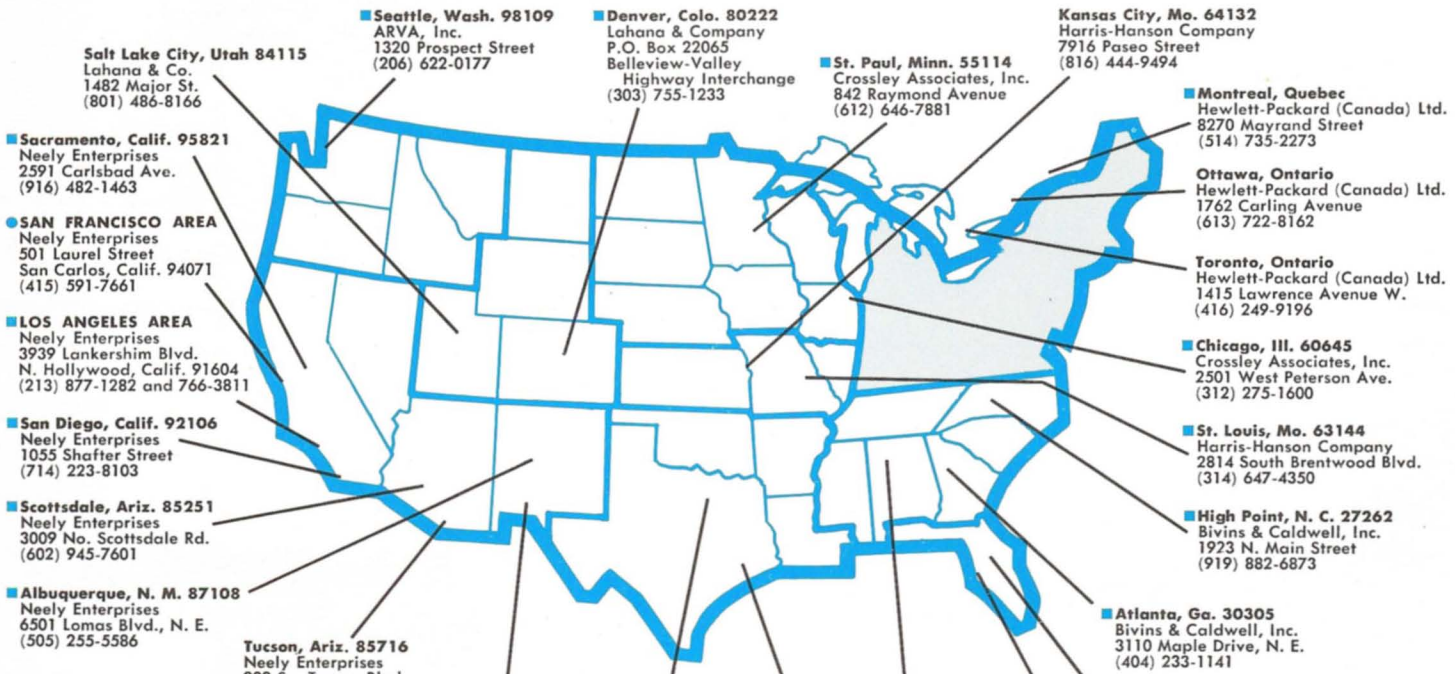

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4242 Richmond Ave.
(713) 667-2407

St. Petersburg, Fla. 33708
Stiles Sales Division
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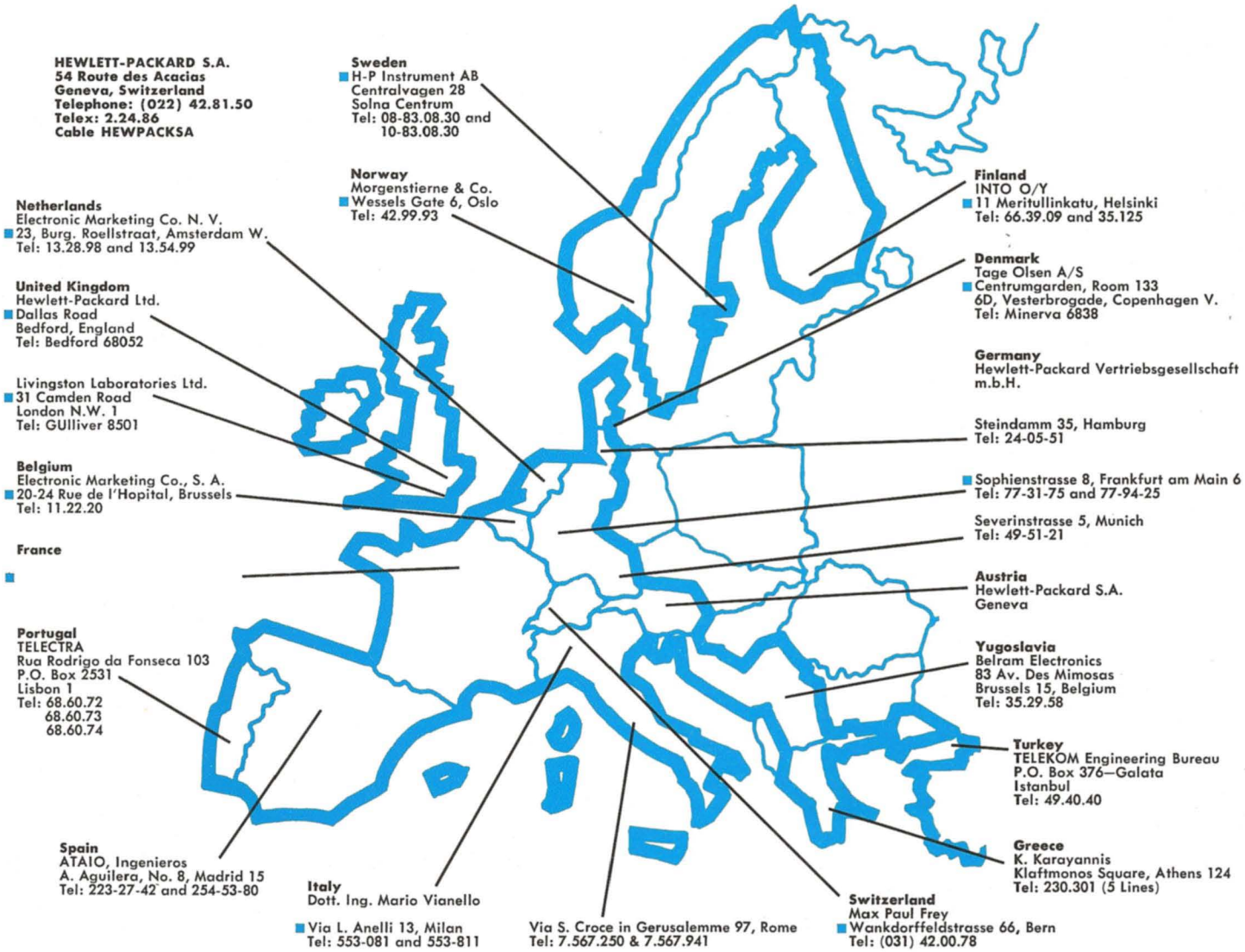
410-150th Ave., Madeira Beach
(813) 391-0211

● For replacement parts and repair services in the San Francisco area, please contact Hewlett-Packard Company at: 395 Page Mill Road, Palo Alto, California 94306 (415) 326-3950.

■ Indicates Instrument Repair Stations.

SALES AND SERVICE OFFICES IN WESTERN EUROPE



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10-83.08.30

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Steindamm 35, Hamburg
Tel: 24-05-51

Belgium
Electronic Marketing Co., S. A.
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Tel: 11.22.20

■ Sophienstrasse 8, Frankfurt am Main 6
Tel: 77-31-75 and 77-94-25

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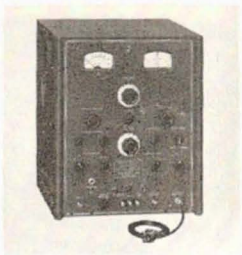
BULLETIN

BOONTON RADIO CORPORATION · BOONTON, NEW JERSEY

Sweep Generators for the Windswept Arctic

Boonton Sweeping Signal Generators Chosen for DEW-Line Maintenance

From the northwest coast of Alaska eastward over 3000 miles of rugged Arctic wastes to the shores of Baffin Bay is an integrated chain of radar and communication stations known to the world as the DEW Line. It is entirely within the Arctic Circle. Many of these stations are completely isolated from the rest of the world except for "cat" trains which bring in supplies during the "summer" season; they are designed to be completely self-sufficient during the long winter season.



Sweep Signal Generator, Type 240-A

Each station houses some of the most advanced electronic equipment available through the combined resources of the entire electronics industry, and their job is to provide the earliest possible warning of the approach of airborne objects over the polar regions. Twenty-four hours a day, seven days a week, and 365 days a year, these stations must provide accurate, reliable data vital to our nation's security.

One of the instruments selected to maintain the equipment in these isolated outposts is the Boonton Radio Type 240-A Sweeping Signal Generator. Backed by over twenty-three years of "know-how" in the building of *reliable* precision electronic laboratory instruments, the Type 240-A has been carefully designed to provide dependable service under extreme conditions. Completely tested for the ability to withstand shock and vibration far beyond the conditions encountered in normal laboratory usage, the Type 240-A incorporates modern printed circuitry along with time-proven mechanical design to provide years of trouble-free service.

Electronically, the Type 240-A Sweeping Signal Generator provides *CW, AM,* and *sweep* coverage from 4.5 to 120 MC. Through the use of the accessory Type 203-B Univerter, coverage is further extended down to 100 KC. The 240-A is a *true* signal generator with ± 1% frequency calibration, ± 10% RF output level calibration continuously from 1 to 300,000 microvolts, and flatness of RF output better than 7% under all sweep conditions.

A unique internal crystal controlled marker system will calibrate the CW output and/or mark the sweep at intervals of 0.1, 0.5, and 2.5 MC to an accuracy of ± .005%. In addition, two independent, continuously variable pip-type markers provide a convenient means for marking discrete frequencies in complex alignment patterns. An internal marker system adds the markers to the signal from the circuit under test and feeds the composite signal to an output connector for presentation on an oscilloscope.

RF Voltage Standard, Type 245-B

Turn the page to learn how the Type 240-A Sweeping Signal Generator can solve your measurement problems.

RF "Referee" Insures Reliable Aircraft Communications

Each time you join the growing number of air travelers for a cross-country flight or a local "hop", you depend upon reliable radio contact with the ground many miles below. Radio links provide weather and navigation information and permit safe landing under the most adverse conditions.

All of these systems are sensitive to the strength of the detected RF signal and are carefully checked against established performance standards on a routine, periodic basis. Lack of receiver sensitivity can completely disrupt communications. Voice information may be completely blanked out, even under normal flight conditions. Both the omnirange (VOR) and Instrument Landing System (ILS) incorporate "flag" type of indicators on the cockpit instrument panel to warn the pilot when insufficient receiver output is available for reliable navigation and landing.

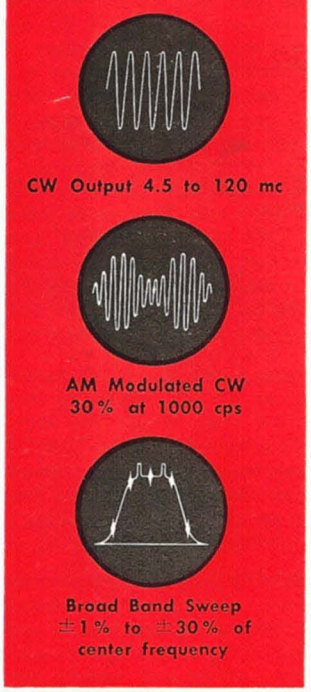
Precision signal generators have been employed in the calibration of aircraft receivers for many years but with the advent of the Boonton Radio Type 245-B RF Voltage Standard, the first convenient tool for accurate RF calibration became available to designers, producers, and users of electronic equipment.

Completely portable and powered by self-contained batteries, this transistorized RF micropotentiometer is continually receiving commendations for performance above and beyond the call of duty. Take the case of the signal generator that would pass all of the "problem" repairs. When management of a major airline found that shop personnel were passing all of the reject receivers on a particular signal generator, the Type 245-B RF Voltage Standard quickly revealed that the RF output of the generator was in error by 200%!

We can all profit by this experience. Doesn't it make sense to "know where you stand"? Turn the page to see how this basic laboratory tool can provide a new degree of precision in your measurements.

SWEEP SIGNAL GENERATOR
TYPE 240-A

PRICE: $1585.00 f.o.b. Boonton, N. J.



In this one instrument —

A SWEEPING, CW, and AM
SIGNAL GENERATOR
with Crystal-controlled Markers
4.5mc to 120mc

FEATURES:

- All-electronic, AGC-controlled, constant amplitude, variable width linear frequency sweep.
- Extremely low leakage — can be used down to 0.1 microvolt.
- RF output level accurately monitored on both CW and sweep.
- Basic frequency accuracy of ±1% — can be standardized against internal crystal to ±.005%.
- Internal crystal and pip interpolation markers.
- Markers do not pass through system under test — internal mixer adds frequency identification to system output.

SPECIFICATIONS

RF FREQUENCY RANGE: 4.5 to 120 mc continuously variable in five ranges accurate to ±1%.

RF OUTPUT VOLTAGE: 1.0 to 300,000 microvolts continuously variable as swept frequency generator — same except 100,000 microvolts maximum on CW accurate to approximately ±10% of full-scale "RF Level" meter readings.

AM MODULATION: Factory adjusted to 30% from internal 1000 cps oscillator.

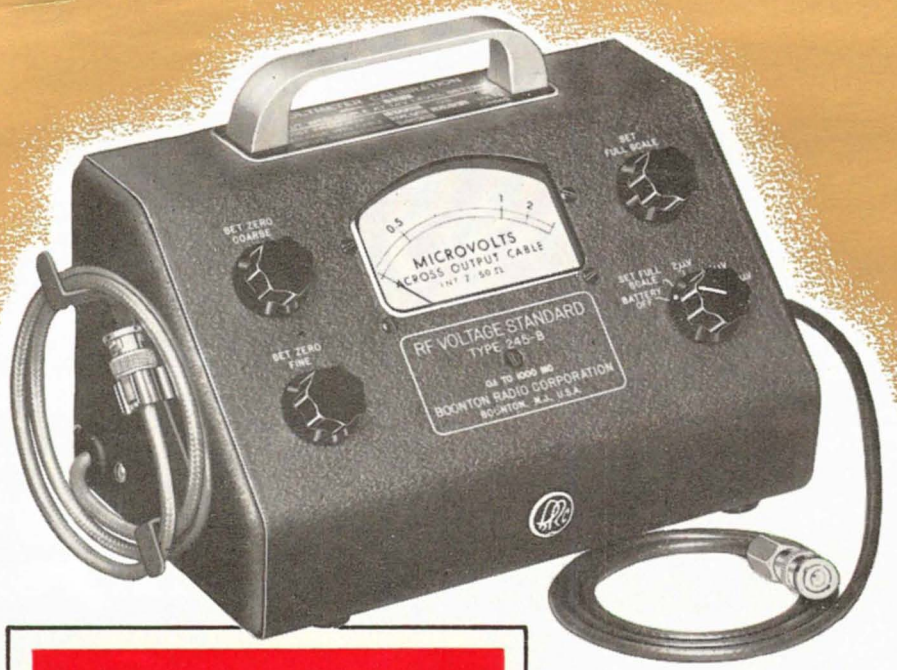
RANGE OF SWEEP WIDTH: Continuously variable from ±1% of center frequency to ±15 mc or ±30% of center frequency, whichever is smaller.

LINEARITY OF SWEPT RF FREQUENCY: Within 10% over middle 80% of sweep excursion, within 20% over remainder.

FLATNESS OF SWEPT RF OUTPUT: Better than 7% while sweeping for any combination of output, center frequency, and sweep width.

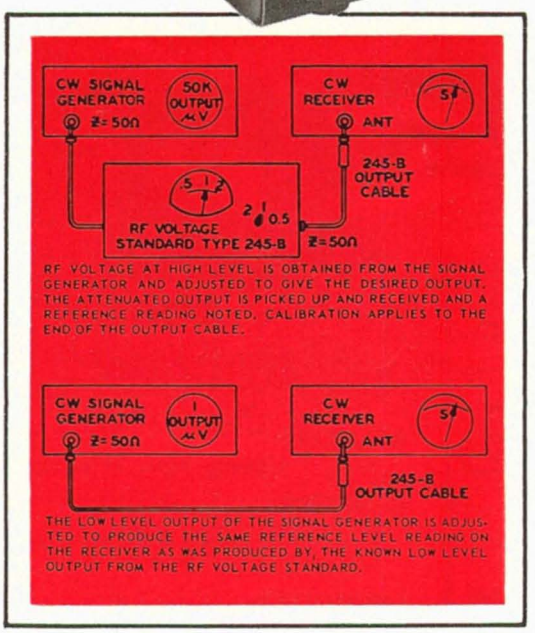
MARKER CHARACTERISTCS: Crystal birdie type markers switchable to spacing of 0.1, 0.5, or 2.5 mc accurate to ±0.005%. Two stable pip type markers adjustable to any position on the internal sweep excursion.

BOONTON RADIO CORPORATION
Boonton, New Jersey



RF VOLTAGE STANDARD
TYPE 245-B

PRICE: $360.00 f.o.b. Boonton, N. J.



How to get a new degree of *precision* in RF measurements

100kc to 1000mc

The R.F. Voltage Standard Type 245-B is a precision micopotentiometer supplying a standard source of R.F. voltage at fixed levels of 0.5, 1, and 2 microvolts. The instrument consists of a fixed, precision 25,000:1 attenuator, and a metering circuit employing a new UHF crystal in a specially designed coaxial mounting.

In use, the signal generator to be calibrated is connected to the input cable and a receiver with a d.c. meter across its detector is connected to the output of the RF Voltage Standard. The signal generator output is adjusted for proper indication on the meter of the RF Voltage Standard and the reading of the d.c. meter is noted. The RF Voltage Standard is then removed from the circuit and the output of the signal generator is adjusted to produce the same reading on the d.c. meter.

FEATURES

- **Provides direct calibration of signal generators and receivers at known levels of 0.5, 1, and 2 microvolts.**
- **Checks signal generator outputs at 25,000, 50,000, and 100,000 microvolts.**
- **50 ohm output impedance. VSWR less than 1.06 to 500 MC.**
- **Rapid and convenient to use.**
- **Completely portable — battery powered.**

SPECIFICATIONS

FREQUENCY RANGE: 0.1 mc to 1000 mc.

OUTPUT VOLTAGE: 0.5, 1.0, 2.0 microvolts.

OUTPUT VOLTAGE ACCURACY: ±10% to 100 mc. Above 100 mc output voltage obtained from standard frequency correction curve to the following accuracies: ±15% to 500 mc; ±20% to 1000 mc.

IMPEDANCE AT OUTPUT END OF OUTPUT CABLE: 50 ohms.

VSWR AT OUTPUT END OF OUTPUT CABLE:
Less than 1.04 to 100 mc. — Less than 1.06 at 500 mc.
Less than 1.10 at 1000 mc.

OUTPUT IMPEDANCE AT OUTPUT JACK ON INSTRUMENT: 50 ohms.

INPUT VOLTAGE ACCURACY FOR A READING OF 1 MICROVOLT ON THE METER FROM A VOLTAGE SOURCE OF 50 OHMS IMPEDANCE: ±10% to 300 mc.

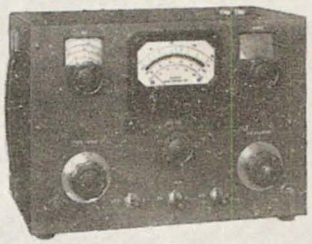
INPUT IMPEDANCE: 50 ohms nominal. Calibrated at approx. 100 mc.

POWER REQUIREMENTS: All necessary power obtained from internally mounted mercury battery.

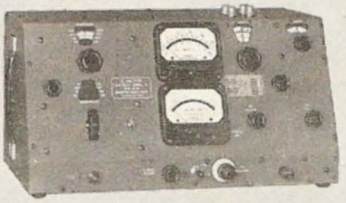
HEIGHT: 6½" **WIDTH:** 9¾" **DEPTH:** 6" **WEIGHT:** 5 LBS.

BOONTON RADIO CORPORATION
Boonton, New Jersey

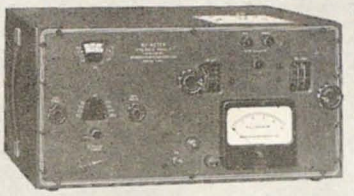
BRC ELECTRONIC TEST and MEASURING INSTRUMENTS



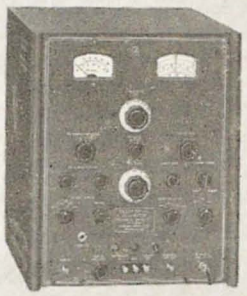
Q METER TYPE 190-A



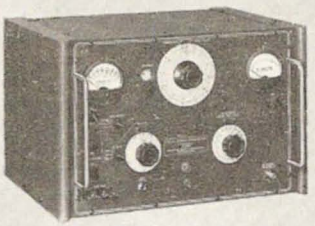
Q METER TYPE 260-A



RX METER TYPE 250-A

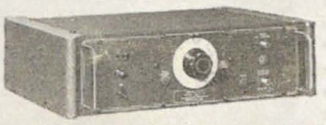


SWEEP SIGNAL GENERATOR
TYPE 240-A

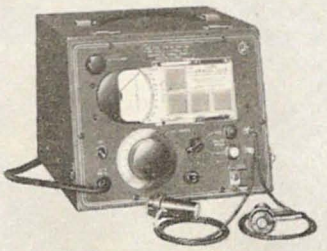


FM-AM SIGNAL GENERATOR
TYPE 202-E

RF VOLTAGE STANDARD
TYPE 245-A



UNIVERTER TYPE 207-E



FILM GAUGE TYPE 255-A

Q METERS

Type	Freq. Range	Q Range	Tuning Capacity Range	Q Accuracy	Price
260-A	50 kc to 50 mc	10 to 625	30-450 mmf	5% to 30 mc	$775.
190-A	20 mc to 260 mc	5 to 1200	7.5 to 100 mmf	7% to 100 mc	$760.

FM-AM SIGNAL GENERATORS

Type	Freq. Range	Output Range	Modulation FM	Modulation AM	Application	Price
202-E	54-216 mc	0.1 to 200,000 μv	0-240 kc	0-50%	General	$1090.
202-F	175-250 mc	0.1 to 200,000 μv	0-240 kc	0-100%	Telemetering	$1075.

SWEEP SIGNAL GENERATOR

Type	Freq. Range	Output Range	Modulation FM	Modulation AM	Markers	Price
240-A	4.5 to 120 mc	1.0 to 300,000 μv CW 1.0 to 100,000 μv	±1% to ±30% Center Freq.	30%	Crystal & Pip.	$1585.

OMNI-RANGE SIGNAL GENERATOR (Crystal Monitored)

Type	Freq. Range	Output Range	Modulation	Application	Price
211-A	88-140 mc	0.1 to 200,000 μv	0-100% am	Omni-Range Rcvrs.	$1800.

GLIDE SLOPE SIGNAL GENERATOR

Type	Freq. Range	Output Range	Modulation	Application	Price
232-A	329-335 mc	1.0 to 200,000 μv	0-100% am	Glide Slope Rcvrs.	$1700.

WIDE BAND IMPEDANCE MEASURING EQUIPMENT—RX Meter

Type	Freq. Range	R Range	C Range	L Range	Price
250-A	0.5 to 250 mc	15 to 100,000 ohms	0-20 μμf	0.001 μh-100 mh	$1320.

RF VOLTAGE STANDARD

Type	Freq. Range	Calibrated Out.	Output Impedance	Application	Price
245-A	0.1 to 1,000 mc	0.5,1.0,2.0 μv	50 ohms	Calibrates Signal Generators	$360.

UNIVERTERS

Type	Freq. Range	Output Range	Modulation FM	Modulation AM	Accessory to	Price
207-E	0.1 to 55 mc	0.1 to 100,000 μv	0-240 kc	0-50%	202-E	$390.
207-F	0.1 to 55 mc	0.1 to 100,000 μv	0-240 kc	0-50%	202-F	$380.
203-B	0.1 to 25 mc	1.0 to 100,000 μv	1.5 to 30 mc	30%	240 A	$380.

FILM GAUGE

Type	Measures	Thicknesses	Price
255-A	Non-magnetic Metals	0.000004″ to 0.0002″	$450.

RX METER:
Wide Frequency Band RF Bridge

Q METERS:
Low, Medium, High and Very High Frequencies

UNIVERTERS:
Low, Medium and High Frequency Converters

SIGNAL GENERATORS:
Frequency and Amplitude Modulated for Aircraft Navigation, Mobile and TV Receivers, Precision broad band sweeps with markers

SIGNAL GENERATOR CALIBRATORS:
RF Voltage Standard in the low microvolt range over a wide frequency range

FILM GAUGE:
Measures metal film and plating thicknesses

BOONTON RADIO CORPORATION
Boonton, New Jersey

HEWLETT PACKARD BOONTON DIVISION

VHF OSCILLATOR

model 3200A

TECHNICAL DATA 2/15/65

Features

- 10 to 1000 mc Continuous Coverage
- ± 0.002% Frequency Stability
- External AM and Pulse Modulation
- Waveguide-below-cutoff Output Attenuator
- Solid-state Power Supply

Description

The VHF Oscillator, Model 3200A, is designed for general purpose laboratory use including receiver and amplifier testing, driving bridges, slotted lines, antenna and filter networks, and as a local oscillator for heterodyne detector systems in the frequency range from 10 to 1000 mc.

The push-pull oscillator is housed in a rugged aluminum casting for maximum stability and extremely low leakage; six frequency ranges are provided for adequate bandspread on the slide-rule dial. Internal CW operation is provided; AM and pulse modulation may be obtained through the use of a suitable external source. The RF output is coupled through a waveguide-below-cutoff variable attenuator; in addition, an electrical RF level vernier is included as a front panel control.

A solid-state power supply furnishes all necessary operating voltages including regulated dc to the oscillator heaters for minimum hum modulation and maximum tube life. The cabinet is designed for bench use and can be readily adapted for standard 19-inch rack mounting.

An optional accessory Frequency Doubler Probe, Model 13515A, incorporates a solid-state doubler circuit and provides additional frequency coverage from 500 to 1000 mc.

Specifications

3200A VHF OSCILLATOR

Radio Frequency Characteristics

RF RANGE:

Total Range: 10 to 500 mc
No. Bands: 6

Band Ranges:		
10 - 18.8 mc	68 - 130 mc
18.5 - 35 mc	130 - 260 mc
35 - 68 mc	260 - 500 mc

RF ACCURACY

± 2% (after 1/2 hour warmup)

RF CALIBRATION:

Increments of less than 4%

RF STABILITY:

Short Term: ± 0.002%* (5 minutes)
Long Term: ± 0.02%* (1 hour)
Line Voltage: ± 0.001%* (5 volts)

* After 4 hour warmup, under 0.2 mw load. When frequency is changed by dial or bandswitching, sufficient time must be allowed for restabilization.

RF OUTPUT:

Maximum Power: >200 mw* (10-130 mc)
>150 mw* (130-260 mc)
> 25 mw* (260-500 mc)

* across external 50-ohm load

Range: 0 to >120 db attenuation from maximum output

Load Impedance: 50 ohms nominal

RF LEAKAGE:

Sufficiently low to permit measurements at 1 μv

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Europe: 54 Route des Acacias, Geneva, Switzerland, Cable: "HEWPACKSA" Tel: (022) 42.81.50

Printed in U.S.A.

Amplitude Modulation Characteristics

AM RANGE:
External: 0 to 30%

AM DISTORTION:
<1% at 30% AM

EXTERNAL AM REQUIREMENTS:
Approximately 30 volts RMS into 600 ohms for 30% AM

Pulse Modulation Characteristics

PM SOURCE: External

EXTERNAL PM REQUIREMENTS:
140 volts peak pulse into 2000 ohms for maximum power output; typically 10 volts peak (except 50 volts on 260-500 mc range) for 1 mw peak power output

Accessories

FURNISHED: None

AVAILABLE: 501B Output Cable
502B Patching Cable
506B Patching Cable
514B Output Cable
517B Output Cable
13515A Frequency Doubler Probe

Physical Characteristics

MOUNTING:
Cabinet for bench use; readily adaptable for 19-inch rack mounting

FINISH:
Gray engraved panel; blue cabinet (other finishes available on special order)

DIMENSIONS:

Height:	6-1/2″	(165 mm)
Width:	7-25/32″	(198 mm)
Depth:	12-17/32″	(318 mm)

WEIGHT:

Net:	15 lbs. (6,8 Kg.)
Gross Export:	35 lbs. (15,9 Kg.)
Gross Domestic:	19 lbs. (8,6 Kg.)
Legal Export:	17 lbs. (7,7 Kg.)

Power Requirements

3200A: 105-125/210-250 volts, 50-60 cps, 30 watts

Price:

3200A: $475.00 F.O.B. Rockaway, New Jersey

Tentative Specifications

13515A FREQUENCY DOUBLER PROBE

Radio Frequency Characteristics

RF RANGE: 500 to 1000 mc*
* with 3200A operating 260-500 MC (Range No. 6)
250-260 MC (Range No. 5)

RF OUTPUT: Maximum Power: > 4 mw*
* across external 50 ohm load with VSWR < 1.1

HARMONIC SUPPRESSION:
Fundamental: > 16 db*
Higher Order: > 16 db* (500-800 MC)
> 14 db* (800-1000 MC)
* below desired signal

Physical Characteristics

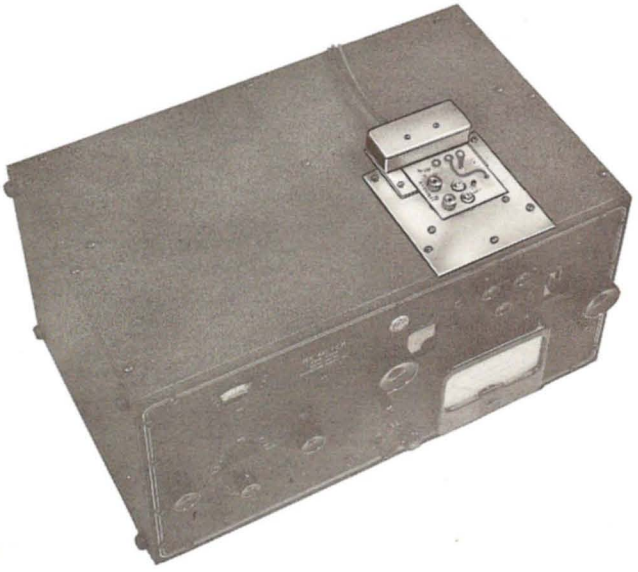
MOUNTING: installs in place of standard 3200A output attenuator probe; readily removable

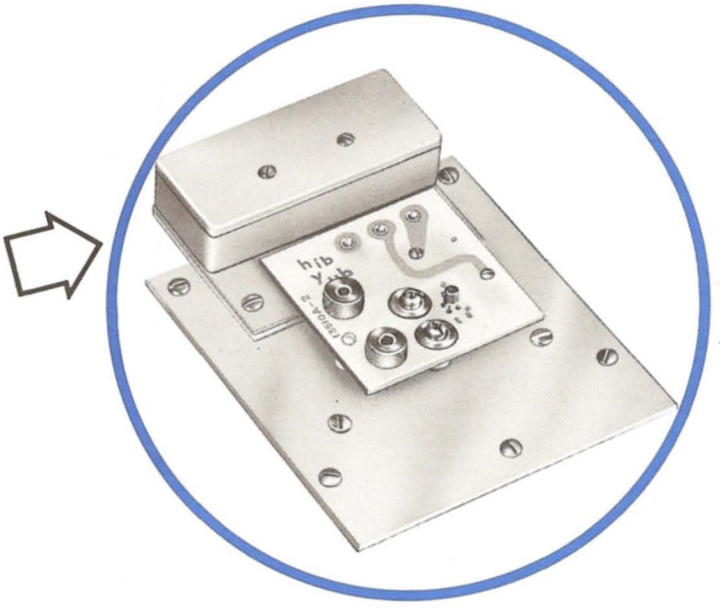
WEIGHT: 4 oz. net

Price: 13515A $95.00 f.o.b. Rockaway, N. J.

Data subject to change without notice.

TRANSISTOR TEST JIG
TYPE 13510A





Description

The Transistor Test Jig, Type 13510A, is designed to provide a convenient means for measuring the Y parameters of transistors on the RX Meter, Type 250A, over the frequency range from 500 kc to 250 mc. The jig consists of four basic components: a Mounting Adapter and three separate plug-in test circuits for measuring Y_{ib}, Y_{ie}, and Y_o.

The Mounting Adapter mounts conveniently on the RX Meter and includes bias feed and bypassing for an external power supply (-hp- 721-A). Each of the test circuits is constructed on a printed circuit board for maximum stability and repeatability. Residual reactances have been held to a minimum, providing maximum measurement accuracy.

Features

- Convenient plug-in test circuits
- Handles most popular TO packages

Specifications

RF RANGE: 500 kc to 250 mc

TEST CIRCUITS:
Provide for readout of R_p and C_p on RX Meter to yield to yield Y_{ib}, Y_{ie}, and Y_o.

$$\left[Y_{(\ )} = \frac{1}{R_p} + jwC_p \right]$$

EXTERNAL BIAS RANGE: 50 ma. dc maximum
30 volts dc maximum

TRANSISTOR MOUNTING:
Acommodates TO-1, 5, 9, 11, 18, 23, 24, 39 and similar packages.

Price: 13510A: $195.00
F.O.B. Rockaway, New Jersey

Data subject to change without notice.

2-65

BOONTON DIVISION
Hewlett-Packard Company

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ROCKAWAY, NEW JERSEY 07866
Precision Electronic Instruments since 1934

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DESIGN OF "Q" SIMPLE METER

By DAVID H. SANDROCK

Requiring only an external r.f. source and a v.t.v.m., this handy little device can be used to determine various values of L,C, and "Q".

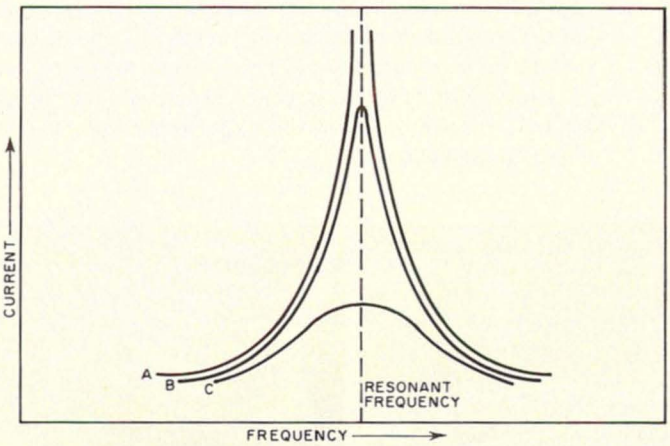


Fig. 1. Current through a series-resonant circuit (A) with zero losses, (B) very low losses, and (C) with high losses.

BESIDES measuring the "Q" of a resonant circuit or inductor, a "Q" meter may also be used to measure inductance, capacitance, distributed capacitance of a coil, and the reactance of an inductor or capacitor.

The instrument to be described in this article will measure capacitance between 1 and 450 pf. directly, although its range can be extended to higher values. Inductance measurement range is from 1 μh. to 12 mh., with this range capable of being extended. "Q" can be determined over a range from approximately 10 to 200, and the useful frequency range is from 100 kc. to 30 mc.

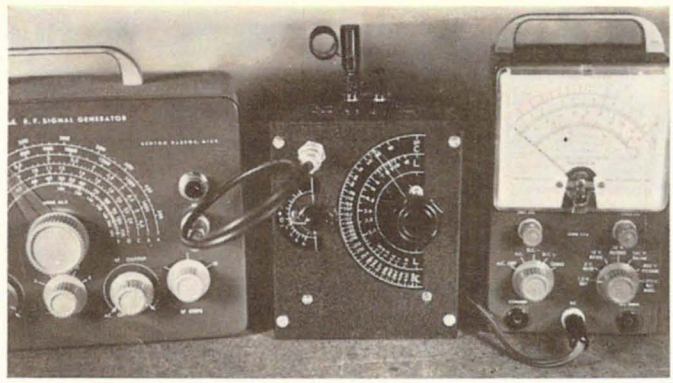
An external r.f. generator and v.t.v.m. are required although a 20,000-ohms-per-volt multimeter may be used in place of the v.t.v.m., but with a loss of about half sensitivity.

Theory of Operation

The shape of the curve of current through a series-resonant circuit is determined by the ratio of the reactance to the series resistance, as shown in Fig. 1 and Fig. 2A. This ratio is called "Q", and the higher the "Q", the less are the losses in the resonant circuit.

This "Q" meter measures the r.f. voltage across the capacitor of a series-resonant circuit (Fig. 2B). The actual v.t.v.m. used is a diode (*V1A* in Fig. 3) which will detect any r.f. voltage present. As the shunt capacitance of the diode is in parallel with the main capacitor *C3* when it is calibrated, it can be neglected in all measurements.

Differential amplifier *V2* has its input isolated from r.f.



External r.f. source and v.t.v.m. complete the "Q" meter.

by *R1*. The output of this circuit is proportional to the difference between its two inputs. The contact potential developed by *V1A* is bucked out by that developed by *V1B*. As the two diodes are matched, equal contact potentials are developed, and the differential amplifier will indicate zero as long as no signal rectification takes place in *V1A*. Power supply variations also have a negligible effect as they are applied equally to each half of the amplifier. Any small differences that do exist in either the diodes or the amplifier can be balanced out by adjustment of potentiometer *R8*.

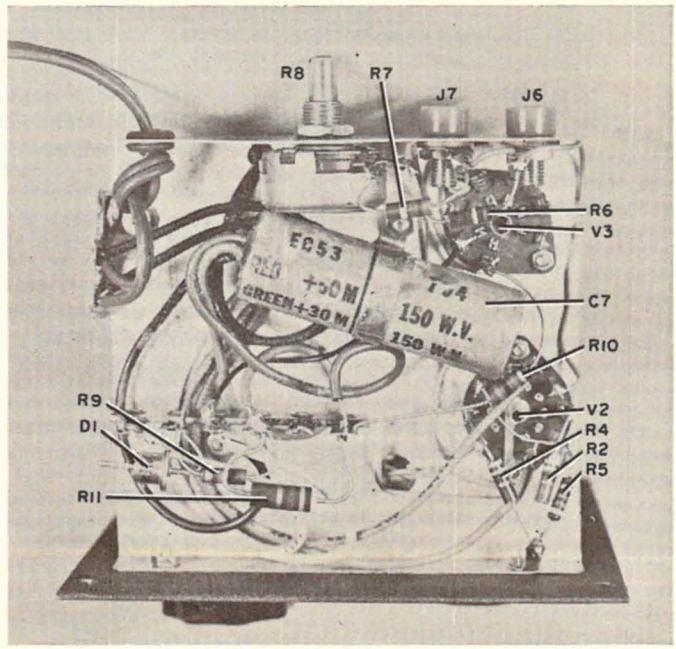
Construction

The instrument is housed in a 4x5x6-inch utility cabinet. A sheet metal chassis is formed and bolted to the front panel as shown in the photographs. Placement of parts on this chassis is not critical, and any convenient layout may be used. As it is not necessary to adjust the balance potentiometer (*R8*) often, it was placed on the rear apron of the chassis. Because the power consumption is so low (less than 5 watts), no power switch was used. In any case, it is a good idea to leave the device turned on for a long period of time for maximum stability.

For the device shown, a broadcast-band superhet tuning capacitor of approximately 15 to 467 pf. was used for the main capacitor *C3*. Any variable capacitor with this approximate value may be used. If the maximum capacitance is not high enough, two sections may be paralleled. Remove any trimmers to obtain a low minimum capacitance.

A small bracket to hold *V1*'s socket and associated termi-

Underchassis view showing placement of associated components.



nal strips should be mounted as near to the terminal of the variable capacitor as possible to reduce stray capacitance and lead inductance. Capacitor *C2* should be mounted with the shortest leads possible between *J2* and *J5*. This is necessary for proper operation at the higher frequencies. The minimum spacing between the vernier capacitor *C4* and the main capacitor should also be used. The vernier capacitor is not absolutely necessary, but its use makes some measurements easier and more accurate. Be sure to leave enough room for a reasonably sized dial. About 2″ radius will give a large enough dial for good accuracy. For the dials, black cardboard marked with a lettering pen using white drawing ink may be used. After calibration, the dial should be sprayed with a plastic protective coating.

If desired, a vernier dial can be used to eliminate the need for the vernier capacitor, as such a dial can be read to less than 0.5 pf. The use of such a dial would require that a cali-

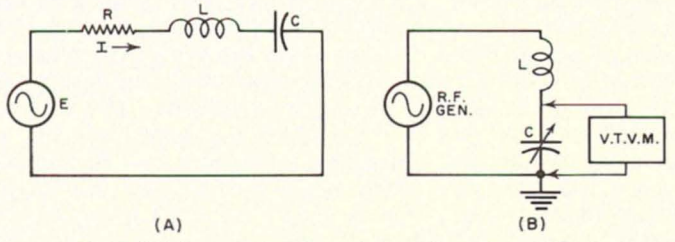


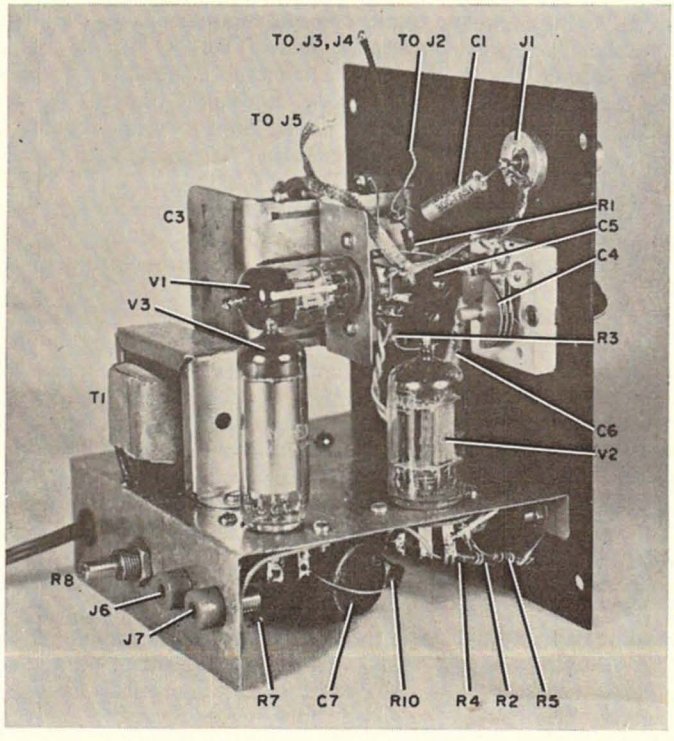
Fig. 2. (A) Amount of series resistance determines "Q" of series-resonant circuit. (B) Basic circuit of "Q" meter.

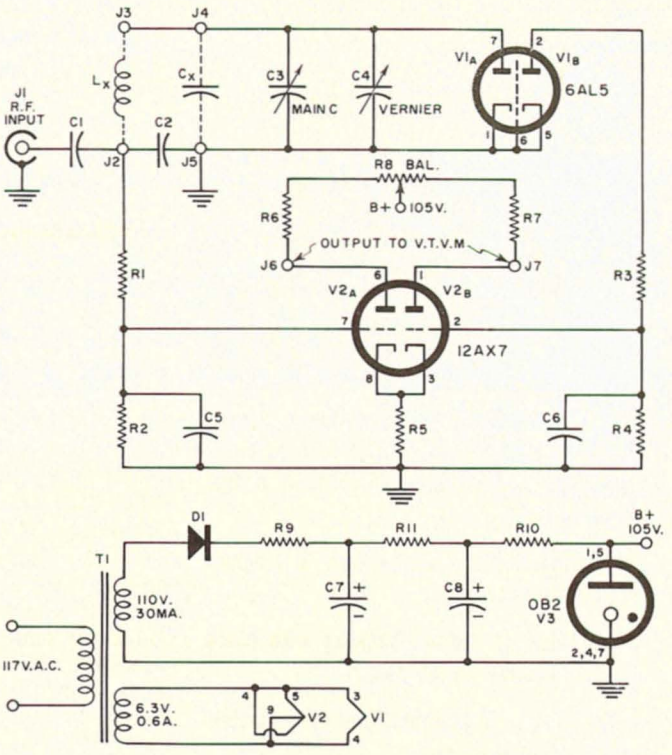
bration chart be made for the capacitance and inductance readings. As this is not as convenient as a direct reading dial, it was not incorporated in this particular unit.

The dial pointer for the main capacitor is made from a thin sheet of clear plastic. Scribe a fine line on the reverse side and fill this line with ink of a color that contrasts with the dial. Glue the pointer to the knob.

The standard coil (L_X), used for calibration of the capacitor, consists of 100 turns of #30 enameled wire on a form ¾″ in diameter. The wire is closewound with no overlapping turns.

Chassis of "Q" meter is neat and clean. Jacks for unknown L (J2,J3) and C (J4,J5) are mounted on top of the cabinet.





R1,R2,R3,R4—3.3 megohm, ½ w. res.
R5—4700 ohm, ½ w. res.
R6,R7—220,000 ohm, ½ w. res.
R8—50,000 ohm pot
R9,R10—100 ohm, ½ w. res.
R11—4700 ohm, 1 w. res.
C1—.01 μf., 100 v. capacitor
C2—.005 μfd., 500 v. disc ceramic capacitor
C3—15-467 pf. tuning capacitor
C4—3-15 pf. vernier capacitor
C5,C6—0.1 μf., 100 v. capacitor
C7,C8—30-50 μf., 150 v. elec. cap.
J1—BNC panel connector (UG-625/U)
J2,J3,J4,J5—Banana jack
J6,J7—Insulated jack/post
D1—130 v. r.m.s., 30 ma. silicon or selenium rectifier
T1—Instrument trans. 6.3 v. @ 0.6 amp, 110 v. @ 30 ma.
V1—6AL5 tube
V2—12AX7 tube
V3—0B2 tube

Fig. 3. Circuit and parts list for the "Q" meter. To use device, external r.f. source and v.t.v.m. are required.

The finished coil will be about 1.1″ long. The ends of the wire should be looped through two small holes drilled in each end of the form to hold them in place. A heavier wire should also be looped through these holds, and the coil ends soldered to it. Spray the coil with plastic or varnish to protect the fine wire. For convenience, the coil can be mounted on a double banana plug. Inductance should be about 100 μh.

Capacitor Calibration

The frequencies used for calibration must be accurately known. Zero beating the signal against known broadcast-band stations (which must be within 20 cycles of assigned frequency) will yield high accuracy. For required frequencies above the broadcast band, the second harmonic can be used.

Plug in the instrument and allow it to warm up. Connect the v.t.v.m. and signal generator. Connect the standard coil to "L" terminals *J2*, *J3*. Set main and vernier capacitors to minimum. After the "*Q*" meter has warmed up, adjust the balance potentiometer *R8* for zero indication on the v.t.v.m. Adjust the signal generator for a peak indication and note the frequency. Calculate the minimum capacitance from $C = 25{,}400/(f^2L)$ where C is the capacitance in pf., f is the frequency in mc., and L is the inductance in μh.

Fully close the vernier capacitor plates, find the resonant frequency, and again calculate the capacitance. The average of the difference between these two capacitances will be used as the vernier zero capacitance. Calculate the resonant frequency for this capacitance from $f = 159/\sqrt{LC}$ where f is the frequency in mc., L is the inductance in μh., and C is the capacitance in pf.

Apply this frequency and adjust the vernier for a maximum indication. Mark this point as zero on the vernier dial.

Calculate the resonant frequency for capacitance increments of one pf. to a maximum of plus and minus 3 pf. or higher, resonate as before, and mark these points. The half pf. values can be interpolated with reasonable accuracy.

The same procedure is used to calibrate the main "C" dial with the vernier set to its zero position. Recommended calibration points are every 5 pf. from the minimum capacitance up to 100 pf.; every 10 pf. from 100 to 200 pf.; and every 20 pf. thereafter. The intermediate 5 and 10 pf. points can be interpolated and marked on the dial.

The "L" scale can now be calculated and marked on the dial. For a frequency of 7.9 mc., the capacitance required to resonate with 1 μh. is 406 pf. The "L" scale 1.0 is marked at this capacitance. Using this same frequency, capacitance values required to resonate with inductances from 1 to 12 μh. are calculated and marked on the dial. Recommended intervals are in steps of 0.1 from 1 to 2; 0.5 from 2 to 10; and 1 from 10 to 12.

This range can be multiplied by use of the proper frequencies, with frequencies and multiplication factors of 7.9 mc. = $\times$1; 2.5 mc. = $\times$10; 790 kc. = $\times$ 100; and 250 kc. = $\times$ 1000. A small chart with this information can be attached to the "*Q*" meter case.

These frequencies were chosen for calibration ease. The 250 kc. and 2.5 mc. frequencies can be checked against WWV, while a 790-kc. broadcast station can be used to check the 790 kc. and 7.9 mc. frequencies.

Slide-rule accuracy is quite sufficient for all necessary calculations. An easier method is the *Allied* "R.F. Resonance and Coil Winding Calculator," or reactance charts such as in *Allied Radio* "Data Handbook" or several other reference books. These methods will also give the required accuracy.

For "*Q*" readings, the voltmeter scale must be calibrated with known voltages. The "L" terminals are shorted, and a low frequency (10 kc. to 100 kc.) is applied to the input. Adjust this input voltage for a convenient voltmeter reading such as 1.0 or full scale. Reduce the input voltage by 3 db or .707 times its original value. Note the v.t.v.m. reading. This is the value to be used for the -3 db points for "*Q*" measurements. Each different scale to be used for "*Q*" measurements must be so calibrated, as the diode rectifier is nonlinear.

To measure capacitance up to 420 pf., connect the unknown capacitor across the "C" terminals, set the "C" dial to the lowest capacitance reading, and adjust the input frequency for resonance. Remove the unknown capacitor and adjust the "C" dial for resonance. The difference between the two readings is the unknown capacitance.

To measure capacitance above 420 pf., connect the unknown to the "C" terminals, and resonate with the "C" dial set to its minimum reading. The capacitance is $C_x = (25{,}400/f^2L) - C_{min.}$ The inductance used here can be any convenient, previously measured value, or the standard coil.

To measure inductance, the unknown inductance is placed across the "L" terminals, and with r.f. applied, the "C" dial is adjusted for resonance. The inductance is given by $L = 25{,}400/f^2C$. If the dial has been calibrated in inductance values and the proper frequency applied for a given range, the inductance will be indicated directly on the "L" dial.

To measure distributed capacitance, resonate the coil at a convenient frequency with the "C" dial. Call this value of capacitance $C1$. Again resonate at exactly twice the frequency. This capacitance is $C2$. The distributed capacitance is given by the following: $C_o = (C1 - 4C2)/3$. This will not work with values of C_o below about 1 pf. unless the distributed capacitance of the standard coil (about 1 pf.) has been taken into consideration during the "C" dial calibration.

There are two methods of measuring "*Q*" with this device: frequency variation and capacitance variation. The frequency variation method requires that the r.f. source be accurately calibrated and flat over the range used. For this method, resonate the coil at a known frequency, f_o, then increase the frequency to a value of f_1, such that the output drops to .707 times the peak value. Decrease to a frequency f_2 such that the output again drops to .707 times the peak value. Then "Q" $= f_o/(f_1 - f_2)$.

The capacitance variation method uses a fixed frequency and the capacitance is varied from its original value of C_o to obtain the .707 points with capacitances $C1$ and $C2$. "Q" $= C_o/(C1 - C2)$.

In both of these methods, use the calibrated values for peak reading and the .707 points as determined under "*Q*" calibration.

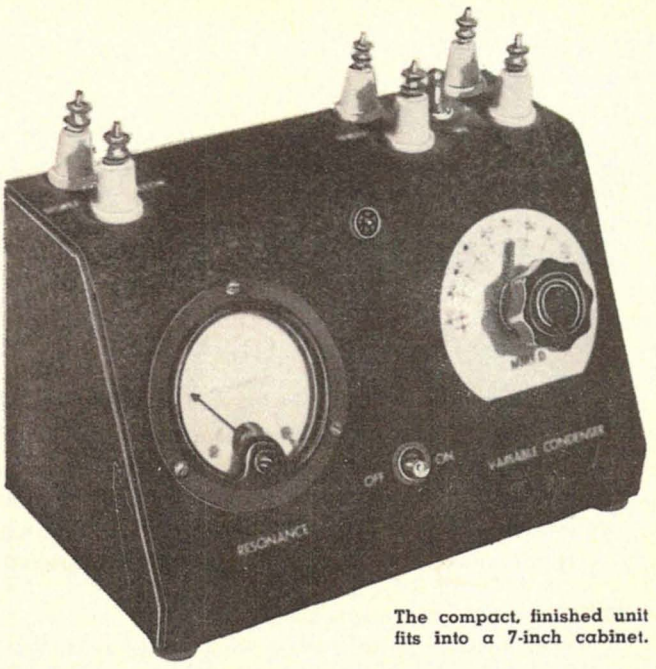
To determine reactance, the following formulas are used after the inductance or capacitance has been determined: $X_L = 2\pi fL$ and $X_c = 1/2\pi fC$ where X_L is the inductive reactance in ohms, X_c is the capacitive reactance in ohms, f is the frequency in mc., L is the inductance in μh., and C is the capacitance in μf.

As the ground terminal of the v.t.v.m. is connected to one plate of the differential amplifier $V2$, the v.t.v.m. case will be about 75 volts above ground. Don't let the two instruments touch, or the signal will be shorted out. As the maximum short circuit current is only 0.6 ma., no shock hazard exists. ▲

The Resonance Meter

By **JOSEPH L. REIFFIN,**
W5CWP

This easily built unit does many jobs in ham shack or service shop normally provided only by laboratory instruments.



The compact, finished unit fits into a 7-inch cabinet.

OF ALL the phenomena of electronics, that of resonance is one of the most widely used and observed and many instruments for the measurement of resonance have been devised. Some are inexpensive and simple to operate, while others are both expensive and complicated. One would suspect that the inexpensive and simple devices are lacking in some degree, else there would be no need for the more elaborate units. That is true and the "Resonance Meter" described here is intended to bridge the gap. It is quite inexpensive to build, simple to operate, and provides a number of functions that are not easily performed by the less costly instruments now available.

The grid-dip meter is probably the most popular instrument in current use for measuring resonance. Many radio amateurs, serious hobbyists, and service technicians have a "grid-dipper" available for measurements of resonance involving coils, r.f. chokes, antennas, and the like. This relatively simple instrument does a fine job but has a number of limitations that somewhat restrict its use.

For example, it is extremely difficult, if not impossible, to measure the resonant frequency of a coil that is completely shielded, with a grid-dip meter. Also the degree of accuracy of the resonance reading is dependent, to a great extent, on the amount of coupling between the circuit being measured and the instrument. This introduces a variable that is difficult to control.

The *"Q"* meter is one of the most accurate devices available for the measurement of resonance of combinations of inductance and capacitance. Those who have ever used a *"Q"* meter will readily attest to the ease and accuracy with which the resonant frequency of an unmarked i.f. transformer is found, to cite one example. Or, to use another example, how easy it is to find how much capacitance is required to tune a given coil to a desired frequency. Like most good things, unfortunately, good *"Q"* meters are quite expensive.

The "Resonance Meter" described here can be built for less than $20, using all new components. The well stocked "scrounge-box" could reduce that cost considerably.

Basically, the "Resonance Meter" is an amplifier so designed and constructed that the frequency-determining inductance and capacitance can be conveniently plugged into the circuit. The output of this amplifier is fed to a cathode-follower stage, and then to a meter that measures the output voltage. By careful selection of the values of resistance and capacitance used in the amplifier circuit, the usable frequency range extends all the way from the higher audio frequencies to above 50 megacycles. Particular care is re-

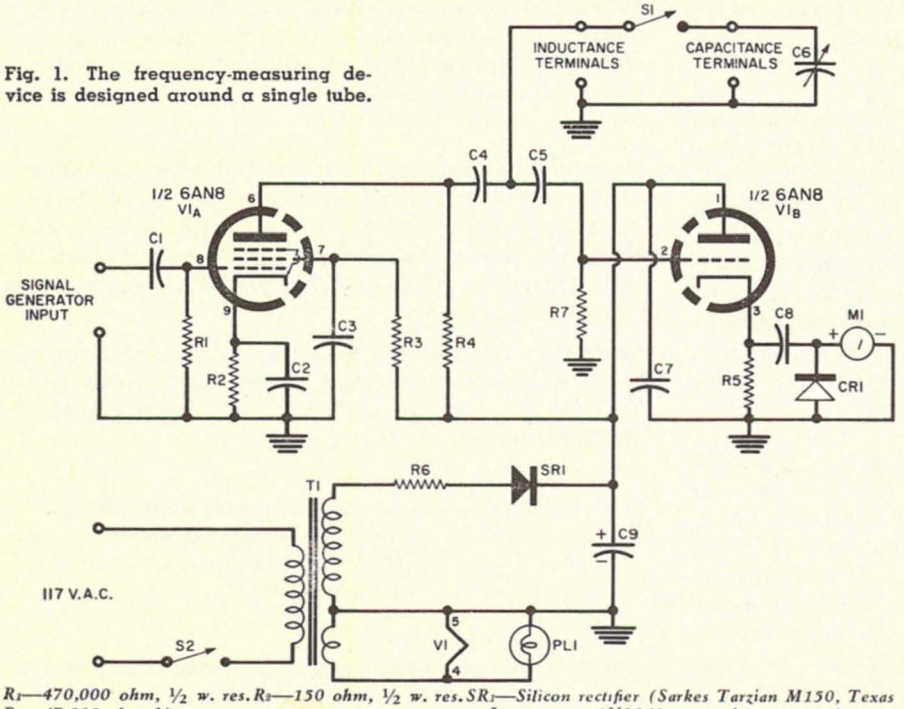


Fig. 1. The frequency-measuring device is designed around a single tube.

R_1—470,000 ohm, ½ w. res. R_2—150 ohm, ½ w. res. R_3—47,000 ohm, ½ w. res.
R_4—33,000 ohm, 1 w. res.
R_5—1000 ohm, 1 w. res. R_6—22 ohm, 1 w. res.
R_7—1 megohm, ½ w. res.
C_1, C_4, C_5—1500 μμf. disc ceramic capacitor
C_2, C_3, C_7, C_8—.01 μf. disc ceramic capacitor
C_6—5-100 μμf. var. capacitor (Hammarlund HF-100)
C_9—50 μf., 250 v. elec. capacitor
CR_1—1N34 germanium diode
SR_1—Silicon rectifier (Sarkes Tarzian M150, Texas Instruments 1N2069 or equiv., see text)
S_1—S.p.s.t. toggle switch ("Capacitance In-Out," see text)
S_2—S.p.s.t. toggle switch ("Power On-Off")
M_1—0-1 ma. meter, 2" dia.
T_1—Power trans. 115 v. pri. to 150 v. sec. and 6.3 v. fil. winding (Merit P-3046 or equiv.)
PL_1—#40 or #47 pilot lamp V_1—6AN8 tube
1—7" wide, sloping panel utility box (Bud C-1605)

quired in the placement of the various components in order to reduce stray capacitance to a minimum.

A 6AN8 tube is used in this circuit. The pentode section makes a good amplifier and the triode section serves very nicely as the cathode-follower. The output of the cathode-follower is rectified by the germanium diode (CR_1 in Fig. 1) and the resultant voltage is read directly on the output meter.

The "Resonance Meter" is entirely self-contained with a built-in power supply using a small plate and filament transformer to provide safe isolation from the line. It is built into a sloping-panel utility box (*Bud* C-1605) seven inches wide. The entire amplifier is assembled on an easily constructed aluminum chassis and this is mounted within the utility box.

The tube is mounted upside down in order to keep the leads to the coil terminals and the capacitor terminals as short as possible. Figs. 2 and 3 give some idea as to how this is managed.

It will be noted that the terminals for the signal-generator input and the terminals for the external coil and capacitor are the porcelain feedthrough type commonly used for high-voltage applications. The original model used standard binding posts made of some Bakelite compound. These proved to be unacceptable in this application, since they added so much capacitance and inductance to the circuit that a false frequency reading was obtained. Many different types of binding posts were tried, but it was impossible to find any entirely free from this effect. The use of the high-voltage feedthroughs minimized the added capacitance and inductance effects to the point where they were acceptable.

The toggle switch (S_1) that enables the calibrated capacitance to be inserted into the circuit also produced this problem and actually no real solution was found. There is evidently a need for a switch with very low capacitance and inductance in a size small enough for this application. If one could be found, it is recommended that it be used in place of the toggle switch the author employed in his model.

The chassis that contains most of the components of the "Resonance Meter" is made from a piece of aluminum stock approximately 2" wide, 5½" long, and 1/16" thick, bent into a sort of "L" shape. See Fig. 2. The 9-pin socket for the 6AN8 tube is mounted in the center of the top part of this chassis. The socket is mounted so that the pin terminals face up and the tube, when inserted in the socket, will be upside down. On the top side of the chassis, two tie-point strips are mounted along the edges next to the bottom side of the socket. These provide handy connecting points for the various capacitors and resistors used in the circuit.

The power transformer is mounted on a 2" x 2½" strip of aluminum (Fig. 2) that has a ½" lip on one end for mounting to the main chassis. This is mounted to the right side—looking at the chassis from the rear of unit.

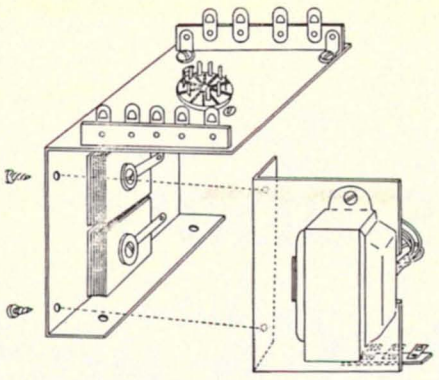


Fig. 2. Layout for two chassis plates and main parts. Two selenium units may replace single silicon diode of Fig. 1.

In the original model, the power rectifier consisted of two 60-ma. selenium rectifiers, connected in series, as shown in Fig. 2. Two were used because the r.m.s. voltage output of the power transformer is 150 volts whereas the maximum r.m.s. voltage rating of the selenium rectifiers is 130 volts each. From a safety standpoint, the use of two rectifiers in series was indicated to take care of the full voltage more than adequately without danger of breakdown. It would doubtless be more convenient and less costly to use one of the newer silicon rectifiers now available, as indicated in the parts list. These rectifiers take up very little space and have r.m.s. voltage-breakdown ratings in excess of 200 volts, which makes them a natural for this application.

The variable capacitor used for external tuning (C_6) is mounted on the sloping panel of the utility box. The one used was a *Hammarlund* type HF-100, which is designed to have a straight-line characteristic. The plates of this capacitor are so formed that there is a linear change of capacitance with a given amount of rotation of the rotor plates. It is, therefore, a relatively easy matter to draw a calibrated capacitance scale for this external adjustment. The minimum capacitance is 5 $\mu\mu$f. and the maximum is 100 $\mu\mu$f. The 180 degrees of rotation between the minimum and maximum is then divided into ten equal divisions and marked with the appropriate capacity values. This may not be an absolutely precise calibration but it is certainly close enough for all practical purposes. It would not vary much more than about 3 or 4 $\mu\mu$f. at the very most, and that tolerance is well within the anticipated needs of most users.

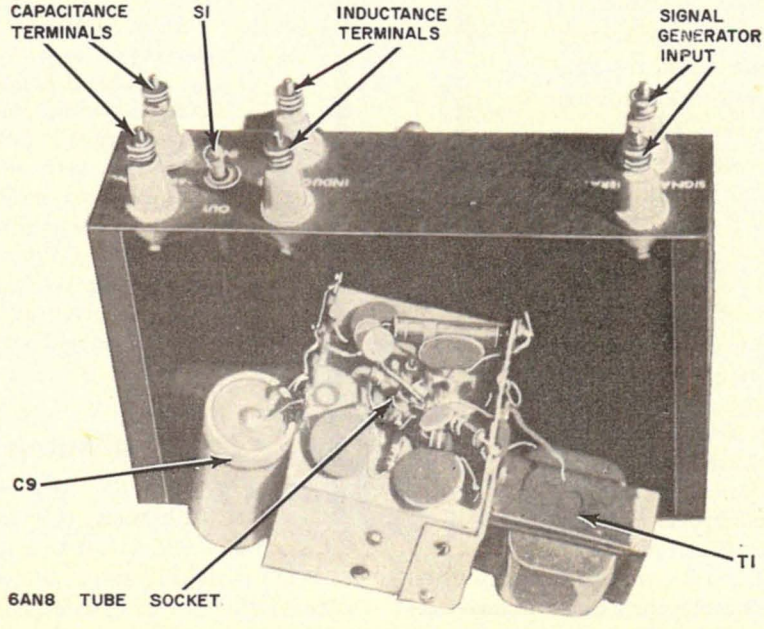
The meter, M_1, is also mounted on the sloping panel of the box. A 0-1 ma. meter provides ample sensitivity and, fortunately, units of this type are readily available at low cost.

The "Resonance Meter" performs many functions. The one that will probably find the greatest application is the determination of the resonant frequency of a coil when tuned either by circuit capacitance or by any size capacitor desired. Specifically, you may want to find out what frequency will be covered by a 20-turn coil of 1-inch diameter when tuned with a 50 $\mu\mu$f. capacitor. Or you may want to find out what frequency range will be covered by a slug-tuned coil of any given number of turns by running the slug up and down. These measurements are very simply made in the following manner.

A calibrated signal generator is connected to the input terminals of the "Resonance Meter." This connects the signal to the grid of the pentode section of the 6AN8 tube. The coil under measurement is connected to the inductance terminals. This puts the coil in the plate circuit of the pentode, which circuit is designed so that there is no d.c. present at these terminals—making it safe at all times. The fre-

(*Continued on page* 100)

Fig. 3. Main chassis ready for mounting in case and location of terminals.



The Resonance Meter

(*Continued from page* 95)

quency of the signal generator is then varied until a reading is obtained on the output meter. The frequency that produces the peak reading on the meter is the resonant frequency of the coil.

If it is desired to tune this coil with any given amount of capacitance, all that is necessary is for the capacitance switch to be thrown to the "in" position. This connects the 100 $\mu\mu$f. variable capacitor across the coil and any desired amount of capacitance can be inserted. The frequency of the signal generator that produces the peak reading of the output meter is the resonant frequency of the coil and capacitor combination. If more capacitance than the 100 $\mu\mu$f. built into the meter is desired, it is a simple matter to connect the required additional capacitor to the capacitor terminals on the meter. This automatically puts the added component in parallel with the 100 $\mu\mu$f. variable, and there is no limit to the amount of capacitance that can be inserted in this way.

The meter readings obtained are very sharp and clearly defined. Due to the sensitivity of this instrument, care must be taken to insure that a false reading is not obtained through inadvertent peaking on a harmonic of the signal generator. This is very easily checked out, however, by tuning the signal generator through the next higher frequency range and, if no peaking is obtained, then the highest frequency that did produce the peaking is the correct reading. In actual practice, the readings obtained from the fundamental frequencies are considerably higher than those obtained from the harmonic frequency due to the greater fundamental output from the signal generator. This fact will also help to avoid error.

Operating Techniques

Some of the many special functions that this device will perform include the relative measurement of the *"Q"* of a coil or capacitor and a check of the bandpass characteristics of a tuned circuit. The methods involved will be discussed subsequently. However, to the author, one of the most gratifying uses has been the determination of the proper combination of coil and capacitor to provide a desired range of tuning. Specifically, this is of interest in arriving at suitable values for the right amount of bandspread in a ham receiver or a transmitter v.f.o.

It is quite simple to insert a coil of a given size in the meter experimentally and to determine how much capacitance is required to tune it to a desired frequency. Once the capacitance is determined, the latter may then be varied to see how much the resonant frequency changes with capacitance variations. By changing the value of the coil experimentally, it is then possible to arrive at the right combination of values of inductance and capacitance that will provide the exact amount of bandspread required.

While this determination usually constitutes a knotty problem, the suggested method not only provides a simple solution but an accurate one, as well. The amplifier used in the meter simulates closely, as a rule, the stray circuit and tube capacitances in those circuits of conventional receivers and similar equipment in which the coil-capacitor combination will be used. Thus there is very little change when the tested components are transferred to the circuit for which they have been selected.

It is also a very simple matter to measure the relative *"Q"* of a coil or capacitor. Since *"Q"* is a figure of merit, a coil having a high *"Q"* will give a higher meter reading than one having a lower *"Q"*. The same is true of a capacitor. The relative *"Q"* of a capacitor can be quickly determined by substituting various capacitors of the same nominal value across the test coil. The capacitor that gives the highest meter reading has the highest *"Q"* of those being tested. This test will graphically illustrate how important it is to use high-quality components in tuned circuits, especially at the higher frequencies, if any reasonable efficiency is desired.

It is also possible to measure the bandpass characteristics of a given tuned circuit. Most bandpass characteristics are measured on the resonance curve at a point 6 db down from maximum. Using the coil and capacitor combination under test in the "Resonance Meter," the frequency of the signal generator is varied until a peak reading is obtained on the meter. This is the center frequency of this resonance curve. If there is an attenuator on the signal generator, vary the output until a convenient reading of, say, .8 ma. is obtained on the meter. The frequency of the signal generator is then shifted higher in frequency until the meter reads exactly one half of the center frequency reading; in this case, .4 ma. This frequency is noted. Then the frequency of the signal generator is changed again, this time to the low-frequency side of the center frequency, until the meter once again reads half of the maximum reading. These "half-maximum" readings are the "6 db points" down the slope of the resonance curve. The frequency spread between the high-frequency reading that gave the .4 ma. meter reading and the low-frequency reading that gave the same .4 ma. meter reading is the bandpass of that particular coil and capacitor combination at 6 db down.

The number of uses to which the "Resonance Meter" can be put seems to be unlimited. It has proven itself invaluable many times and has taken a well-deserved place right next to the author's overworked and uncomplaining v.t.v.m. Build it and see if you don't agree. —30—