

BOONTON ELECTRONICS CORPORATION

ELECTRONIC MEASURING INSTRUMENTS



RF VOLTMETERS • CAPACITANCE BRIDGES • RF ADMIT-
TANCE BRIDGES • INDUCTANCE BRIDGES • DC METERS
AC AND DC NULL DETECTORS • UHF GRID DIP METERS

BOONTON
ELECTRONICS ||||| Announces....
CORPORATION

a move to new plant and offices at:



ROUTE 287 at SMITH ROAD
PARSIPPANY, NEW JERSEY



TELEPHONE: 201-887-5110 • TWX: 201-887-5059

SENSITIVE RF VOLTMETER

300 μ v to 300 VOLTS

**MODEL
91D
SENSITIVE
RF VOLTMETER**

Frequency Range: 20 KC to 1200 MC

Accuracy: to 3%

RMS response from 300 μ v to 3v

Meter Scales: Linear over calibrated region

DC Protection: Probes tested at 400v DC

**Negligible error over a wide range
of temperature**

DC Output Available at Front Panel

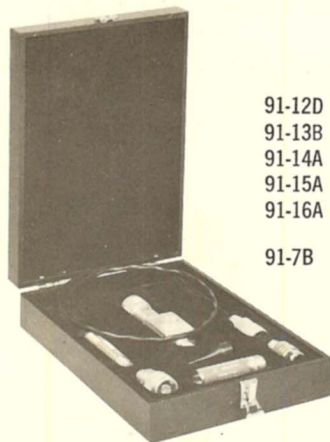
The Model 91D RF Voltmeter is a refinement of the highly successful design of the Model 91CA RF Voltmeter. In achieving greater accuracy and stability plus wider frequency range, in providing d-c output and high d-c voltage protection of probes, the 91D represents the best performance of a sensitive r-f voltmeter available today.



Model 91D: \$750
Complete with Probe Kit shown

RF VOLTMETER PROBE KIT

The versatility of measurements of the Model 91D RF Voltmeter is made possible with a number of probe accessories. All of these accessories are provided as standard equipment with the Model 91D. For convenience of storage and for ease of carrying these accessories and the probe with attached cable are packed in a durable, well cushioned box. These items are:



- 91-12D RF Probe
- 91-13B Probe Tip
- 91-14A Type N "Tee" Adapter
- 91-15A 50 Ω Termination
- 91-16A Unterminated Type N Adapter
- 91-7B 100:1 Voltage Divider

SPECIFICATIONS

- VOLTAGE RANGE:** 300 microvolts to 3 volts
Measurements to 300V up to 250MC may be made with 91-7B Voltage Divider provided
- FULL SCALE VOLTS:** .001, .003, .01, .03, .1, .3, 1, and 3
- DB RANGE:** 80 (70 in 10 db switch steps plus 10 db on meter scale)
- VOLTAGE ACCURACY:** 150 KC to 100 MC: $\pm 3\%$
50 KC to 400 MC: $\pm 5\%$
20 KC to 1200 MC: $\pm 10\%$
- APPROX. PROBE CAPACITANCE WITH TIP:** Varies from 2.0 to 3.0 pf inversely with voltage
- VSWR:** Less than 1.2 to 1200 MC with Tee Adapter
- FREQUENCY RANGE:** 20 KC to 1200 MC. Useful to above 2500 MC
- WAVEFORM RESPONSE:** True RMS below 0.03V changing to peak reading (calibrated in RMS) at higher levels. With 91-7B Voltage Divider RMS response may be extended to 3V.
- LINEAR DC OUTPUT:** Approx. 1.3v DC into 1000 Ω load
- POWER SENSITIVITY:** .0018 microwatt maximum
- POWER REQUIREMENTS:** 105 to 125V, 60 cycles, 45 watts,
210 to 250 volt, 50 cycle operation available at the extra cost of \$20.00.
- STANDARD EQUIPMENT SUPPLIED WITH 91D:** See probe kit at left.
- SIZE:** 7 $\frac{1}{4}$ W x 9 $\frac{1}{2}$ D x 11H excluding handle
- WEIGHT:** 18 lb. packed for shipping. 13 $\frac{1}{2}$ lb. net

SPECIFICATIONS AND PRICES SUBJECT TO CHANGE WITHOUT NOTICE



Boonton ELECTRONICS Corporation

ROUTE 287 at SMITH ROAD, PARSIPPANY, NEW JERSEY — 07054
PHONE: 201-887-5110 • TWX: 201-887-5059

SENSITIVE RF VOLTMETERS

The Industry Standard for Low Level
Broad Band RF Voltage Measurements

**MODEL
91CA AND 91C
RF
VOLTMETERS**

VOLTAGE RANGE:

300 μ v to 3v-91CA

1000 μ v to 3v-91C

FREQUENCY RANGE:

10Kc to 600Mc

Useful to above 1500Mc

VSWR:

1.2 Max to 600Mc

SUPPLIED WITH:

High Impedance Probe
50 ohm Adapter

RMS Response Below 0.03v

To 3v with 100:1 Voltage Divider



Model 91C
Price \$450

Model 91CA
Price \$550



Boonton *ELECTRONICS* Corporation

MORRIS PLAINS, NEW JERSEY
TELEPHONE: 201-539-4210



BLOCK DIAGRAM
91CA and 91C
RF Voltmeters

GENERAL DESCRIPTION

The Model 91CA RF Voltmeter represents a major advance in the art of low level radio frequency voltage measurements. Until the advent of this instrument it had been customary to think of ac voltmeters of 1 millivolt sensitivity as having an upper frequency limit of a few megacycles. Higher frequency voltmeters had a sensitivity limited to about .1 volt. The 91CA RF Voltmeter combines the sensitivity of the electronic voltmeter with the frequency range of the diode-probe voltmeter giving the electronic industry a versatile new tool. Low level rf voltage measurements can now be made which were formerly difficult, time consuming, and required such elaborate equipment as to be considered impractical.

The block diagram shows the basic elements of the 91CA RF Voltmeter. The signal may be applied either directly to the high impedance Probe or through the 50 ohm Adapter. The Probe uses a pair of germanium diodes in a full wave rectifier circuit which operates as a square law detector below 0.03 v, thus providing RMS response in this region. The 50 ohm Adapter is a well designed termination for use with coaxial system measurements. The VSWR of the 50 ohm Adapter is less than 1.2 at frequencies up to 600 MC. The low level dc output from the Probe is applied to the attenuator through a specially designed low-noise input cable assembly. The dc voltage is converted to 60 cycles by the low-level, low-noise chopper, and then fed to a high gain narrow band feed-back stabilized amplifier. The output of this amplifier is rectified, then applied to a linearizing circuit and to the panel meter. The linearizing circuit compensates for the non-linear characteristics of the probe diodes, and because each range requires a different linearizing adjustment, separate linearizing circuits are gang switched with the input attenuator. The meter has been so simplified that only two scales, 1 to 3 and 3 to 10 are needed to display the 8 voltage ranges. A db scale, 0 to 10 completes the meter markings.

The voltage range of the 91CA can be extended to 300V using the 100 to 1 Voltage Divider. The high shunt resistance of the Voltage Divider, (more than 10 times that of the typical vacuum diode probe) may be of prime interest where light loading of the circuit under test is a requirement. The use of the Voltage Divider extends the RMS reading of the RF Voltmeter to the 3 volt region.

APPLICATIONS

The 91CA RF Voltmeter has application wherever broadband low level testing is required. A few of the many applications are listed here.

- Transistor gain measurements.
- Amplifier gain measurements.
- Filter network loss measurements.
- Attenuator loss measurements.
- Null indicator to 200 microvolts.
- Signal generator output measurements.

SPECIFICATIONS

MODEL 91CA RF VOLTMETER

VOLTAGE RANGE:	300 Microvolts to 3 volts.
FULL SCALE VOLTS:	.001, .003, .01, .03, .1, .3, 1 and 3.
DB RANGE:	80, 70 in 10 DB switch steps plus 10 DB on meter scale.
ACCURACY:	
Voltage:	5% full scale up to 200 mc.
Accuracy:	10% full scale above 200 mc.
VSWR:	1.2 max. to 600 MC
FREQUENCY RANGE:	10 KC to 600 MC. Useful to above 1500 MC.
WAVEFORM RESPONSE:	RMS below 0.03 v changing to peak reading (calibrated in RMS) at higher levels.
POWER SENSITIVITY:	.0018 Microwatt max.
FULL SCALE	.02, 0.18, 2, 18 microwatts.
POWER SENSITIVITIES:	0.2, 1.8, 20, 180 milliwatts.
POWER REQUIREMENTS:	105 to 125V, 50-60 cycles, 35 watts, 210 to 250 volt 50-60 cycle operation available at the extra cost of \$10.00.
SIZE:	7¼ W, x 9½ D x 11 H excluding handle.
WEIGHT:	16 lb. packed for shipping, 12 lb. net.
STANDARD EQUIPMENT SUPPLIED WITH 91CA:	1 Model 91-3B 10K to 600 MC Probe. 1 Model 91-8B 50 Ω Adapter. (Other values of termination resistance available on special order.)
PRICE:	\$550.00 F.O.B. Morris Plains, N. J.
RACK MOUNTING:	Also available the 91CA-R on an 8¾ x 19 rack panel. Extends 8¾ inch behind front panel. Price \$575.00.
ACCESSORIES AVAILABLE:	91-4B 1KC to 250 MC Probe. 91-7B 100-1 Voltage Divider. 91-6B BNC Adapter.

MODEL 91C RF VOLTMETER

The 91C differs from the 91CA only in the elimination of the most sensitive range and its associated thermal voltage bucking circuit. The specifications affected by these differences are given below. All other specifications are identical with the Model 91CA specifications given above.

VOLTAGE RANGE:	1 Millivolt to 3 volts.
FULL SCALE VOLTS:	.003, .01, .03, .1, .3, 1 and 3.
DB RANGE:	70, 60 in 10 DB switch steps plus 10 DB on meter scale.
POWER SENSITIVITY:	.02 microwatt max.
FULL SCALE	0.18, 2, 18 microwatts.
POWER SENSITIVITIES:	0.2, 1.8, 20, 180 milliwatts.
PRICE:	\$450.00 F.O.B. Morris Plains, N. J.
RACK MOUNTING:	Also available, the 91C-R on an 8¾ x 19 rack panel. Extends 8¾ inch behind front panel. Price \$475.00.

Specifications and prices subject to change without notice

Represented by

RF Distortion Meter and Voltmeter



**MODEL 85B
FOR
DISTORTION MEASUREMENTS
FROM 1 TO 100 MC**

**MODEL 85C
FOR
DISTORTION MEASUREMENTS
FROM 0.1 TO 6 MC**

Two models of the Boonton Electronics RF Distortion Meter and Voltmeter are now available, the Model 85B for total distortion measurements of any RF signal from 1 to 100 megacycles, and the Model 85C for lower frequencies from 0.1 to 6 megacycles. Either instrument may also be used as an extremely sensitive broadband voltmeter covering a range of .001 volt to 3 volts over a frequency range of 50 KC to 600 megacycles.

FEATURES

RF DISTORTION METER

- **FREQ. RANGE:** 85B 1 TO 100 MC
85C 0.1 TO 6 MC
- **SENSITIVITY:** 60DB BELOW 1 VOLT
- **ACCURACY:** ± 2 DB
- **INPUT IMPEDANCE:** APPROX. 50 OHMS
- **FAST, EASY OPERATION**

RF VOLTMETER

- **FREQ. RANGE:** 50 KC TO 600 MC
- **VOLTAGE RANGE:** .001 TO 3 VOLTS
- **ACCURACY:** $\pm 5\%$ TO 200 MC
 $\pm 10\%$ TO 600 MC
- **HIGH IMPEDANCE PROBE**
- **52 OHM ADAPTER:** VSWR APPROX. 1.2
- **NO ZERO DRIFT**

APPLICATIONS

- **AMPLIFIER DISTORTION AND GAIN MEASUREMENTS**
- **OSCILLATOR DISTORTION AND OUTPUT MEASUREMENTS**
- **TRANSMITTER HARMONIC MEASUREMENTS**
- **MIXER GAIN AND DISTORTION MEASUREMENTS**
- **FILTER FREQUENCY LOSS MEASUREMENTS (70DB RANGE)**
- **ATTENUATOR LOSS MEASUREMENTS**
- **TRANSISTOR GAIN TESTING AT LOW LEVELS**
- **MISCELLANEOUS PRODUCTION ADJUSTMENTS AND TESTING**
- **IDEAL FOR RAPID ADJUSTMENTS TO ATTAIN OPTIMUM PERFORMANCE WITH MINIMUM DISTORTION**

— MODEL 85 B & 85 C Price: \$825.00 each, fob Morris Plains, New Jersey —

PRICE & SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

2M-4-63



Boonton *ELECTRONICS* Corp.
Morris Plains, N. J. Phone: JEFFERSON 9-4210

TECHNICAL DESCRIPTION

RF DISTORTION METERS

MODEL 85-B AND 85-C

The BOONTON ELECTRONICS RF Distortion Meters are unique in their ability to measure total harmonic content of radio frequency signals in the range of 0.1 to 100 megacycles. They have been designed to provide the electronics industry with low cost, easy to operate, but accurate means for determining harmonic distortion at radio frequencies.

Both Models 85B and 85C have been found particularly useful for monitoring harmonic level during adjustments of circuit parameters such as grid bias, plate voltage, interstage impedance, output coupling, feedback, etc.

The combination of ease of operation, low cost, and accuracy obtainable, invites consideration for making RF harmonic measurements on a production basis.

The principle of operation is the same as that commonly used in the audio frequency distortion meter, where a null circuit suppresses the fundamental frequency only, thus enabling the harmonic amplitude to be measured on a sensitive broadband voltmeter.

The null circuit consists of a specially designed series-resonance bridge capable of 60DB suppression to the desired fundamental frequency, while providing almost perfect transmission for its harmonic frequencies up to 200 MC and approximately 4DB loss at 300 MC. The voltmeter circuit consists of a full wave crystal diode rectifier operating in the square law region during harmonic measurements. This provides indications proportional to the RMS of the harmonic content. A chopper type DC amplifier with adequate feedback is utilized to attain the sensitivity, stability and accuracy required.

The 85B and 85C Distortion Meters both have provision for separate utilization of the extremely sensitive RF Voltmeter by means of an external crystal diode probe attachment. Seven ranges calibrated in both DB and Volts enable measurements to be made from .001 volt to 3 volts over a frequency range of 50KC to 600MC.

Boonton *ELECTRONICS* Corporation

738 SPEEDWELL AVENUE, MORRIS PLAINS, NEW JERSEY, U. S. A.

SENSITIVE DC METER

**MODEL
95 A**
SENSITIVE
DC METER

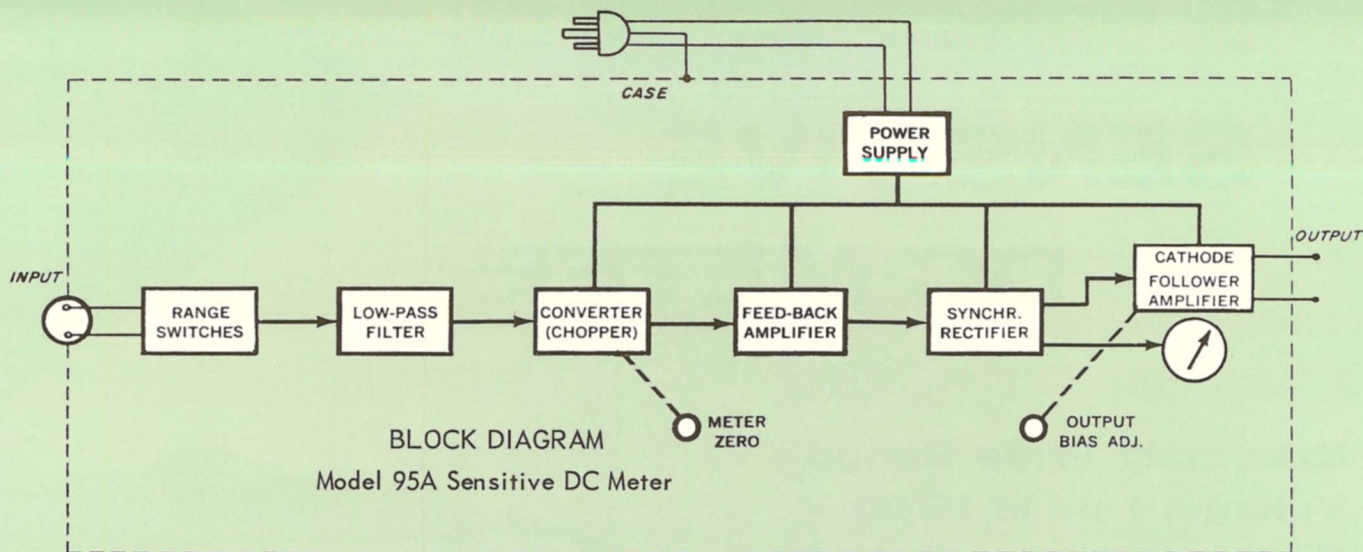
- Extremely Wide Range
Voltage: 1 μ v to 1000 V
Currents: 0.1 μ a to 1 amp.
- Simplicity of Range Switching
and Meter Reading
- Constant Input Resistance
of 10 Megohms on all
Voltage Ranges.
- Floating Input
- Fast Response
- Low Drift
- Amplifier Output
at Front Panel



Price \$550



Boonton *ELECTRONICS* Corporation



GENERAL DESCRIPTION

The Model 95A Sensitive DC Meter is a sensitive wide range combination voltmeter, ammeter and amplifier. A unique multiplex range switching system permits rapid selection of any of the 42 voltage or current ranges and displays in large lighted windows the full scale value and unit of measure of the range in operation. This range switching system makes for easy operation and instant recognition of the scale in use thereby reducing the incidence of errors of interpretation. The range of measurements, 1 μ volt to 1000 volts and 0.1 μ a to 1 ampere, it is believed, is the greatest of any commercially available instrument.

CIRCUIT

The instrument is a stable, high gain, feedback, ac amplifier operating from the output of a low noise chopper. A synchronous output rectifier consisting of a transistor switching circuit driven in phase with the input chopper produces a dc output current proportional in amplitude and identical in polarity to the input voltage. A zero center meter indicates positive to the right and negative to the left. The input voltage is applied to the chopper through a switching system which either attenuates the input voltage or varies the gain of the amplifier. Current ranges are provided by internally shunting the input with an appropriate resistance and then reading the voltage drop across this resistance in terms of current calibration. A meter ZERO ADJ control is provided; however, after a 30 minute warm-up normally there is no need to reset the zero when changing sensitivity ranges. An exception to this is the most sensitive range where some correction may be needed, particularly when thermals or residual voltages are present in the test circuit.

FLOATING INPUT

The input circuit may be operated either grounded or floating. A jumper across the terminal posts at the bottom left of the front panel connects the input circuit to the panel for grounded operation. When the jumper is removed the input circuit floats a minimum of 500 megohms above ground.

CONSTANT INPUT RESISTANCE

The input resistance of the Model 95A is held to a constant 10 megohms on all voltage ranges. This frees the Model 95A of a range switching error which is inherent in all meters that have their input resistance varying with range. By presenting a constant load to a high resistance source the Model 95A can be switched from range to range without changing the voltage at the source.

AMPLIFIER OUTPUT

The output of the synchronous rectifier is also applied to a cathode follower where separate gain and bias controls give complete flexibility in the control of the output gain and reference level without interacting with the internal meter. This feature allows the high sensitivity of the Model 95A to be used in conjunction with a variety of recording or control devices.

SPECIFICATIONS

VOLTAGE RANGE:	± 1.0 microvolt to 1,000 volts dc
CURRENT RANGE:	$\pm 0.1 \mu\text{a}$ (10^{-13}) to 1.0 ampere dc
INPUT RESISTANCE:	
Voltmeter:	10 megohms all ranges
Ammeter:	1.0 μa to 100 μa Range: 10 megohms
300 μa :	3.33 megohms
1 ma:	1.0 megohms
3 ma:	333 ohms
10 ma:	100K ohms
30 ma:	33.3K ohms
100 ma:	10K ohms
300 ma:	3.33K ohms
1 μa :	1K ohms
3 μa :	333 ohms
10 μa :	100 ohms
30 μa :	33.3 ohms
100 μa :	10 ohms
300 μa :	3.33 ohms
1 ma to 1a:	1.0 ohm
FULL SCALE SENSITIVITIES:	
Voltage:	± 10 microvolts to 1,000 volts dc
Current:	± 1.0 micromicroampere to 1 ampere
ACCURACY:	
Voltmeter:	$\pm 3\%$ of Full Scale
Ammeter:	$\pm 4\%$ of Full Scale
RANGES:	
Voltmeter:	17 Ranges 1,3,10,30 etc. sequence
Ammeter:	25 Ranges 1,3,10,30 etc. sequence
NOISE:	1 μv PP (approx.) referred to input
DRIFT:	less than $\pm 2 \mu\text{v}$ after 30 minute warm up referred to input.
BANDWIDTH:	1 cycle at 3 DB
RESPONSE TIME:	Approx. 1 Sec. to 90% of Full Scale
60 CYCLE REJECTION:	greater than 60 DB
METER:	Zero center with mirror scale
RESISTANCE FROM INPUT CIRCUIT TO CASE:	500 megohms minimum
AMPLIFIER:	Gain 100,000 maximum
OUTPUT:	0 to ± 1.0 volt into 1,000 ohm load polarity same as applied Input. Output is continuously adjustable.
	Approximately 400 ohms.
OUTPUT IMPEDANCE:	
RACK MOUNTING:	Also available, the 95A-R on a 5 1/4 x 19' rack panel. Extends 8 3/4' behind panel. Price \$575.
POWER REQUIREMENTS:	105 to 125V, 50-60 cycles, 40 watts.
	210 to 250V, 50-60 cycles (Special)
SIZE:	7 1/2W x 9 1/2D x 11H excluding handle
WEIGHT:	17 lbs. packed.
	Approx. 22 lbs. packed (rack mounted)
SUPPLIED WITH:	4 ft. shielded test leads terminated in insulated clips.



Model 95A-R

Boonton *ELECTRONICS* Corp.

MORRIS PLAINS, NEW JERSEY

Telephone: 201-539-4210

**MODEL
56A**

**DC NULL
DETECTOR**



DC NULL DETECTOR

**For use with Wheatstone Bridges or in other Applications
Where a Sensitive Galvanometer is required.**

10 μ v at Full Scale
on Most Sensitive
Range

10 Megohms Input
Impedance on all
Ranges

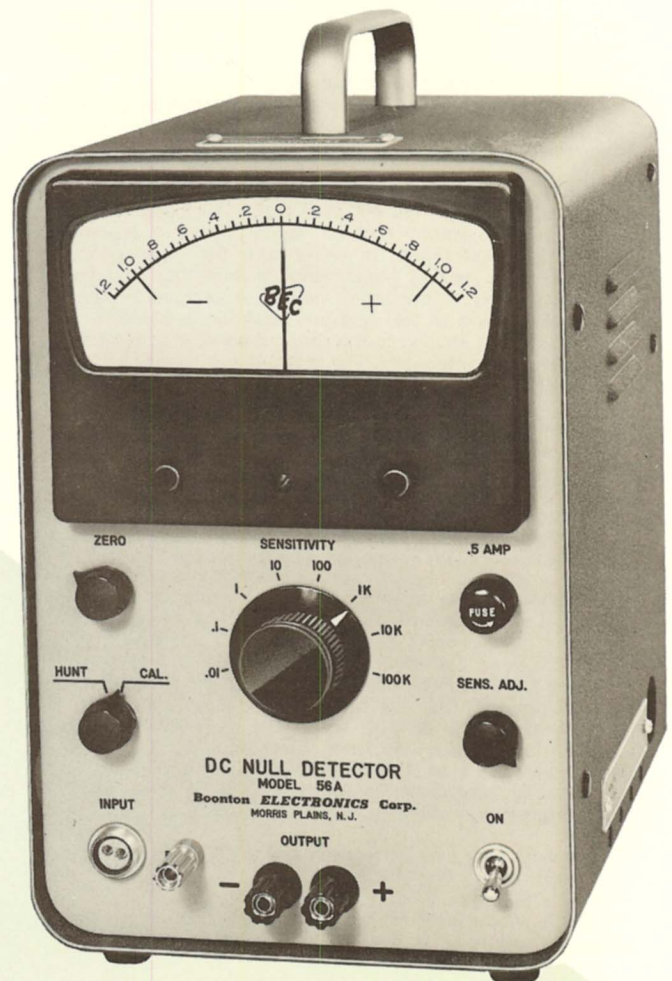
160DB Control of
Sensitivity in 8
Ranges

Fast Response

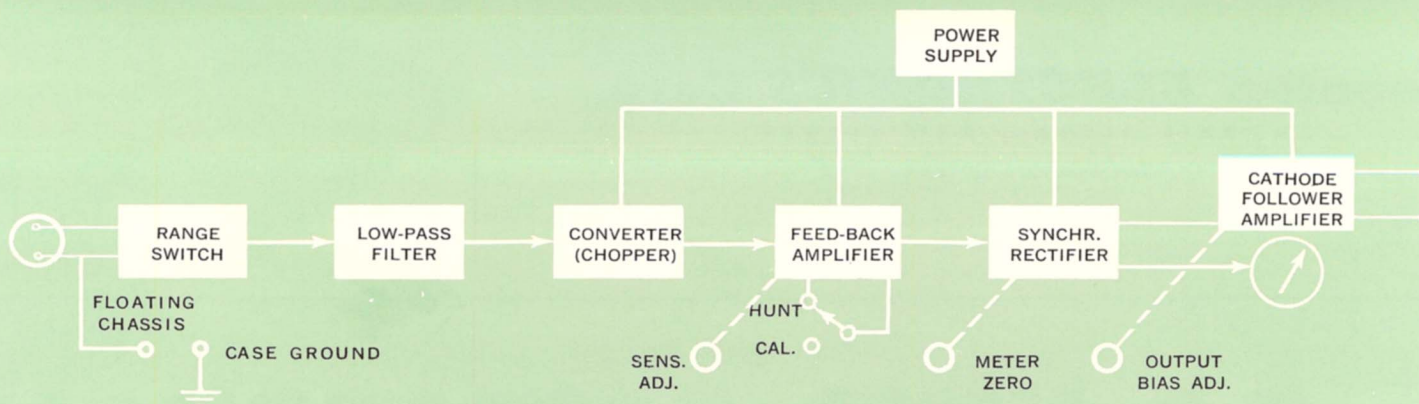
Floating Input

60DB of Gain Compression
for "Hunting" of Bridge Balance

Amplifier Output Available at Front Panel



PRICE: \$450.



GENERAL DESCRIPTION

The Model 56A Null Detector is a sensitive, high impedance indicating device designed for use with dc bridges or for other applications where sensitivities are required that are considerably greater than available from the best mechanical galvanometers. The increase in current sensitivity approaches 10,000 times. The features necessary for making the rapid series of measurements involved in the adjustment of precision components on a production basis have been incorporated in the Model 56A. It is particularly useful as an indicator for Wheatstone bridges in the production of close tolerance wirewound and deposited carbon resistors. One part per million may be readily resolved using a precision bridge and low test voltages.

Basically the instrument is a stable, high gain, feedback, ac amplifier operating from the output of a low noise chopper. A synchronous output rectifier consisting of a transistor switching circuit driven in phase with the input chopper produces a dc current proportional in amplitude and identical in polarity to the input voltage. A zero center meter indicates positive to the right and negative to the left. The input voltage is applied to the chopper through an eight step, high resistance attenuator. The eight ranges varying from .01 to 100,000 relative units (approximate gain as amplifier) in 1 to 10 steps provide the extremely wide range of 160 db control of indicator sensitivity. A sensitivity control used in conjunction with the range switch permits relating a desired percentage tolerance to the limits marked on the meter scale. A meter ZERO control is provided; however, after a 30 minute warm-up there is no need to reset the zero when changing sensitivity ranges except on the most sensitive range where a slight correction may be needed.

A switch allows the selection of either a compressed (HUNT) or linear (CAL) amplifier mode of operation. In the HUNT mode of operation 60 db of meter scale compression virtually eliminates the need to switch sensitivity ranges while hunting for a balance when working with an unknown component. In the CAL (calibrate) mode the meter scale is linear over a -1.2 to $+1.2$ range. The HUNT-CAL switching may be operated at the front panel or remotely by cable connection to a side receptacle. This feature permits the use of a foot switch thereby freeing the operator's hands for full-time attention to adjustment of the component under test.

The input circuit may be operated either grounded or floating. A jumper across the binding posts at the rear of the case connects the input circuit to the case for grounded operation. With this jumper removed the input circuit floats a minimum of 200 megohms above ground.

SPECIFICATIONS

VOLTAGE SENSITIVITY: 1.0 microvolt to 100 volts dc.
CURRENT SENSITIVITY: 10^{-13} to 10^{-5} ampere dc.
INPUT RESISTANCE: 10 megohms all ranges.
SENSITIVITY RANGES: 8 calibrated in amplifier gain.
 .01, .1, 1.0, 10, 100, 1K, 10K and 100K.

FULL SCALE SENSITIVITIES: (SENS. ADJ. at max.)
 Voltage: 10 microvolts to 100 volts dc.
 Current: 1 micro-microampere to 10 microampere.
 Power: 10^{-17} watt to 10^{-3} watt.

SENSITIVITY PER DIVISION ON MOST SENSITIVE (x100) RANGE:

Voltage: .5 microvolt.
 Current: .05 micro-microampere.
NOISE LEVEL: Approx. 1 μ V peak to peak.

ZERO SHIFT:
Source Resistance
 1 megohm 1 μ V
 10 megohms 7 μ V
 Open circuit 15 μ V

ZERO DRIFT: Less than 2 microvolts after warm-up.
RESPONSE TIME: Approximately 1 second full scale.

MODES OF OPERATION:
 Hunt: Provides 60 DB meter scale compression.
 Calibrate: Provides linear indication with resolution to 1 microvolt.

MODE SWITCHING: Front panel or by remote switch.
METER: 1.2 — 0 — 1.2 scale.

METER LINEARITY: 2% maximum error.
AMPLIFIER GAIN: Continuously variable from -40DB to 100DB.
AMPLIFIER OUTPUT: ± 1.0 ma into 1000 Ω ; $2 \pm$ ma into 100 Ω or less. Polarity the same as input.
OUTPUT IMPEDANCE: Approximately 400

OVERLOAD TOLERANCE:

Range	Approx. Full Scale Voltage	Overload Voltage Tolerated	Overload Factor
.01	100V	1000	10
.1	10V	1000	100
1	1V	1000	1K
10	.1V	1000	10K
100	.01V	1000	100K
1K	1mv	100	100K
10K	.1mv	10	100K
100K	.01mv	1	100K

POWER REQUIREMENTS: 105 to 125V, 50-60 cycles, 40 watts, 210 to 250 volt, 50-60 cycle operation available at the extra cost of \$10.00.

SIZE: 7 $\frac{1}{4}$ "W x 9 $\frac{1}{2}$ "D x 11H excluding handle.

WEIGHT: 12 lb. net.

PRICE: \$450. F.O.B. Morris Plains, New Jersey.

RACK MOUNTING: Also available, the 56 A-R on a 7" x 19" rack panel. Extends 8-3/4" behind panel. Price: \$475.

Price and specifications subject to change without notice.

Boonton
ELECTRONICS
Corporation

MORRIS PLAINS, NEW JERSEY

Represented by

DIFFERENTIAL DC VOLTMETER - AMPLIFIER

MODEL 98-A

SPECIFICATIONS



MODEL 98-A

- VOLTAGE RANGE: $10\mu\text{V}$ TO 1000 VOLTS
- FULL SCALE RANGES: .3, 1.0, 3.0, 10, 30, 100, 300 MV
1.0, 3.0, 10, 30, 100, 300, 1000 V
- ACCURACY: 3% OF FULL SCALE ON 1 MV RANGE AND UP
4% OF FULL SCALE ON .3 MV RANGE
- INPUT: HIGH RESISTANCE BALANCED TO GROUND
- DIFFERENTIAL DC BALANCE: APPROX. 80 DB
- 60 CYCLE REJECTION: BETTER THAN 60 DB
- AMPLIFIER GAIN: (MAX) 70 DB OR 3300
- OUTPUT IMPEDANCE: (APPROX) 1200 OHMS
- OUTPUT CAPABILITY: ± 5 MILLIAMP INTO 1500 OHMS
OR $\pm 1.5\text{V}$ UNLOADED
- ZERO DRIFT: (AFTER WARMUP) LESS THAN 2% OF F.S.
- POWER REQUIREMENTS: 30 WATTS

APPLICATIONS

The Model 98A Differential Voltmeter-Amplifier is a self-contained precision instrument capable of measuring differential or grounded DC voltages accurately. The differential feature has numerous applications in the DC measuring field where conventional two-terminal voltmeters cannot be used because of exposed voltage or grounding problems. A few of its many possible applications are listed below:

- DC VOLTMETER AND/OR AMPLIFIER (GROUNDED)
- DIFFERENTIAL DC VOLTMETER AND/OR AMPLIFIER (UNGROUNDED)
- DC RECORDER AMPLIFIER
- HIGH SENSITIVITY DC NULL DETECTOR
- THERMOCOUPLE GALVANOMETER
- PERFORMANCE TESTING OF REGULATED POWER SUPPLIES
- ACCELEROMETER INDICATOR-AMPLIFIER
- PHOTOCCELL INDICATOR-AMPLIFIER
- HIGH IMPEDANCE DC GALVANOMETER
- TRANSDUCER INDICATOR-AMPLIFIER
- INDICATOR FOR CALIBRATING DC ATTENUATORS, AMPLIFIERS OR TEST EQUIPMENT
- POLARIZED LIMIT AMPLIFIER (USED WITH POLARIZED RELAYS)

— Price: \$450.00, fob Morris Plains, New Jersey —

PRINTED IN USA

SEE REVERSE SIDE FOR ADDITIONAL INFORMATION



Boonton ELECTRONICS Corp.
Morris Plains, N. J. Phone: JEFFERSON 9-4210

TECHNICAL DESCRIPTION

DIFFERENTIAL DC VOLTMETER – AMPLIFIER MODEL 98 – A

The Model 98–A Differential DC Voltmeter-Amplifier is a three terminal voltmeter amplifier designed for DC measurements over the range of 10 microvolts to 1000 volts.

The three terminal feature permits the instrument to be used for voltage measurements above ground, or to be operated as a differential voltmeter or amplifier to measure small difference voltages between relatively large DC voltages. Also the instrument is ideal for comparing or adjusting critical voltages against reference voltages such as a standard cell, or for measuring the voltage variations of highly regulated DC power supplies.

The 98–A may also be used as a conventional two terminal DC voltmeter. This requires that the negative input be grounded. Then all measurements made between the plus input and ground will indicate amplitude and polarity directly on the front panel meter.

A six-inch, direct-reading, zero-center, mirrored meter scale indicates voltage polarity, and eliminates the necessity of reversing meter test leads, or of using a polarity reversing switch when measuring voltages. This is achieved through the use of a synchronous output rectifier consisting of a transistor switching circuit driven in phase with the input chopper. The arrangement provides the proper polarity indication on the panel meter. It also completely isolates output from input, thus eliminating the undesirable feedback often encountered when both input and output choppers are enclosed in the same envelope.

The high input impedance of the Model 98–A Differential DC Voltmeter-Amplifier is achieved by means of special break-before-make, low noise chopper circuitry, plus a high input resistance voltage divider. The chopper output is amplified by a stable, high-gain feedback a-c amplifier, then synchronously rectified to provide voltage indications of a magnitude and polarity proportional to those of the test voltages. Thus the exceptionally high degree of stability of the Model 98–A is attained without the use of d-c amplification stages.

DC output binding posts mounted on the front panel permit interconnection and operation of indicating or control devices such as relays or recording milliammeters. The output at the binding posts may be used simultaneously with the meter without interaction.

Voltages as high as 1500 volts may be accidentally applied to the Model 98–A input without causing damage to the equipment and with rapid recovery. A protective circuit at the attenuator output guards the instrument from accidental overload.

As a d-c amplifier the Model 98–A has a maximum gain of 70 DB and is capable of providing ± 0.5 ma into a 1500-ohm load. An output bias control in the instrument allows the adjustment of output to any current between 0 and 0.6 ma, with zero d-c input condition.

PRINTED IN USA



Boonton *ELECTRONICS* Corp.
Morris Plains, N. J. Phone: Jefferson 9-4210

DC VOLTMETER - AMPLIFIER

MODEL 97-A

SPECIFICATIONS



MODEL 97-A

- VOLTAGE RANGE: 10 μ V TO 1000 VOLTS
- FULL SCALE RANGES: .3, 1.0, 3.0, 10, 30, 100, 300 MV
1.0, 3.0, 10, 30, 100, 300, 1000 V
- ACCURACY: 3% OF FULL SCALE ON 1 MV RANGE AND UP
4% OF FULL SCALE ON .3 MV RANGE
- INPUT IMPEDANCE: 100 MEGOHMS ON 10 MILLIVOLT RANGE
& ABOVE
30 MEGOHMS 3 MILLIVOLT RANGE
10 MEGOHMS .3 AND 1 MILLIVOLT RANGE
- AMPLIFIER GAIN: (MAX) 70 DB OR 3300
- OUTPUT IMPEDANCE: (APPROX) 1200 OHMS
- OUTPUT CAPABILITY: $\pm .5$ MILLIAMP ACROSS 1500 OHMS
OR ± 1 V UNLOADED
- ZERO DRIFT: (AFTER WARMUP) LESS THAN 2% OF F. S.
- POWER REQUIREMENTS: 117 VOLTS, 60 CYCLES 30 WATTS;
50 CYCLE UNITS ON SPECIAL
REQUEST

GENERAL DESCRIPTION

The Model 97-A DC Voltmeter-Amplifier combines simple operation with high sensitivity, input impedance, stability and accuracy. It is designed for general purposes d-c measurements covering a voltage range of 10 microvolts to 1000 volts. High stability and calibration accuracy is achieved with a chopper type high feed-back amplifier which may be used simultaneously as a meter or as a d-c amplifier with the output available at the front panel.

The Model 97-A is particularly easy to use. The zero center meter, indicating positive to the right and negative to the left, eliminates the necessity for reversing test leads or using a polarity reversing switch. The 14 voltage ranges, calibrated in multiples of 1 and 3, are easily read on the large 6 inch mirrored scale meter.

An overload feature permits accidental application of as much as 1000 volts even on the most sensitive range without damage and with rapid recovery.

— Price: \$375.00, fob Morris Plains, New Jersey —

SEE REVERSE SIDE FOR ADDITIONAL INFORMATION

PRINTED IN USA

2M-4-63



Boonton *ELECTRONICS* Corp.
Morris Plains, N. J. Phone: JEfferson 9-4210

TECHNICAL DESCRIPTION

DC VOLTMETER-AMPLIFIER MODEL 97-A

Boonton Electronics has now added to its test equipment line a new precision DC Voltmeter-Amp-ifier designated the Model 97-A. This instrument offers ease of operation and direct reading in the range of 10 microvolts to 1000 volts. It combines high sensitivity and input impedance with high stability and accuracy while retaining the greatest simplicity of operation.

Operating simplicity results from the use of a zero center meter that indicates positive to the right and negative to the left, thus eliminating the necessity for reversing test leads or using a polarity reversing switch. The 14 voltage ranges calibrated in multiples of 1 and 3 are easily read on the large 6 inch mirrored scale meter.

The voltage to be measured is applied thru a shielded cable to the step attenuator which uses precision carbon film type resistors for range selection. At the attenuator output a protective circuit guards the instrument from accidental overload. Voltages as high as 1500 may be accidentally applied even on the most sensitive ranges without damage to the instrument and with rapid recovery.

The high input impedance is achieved by means of special break-before-make, low noise chopper circuitry plus a high input impedance voltage divider. The chopper output is amplified by a stable, high feed-back a-c amplifier, then synchronously rectified to provide meter indications of both voltage magnitude and polarity proportional to that of the test voltage. The exceptionally high degree of zero stability in the Model 97-A is attained without use of DC amplification stages and their associated complexity.

The synchronous output rectifier consists of a unique transistor switching circuit driven in phase with the input chopper to obtain proper polarity indication on the panel meter. This feature completely isolates output from input, thus avoiding undesirable feedback often encountered when both input and output chopper are enclosed in the same envelope.

The d-c output at the front panel binding posts of the Model 97-A will operate indicating or control devices such as relays or recording milliammeters. The output at the binding posts may be used simultaneously with meter indications without interaction.

As a d-c amplifier the Model 97-A has a maximum gain of 70 DB and is capable of providing ± 5 ma into a 1500 ohm load. An output bias control in the instrument allows the adjustment of output to any current between 0 and .6 ma, with zero d-c input condition.



RF ADMITTANCE BRIDGE

IDEALLY SUITED FOR MEASURING
SEMICONDUCTOR DEVICES

**MODEL
33A**

**RF ADMITTANCE
BRIDGE**

- ✔ **CRYSTAL CONTROLLED TEST FREQUENCIES:**
1, 5, 10, 20, 30, 50 & 100 Mc
- ✔ **CAPACITANCE RANGE:**
0 TO 150 pf
- ✔ **CONDUCTANCE RANGE:**
0 TO 25,000 μ mhos (40 Ω)
- ✔ **DC BIAS RANGE: -5 TO +100V**
(250V EXT.)
- ✔ **NO FALSE OR SLIDING NULLS**



The 33A Radio Frequency Admittance Bridge represents the latest contribution by Boonton Electronics in the field of high frequency capacitance and conductance measurements. It incorporates a novel bridge network that provides adequate range, resolution, and accuracy under the required d-c bias conditions. All variable elements in the bridge are air capacitors thus insuring continuous smooth operation without calibration deterioration thru-out the life of the instrument.

SPECIFICATIONS

CAPACITANCE RANGE: 0 to 150 pf continuously variable

CAPACITANCE RESOLUTION: 0.02 pf

CAPACITANCE ACCURACY: $1\% + \frac{0.2}{L^*} \% + 0.05$ pf. High frequency correction curves provided. *Where L is resonating inductance

CONDUCTANCE RANGE: 0 to 25,000 μ mhos (40 ohms) spread over 32 inches of dial length

CONDUCTANCE RESOLUTION: 0.5 μ mho at 100 mv test level

CONDUCTANCE ACCURACY: $2\% + \frac{QF}{1000} + 0.5$ μ mho
where Q is Q factor of test component and F is frequency in MC

TEST FREQUENCIES: 1, 5, 10, 20, 30, 50 and 100 Mc switch selected and crystal controlled. No tuning is required.

TEST VOLTAGE RANGE: 0.001v to 0.1v continuously variable

DC BIAS: Internal bias supply from -5 to +100 volts. External bias may be applied up to 250 volts. DC resistance of "external bias" circuitry is kept extremely low to permit measurement of high current tunnel diodes.

STANDARD EQUIPMENT SUPPLIED: A set of 7 work coils (one for each test frequency) to permit zeroing the bridge prior to connecting the test.

POWER REQUIREMENTS: 105 - 125 volts, 50-60 cycles, 35 watts

SIZE: 20½ wide, 10½ high, 12 deep

WEIGHT: 33 lbs. net.

PRICE: \$2000.00 F.O.B. Parsippany, N. J.



Specifications and Prices subject to change without notice.

Boonton *ELECTRONICS* Corporation

ROUTE 287 at SMITH ROAD, PARSIPPANY, NEW JERSEY - 07054
PHONE: 201-887-5110 • TWX: 201-887-5059

Precision Three-Terminal CAPACITANCE BRIDGE

**MODEL
74 C
CAPACITANCE
BRIDGE**



**MODEL 74C
PRICE \$1050**

**MODEL 74C-S8 (shown)
PRICE \$1125**

- **Capacitance Range - 0.0002 to 11,000 pf**
- **Conductance Range - 0.001 to 1000 μ mhos**
- **Resistance Range - 1000 ohms to 1000 megohms**
- **Self-contained 100 kc Oscillator - Detector**
- **Differential Capacitance Measurements**
- **Insensitive to Capacitance from Test Terminals To Ground**



Boonton *ELECTRONICS* Corporation

MORRIS PLAINS, NEW JERSEY Telephone: JEfferson 9-4210

74C THREE TERMINAL CAPACITANCE BRIDGE GENERAL DESCRIPTION

The Model 74C Three Terminal Capacitance Bridge was designed to provide the industry with a compact, self-contained, precision instrument for measuring either **DIRECT** or **GROUNDED** capacitance. The 74C when used in the **DIRECT** capacitance position is completely insensitive to stray ground capacitance. This is extremely important when measuring a small capacitance where the stray capacitance to ground may be large compared to the value being measured.

CAPACITANCE RANGE: The range of measurement is from .0002 $\mu\mu\text{f}$ to 11,000 $\mu\mu\text{f}$. A multiplier switch provides full scale ranges of 1, 10, 100, and 1,000 $\mu\mu\text{f}$. A capacitance decade switch connects precision mica capacitors across the standard arm of the bridge in increments of 1,000 to 10,000 $\mu\mu\text{f}$, thus providing continuous coverage to 11,000 $\mu\mu\text{f}$. Precision of readability for all values between 0.1 $\mu\mu\text{f}$ and 1,000 $\mu\mu\text{f}$ is 0.1% to 0.01% depending on dial setting. For values between 1,000 and 11,000 $\mu\mu\text{f}$ readability is improved by a factor of 10.

CONDUCTANCE RANGE: The Conductance Dial is calibrated in conductance and parallel resistance with ranges covering from 0.001 to 1,000 μmhos and 1,000 Ω to 1,000 megohms. The capacitance and conductance adjustments are largely independent of each other. This allows easier adjustment under a wide variety of test conditions, and also prevents false nulls which can occur with a sliding balance.

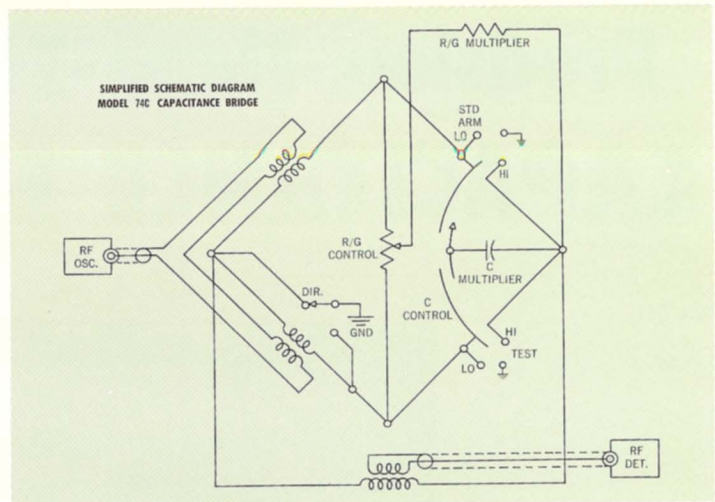
TEST FREQUENCY: In the 74C Capacitance Bridge a fixed test frequency of 100 KC has been selected as the highest practical frequency consistent with minimum errors attributable to lead inductance. Where measurements must be made at 1 MC, as in military specification testing, the Boonton ELECTRONICS 75A Three Terminal Capacitance Bridge with less range and accuracy is recommended.

REMOTE TESTING: In addition to the regular test binding posts, BNC coaxial receptacles are provided to facilitate the connection of coaxial test leads for measuring **DIRECT** capacitance at locations remote from the bridge. The bridge is insensitive to variation of grounded capacitance. Thus no errors result from changes in temperature or position of these leads. This makes it possible to measure precisely the **DIRECT** capacitance changes in test samples when subjected to variations in temperature, shock, or other extreme environmental conditions.

TEST VOLTAGE LEVEL: Controls are provided on the rear which permit the level of the internal test voltage to be varied from approximately 3.0 volts to as low as 0.02 volts. A fixed attenuator, the 75-1A, may be used to reduce the test voltage to below a millivolt. An external RF Voltmeter may be connected between the LO TEST post and GND to read the level of the test voltage. Control of the test voltage is essential in measuring the capacitance of non-linear devices such as diodes, transistors, vacuum tubes, HI-K material, etc. With this type of component low test voltages are required to obtain a sharp null in bridge balance. In some instances the capacitance of the component varies with the level of the test voltage.

DC BIAS: On special order a dc bias supply can be built into the bridge permitting the measurement of component capacitance under different bias conditions. The range of bias voltage is from -5 to +100. This feature is of particular usefulness in the measurement of the voltage variable capacitor, and also finds application in measurements on diodes, transistors, and other non-linear devices. This variation is designated the Model 74C-S8.

THE STANDARD ARM: The standard arm of the bridge has been made available at banana jacks at the top of the case. Here external standards or balancing capacitors may be connected. This enables the bridge to be used as a comparison bridge or for the measurement of the temperature coefficient of capacitors using the differential sensitivity of the X.001 multiplier for values up to approximately 1,000 $\mu\mu\text{f}$. The sensitivity and readability for temperature coefficient measurements is of the order of $\pm .0001\%$ of nominal capacitance + .0002 $\mu\mu\text{f}$ or 1 PPM / $^{\circ}\text{C}$ for values above 200 $\mu\mu\text{f}$. The Model 74C Capacitance Bridge utilizes the three terminal circuit as described by C. H. Young.* A modification of this circuit has been made to permit its use for grounded capacitance as well as direct. Reference to this bridge circuit for measuring interelectrode capacitance of vacuum tubes is made in the IRE Standards on Vacuum Tubes, published in the Proceedings of the IRE, August 1950, page 937, and in MIL-E-1C, the Military Specification on Electron Tubes and Crystal Rectifiers.



SPECIFICATIONS

CAPACITANCE RANGES:

Multiplier	Cap. Range	Smallest Division	Direct *	Accuracy	Grounded
1	100 to 11,000 $\mu\mu\text{f}$	0.2 $\mu\mu\text{f}$	$\pm(0.25\% + 0.2 \mu\mu\text{f})$	$\pm(0.25\% + 0.5 \mu\mu\text{f})$	$\pm(0.25\% + 0.5 \mu\mu\text{f})$
.1	10 to 1,000 $\mu\mu\text{f}$	0.02 $\mu\mu\text{f}$	$\pm(0.25\% + 0.02 \mu\mu\text{f})$	$\pm(0.25\% + 0.5 \mu\mu\text{f})$	$\pm(0.25\% + 0.5 \mu\mu\text{f})$
.01	1 to 100 $\mu\mu\text{f}$	0.002 $\mu\mu\text{f}$	$\pm(0.25\% + 0.005 \mu\mu\text{f})$	$\pm(0.25\% + 0.5 \mu\mu\text{f})$	$\pm(0.25\% + 0.5 \mu\mu\text{f})$
.001	.05 to 10 $\mu\mu\text{f}$	0.0002 $\mu\mu\text{f}$	$\pm(0.25\% + 0.001 \mu\mu\text{f})$	$\pm(0.25\% + 0.5 \mu\mu\text{f})$	$\pm(0.25\% + 0.5 \mu\mu\text{f})$
.001	0 to .05 $\mu\mu\text{f}$	0.0002 $\mu\mu\text{f}$	$\pm(2.00\% + 0.0002 \mu\mu\text{f})$		

*REMOTE TESTING ERROR: $\pm .008\% / 1000 \mu\mu\text{f}$ of test capacitance/foot of test cable (where test cable is defined as total length of RG-58/U cable divided by 2).

CONDUCTANCE RANGES:

Divider	Cond. Range	Accuracy†
1	100 to 1000 μmhos	$\pm(10\% + 10 \mu\text{mhos})$
10	10 to 100 μmhos	$\pm(10\% + 1 \mu\text{mho})$
100	1 to 10 μmhos	$\pm(10\% + 0.1 \mu\text{mho})$
1000	0.1 to 1 μmho	$\pm(10\% + 0.01 \mu\text{mho})$
10,000	0 to 0.1 μmho	$\pm(10\% + 0.001 \mu\text{mho})$

RESISTANCE RANGES:

Multiplier	Resistance Range	Accuracy †‡
1	1K to 10K ohms	$\pm(10\% + \frac{R}{10^3} \%)$
10	10K to 100K ohms	$\pm(10\% + \frac{R}{10^4} \%)$
100	100K to 1 megohm	$\pm(10\% + \frac{R}{10^5} \%)$
1000	1 megohm to 10 megohms	$\pm(10\% + \frac{R}{10^6} \%)$
10,000	10 megohms up	$\pm(10\% + \frac{R}{10^7} \%)$

† Specified CONDUCTANCE and RESISTANCE accuracies apply only below 1000 $\mu\mu\text{f}$ when test is connected directly to the HI and LO TEST binding posts.

‡ Where R is resistance of the test in ohms.

TEST FREQUENCY: 100KC with self-contained oscillator-detector.

TEST VOLTAGE LEVEL (Approx.): Low Range 0.02V to 0.8V. High Range 0.6V to 3V.

A fixed attenuator, Model 75-1A, available for internal use reduces these ranges by 40 DB permitting test voltages of below 1MV.

POWER REQUIREMENTS: 105-125 volts, 50-60 cycles, 40 watts. 200-240V, 50-60 cycle operation available at the extra cost of \$10.00.

SIZE: 14 $\frac{1}{2}$ " wide x 11 $\frac{1}{2}$ " high x 9 $\frac{1}{2}$ " deep case mounted.

WEIGHT: 28 lbs. packed for shipping, 25 $\frac{1}{4}$ lbs. net.

STANDARD EQUIPMENT SUPPLIED: 1 pair of 3 ft. BNC terminated test cables; TS-1 Terminal Shield; Standard Arm Connection Board.

PRICE: 74C \$1,050.00 FOB Morris Plains, N. J.
74C-S8 (with dc bias supply) \$1,125.00

RACK MOUNTING: Also available on a 10 $\frac{1}{2}$ " x 19" rack panel. Extends 8 $\frac{1}{4}$ " behind panel. Extra cost \$50.00.

ACCESSORIES AVAILABLE: 75-1A Fixed Attenuator designed to reduce the test voltage by 40 DB. Price \$15.00

AC-1 Auxiliary Capacitor. A plug-in unit for use on the standard arm of the bridge incorporates a variable capacitor in shunt with a decade capacitor to provide continuous tuning over a range of 20 to 1,100 pf. Facilitates the use of the 74C bridge in differential capacitance measurements. Price \$50.00.

CS—CAPACITANCE STANDARDS. Ruggedly housed, electrically stable, highly accurate three terminal capacitors particularly useful for checking the accuracy of the series 74 and 75 Capacitance Bridges. Available in any value between .01 and 1000 pf. Price \$75.00. National Bureau of Standards Certification available for \$40.00.

Note: Price and specifications subject to change without notice.

*C. H. Young "Measuring Interelectrode Capacitance" published in "Tele-Tech" Vol. 6, pages 68, 70, 109. Feb. 1947.

74C CAPACITANCE BRIDGE

ALTERNATE MODELS

- 74C-S1. The internal oscillator and detector operate at 1000 γ rather than 100 kc. Measures only direct capacitance. The DIRECT/GROUNDED switch has been eliminated. Capacitance and R/G measuring range indentical with 74C. Of particular usefulness where the capacitance to be measured has high series inductance. Price: \$1425.00.
- 74C-S7. A LIMIT/NORMAL switch and an external meter jack have been added on the front panel. In the LIMIT position the calibration of the null indicator is essentially linear for use as a limits device. In the NORMAL position the null indicator has the normal high degree of AVC action which provides a wide hunting range. The jack permits connecting an external meter in place of the internal null indicator. All other features remain identical with the 74C. Price: \$1075.00.
- 74C-S8. A built in bias supply of regulated -5 to +100 volts, a bias level control, selector switch, and a jack for external metering of the bias level have been added. The bias voltage is applied across the capacitance under test. This feature is useful in the measurement of components that have a capacitance which varies with an applied dc voltage, such as transistors, diodes, etc. It is particularly useful when working with the voltage variable capacitor, (Varicap, Varactor etc.). All other features are identical with the 74C. Price: \$1125.00.
- 74C-S15. Same as standard 74C except that the oscillator and detector operate at 50 Kc. Price: \$1700.00
- 74C-S18. This has both the NORMAL/LIMIT feature as in the 74C-S7, and the built-in bias supply as in the 74C-S8. Price \$1150.00

b.

Boonton *ELECTRONICS* Corporation

738 SPEEDWELL AVENUE, MORRIS PLAINS, NEW JERSEY, U. S. A.

THREE TERMINAL CAPACITANCE BRIDGE

**MODEL
75A
CAPACITANCE
BRIDGE**

1MC Measurements -- As Required in Mil. Specs.



PRICE:
75A \$1125.
75A-58 \$1200. (shown)

Capacitance Range - .0002 to 1000 μf

Conductance Range - .01 to 1000 μmhos

Resistance Range - 1000 ohms to 100 megohms

Self-Contained 1 MC Oscillator - Detector

Provision for Using External Oscillator - Detector

Differential Capacitance Measurements

Provision for Internal and External DC Bias Available



Boonton ELECTRONICS Corporation

INTED IN U.S.A.

10M-4-63

MORRIS PLAINS, NEW JERSEY

Telephone: 201-539-4210

GENERAL DESCRIPTION

The Model 75A Three Terminal Capacitance Bridge, which operates at 1 MC, is the answer to a long-standing need for a self-contained, precision instrument for making the measurements required by many of the military specifications* governing capacitors and insulating materials. The circuitry used is an adaption of that used in the widely accepted 100 KC equivalent, the Model 74C Capacitance Bridge. The 10 fold increase in frequency has imposed some restrictions on measuring ranges and has led to a relocation of panel controls. However, the high order of accuracy and the unique ability to measure very small capacitance by either the direct, grounded or differential method, characteristic of the Model 74C, have been retained. The 75A Capacitance Bridge provides the industry with a self-contained, precision instrument for measuring either three terminal DIRECT capacitance or GROUNDED capacitance and conductance. The Bridge, when measuring DIRECT capacitance is insensitive to stray capacitance to ground. This is extremely important when measuring small capacitance where the stray capacitance to ground may be large compared to the total capacitance.

CAPACITANCE RANGE: The total range of capacitance measurements is from .0002 $\mu\mu\text{f}$ to 1000 $\mu\mu\text{f}$ divided into four ranges. Precision of readability for all values above .1 $\mu\mu\text{f}$ is 0.1% to .01% depending on dial setting.

CONDUCTANCE RANGE: The conductance dial is calibrated in both conductance and parallel resistance with four ranges covering from .01 to 1000 μmhos and 1000 Ω to 100 megohms. The capacitance and conductance adjustments are largely independent of each other. This allows easier adjustment under a wide variety of test conditions, and also prevents false nulls which can occur with a sliding balance.

REMOTE TESTING: In addition to the regular test binding posts, BNC coaxial receptacles are provided to facilitate the connection of coaxial test leads for measuring DIRECT capacitance at locations remote from the bridge. The bridge is insensitive to variation of grounded capacitance thus minimizing errors resulting from changes in temperature or position of these leads. This makes it possible to measure precisely the DIRECT capacitance changes in test samples when subjected to variations in temperature, shock or other extreme environmental conditions. Errors in measuring capacitance remotely increase with the value of the capacitance and the length of the remote leads.

TEST VOLTAGE LEVEL: Controls are provided on the front panel which permit the level of the internal 1 MC test voltage to be varied from approximately 3.0 volts to as low as .02 volts. An external RF Voltmeter may be connected between the LO TEST post and ground to read the level of the test voltage. Control of the test voltage is essential in measuring the capacitance of non-linear devices such as diodes, transistors, vacuum tubes, HI-K material, etc. With this type of component, low test voltages are required to obtain a sharp null in bridge balance. In some instances, the capacitance of the component varies with the level of the test voltage.

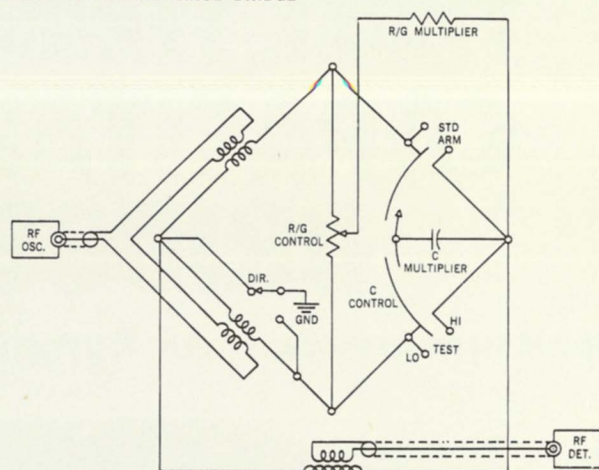
DC BIAS: The Model 75A-S8 offers all features of the regular 75A, plus a built-in DC bias supply permitting the measurement (on DIRECT only) of component capacitance and conductance in the presence of DC bias. The internal bias is continuously adjustable from 0 to -5V and from 0 to +125V, and both voltage and current may be monitored with external meters. Alternatively, external bias of up to 400V at 100 ma. may be applied at the EXTERNAL binding posts.

Measurement applications requiring the presence of DC bias include: semiconductor junction capacitance and conductance, performance of voltage variable capacitors, and determination of the voltage coefficient of capacitors.

STANDARD ARM: The standard arm of the bridge has been made accessible at BNC connectors on the front panel so that external standards or balancing capacitors may be connected. This enables the bridge to be used as a comparison bridge or for the measurement of the temperature coefficient of capacitors using the differential sensitivity of the X.001 multiplier for values up to and above 1000 $\mu\mu\text{f}$. The sensitivity and readability for temperature coefficient measurements is of the order of $\pm .0001\%$ of nominal capacitance + .0002 $\mu\mu\text{f}$ or 1 PPM/ $^{\circ}\text{C}$ for values above 200 $\mu\mu\text{f}$.

EXTERNAL OSCILLATORS AND DETECTORS: Provision is made for using external oscillators and detectors. The BNC terminated cables, which are attached to the bridge proper may be disconnected from the internal oscillator and detector and connected to the BNC to BNC adapters mounted on the detector chassis. The external oscillator and detector may then be connected to the adapters. The bridge will operate satisfactorily over a range of 100 KC to 1 MC. The Model 75A Capacitance Bridge utilizes the three terminal circuit as described by C. H. Young**. A modification of this circuit has been made to permit its use for grounded capacitance as well as direct. Reference to this bridge circuit for measuring interelectrode capacitance of vacuum tubes is made in the IRE Standards on Vacuum Tubes, published in the Proceedings of the IRE, August 1950, page 937, and in MIL-E-1C the Military Specification on Electron Tubes and Crystal Rectifiers.

SIMPLIFIED SCHEMATIC DIAGRAM
MODEL 75A CAPACITANCE BRIDGE



SPECIFICATIONS

CAPACITANCE RANGES:

Multiplier	Cap. Range	Smallest Division	Direct Accuracy	Grounded Accuracy
1	100 to 1,000 $\mu\mu\text{f}$	0.2 $\mu\mu\text{f}$	$\pm(0.25\% + 0.2 \mu\mu\text{f})$	$\pm(0.25\% + 0.5 \mu\mu\text{f})$
.1	10 to 100 $\mu\mu\text{f}$	0.02 $\mu\mu\text{f}$	$\pm(0.25\% + 0.02 \mu\mu\text{f})$	$\pm(0.25\% + 0.5 \mu\mu\text{f})$
.01	1 to 10 $\mu\mu\text{f}$	0.002 $\mu\mu\text{f}$	$\pm(0.25\% + 0.005 \mu\mu\text{f})$	$\pm(0.25\% + 0.5 \mu\mu\text{f})$
.001	.05 to 1 $\mu\mu\text{f}$	0.0002 $\mu\mu\text{f}$	$\pm(0.25\% + 0.001 \mu\mu\text{f})$	$\pm(0.25\% + 0.001 \mu\mu\text{f})$
.001	0 to .05 $\mu\mu\text{f}$	0.0002 $\mu\mu\text{f}$	$\pm(2.00\% + 0.0002 \mu\mu\text{f})$	

CONDUCTANCE RANGES:

Divider	Cond. Range	Accuracy†
1	100 to 1000 μmhos	$\pm(10\% + \frac{Q}{500}\% + 10 \mu\text{mhos})$
10	10 to 100 μmhos	$\pm(10\% + \frac{Q}{500}\% + 1 \mu\text{mho})$
100	1 to 10 μmhos	$\pm(10\% + \frac{Q}{500}\% + .1 \mu\text{mho})$
1000	0 to 1 μmho	$\pm(10\% + \frac{Q}{500}\% + .01 \mu\text{mho})$

RESISTANCE RANGES:

Multiplier	Res. Range	Accuracy †‡
1	1 K to 10 K	$\pm(10\% + \frac{Q}{500}\% + \frac{R}{10^3}\%)$
10	10 K to 100 K	$\pm(10\% + \frac{Q}{500}\% + \frac{R}{10^4}\%)$
100	100 K to 1 Megohm	$\pm(10\% + \frac{Q}{500}\% + \frac{R}{10^5}\%)$
1000	1 Megohm to ∞	$\pm(10\% + \frac{Q}{500}\% + \frac{R}{10^6}\%)$

†at HI and LO TEST binding posts only.

‡Where R is resistance of the test in ohms.

TEST FREQUENCY: 1 MC with internal oscillator and detector. Provision for connecting in external oscillators and detectors for measuring in the 100KC to 1MC Range.

POWER REQUIREMENTS: 105-125 volts, 50-60 cycles, 40 watts. 210-250 volts, 50-60 cycle operation available at the extra cost of \$10.00.

SIZE: 19¼ wide x 10¾ high x 11¼ deep case mounted.

MOUNTING: Case mounting is standard. Also available for 19 inch rack mounting at no extra cost.

WEIGHT: 31 lbs. net.

PRICE: 75A \$1125. f.o.b. Morris Plains, N. J.
75A-S8 (with d-c bias supply) \$1050. f.o.b. Morris Plains, N. J.

*The following is a partial list of those specifications which reference 1 MC as a test frequency for measuring either capacitance or Q.

- MIL-C-5B, Fixed Mica Capacitor
- MIL-C-17B RF Cables
- MIL-C-20B, Fixed Ceramic Capacitor
- MIL-C-81A, Variable Ceramic Capacitor
- JAN-C-92A, Variable Air Capacitor
- MIL-C-10950B, Fixed Mica Capacitor (Button Style)
- MIL-C-11272A, Fixed Glass Capacitor
- MIL-C-14409A, Tubular Trimmer (Piston Type)
- JAN-I-10, Insulating Materials, Ceramic, Radio

**C. H. Young "Measuring Interelectrode Capacitance" published in "Tele-Tech" Vol. 6, pages 68, 70, 109. Feb. 1947.

75A CAPACITANCE BRIDGE

ALTERNATE MODELS

- 75A-S4. Same as 75A-S8 except that the use of a tuned high-Q bridge output transformer gives greatly increased resolution to allow the measurement of small values of capacitance when using low test voltage levels. In addition, provision is made for the use of an external indicator such as the Model 98-A Differential Voltmeter to give a further increase in sensitivity. A special 40db attenuator, removable if TEST signal levels above 40 mv are required, is factory connected in series with the oscillator output. Operation is restricted to 1 Mc. Price: \$1275.00.
- 75A-S6. The internal crystal controlled oscillator and the detector operate at 465 Kc. The TEST signal level adjustment control range is restricted to approximately 0.3v to 3v. All other features are identical with the 75A. Price: \$1250.00
- 75A-S7. A LIMIT/NORMAL switch and an external meter jack have been added on the front panel. In the LIMIT position the calibration of the null indicator is essentially linear for use as a limits device. In the NORMAL position the null indicator has the normal degree of AVC action which provides a wide hunting range. The jack permits connecting a larger or more accurate meter in place of the internal null indicator, useful in the LIMITS mode of operation. All other features remain identical with the 75A. Price: \$1140.00.
- 75A-S8. Has provisions for biasing the component under test with DC from internal supplies, or from an external source. Bias may be applied only when making "DIRECT" capacitance measurements. The circuit modifications used normally limit operation to 1Mc. (whether or not bias is applied). A switch selects internal bias of either polarity, no bias, or external bias. The level of the internal bias is continuously adjustable from 0 to +125V or -5V, using the ADJUST control. Internal bias voltage and current may be monitored at the "VOLTAGE" posts and "CURRENT" jack provided (circuit improvements have eliminated all paths for the bias current except through the test). Posts are provided to allow up to 400V at 100ma. to be applied from an external source, but adjustment and monitoring must then be done at the source. All other features are identical with the 75A. Price: \$1200.00.
- 75A-S9. This has both the NORMAL/LIMIT features as in the 75A-S7, and the built-in bias supply as in the 75A-S8. Price: \$1225.00.
- 75A-S13. This is identical to the 75A-S4 except without the provision for connecting a 98-A or other external detector. Price: \$1250.00.
- 75A-S16. Same as the 75A-S6 except operating frequency is 500Kc. Price: \$1250.00

b.

Boonton *ELECTRONICS* Corporation

738 SPEEDWELL AVENUE, MORRIS PLAINS, NEW JERSEY, U. S. A.

C A P A C I T A N C E S T A N D A R D S

THREE-TERMINAL MODEL CS

These fixed standards have been designed to permit periodic checking of the capacitance accuracy of the 74C and 75A Capacitance Bridges.

They feature a rugged mechanical design and stabilized electrical characteristics. Each capacitor is mounted in a 4 x 3 x 3 metal case with BNC receptacles for connection.

The three-terminal design, which minimizes lead and connection errors, permits a precise determination of the direct capacitance between the center conductors of the BNC receptacles when used in a three-terminal circuit. Any value of capacitance between 0.01 and 1,000 pf, within the limits of setability, can be supplied.

The use of air dielectric for all standards below 500 pf provides essential freedom from changes in capacitance with frequency (except, of course the error due to internal inductance, the effect of which is generally negligible for values below 50 pf.).

A certificate is furnished with each order, giving the exact capacitance value (generally to 4 significant figures), and the measured temperature coefficient.*

SPECIFICATIONS

1 KC to 1 MC

<u>Capacitance</u> <u>Values Between:</u>	<u>Accuracy</u>	<u>Approximate</u> <u>Temp. Coefficient</u>
100-1000 pf	$\begin{matrix} + \\ - \end{matrix} (0.1\% + 0.1 \text{ pf})$	$\begin{matrix} + \\ - \end{matrix} 30 \text{ PPM}/^{\circ}\text{C}$
10-99.9 pf	$\begin{matrix} + \\ - \end{matrix} (0.1\% + 0.01 \text{ pf})$	$\begin{matrix} + \\ - \end{matrix} 30 \text{ PPM}/^{\circ}\text{C}$
1-9.99 pf	$\begin{matrix} + \\ - \end{matrix} (0.1\% + 0.004 \text{ pf})$	$\begin{matrix} + \\ - \end{matrix} 30 \text{ PPM}/^{\circ}\text{C}$
0.01-0.999 pf	$\begin{matrix} + \\ - \end{matrix} (0.3\% + 0.0004 \text{ pf})$	$\begin{matrix} + \\ - \end{matrix} 80 \text{ PPM}/^{\circ}\text{C}$

Price \$75.00

*Reference standards are traceable to the National Bureau of Standards.

b

Boonton *ELECTRONICS* Corporation

738 SPEEDWELL AVENUE, MORRIS PLAINS, NEW JERSEY, U. S. A.

Precision Three-Terminal CAPACITANCE BRIDGE

Measures 0.1 pf Full Scale!

MODEL 75B
CAPACITANCE BRIDGE

- ▷ Capacitance range: 20 μ pf to 1000 pf
- ▷ Conductance range: 0.01 to 1000 μ mhos
- ▷ Self contained 1 Mc Oscillator & Detector
- ▷ Measures temperature coefficient of capacitors as small as 1 pf
- ▷ Extremely high resolution for differential capacitance measurements
- ▷ Provision for internal and external d-c bias available in the 75B-S8



Model 75B
Price: \$1375

The Model 75B Three-Terminal (Direct) Capacitance Bridge extends capacitance measurement capabilities at 1 Mc by an order of magnitude over previously available equipment. The circuitry used is basically that of its predecessors, the 74C and 75A, but several refinements have been made to provide increased resolution, greater stability, and greater ease of operation.

Originally designed for use in measuring the temperature coefficient of small "zero temperature coefficient" ceramic capacitors, it is also well suited for capacitance measurements of semiconductors when the test signal level must be kept in the millivolt region.

SPECIFICATIONS

CAPACITANCE

Multiplier	Cap. Range (pf)	Smallest Division (pf)	Accuracy
1	100 to 1,000	0.2	$\pm (0.25\% + 0.5 \text{ pf})$
0.1	10 to 100	0.02	$\pm (0.25\% + 0.02 \text{ pf})$
0.01	1 to 10	0.002	$\pm (0.25\% + 0.005 \text{ pf})$
0.001	0.05 to 1	0.0002	$\pm (0.25\% + 0.001 \text{ pf})$
0.001	0 to 0.05	0.0002	$\pm (2\% + 0.0002 \text{ pf})$
0.0001	0 to 0.1	0.00002	$\pm (2\% + 0.00005 \text{ pf})$

CONDUCTANCE

Divider	Conductance Range	Accuracy*
1	100 to 1000 μ mhos	$\pm (10\% + \frac{Q}{500} \% + 10 \mu\text{mhos})$
10	10 to 100 μ mhos	$\pm (10\% + \frac{Q}{500} \% + 1 \mu\text{mho})$
100	1 to 10 μ mhos	$\pm (10\% + \frac{Q}{500} \% + 0.1 \mu\text{mho})$
1000	0 to 1 μ mho	$\pm (10\% + \frac{Q}{500} \% + 0.01 \mu\text{mho})$

RESISTANCE

Multiplier	Resistance Range	Accuracy *
1	1K to 10K	$\pm (10\% + \frac{Q}{500} \% + \frac{R}{10^3} \%)$
10	10K to 100K	$\pm (10\% + \frac{Q}{500} \% + \frac{R}{10^4} \%)$
100	100K to 1 Megohm	$\pm (10\% + \frac{Q}{500} \% + \frac{R}{10^5} \%)$
1000	1 Megohm to ∞	$\pm (10\% + \frac{Q}{500} \% + \frac{R}{10^6} \%)$

*at HI and LO coaxial receptacles only.

** Where R is measured resistance in ohms.

TEST VOLTAGE LEVEL: Adjustable from approximately 30 to 20 mv. On the 75B-S8, a removable 40 db pad is furnished installed in the oscillator output line to provide adjustment range between approximately 40 mv and 1 mv.

TEST FREQUENCY: 1 Mc with internal oscillator and detector.

DC BIAS: in the Model 75B-S8 an internal d-c supply provides d-c bias to the test which is continuously adjustable from 0 to -5 v and from 0 to +125 v. Both voltage and current may be monitored with external meters. Alternatively, external bias up to 400 v at 100 ma may be applied at the EXTERNAL binding posts.

STANDARD ARM: The standard arm of the bridge has been made accessible at BNC connectors on the front panel so that external standards or balancing capacitors may be connected. This enables the bridge to be used as a comparison bridge or for the measurement of the temperature coefficient of capacitors using the differential sensitivity of the X0.0001 multiplier for values up to approximately 1000 pf. The sensitivity and readability for temperature coefficient measurements is of the order of $\pm(0.0001\%$ of nominal capacitance + 0.00002 pf) or 1 PPM/ $^{\circ}$ C for values above 20 pf.

POWER REQUIREMENTS: 105-125 volts, 50-60 cycles, 40 watts. 210-250 volts, 50-60 cycle operation available at the extra cost of \$10.00.

SIZE: 19 $\frac{1}{2}$ wide x 11 $\frac{1}{4}$ high x 12 $\frac{3}{4}$ deep case mounted.

MOUNTING: Case mounting is standard. Also available for 19 inch rack mounting at no extra cost.

WEIGHT: 31 lbs. net.

PRICE: 75B \$1375 f.o.b. Morris Plains, N. J. 75B-S8 (with d-c bias supply) \$1450 f.o.b. Morris Plains, N. J.



Specifications and Prices subject to change without notice.

Boonton ELECTRONICS Corporation

MORRIS PLAINS, NEW JERSEY

TELEPHONE: 201-539-4210

VARIABLE FREQUENCY BRIDGE FOR COMPONENT ANALYSIS (5-500KC)

CAPACITANCE RANGE:

200 μ pf to 1000 pf

CONDUCTANCE RANGE:

0.001 to 1000 μ mhos

FREQUENCY RANGE:

5 KC to 500 KC

INTERNAL D. C. BIAS

BUILT-IN DET & OSC



DIRECT CAPACITANCE (3 TERMINAL) BRIDGE

APPLICATIONS

- Capacitors from 200 μ pf to 1000 pf can be measured accurately over the test frequency range of 5 KC to 500 KC. The test signal level is continuously variable from below 1 millivolt to 3 volts.
- The direct-capacitance method of measurement is used by the 75C to obtain precise values in areas where stray capacitance becomes important and other measuring techniques impractical. Typical examples of direct-capacitance measurements are: capacitance measurement between control grid and plate of a tube, capacitance measurement between two conductors in a multi-conductor cable, capacitance measurement between a single conductor and its shield, capacitance measurement between any two conductors of a printed circuit, and capacitance measurement between the windings of transformers.
- Resistors from 1000 ohms to 1000 megohms can be measured, and resistor performance can be analyzed through the test frequency range of 5 KC to 500 KC.
- Dielectrics can be inspected to determine characteristics throughout the test frequency and test signal level ranges.
- At low test signal levels, capacitance and conductance characteristics of semiconductors can be investigated through the variable frequency range of 5 KC to 500 KC, with the availability of internal d-c bias from -5 volts to +100 volts.
- Remote measurements of capacitance can be made with extended coaxial cables.
- The capacitance and conductance of dielectric solutions can be investigated through the variable frequency range.
- Complex networks can be checked to determine the equivalent capacitance and conductance over the test frequency range.



RF VOLTMETERS • CAPACITANCE BRIDGES • RF ADMIT-
TANCE BRIDGES • INDUCTANCE BRIDGES • DC METERS
AC AND DC NULL DETECTORS • UHF GRID DIP METERS

GENERAL DESCRIPTION

The Model 75C is a versatile, direct-capacitance (three terminal) bridge with a measuring frequency CONTINUOUSLY ADJUSTABLE from 5 KC to 500 KC. The Wien bridge oscillator, multi-stage tuned detector, and power supply are self-contained, eliminating the necessity of using additional equipment. The 75C is a portable, precision instrument for the measurement of direct capacitance. The bridge, using the direct capacitance measuring technique, is insensitive to stray ground capacitance. This feature is extremely important when measuring a small capacitance where the stray capacitance to ground may be large compared to the value being measured. The Model 75C Capacitance Bridge utilizes the three terminal circuit as described by C. H. Young.*

CAPACITANCE RANGE: The range of measurement for the Model 75C is from 200 μ pf to 1000 pf. A multiplier switch provides full scale ranges of 1, 10, 100 and 1000 pf. Precision of readability for all values between 0.1 pf and 1000 pf is 0.1% to 0.01% depending on dial setting.

CONDUCTANCE RANGE: The CONDUCTANCE dial is calibrated in conductance and parallel resistance with ranges covering 0.001 micromho to 1000 micromhos and 1000 ohms to 1000 megohms. The capacitance and conductance adjustments are largely independent of each other. This feature allows easier adjustment under a wide variety of test conditions and also prevents false nulls which can occur with a sliding balance.

TEST FREQUENCY: Test frequency is continuously variable from 5 KC to 500 KC. Frequency accuracy is $\pm 5\%$.

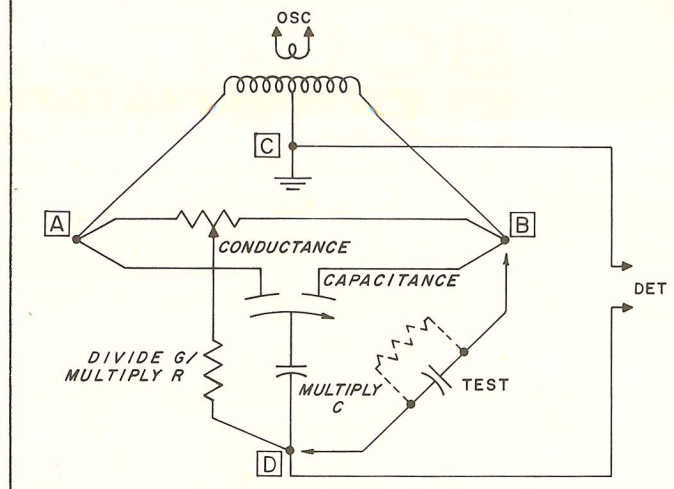
TEST VOLTAGE LEVEL: The test voltage level can be varied from below 1 millivolt to approximately 3 volts. An external r-f voltmeter may be connected between the LO TEST post and the GND post to read the level of the test voltage. Control of the test voltage is essential in measuring the capacitance of non-linear devices such as diodes, transistors, vacuum tubes, HI-K material, etc. With this type of component, low test voltages are often required to obtain a sharp null in bridge balance. In some instances the capacitance of the component varies with the level of the test voltage.

REMOTE TESTING: In addition to the regular test binding posts, BNC coaxial receptacles are provided to facilitate the connection of coaxial test leads for measuring DIRECT capacitance at locations remote from the bridge.

D.C. BIAS: D.C. Bias provision is standard for the Model 75C. The bias range is from -5 volts to +100 volts for application to the specimen under test. The Bias provision is of particular usefulness in the measurement of the voltage variable capacitor, and this feature also finds application in measurements on diodes, transistors and other non-linear devices.

THE STANDARD ARM: The standard arm of the bridge has been made available at BNC receptacles located on the front panel. Standards or balancing capacitors may be connected at these receptacles, and the instrument used as a comparison bridge. Measurement of the temperature coefficient of capacitors can also be made using the differential sensitivity of the X .001 multiplier for values up to approximately 1000 pf. The sensitivity and readability for temperature coefficient measurements is of the order of $\pm 0.0001\%$ of nominal capacitance ± 0.0002 pf, or 1 PPM/ $^{\circ}$ C for values above 200 pf.

SIMPLIFIED SCHEMATIC DIAGRAM
MODEL 75C CAPACITANCE BRIDGE



SPECIFICATIONS

CAPACITANCE RANGES:

Multiplier	Capacitance Range	Smallest Division	Accuracy \pm *
1	100 to 1000 pf	0.2 pf	$\pm (0.25\% + \frac{1000}{R_p} \text{ pf} + 0.2 \text{ pf})$
.1	10 to 100 pf	0.02 pf	$\pm (0.25\% + \frac{1000}{R_p} \text{ pf} + 0.02 \text{ pf})$
.01	1 to 10 pf	0.002 pf	$\pm (0.25\% + \frac{1000}{R_p} \text{ pf} + 0.005 \text{ pf})$
.001	0.05 to 1 pf	0.0002 pf	$\pm (0.25\% + \frac{1000}{R_p} \text{ pf} + 0.001 \text{ pf})$
.001	0 to 0.05 pf	0.0002 pf	$\pm (2\% + \frac{1000}{R_p} \text{ pf} + 0.0002 \text{ pf})$

*Where R_p is the equivalent parallel resistance of the test in ohms.

CONDUCTANCE RANGES:

Divider	Conductance Range	Accuracy \pm
1	100 to 1000 μ mhos	$\pm (10\% + \frac{Q}{500} \% + 10 \mu\text{mhos})$
10	10 to 100 μ mhos	$\pm (10\% + \frac{Q}{500} \% + 1 \mu\text{mho})$
100	1 to 10 μ mhos	$\pm (10\% + \frac{Q}{500} \% + 0.1 \mu\text{mho})$
1000	0.1 to 1 μ mho	$\pm (10\% + \frac{Q}{500} \% + 0.01 \mu\text{mho})$
10,000	0 to 0.1 μ mho	$\pm (10\% + \frac{Q}{500} \% + 0.001 \mu\text{mho})$

RESISTANCE RANGES:

Multiplier	Resistance Range	Accuracy \pm
1	1K to 10K	$\pm (10\% + \frac{Q}{500} \% + \frac{R}{10^3} \%)$
10	10K to 100K	$\pm (10\% + \frac{Q}{500} \% + \frac{R}{10^4} \%)$
100	100K to 1 megohm	$\pm (10\% + \frac{Q}{500} \% + \frac{R}{10^5} \%)$
1000	1 megohm to 10 megohms	$\pm (10\% + \frac{Q}{500} \% + \frac{R}{10^6} \%)$
10,000	10 megohms up	$\pm (10\% + \frac{Q}{500} \% + \frac{R}{10^7} \%)$

\pm Where R is resistance of the test in ohms.

\dagger At HI and LO TEST binding posts only.

TEST FREQUENCY: Continuously variable from 5 KC to 500 KC.

TEST VOLTAGE LEVEL: Continuously variable from below 1 millivolt to approximately 3 volts.

POWER REQUIREMENTS: 105-125 volts, 50-60 cycles, 65 watts. 200-240 volts, 50-60 cycle operation available.

DIMENSIONS: 19 $\frac{1}{2}$ " wide x 13" high x 14 $\frac{7}{8}$ " deep case mounted. Rack mounting available at no extra cost. Weight: 39 lbs.

CAPACITANCE STANDARDS: Three-terminal Capacitance Standards, particularly useful for checking the accuracy of the Model 75C Capacitance Bridge, are available in any value between 0.01 pf and 1000 pf. Price: \$75 each. The Capacitor Standards are ruggedly housed, electrically stable and highly accurate.

PRICE: \$1900 f.o.b. Parsippany, New Jersey.

Specifications and Prices subject to change without notice.

*C. H. Young "Measuring Interelectrode Capacitance" published in "Bell Labs. Record", Dec. 1946.



**BOONTON
ELECTRONICS
CORPORATION**
PARSIPPANY, N. J.

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MORRIS PLAINS, NEW JERSEY

Telephone: 201-539-4210

**MODEL
63A
INDUCTANCE
BRIDGE**



INDUCTANCE BRIDGE

For the Lower Values of Inductance



PRICE: \$1,850.

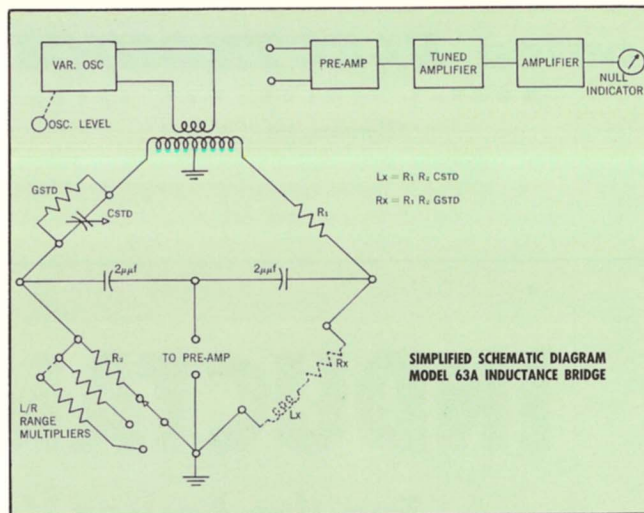
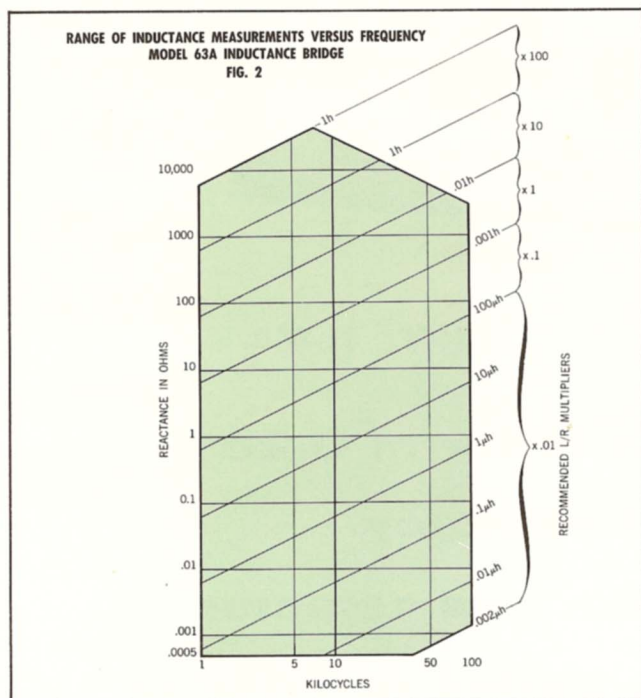
- ▷ **.002 μ h to 1.1 hy.**
- ▷ **Accuracy of the order of 0.25%**
- ▷ **1 KC to 100 KC test frequency**
- ▷ **Self contained oscillator and detector**
- ▷ **.002 Ω to 110K Ω series resistance**
- ▷ **Resolution to .01%**
- ▷ **Exceptional stability for temperature coefficient work**
- ▷ **No false or sliding nulls**

GENERAL DESCRIPTION

The Model 63A Inductance Bridge is a Maxwell bridge (See Fig. 1) modified* to permit effective series inductance measurements over a wide frequency range. This type of bridge has the advantage of direct reading of inductance and resistance at all test frequencies. In addition the accuracy of the test frequency has very little effect on the accuracy of the inductance measurement. It is entirely self-contained, including a variable frequency generator, a tuned detector, and standards. The inductance balance is a precision variable capacitor in parallel with a switched capacitor decade calibrated in microhenries of series inductance. The series resistance balance is a variable conductance network calibrated in ohms of series resistance. Extensive precautions have been taken to eliminate or minimize residual sources of error.

A multiplier switch is arranged to apply a common multiplying factor to both the inductance and resistance arms extending the balance range of these arms from x100 down to x.01. This results in an inductance range of .002 μ h to 1.1 h spread across more than 850 inches of calibrated dial. Separate zero adjustments are provided for the inductance and resistance arms. The annoyance of sliding balance is avoided here through the use of circuitry and careful design which results in the elimination of interaction between the inductance and resistance arms of the bridge.

The frequency of measurement can be varied from 1 kc to 100 kc with some restrictions at the higher and lower inductance values as shown in the chart of Fig. 2. A generator level control and a dial calibrated in kilocycles are located on the front panel. The detector is tuned by a separate panel control permitting maximum sensitivity and discrimination against unwanted frequencies. High resolution, approximately .01%, and good stability combined with the excellent readability afforded by the long scale, make the Model 63A extremely useful for temperature coefficient and inductance matching work. The variable test frequency feature is particularly useful in measuring coils with powdered iron and iron alloy cores and other inductances that vary with frequency. Measurements on components of extremely low Q can be made on the 63A, such as the measurement of residual inductance of wire wound resistors below 1000 ohms.



SPECIFICATIONS

INDUCTANCE MEASURING RANGE: .002 μ h to 1.1 in 5 steps as follows:

Multiplier	Inductance Range	Resolution of Inductance Reading
100.	0 to 1.1 h	.01% + 20 μ h
10	0 to 110 mh	.01% + 2 μ h
1	0 to 11 mh	.01% + .2 μ h
.1	0 to 1100 μ h	.01% + .02 μ h
.01	0 to 110 μ h	.01% + .002 μ h

INDUCTANCE MEASURING ACCURACY: $0.25\% + \frac{300}{C} \% + .002 \mu$ h, where C is the resonating capacitance in μ mf of the test inductor at the frequency of test.

SERIES RESISTANCE MEASURING RANGE: .002 ohm to 110K ohms in five ranges as follows:

Multiplier	Series Resistance Range	Accuracy
100	0 to 110K ohms	$3\% + \frac{Q}{25} \% + 20$ ohms
10	0 to 11K ohms	$3\% + \frac{Q}{25} \% + 2$ ohms
1	0 to 1100 ohms	$3\% + \frac{Q}{25} \% + .2$ ohm
.1	0 to 110 ohms	$3\% + \frac{Q}{25} \% + .02$ ohm
.01	0 to 11 ohms	$3\% + \frac{Q}{25} \% + .002$ ohm

FREQUENCY RANGE: 1 kc to 100 kc with internal oscillator and detector.

FREQUENCY ACCURACY: $\pm 3\%$

Note: The accuracy of the test frequency has negligible effect on the accuracy of the inductance measurement.

FREQUENCY STABILITY: Approx. $\pm 1/2\%$ after warm-up.

DC CURRENT THROUGH TEST COIL.

Multiplier	Max. DC ma.
100	8
10	40
1	40
.1	40
.01	150

CAPACITANCE ACROSS THE TEST TERMINALS: Approximately 3 μ mf.

POWER REQUIREMENTS: 105 to 125V, 50-60 cycles, 50 watts
210 to 250 volt 50-60 cycle operation available at the extra cost of \$10.

SIZE: 19 $\frac{1}{4}$ wide by 10 $\frac{3}{4}$ high by 11 $\frac{1}{4}$ deep case mounted.

MOUNTING: Case mounting is standard. Also available for 19 inch rack mounting at no extra cost.

WEIGHT: Approximately 35 lbs.

PRICE: \$1850 F.O.B. Morris Plains, New Jersey.

Price and specifications subject to change without notice.

Represented by

Boonton
ELECTRONICS
Corporation

INDUCTANCE BRIDGE

FOR THE LOWER VALUES OF INDUCTANCE

**MODEL
63C**
INDUCTANCE
BRIDGE



Inductance Range: 0.0002 μ h to 110mh

Series Resistance: 0.0002 to 11k ohms

Resolution to 0.01%

Accuracy of the order of 0.25%

Built-in oscillator-detector variable from 5 to 500 kc

GENERAL DESCRIPTION

The Model 63C Inductance Bridge is a Maxwell bridge modified to permit effective series inductance measurements over a wide frequency range. This type of bridge has the advantage of direct reading of inductance and resistance at all test frequencies. In addition the accuracy of the test frequency has very little effect on the accuracy of the inductance measurement. It is entirely self-contained, including a variable frequency generator, a tuned detector, and standards. The inductance balance is a precision variable capacitor in parallel with a switched capacitor decade calibrated in microhenries of series inductance. The series resistance balance is a variable conductance network calibrated in ohms of series resistance. Extensive precautions have been taken to eliminate or minimize residual sources of error. The annoyance of sliding balance is avoided here through the use of circuitry and careful design which results in the elimination of interaction between the inductance and resistance arms of the bridge.

SPECIFICATIONS

INDUCTANCE MEASURING RANGE: 0.0002 μ h to 110 mh in 5 steps as follows:

MULTIPLIER	INDUCTANCE RANGE	RESOLUTION OF INDUCTANCE READING
10	0 to 110 mh	0.01% + 2 μ h
1	0 to 11 mh	0.01% + 0.2 μ h
0.1	0 to 1100 μ h	0.01% + 0.02 μ h
0.01	0 to 110 μ h	0.01% + 0.002 μ h
0.001	0 to 11 μ h	0.01% + 0.0002 μ h

INDUCTANCE MEASURING ACCURACY: $0.25\% + \frac{300}{C} \% + 0.0002 \mu\text{h}$,

where C is the resonating capacitance in pf of the test inductor at the frequency of test

SERIES RESISTANCE MEASURING RANGE: 0.0002 ohm to 11K ohms in five ranges as follow:

MULTIPLIER	SERIES RESISTANCE RANGE	ACCURACY
10	0 to 11K ohms	$3\% + \frac{Q}{25} \% + 2 \text{ ohms}$
1	0 to 1100 ohms	$3\% + \frac{Q}{25} \% + 0.2 \text{ ohm}$
0.1	0 to 110 ohms	$3\% + \frac{Q}{25} \% + 0.02 \text{ ohm}$
0.01	0 to 11 ohms	$3\% + \frac{Q}{25} \% + 0.002 \text{ ohm}$
0.001	0 to 1.1 ohms	$3\% + \frac{Q}{25} \% + 0.0002 \text{ ohm}$

FREQUENCY RANGE: 5 Kc to 500 Kc with internal oscillator and detector

FREQUENCY ACCURACY: $\pm 3\%$

Note: The accuracy of the test frequency has negligible effect on the accuracy of the inductance measurement

FREQUENCY STABILITY: Approx. $\pm \frac{1}{2}\%$ after warm-up

DC CURRENT THROUGH TEST COIL:

Multiplier	Max. d-c ma.
10	40
1	40
0.1	40
0.01	150
0.001	200

CAPACITANCE ACROSS THE TEST TERMINALS: Approximately 3 pf.

POWER REQUIREMENTS: 105 to 125 volts, 50 to 60 cycles, 50 watts; 210 to 250 volts, 50 to 60 cycle operation available at the extra cost of \$10.00

SIZE: $19\frac{1}{4}$ wide by $10\frac{1}{4}$ high by $11\frac{1}{4}$ deep case mounted

MOUNTING: Case mounting is standard. Also available for 19 inch rack mounting at no extra cost

WEIGHT: Approximately 35 lbs.

PRICE: \$1850. F.O.B. Morris Plains, New Jersey

Specifications and prices subject to change without notice



Boonton ELECTRONICS Corporation

MORRIS PLAINS, NEW JERSEY

TELEPHONE: 201-539-4210

UHF GRID DIP METER

300-1000 MC MODEL 101-B

PATENT REGISTERED WITH U. S. PATENT OFFICE

•FOR THE
LABORATORY

•FOR THE
FIELD

•FOR THE
PRODUCTION LINE



The 101-B UHF Grid Dip Meter incorporates a unique series-tuned circuit capable of efficient operation in the UHF region from 300 to 1000 megacycles. This circuit accommodates much higher values of external coupling inductance than would normally be used in an oscillator at these frequencies. It is thus possible to utilize plug-in coils of practical size that permit adequate coupling to test circuits.

This instrument may be operated either as an oscillating grid dip meter for locating resonance frequencies of passive networks, or as a diode detector for measuring both the frequency and the relative level of an oscillating circuit.

SPECIFICATIONS:

Frequency Range Coils: 300 to 1000 MC, with three plug-in coils: 300-425 MC, 425-650 MC, 650-1000 MC

Frequency Accuracy: 2% (Dial individually calibrated)

Modulation: Internal modulation to approximately 30%, 120 cps AM. Phone jack for applying external modulation.

Tube Types: One type 6F4 Oscillator — One type 0B2 Regulator — One type 6X4 Rectifier

Power Supply: 115 volts 50/60 cps, 30 Watts

Dimensions: Probe — 3½" x 2¾" x 2½" — Indicator Unit — 6" x 5" x 9"

Weight: 8 lbs. — Shipping Weight, 9 lbs.

— Price: \$350.00, fob Morris Plains, New Jersey —

SEE REVERSE SIDE FOR ADDITIONAL INFORMATION

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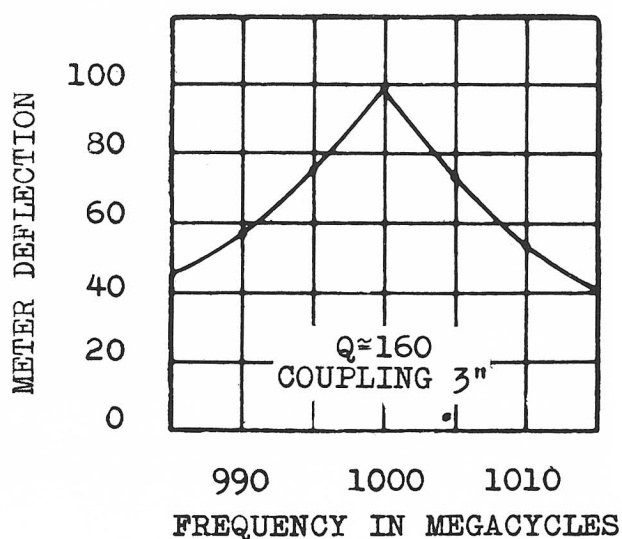
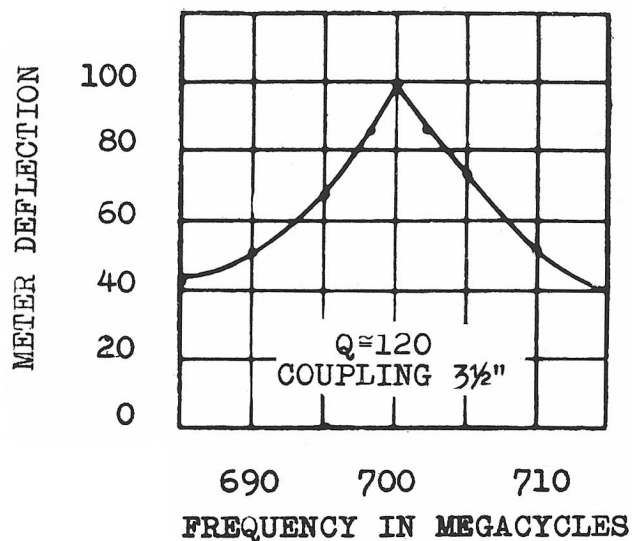
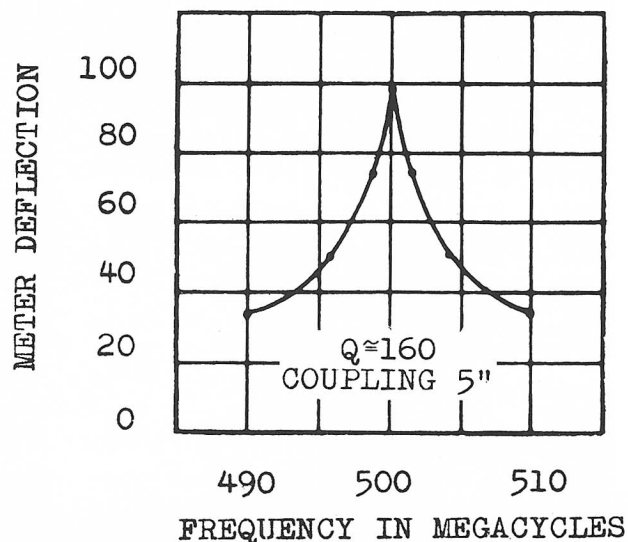
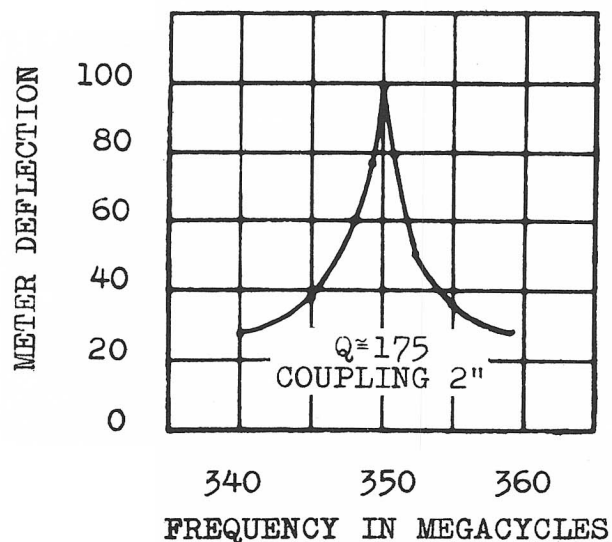
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Boonton *ELECTRONICS* Corp.
Morris Plains, N. J. Phone: JEfferson 9-4210

SELECTIVITY CURVES

101-B GRID DIP METER (USED AS DETECTOR)



ZERO SIGNAL=30. SIGNAL SOURCE IS OSCILLATING 101-B
 COUPLING: IS DISTANCE REQUIRED FOR FULL SCALE METER
 DEFLECTION AT MAXIMUM SENSITIVITY.



Boonton *ELECTRONICS* Corp.
 Morris Plains, N. J. Phone: Jefferson 9-4210

P R I C E L I S T

February 1, 1963

<u>Model</u>	<u>Description</u>	<u>Unit Price</u>
33A	RF Admittance Bridge	\$2,000.00***
44A	RF Microwatt Meter	750.00
51A	AC Null Detector (rack mounted)	2,100.00
56A	DC Null Detector	450.00*
63A, B & C	Inductance Bridge	1,850.00***
74C	Capacitance Bridge (100 Kc)	1,050.00**
74C-S8	Capacitance Bridge (100 Kc with DC bias)	1,125.00**
75A	Capacitance Bridge (1 Mc)	1,125.00***
75A-S8	Capacitance Bridge (1 Mc with DC bias)	1,200.00***
75B	Capacitance Bridge (1 Mc low range)	1,375.00***
75B-S8	Capacitance Bridge (1 Mc low range with DC bias)	1,450.00***
75C	Capacitance Bridge (5-500 Kc variable with DC bias)	1,900.00***
85B & C	RF Distortion Meter and Voltmeter	825.00
91C	RF Voltmeter (1 mv at 600 Mc)	450.00*
91CA	RF Voltmeter (300 μ v at 600 Mc)	550.00*
91D	RF Voltmeter (300 μ v at 1,200 Mc)	750.00*
95A	Sensitive DC Meter	550.00*
97A	DC Voltmeter-Amplifier	375.00*
98A	Differential DC Voltmeter-Amplifier	450.00*
101B	Grid Dip Meter	350.00

Add \$10.00 for 210-250 volt operation on all instruments.

Add \$10.00 for 50 cycle operation on 91CA & 91D only.

Add \$25.00 for special paint.

*Add \$25.00 for rack mounted version.

**Add \$50.00 for rack mounted version.

***Portable or rack mounted (same price)

NOTE: Prices of modified 74C and 75A Bridges are on Alternate Model Sheets.

All prices F.O.B. Morris Plains, N. J.

Terms: Net 30 days.

Boonton *ELECTRONICS* Corporation

738 SPEEDWELL AVENUE, MORRIS PLAINS, NEW JERSEY, U. S. A.

P R I C E L I S T

February 1, 1963

VOLTMETER ACCESSORIES AND PARTS

<u>Model</u>	<u>Description</u>	<u>Unit Price</u>
91-3C	RF Probe for 91C or 91CA RF Voltmeters	\$45.00
91-4B	Special 1 Kc-250 Mc RF Probe for all RF Voltmeters	60.00
91-6B	Unterminated 'BNC' Adapter for all RF Voltmeters	15.00
91-7B	100:1 Voltage Divider for all RF Voltmeters	30.00
91-8B	50 Ω Adapter (other resistances same price) for 91C & CA	20.00
91-12A	RF Probe for 91D RF Voltmeter	50.00
91-13B	Probe Tip Adapter for all RF Voltmeters	2.00
91-14A	"T" Adapter for 91D RF Voltmeter	25.00
91-15A	50 Ω Termination for 91D RF Voltmeter	25.00
91-16A	Unterminated 'N' Adapter for all RF Voltmeters	15.00
	Accessory box for 91D RF Voltmeter	7.00
	Complete accessory kit for 91D RF Voltmeter	150.00
	Replacement chopper for 85B, C, 91A, B, or C, 97A	50.00
	Replacement chopper for 56A, 91CA, 91D, 95A, & 98A	70.00

BRIDGE ACCESSORIES

AC1	Auxiliary Capacitor for 74C Bridge series	50.00
CS	Capacitance Standards	75.00
TS1	Terminal Shield	4.00

All prices F.O.B. Morris Plains, N. J.

Terms: Net 30 days.

. . . HERE ARE OUR REPRESENTATIVES . . .

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Phone: 617-655-1330

CONNECTICUT

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Phone: 203-272-5040

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177 Winton Rd. N., Rochester 10, N.Y.
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SBM Associates
139 E. Main St., Elmsford, N.Y.
Phone: 914-592-8850

SBM Associates
1943 W. Fayette St., Syracuse 4, N.Y.
Phone: 315-468-5041

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NLR Associates
643 Eagle Rock Ave., West Orange, N.J.
Phone: 201-731-0774

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Dayton Associates
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Dayton Associates
14746 Richfield Ave., Livonia, Mich.
Phone: 313-464-1300

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Twx: 314-556-0174

Engineering Services Co.
7546 Troost, Kansas City, Missouri
Phone: 816-EM-1-9600
Twx: 816-556-2347

Engineering Services Co.
4710 E. Mount Vernon Rd., Wichita, Kan.
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Twx: 612-361-7901

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Airep Engineering Company
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Phone: 801-487-7847
Twx: 801-521-2402

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Albuquerque, New Mexico, 87112
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Twx: 415-969-9144

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Twx: 714-276-3911

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Twx: 610-492-1372

Mel Sales Ltd.
P.O. Box 1352, Station "O"
Montreal, Quebec
Phone: 514-627-4313
Twx: 610-422-3970

EXPORT

A. V. Marano & Co., Inc.
276 Fifth Ave., New York 1, N.Y.
Phone: 212-686-5577

BOONTON
ELECTRONICS
CORPORATION

TELEPHONE: 201-887-5110
TWX: 201-887-5059

ROUTE 287 AT SMITH ROAD
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