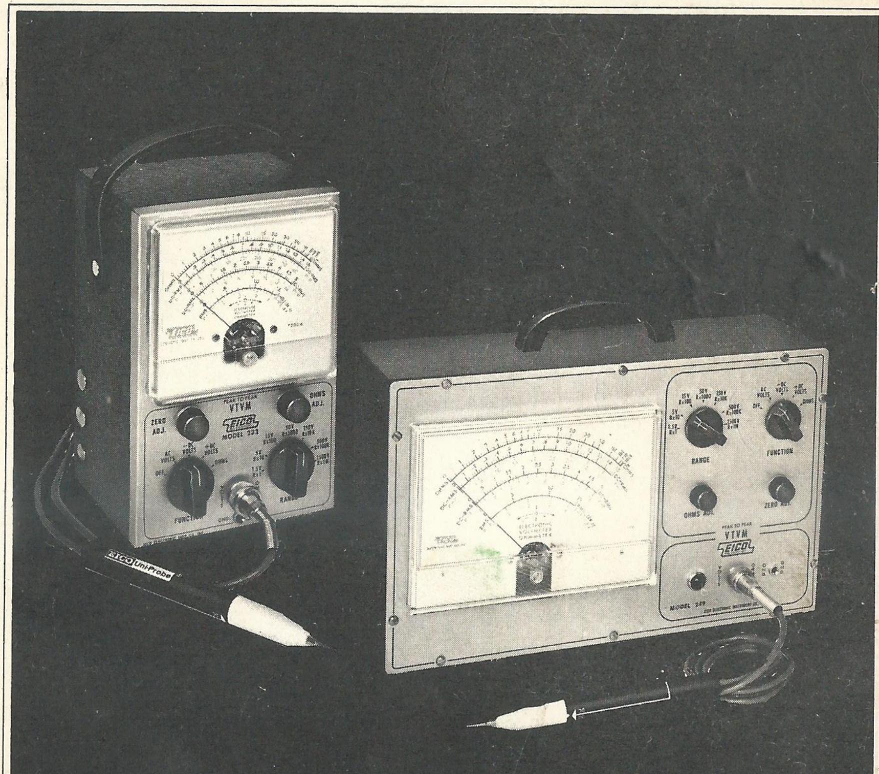
EICO®

232 | Peak to Peak
249 | VTVM



OPERATING MANUAL

GENERAL DESCRIPTION

Expressly designed for TV servicing, the Model 232 (249) Peak-to-Peak VTVM features a full-wave, high-frequency rectifier circuit that responds to and measures the peak-to-peak voltage value of complex and sine waveforms even when dc is present. It also reads the rms voltage of sine waves (on a separate scale), dc voltage values, and resistance values. For consistently high accuracy, there are seven non-skip ranges on all functions to provide a uniform 3 to 1 scale ratio between adjacent ranges.

The input resistance on all dc voltage ranges is 11 megohms, which is high enough to prevent loading error and yet not so high as to impair the stability of the instrument. The dc voltage ranges may be extended to 30,000 volts (with accessory High Voltage Probe HVP-1 or HVP-2) and may also be used for RF voltage measurement up to 250 MHz (with accessory RF Probe Model PRF-11). The frequency response of the ac voltage ranges extends from 30 Hz to 3 MHz for a source of 100 ohms or less.

Facilities that increase the accuracy, versatility, and ease of operation include zero-center indication for discriminator alignment and bias measurements; zero adjustment unaffected by changing function or range; separate scale for low ac voltage measurement; electronic protection against meter burn out; adjustment of all calibration controls without cabinet removal; and UNI-PROBE, a single unit probe used for all functions.

The Model 232 (4-1/2" meter) and the Model 249 (7-1/2" meter) are identical electrically. Where portability is desired, the Model 232 is preferable becaus of its extremely compact design. The Model 249 is an ideal bench instrument, having extra long scales to minimize reading errors and permitting permanent placement of the equipment at a practical working distance. Both instruments are ruggedly housed, professional in appearance, and highly dependable and trustworthy measuring devices that will prove extremely valuable in television fm-am radio servicing, and many industrial applications.

SPECIFICATIONS

DC VOLTMETER:

Ranges	0 to 1.5,5,15,150,500,1500 volts
Input Resistance	11 MΩ
Accuracy	±3% of full scale or better

Range extended to 30,000 volts with High Voltage Probe HVP-1 or HVP-2 (1090 MΩ multiplier resistor recommended).

AC VOLTMETER:

RMS values of Sine Waves . .	0 to 1.5 volts on separate LOW-AC scale 0 to 5, 15, 50, 150, 500, 1500 volts
Peak-to-Peak Values of Sine & Complex Waves . . .	0 to 4 volts on separate LOW-AC scale 0 to 14, 42, 140, 420, 1400, 4200 volts
Input Resistance & Capacity	1 MΩ, shunted by 60 pf (approx.)
Accuracy	±5% of full scale or better
Frequency Response	30 Hz to 3 MHz (source Z 100 Ω or less)

RF voltage measurement to 250 MHz (accuracy ± 10%) with RF Probe PRF-11

OHMMETER: 0 to 1000 Megohms in 7 ranges — RX1, RX10, RX100, RX1000, RX10K, RX100K, RX1 Meg (10 ohms center scale on RX1 range)

TUBE COMPLEMENT: 1-6FQ7/6CG7 twin-triode in vacuum-tube balanced bridge circuit, 2 silicon rectifiers.

POWER SUPPLY: Transformer-operated silicon rectifier; 1.5 volt flashlight cell.

POWER REQUIREMENTS: 105-125 volts ac, 50-60 Hz; drain: 10 watts

OVERALL SIZE: Model 232-8-1/2" H, 5" W, 5" D
Model 249-8-1/2" H, 13" W, 5" D

WEIGHT: Model 232 - 7 pounds
Model 249 - 9 pounds

CASE: Steel cabinet, grey wrinkle finish, satin-aluminum panel, deep-etched and rub-proof.

Supplied complete with UNI-PROBE (combined isolating and direct probe, used for all functions and ranges) and ground lead.

OPERATION

PRELIMINARY ADJUSTMENTS

1. Connect the UNI-PROBE to the VOLTS-OHMS terminal, and the ground cable to the GND terminal.

2. Plug the linecord into an outlet supplying 105-125 volts ac, 50-60 Hz.

3. Set the FUNCTION selector to +DC VOLTS and the UNI-PROBE to DC. Allow several minutes for the instrument to warm up. If necessary, use the ZERO ADJ. control to set the meter pointer within scale limits during the warm-up period.

4. Short the UNI-PROBE to the ground cable and set the meter pointer at the left-hand zero with the ZERO ADJ. control. If turning the FUNCTION selector to -DC VOLTS changes the position of the meter pointer, readjust the mechanical zero of the meter as described under MAINTENANCE.

5. Set the FUNCTION selector to OHMS, the UNI-PROBE to AC-OHMS, and the RANGE selector to RX10. Separate the UNI-PROBE from the ground cable. The meter pointer should move to approximately full scale.

6. Use the OHMS ADJ. control to position the meter pointer on the last graduation of the scale.

7. Set the FUNCTION selector to AC VOLTS. If the meter pointer does not read zero volts when the RANGE selector is at 1.5 V, refer to AC Voltmeter Calibration in the maintenance section.

NOTE: Although the meter is protected against burn-out under ordinary loads, repeated overloads may impair the accuracy of the movement. For this reason, in the following instructions the operator is advised to first make a trial measurement at a range setting higher than the voltage expected.

DC VOLTAGE MEASUREMENT

1. Set the UNI-PROBE to DC and the FUNCTION selector to either +DC VOLTS or -DC VOLTS, depending upon the polarity of the voltage to be measured with respect to ground.

2. Set the RANGE selector to a position considerably higher than the voltage to be measured.

3. Connect the ground cable to the ground side of the voltage being measured and touch the UNI-PROBE to the high side.

4. Reset the RANGE selector to the position which gives a reading nearest to full scale and read the dc voltage on the meter.

ZERO CENTER INDICATION

Zero-center indication permits observation of either positive or negative voltage excursions without resetting of the function selector. To prepare the instrument for zero-center indication, simply set the FUNCTION selector to +DC VOLTS and turn the ZERO ADJ. control (with no voltage applied) until the meter pointer is set at the center -0+. The range selector should be set first to a position at least twice the voltage to be measured and then to the lowest position which permits the meter pointer to remain on the scale. The value of a positive voltage (deflection to the right of the center -0+) is obtained by subtracting half the range selector setting from the dc voltage reading on the scale. The value of a negative voltage (deflection to the left of the center -0+) is obtained by subtracting the dc voltage reading on the scale from half the range selector setting. (Should you be unable to get a zero center on the +DC VOLTS setting of the FUNCTION switch, use the -DC VOLTS setting. The polarities of the readings are then reversed.)

RESISTANCE MEASUREMENT

Remove all power from the equipment under test before making resistance measurements so that no voltages are present.

1. Set the UNI-PROBE to AC-OHMS and the FUNCTION selector to OHMS.

2. Set the RANGE selector to RX10.

3. Short the UNI-PROBE to the ground cable. The meter pointer should be at the left-hand zero. Use the ZERO ADJ. control to reset the pointer at the left-hand zero, if necessary.

4. Separate the UNI-PROBE from the ground cable. The meter pointer should be at the last line on the OHMS scale. Use the OHMS ADJ. control to reset the pointer at the last line on the OHMS scale, if necessary.

5. Connect the clip on the ground cable to one terminal of the resistance to be measured and touch the UNI-PROBE to the other terminal.

6. Reset the RANGE selector to give a convenient deflection and multiply the reading on the OHMS scale by the factor indicated at the RANGE selector setting.

CAUTION: Meter movements, thermocouples, and other low-current, low-resistance devices may be damaged unless a range above RX10 is used. At the RX1 and RX10 positions, the instrument applies up to 1.5 volts to the resistance under measurement.

RESISTANCE MEASUREMENT ABOVE 1000 MEGOHMS

The upper limit of direct resistance measurement with this instrument is 1000 megohms. The leakage resistance of small paper and mica capacitors usually exceeds this value. To measure resistance values above 1000 megohms, an external dc voltage source between 20 and 500 volts can be used to obtain a measurable pointer deflection. The circuit connections are shown in figure 1 and the procedure is as follows.

1. Set the FUNCTION selector to +DC VOLTS and the UNI-PROBE to DC.

2. Measure the voltage at point A and then the voltage at point B.

3. Compute the resistance from the following formula.

$$Rx \text{ (megohms)} = \frac{11 \left[\text{(Volts at A)} - \text{(Volts at B)} \right]}{\text{(Volts at B)}}$$

Example: In measuring a resistance by the method of figure 1, the external dc voltage supply is 300 volts. The instrument measures 300 volts at point A and 1.1 volts at B. Then,

$$Rx = \frac{11\ (300 - 1.1)}{1.1} = 3000 \text{ megohms (approx.)}$$

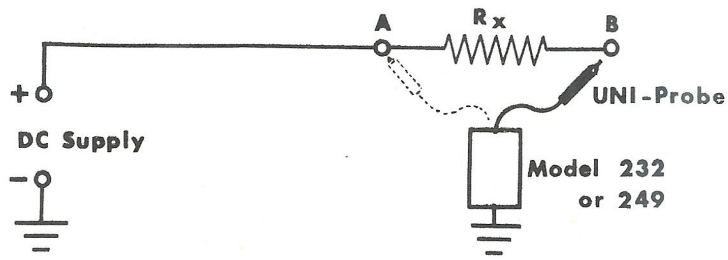


FIGURE 1

AC VOLTAGE MEASUREMENTS

1. Set the UNI-PROBE to AC-OHMS and the FUNCTION selector to AC VOLTS.

2. If necessary, use the ZERO ADJ. control to set the meter pointer at the left-hand zero.

3. Set the RANGE selector to a position considerably higher than the voltage to be measured.

4. Connect the ground cable to the ground side of the voltage source to be measured and touch the UNI-PROBE to the high side.

5. Reset the RANGE selector to the position which gives a reading nearest to full scale and read the ac voltage.

NOTE: All RMS scales are in black with full-scale values of 1.5, 5, 15, 50, 500, and 1500 volts. All peak-to-peak scales are in red with full-scale values 4, 14, 42, 140, 420, 1400, and 4200 volts. When the instrument is set at the 1.5 volt range, the RMS or P-P scales on the lowest arc (designated as LOW-AC) are read; on higher ranges, the scales on the two center arcs are read. It should be noted that the fixed ratio of 2.83 to 1 between corresponding peak-to-peak and rms scales is derived from the relationship between the peak-to-peak and rms values of a sine wave. Therefore, while peak-to-peak readings are valid regardless of whether the waveform is complex or sine, rms readings are valid only for sine waves. Note also that the time delay between the instant the leads are removed from the source being measured and the instant the meter pointer returns to zero is normal and is the result of circuit constants selected to permit accurate measurement of recurrent pulses with low repetition rates.

CAPACITANCE AND INDUCTANCE MEASUREMENTS

NOTE: Additional items required to make the following capacitance and inductance measurements are an external ac power source and two shunt resistors (10K and 300K).

1. Set up the Model 232 (249) and the external power source as shown in figure 2.

WARNING: Make certain the external power source is off before connecting the capacitance or inductance to be measured.

2. Set the UNI-PROBE to AC-OHMS.

3. For capacitance readings of .009 MF to 1 MF or for inductance readings, connect a 10K shunt resistor across the meter leads, set the FUNCTION switch to AC VOLTS and the RANGE switch to 15V, and (with the meter leads

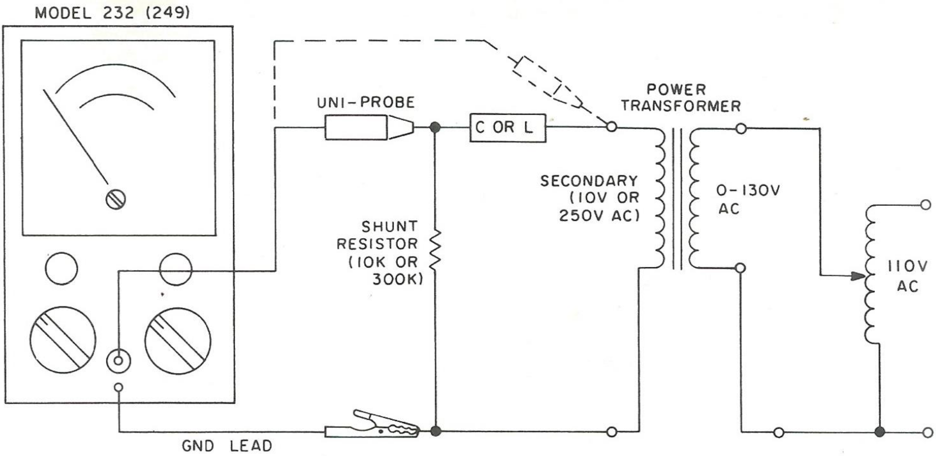


FIGURE 2

connected across the secondary of the power transformer) adjust the external power source for a reading of 10 volts rms. For capacitance readings of .0001 MF to .03 MF, connect a 300K shunt resistor instead of the 10K shunt resistor, set the RANGE switch to 500V, and adjust the external power source for a reading of 250 volts rms.

CAUTION: Adjust the external power source starting from its lowest voltage so as not to overload the meter on the selected scale.

4. With the capacitance or inductance in series with the secondary of the power transformer as shown in figure 2, read the voltage on the meter; then refer to table 1 (capacitance of .009 MF to 1 MF), table 2 (capacitance of .0001 MF to .03 MF), or table 3 (inductance of 5H to 1000H) to obtain the corresponding value of capacitance or inductance.

TABLE 1. VOLTAGE TO CAPACITANCE CONVERSION CHART
(.009 MF TO 1 MF)

Volts (rms)	Capacitance (mf)	Volts (rms)	Capacitance (mf)
.32	.009	5.15	.16
.38	.01	5.61	.18
.73	.02	6.01	.2
1.11	.03	6.86	.25
1.49	.04	7.49	.3
1.85	.05	8.34	.4
2.21	.06	8.83	.5
2.55	.07	9.14	.6
2.87	.08	9.35	.7
3.20	.09	9.50	.8
3.52	.1	9.58	.9
4.12	.12	9.67	1
4.67	.14		

TABLE 2. VOLTAGE TO CAPACITANCE CONVERSION CHART
(.0001 MF TO .03 MF)

Volts (rms)	Capacitance (mf)	Volts (rms)	Capacitance (mf)
2.25	.0001	59	.0026
4.5	.0002	64	.0028
6.75	.0003	68	.003
9.25	.0004	78	.0035
11.8	.0005	88	.004
14	.0006	97.5	.0045
16	.0007	106	.005
18.1	.0008	112	.0055
21	.0009	124	.006
23.3	.001	130	.0065
27.7	.0012	137	.007
32.7	.0014	151	.008
37	.0016	161	.009
42	.0018	172	.01
46.2	.002	221	.02
51	.0022	236	.03
55	.0024		

TABLE 3. VOLTAGE TO INDUCTANCE CONVERSION CHART
(5H TO 1000H)

Volts (rms)	Inductance (L)	Volts (rms)	Inductance (L)
9.83	5	3.14	80
9.75	6	2.81	90
9.67	7	2.56	100
9.57	8	2.16	120
9.47	9	1.86	140
9.35	10	1.63	160
7.99	20	1.45	180
6.63	30	1.31	200
5.52	40	0.88	300
4.67	50	0.64	400
4.04	60	0.53	500
3.52	70	0.27	1000

APPLICATIONS

This instrument may be used to maintain and service television receivers, fm-am and communication receivers, transmitters, audio equipment, and pulsed electronic and electro-mechanical equipment. Indicative of its versatility are some of the special applications described below.

OSCILLATOR GRID-BIAS MEASUREMENT

The negative dc voltage developed on the oscillator grid is always directly proportional to the strength of oscillation. This voltage can be measured very readily at the oscillator grid while the band switch is turned to the various bands, and in each of its positions the main tuning capacitor is rotated from minimum capacity. This will give an indication of the strength of oscillation at all frequencies within the oscillator's range.

AVC-VOLTAGE MEASUREMENTS

The automatic volume control voltage developed by the incoming signal can be measured at a number of places in the receiver. This negative voltage first appears across the diode load resistor. It may also be measured along the avc bus and at the grids of the rf tubes being controlled. The dc voltage measured at the diode load resistor is a very convenient output indication during receiver alignment.

Owing to the high input resistance of this instrument, it is possible to measure bias (avc) voltage on the grid of rf and if amplifier tubes without disrupting the signal.

DC SUPPLY VOLTAGE MEASUREMENTS

Power supply dc voltages can be measured at the rectifier filaments and in the filter circuits. Plate, screen, and cathode dc voltages can be measured at the corresponding pins of the tube sockets.

BIAS CELL VOLTAGE MEASUREMENTS

This instrument will accurately measure the voltage of a bias cell. Current drawing voltmeters are not capable of making this measurement and in many cases will damage the cell.

DETECTION OF GASSY TUBES

One effect of a gassy tube is to reduce the normal negative grid bias, or even make the grid positive. This instrument is ideal for measuring the voltage directly at the control grid of any tube in order to determine whether or not this effect is present. Excessive gas will cause the tube to cease operating normally, and in an audio amplifier will usually cause the volume control to become noisy. This amount of gas will not always produce a noticeable change in the operation of the radio receiver. Consequently, if repeated difficulty is experienced with volume controls becoming noisy in this type of circuit, this instrument should be used to check for incorrect bias.

OUTPUT INDICATION

To measure output in the alignment of am and TV receivers, the instrument is prepared for dc voltage measurement and usually connected to the load resistor of the second detector while the circuit components are adjusted for optimum output. In an fm receiver, the instrument is connected across the limiter load resistor. The zero-center feature is very useful for the alignment of fm discriminators.

DB MEASUREMENTS

In order to avoid crowding of frequently used scales, there is no db scale on the meter. Another reason for the absence of this scale is that there are many different reference levels in use and each reference level results in a different scale. Figure 3 is a graph for one accepted reference level, namely 0.775 volt across 600 ohms resistive load (1 milliwatt), with which rms ac voltage readings can be converted to db readings. However, the db value read from the chart is correct only when the voltage reading has been taken across a 600 ohm resistive load. If the reading has not been taken across a 600 ohm load, the db value read from the chart must be corrected by algebraically adding to it the correction increment specified in table 4 for the particular resistive load. If the resistive load is not included in the table, the correction increment may be calculated from the following formula.

$$\text{Correction Increment} = 10 \log \frac{600}{R} \quad \text{(where R is the resistive load)}$$

It should be noted that decibel measurements must be made with a sine wave form to avoid waveform error and that the correlation between decibels and ear response is greatest at 1000 cycles.

TABLE 4. DB CORRECTION INCREMENTS

Load Res.	DB Added	Load Res.	DB Added
600	0	150	+6.0
500	+0.8	50	+10.8
300	+3.0	15	+16.0
250	+3.8	8	+18.8
		3.2	+22.7

OPERATING INSTRUCTIONS

The central circuit in the operation of this instrument is a vacuum-tube bridge circuit using a 6FQ7/6CG7 twin-triode. When the bridge is balanced, the voltages at the two cathodes will be equal and the meter connected across them will read zero.

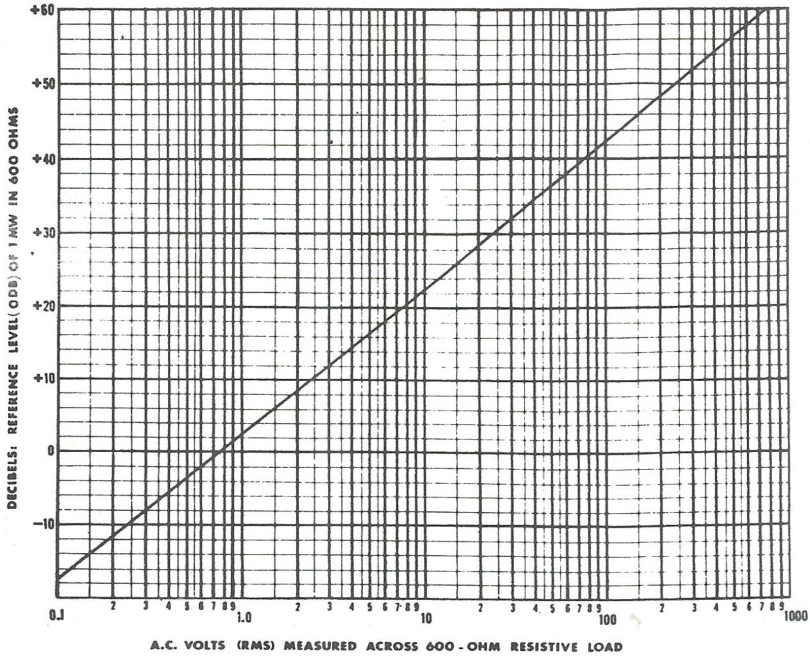


FIGURE 3

DC VOLTMETER OPERATION

When a positive dc voltage is applied, a fraction (depending on the range setting) is taken from the range voltage divider (R12-R18) and applied to the grid of V1A. This causes the current through V1A to increase and, consequently, the cathode voltage of V1A to increase. Concurrently, the voltage on the arm of R22 tends to increase; and since it tends to make the cathode of V1B more positive, causes a decrease in the plate current and cathode voltage of V1B. This push-pull action permits a large value of cathode resistance with negligible degeneration and, consequently, greatly increased stability of operation. The meter circuit is connected across the two cathodes, and the difference in potential across the meter causes current to flow through the meter from the cathode of V1A to the cathode of V1B.

AC VOLTAGE MEASUREMENTS

The applied voltage is first rectified by diodes D1 and D2 which serve as a full-wave, peak-to-peak rectifier. The operation of this circuit is as follows: On the positive swing of the ac signal, diode D1 conducts and a negative dc voltage equal to the positive peak value builds up on the diode-connected side of C2. As the ac signal voltage swings negative, diode D1 ceases to conduct (and so prevents any discharge of C2) while diode D2 begins to conduct. The negative dc voltage on C2 is added in series to the signal voltage on the negative swing and is applied to the cathode of D2. As a result, a negative dc voltage equal to the sum of the positive and negative peaks of the ac signal voltage is built up on the anode-connected side of C3 through conduction of diode D2 and is maintained because of the relatively long time constants of the circuit. The peak-to-peak voltage across C3 is attenuated by R27 before application to the range voltage divider. Thereafter the operation is similar to dc voltage measurement.

OHMMETER OPERATION

The applied resistance determines the current through the battery and the section of the ohms range network (R5-R11) selected by the range switch. With nothing connected across the input terminals, no current is drawn, and consequently there is no voltage drop across the ohms network. As a result, the entire battery voltage is applied to the grid of V1A. Potentiometer R28 in the meter circuit is adjusted to produce full-scale deflection (infinity reading) in this condition. A short across the input terminals produces a voltage drop in the ohms range network equal and opposite to the battery voltage and effectively places the grid of V1A at ground potential for a zero reading. Intermediate values of resistance produce voltage drops exceeded by the battery voltage, and the difference in voltage is applied to the grid of V1A. This voltage causes an intermediate deflection on the meter which has an ohms scale calibrated to read the applied resistance.

MAINTENANCE

Included in this section are instructions for calibration, adjustment, repair, and part replacement.

CALIBRATION

General: Instruments purchased in kit form must be calibrated before use, as described here. Factory-wired instruments have been calibrated and tested at the factory. If a change occurs in the accuracy of the instrument after a long period of use, it is probably due to aging of the components. The accuracy of the instrument may readily be restored by repeating this calibration procedure. Recalibration will also be necessary, whenever parts (tube, diodes, etc.) are replaced.

Mechanical Zero: The meter pointer should rest directly over the left-hand zero when the power is shut off. If the meter pointer comes to rest at a deflected position, adjust it to zero by turning the slotted screw directly beneath the meter face.

Warm-up: Insert the leads and plug the linecord into an outlet supplying 105-125 volts ac, 50-60 Hz. Turn the unit on and allow a minimum of 2 hours for the warm-up preliminary to calibration. For maximum stability of calibration, a 36 hour warm-up period is desirable. If necessary, use the ZERO ADJ. control to set the meter pointer within scale limits during the warm-up period.

AC Voltmeter Calibration: Set the FUNCTION selector to AC VOLTS, the RANGE selector to 150 V, and the UNI-PROBE to AC-OHMS. Connect the UNI-PROBE and the ground cable across the 117 volt ac supply. Adjust the AC calibration potentiometer, R30, until the meter reads 117 volts rms.

If the maximum accuracy of which the instrument is capable is desired (±5% of full scale), apply exactly 150 volts (60 Hz) on the 150 V range (or 50 volts on the "50 V" range) and adjust R30 for exactly full-scale deflection.

DC Voltmeter Calibration: Set the FUNCTION selector to + DC VOLTS, the RANGE selector to 5V, and the UNI-PROBE to DC. Connect the UNI-PROBE and the ground cable across two flashlight cells in series, which will provide a voltage of 3.10 volts when fresh. Adjust the DC calibration potentiometer, R29, until a 3.10 volt reading is obtained on the meter.

Ohmmeter Calibration: No separate calibration is required.

NOTE: Access to the calibration controls is obtained by temporary removal of the plug-buttons inserted in the side of the cabinet. Figure 4 shows the location of each control in Models 232 and 249.

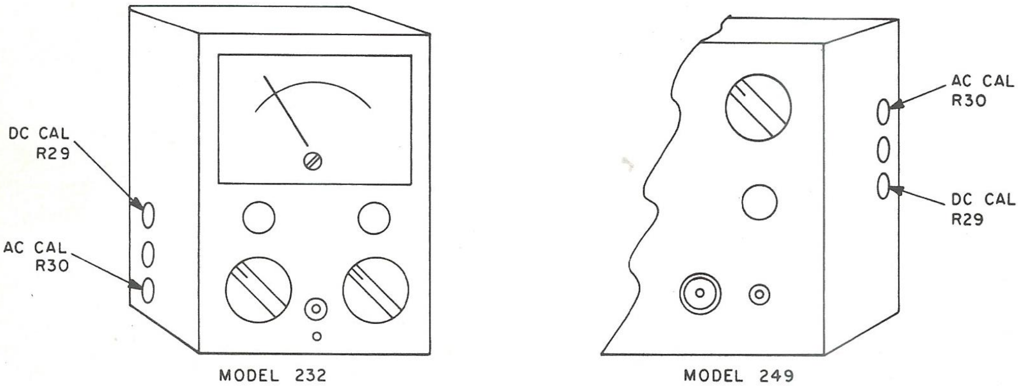


FIGURE 4

TUBE REPLACEMENT

When a new tube is installed in the instrument, it may be necessary to re-zero when switching from the lowest to the highest dc voltage ranges unless the tube is aged by operating it in the instrument for 36 hours. The calibration should be checked after this period.

BATTERY REPLACEMENT

Do not permit an exhausted battery to remain inside the instrument case as the chemicals from a deteriorated battery may damage the components. Indications of a weak battery will be found in the troubleshooting section.

TROUBLESHOOTING THE MODEL 232 OR 249

As an aid to localizing the cause of faulty operation, the following general troubleshooting procedure has been prepared. Obviously all possible troubles cannot be listed and the technician should use the schematic diagram to trace down unlisted troubles. In general, newly constructed kit instruments should be given a thorough, step-by-step check of the wiring, following the tables and pictorial diagrams in the assembly manual, in case the trouble is not listed or cannot be corrected by checking the listed possible causes.

Instrument fails to operate on all functions; tube does not light.

1. Linecord broken or not making contact at outlet.
2. Switch section S1D defective.
3. T1 defective: Check for shorted or open windings.

Tube lights; ZERO ADJ. does not work properly; meter pointer does not move or bangs to right or left.

1. Incorrect operating voltages on bridge tube V1.
   a. No B-plus or B-minus voltage present: Check D1, C5, T1 high voltage winding, R24 and R26 with ohmmeter; check connections between these components also.
   b. B-plus and B-minus voltage present: Open or short in V1 circuit.
   c. V1 defective: See Tube Replacement.
2. Switch section S1C defective or wired incorrectly.
3. Defective meter movement.
4. ZERO ADJ. control erratic in operation: Potentiometer R22 is defective; replace with new control. NOTE: First make sure mechanical zero of pointer is correct. See Mechanical Zero under CALIBRATION.

Meter pointer sticks.

1. Cracked or broken jewel bearing in meter. NOTE: Individual replacement parts for meter movement are not available. Meter should be returned for repairs or replaced with new meter.

Intermittent operation on all functions.

1. Loose or bad connections in probe or cables.
2. Wiper contact on S1B or S1C defective.
3. Loose or bad connection in bridge circuit wiring, including meter terminals: With power applied, probe wiring and components with insulated probe.
4. V1 defective: Replace as described under TUBE REPLACEMENT.
5. D3 intermittent.

Instrument fails to operate on OHMS; works normally on AC and DC VOLTS measurements.

1. Battery exhausted or not making contact.
2. Defective wiper contact on switch section S2C.
3. Ohms contact (terminal 7) on S1B defective.
4. Open circuit in resistor network or burned out resistor around switch section S2C: Check continuity of network R5 through R11. NOTE: This network is made up of resistors which are added in series as switch is rotated. Therefore, one faulty resistor may cause improper operation on one or more ranges.
5. Loose or broken ohms contact on switch section S1C (terminal 1).

OHMS ADJ. fails to give infinity setting on OHMS scale.

1. Battery exhausted.
2. OHMS ADJ. potentiometer, R28, defective.
3. V1 defective. See TUBE REPLACEMENT.

Resistance readings inaccurate on some or all OHMS ranges.

1. One or more resistors in network around switch section S2C have changed value.
2. Excessive leakage in ohms circuit: Check switch wafers on S2C and S1B for dirt or damage. NOTE: High humidity may cause leakage and inaccurate readings on high ohms scales. Bake out inside of instrument with light bulb.
3. Shorted wiring in resistor network around S2C.
4. Faulty or high-resistance connections in ohms circuit.

Instrument fails to operate on any AC VOLTS range; works normally on OHMS and DC VOLTS.

1. D1 or D2 defective.
2. AC volts contact on S1A, S1B, S1C, or S2B defective.
3. Faulty wiper contact on S2D.
4. Open or short in circuitry associated with D1 and D2: Check out wiring and components values with ohmmeter.
5. C1, C2, or R27 open; C3 shorted.

AC VOLTS readings inaccurate on some or all AC ranges; performance on OHMS and DC VOLTS ranges is normal.

1. Defective contacts or wipers, or excessive leakage in S2B: Check for loose or dirty contacts.
2. D1 or D2 defective.
3. C2 or C3 leaky.
4. R27 changed in value: Check with ohmmeter.

If instrument is inaccurate on 500 and 1500 volt ranges only, check contacts 10 and 11 on S2D and also R2, R3, and R4. If inaccurate on 1.5 volt range only, replace D1 and D2.

Instrument fails to operate on any range of +VOLTS or -VOLTS; works normally on OHMS and AC VOLTS.

1. UNI-PROBE resistor is open. Try applying low dc voltage with UNI-PROBE set at AC-OHMS. If reading is obtained (about 10% high), replace UNI-PROBE resistor.
2. DC voltage contacts on switch sections S2A, S1B, or S1C are defective: Check for loose or broken contacts.

Voltage readings inaccurate on +VOLTS; -VOLTS, AC VOLTS and OHMS readings are correct.

1. R29 out of adjustment: Reset as described under DC Voltmeter Calibration.
2. UNI-PROBE switch is shorted, resulting in readings about 10% high on all +DC and -DC voltage ranges: Use ohmmeter to check for short between input and output of probe at DC position as well as AC-OHMS-position.
3. Resistances in network around S2A have changed value: Check with ohmmeter and replace defective resistors.

PARTS LIST

RESISTORS

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
.05	10033	R19	car., 3.3M, 1/2W, 20%	1
.05	10034	R25	car., 4.7M, 1/2W, 20%	1
.05	10406	R20, 21	car., 680Ω, 1/2W, 10%	2
.05	10407	R1	car., 1M, 1/2W, 10%	1
.06	10503	R26	car., 33K, 1/2W, 5%	1
.07	10520	R24	car., 68K, 1/2W, 5%	1
.07	10521	R23	car., 47K, 1/2W, 5%	1
.10	10524	R27	car., 18M, 1/2W, 5%	1
.43	11025	R2	car., dep., 150K, 1/2W, 1%	1
.42	11026	R15	car., dep., 200K, 1/2W, 1%	1
.41	11037	R9	car., dep., 900Ω, 1/2W, 1%	1
.43	11038	R8	car., dep., 9K, 1/2W, 1%	1
.43	11039	R7	car., dep., 90K, 1/2W, 1%	1
.49	11043	R11	car., dep., 9.7Ω, 1/2W, 1%	1
.43	11044	R10	car., dep., 90Ω, 1/2W, 1%	1
.43	11045	R6	car., dep., 900K, 1/2W, 1%	1
.60	11046	R5	car., dep., 9M, 1/2W, 1%	1
.43	11047	R13	car., dep., 2M, 1/2W, 1%	1
.43	11048	R14	car., dep., 700K, 1/2W, 1%	1
.43	11049	R16	car., dep., 70K, 1/2W, 1%	1
.43	11050	R17	car., dep., 20K, 1/2W, 1%	1
.43	11051	R18	car., dep., 10K, 1/2W, 1%	1
.43	11052	R3	car., dep., 325K, 1/2W, 1%	1
.72	11700	R4	car., dep., 900K, 1W, 1%	1
.90	11701	R12	car., dep., 7M, 1W, 1%	1

POTENTIOMETERS

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
.88	16000	R22	car., 2K, 20%, linear	1
1.50	16023	R28	car., 2.5K, 20%, linear	1
1.17	18014	R29, 30	car., 2K, snap-in, linear (red)	2

CAPACITORS

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
.33	20019	C4	mylar, .0033 mf, 600V, 10%	1
1.84	20090	C1	mylar, A.L., .1 mf, 1600V, 10%	1
.38	20107	C2, 3	mylar, .027 mf, 400V, 10%	2
.57	23010	C5	elec., A.L., 10 mf, 150V	1

TRANSFORMER

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
4.09	30012	T1	power	1

HARDWARE

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
.01	40000		nut, hex, #6-32 x 1/4	6
.02	40001		nut, hex, 3/8-32 x 1/2	6
.01	40005		nut, hex, #10-24 x 3/8	2
.01	40007		nut, hex, #4-40 x 1/4	2
.06	40035		nut, hex, #6-32 x 3/16	1
.01	41000		screw, #6-32 x 1/4, b.h.	5
.01	**41006		screw, #10-24 x 3/8, b.h.	2

* For Model 232 only.

** For Model 249 only.

HARDWARE (cont)

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
.01	41008		screw, #6-32 x 1/2, b.h.	1
.02	*41012		screw, #10-24 x 3/8, button head	2
.01	41016		screw, #4-40 x 1/4, b.h.	2
.01	41035		screw, #6 x 1/4, p.k., b.h.	2
.05	41061		screw, set, #8-32 x 3/16, bt. slot	1
.16	41219		screw, set, #8-32 x 1/4, nylon	1
.01	42000		washer, lock, 3/8	4
.01	42001		washer, flat, 3/8	4
.01	42002		washer, lock, #6	2
.01	42006		washer, fiber, shoulder, #6	2
.01	42007		washer, lock, #4	4
.01	42020		washer, fiber, small	1
.01	42021		washer, fiber, large	1
.02	42022		washer, metal cup, 5/32 hole	1
.01	42024		washer, split, #6	1
.03	43000		lug, ground, #6	3
.11	44002		spacer, fiber, small dia.	1
.13	44003		spacer, fiber, large dia.	1
.01	*45000		standoff, #10 x 1/4"	2
.05	46000		grommet, rubber, 3/8	1
.06	**46005		foot, rubber	4
.04	47002		spring	1
.06	48000		plug button, 3/8"	2

CONNECTORS, KNOBS, & TERMINAL STRIPS

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
.87	50002	J1	connector, male, amph.	1
.39	50008	J2	jack, banana, metal, w/lockwasher and nut	1
1.18	51000		connector, female, amph.	1
.58	51005		plug, banana, small	1
.14	51502		clip, crocodile	1
.28	53001		knob, small, round	2
.38	53006		knob, round, bar	2
.08	54018		terminal strip, 4 post w/gnd	1
.10	54093		terminal strip, 4 post w/gnd standoff	1

SWITCHES

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
3.95	60067	S1	function	1
5.30	60250	S2	range	1

METER

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
13.65	*72004	M1	400 ua, 150 ohm (w/hardware)	1
20.25	**73003	M1	400 ua, 150 ohm (w/hardware)	1

SHEET METAL & MISCELLANEOUS

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
.90	57004		linecord	1
2.00	*66584		manual, assembly	1
1.50	66585		manual, operating	1
2.00	**66588		manual, assembly	1
3.30	*80025		panel	1
7.87	**80208		panel	1
.33	81709		chassis	1
.33	81710		bracket, pot.	1
1.14	**87000		handle, metal, small	1
.60	*87003		handle, flat, leather	1
5.40	*88225		cabinet	1
7.25	**88226		cabinet	1
.06	89517		contact rotor, brass, round	1
.17	89518		contact brass, long	1
.12	89519		contact brass, long	1
1.38	89520		contact holder, fiber	1
1.66	89659		probe body, gray	1
	56503		bracket and spring assembly consists of:	
.33	81289		battery bracket	1
.33	81290		battery contact spring	1
	86552		nosepiece & tip assembly consists of:	
.81	89521		metal tip, uniprobe	1
1.32	89658		nosepiece, white w/red indicator	1

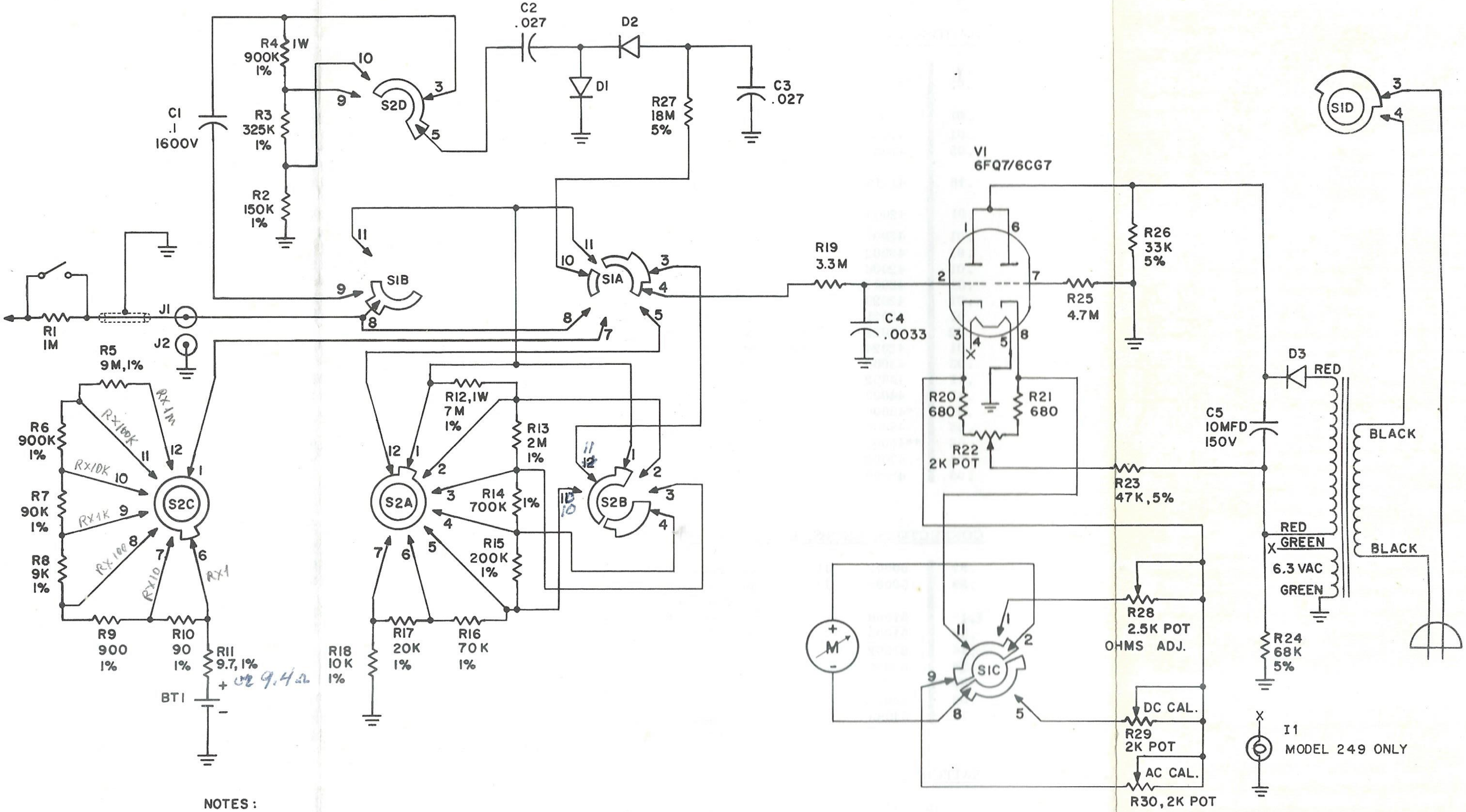
TUBE, BULB, & DIODES

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
.25	**92000	I1	bulb, #47	1
2.10	90097	V1	tube 6FQ7/6CG7	1
.42	93022	D3	rectifier, power, silicon, 500 PIV, 750 ma	1
.72	93042	D1	rectifier, silicon, 400 PIV	1
1.08	93047	D2	rectifier, silicon, 800 PIV	1

TUBE & BULB SOCKETS

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
.20	97025	XV1	socket, 9 pin, min.	1
1.21	**97700	XI1	pilot light assembly	1

Prices and specifications subject to change without notice. To order replacement parts, remit with order; specify part number and descriptions. Add $1.00 for mailing and handling; if a power transformer is included in the order, add instead $1.50 for mailing and handling.



NOTES:

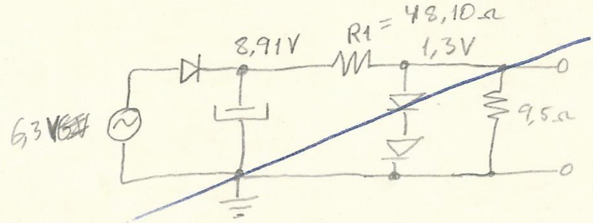
1. RESISTOR VALUES ARE IN OHMS, 1/2 WATT, UNLESS OTHERWISE SPECIFIED.
2. CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. ALL SWITCHES ARE VIEWED FROM SHAFT END AND ARE IN EXTREME CCW POSITION.

SCHEMATIC DIAGRAM

$\frac{1,5\,V}{9,5\,\Omega} = 158\,mA$

1,2
1,4 ⇒ 1,3 V.

$V_{R1} = 7,6$

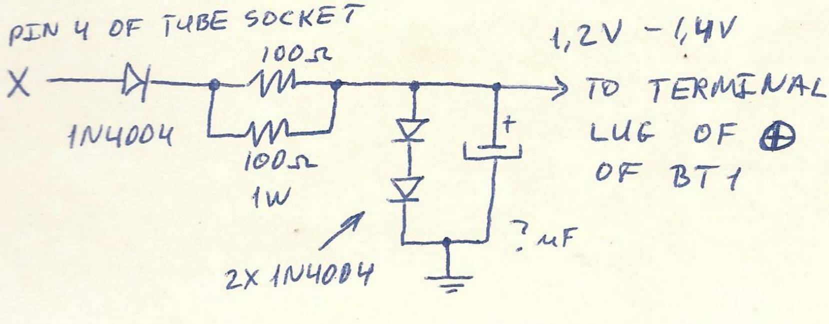


8,9
− 1,3
7,6

R1 = ~~48,~~ 47Ω − 50Ω

1W − 1,5W

IN PLACE OF BT1:



EICO—LEADER IN CREATIVE ELECTRONICS

For over 25 years, EICO has been designing and manufacturing electronic products and is now the world's largest producer of electronic kits and factory wired equipment marketed exclusively through dealers and distributors throughout the world.

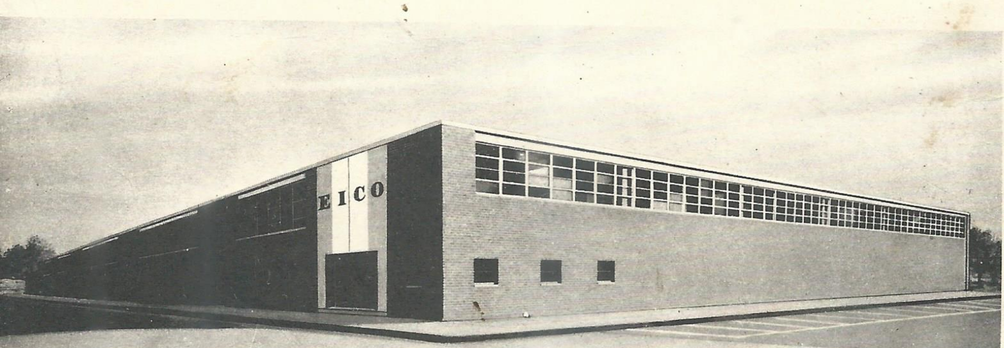
Whatever your electronics interest, there's a wide range of versatile, professional EICO products for you to choose from, and each designed to provide you with the most pleasure and quality performance for your money.

The fact that more than 3 million EICO products are in use throughout the world attests to their quality and performance. EICO kits are so popular because they represent the best value and are available for inspection and immediate over-the-counter delivery at more than 2500 EICO dealers and distributors.

Should you have any questions about the selection or applications of any EICO product, you may at any time consult by mail with our technical correspondence staff. There's no charge for this service.

For your added convenience — EICO has set up a network of 200 service stations to make available to you on a local neighborhood basis the same high-quality technical service competence and replacement parts you get from our factory, should you ever need them.

The EICO Catalog is available to you Free for the asking. The catalog describes Eico's complete line of 200 "Best Buys" in Electronics. Cortina® Stereo Components, EICOCRAFT® Solid State electronic projects, Citizens Band 2-Way Radios, Automotive electronics, Amateur Radio equipment, Visutronic® Educational Training Aids, TRUVOHM® professional Multimeters and the famous EICO line of Test Instruments for home, shop, factory, laboratory and school.



EICO Electronic Instrument Co., Inc., 283 Malta Street, Brooklyn, N. Y. 11207 EICO®