443 | Solid State Semiconductor Curve Tracer

OPERATING MANUAL

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SECTION 1 - GENERAL DESCRIPTION AND SPECIFICATIONS

1-1. GENERAL DESCRIPTION

The EICO Semiconductor Curve Tracer Model 443 tests silicon and germanimum diodes, rectifiers, PNP-NPN, signal and power transistors from manufacturer's specification sheets. Adapts to any general purpose oscilloscope and displays the characteristics of semiconductor devices. Allows direct read out of most wanted data in determining the usefulness and technical application of semiconductors for circuit designers and service technicians.

1-2. SPECIFICATIONS

A. DIODE AND RECTIFIER RANGES

Forward Current (I_f) Ranges: 10, 100 MA per division - 1 amp maximum
Reverse Current (I_r) Ranges: 1, 10, 100 Microamps per division - 1 MA maximum
Peak Inverse Voltage (PIV) Ranges: 1, 10, 50, 100, 200 volt per division - 2000 volts maximum

B. TRANSISTOR RANGES

Family of three curves: BETA (H_{fe}) measurement
BETA Range 15-500 for Signal Transistors; at 10 volts (V_{ce}) 12 MA (I_c) maximum
BETA Range 0-300 for Power Transistors; at 10 volts (V_{ce}) 1 amp (I_c) maximum

C. TEST SOCKETS AND JACKS

TO-1, TO-3, TO-5, TO-18, TO-46, TO-48 etc.
Six Banana Jacks for special transistor configuration connection.

D. OSCILLOSCOPE REQUIREMENTS

Three or five inch General Purpose Oscilloscope, having separate horizontal and vertical inputs.

E. OUTPUT TERMINALS

Oscilloscope Horizontal Output and Ground 5-way Binding Posts
Oscilloscope Vertical Output and Ground 5-way Binding Posts

F. POWER REQUIREMENTS: 117 -volts AC 60 cycles approximately 11 watts

G. SIZE: 2 7/8" high x 11 3/8" wide x 9 1/2" deep

H. WEIGHT: 7 lbs.

SECTION 2 - CONTROLS AND INTERNAL CALIBRATION

2-1. CONTROLS

FUNCTION SWITCH - provides selection of the test to be performed. Transistor Signal "SIG" position, selects a low collector current range (12 ma) for BETA Measurement of small signal type transistors. The SIGNAL BETA ADJ. Control is also selected. Similarly the POWER "PWR" position, selects the high current (1 amp) range and POWER BETA ADJ. Control for power type transistors. Forward "FWD" test position places a variable 10 volt @ 1 amp DC power source across the Diode Test Terminals. Reverse "REV" position places a variable 0-1400 volt peak AC power source interlocked with PIV test pushbutton across the Diode Test Terminals.

PNP-NPN SELECTOR SWITCH - provides the proper polarity of voltages to all transistor test sockets and jacks.

TRANSISTOR A-B MATCHING SWITCH - selects either the left set (A) of transistor sockets and jacks, or the right set (B).

TRANSISTOR AND HV CAL-TEST SWITCHES - provides the necessary calibration voltages. Each position of the function switch EXCEPT for DIODE "FWD" test, requires scope calibration before test is performed.

VOLTS/DIV PIV - SELECTOR SWITCH - determines the appropriate precision multiplier resistor for horizontal deflection. This switch is only utilized in PIV - "REV" testing of diodes, rectifiers and BVceo testing of transistors. Ranges are 1 - 10 - 50 - 100 - 200 volts/box horiz.

CURRENT SELECTOR SWITCH - determines the appropriate shunt resistors for Reverse Current (I_r) PIV Testing and Forward Current (I_f) Diode Rectifier Testing.
Ranges are Red - 1, 10, 100 Microamps/Box vertical
Black - 10, 100 Milliamps/Box horizontal

VOLTAGE ADJUST CONTROL

PIV TEST-PUSHBUTTON - provides a safety interlock when high voltage is present at the Diode Test Terminals. The person performing the PIV High Voltage Test is required to remove one hand from the Diode Test Terminals in order to push the pushbutton. This eliminates the possibility of dangerous shock by having both hands across the terminals when high voltage is present.

OSCILLOSCOPE VOLTAGE CALIBRATOR CONTROL - This control varies the internal calibration voltage from a zener regulated source to provide 1.7 volts RMS AC to both horizontal and vertical oscilloscope output binding posts.

SECTION 3 - CALIBRATION PROCEDURES

3-1. INSTRUMENT CALIBRATION

Equipment Required: - VTVM'S EICO Model No. 235 - 240 - 242 - 249 or similar

Step A - Position AC Power On - Off Switch to "OFF".
Step B - Rotate "Voltage Adjust" Control - fully counterclockwise.
Step C - Connect AC line cord to 117 VAC 60 cycle.
Step D - Position "Power" "On - Off" Switch to "ON".
Step E - Position "HV - Test - Cal" Switch to "CAL".
Step F - Connect VTVM to Vertical Binding Post and Ground on rear of Curve Tracer.
Step G - Adjust Calibrate Control R6, until VTVM reads 1.7 volts AC RMS.
Step H - Remove VTVM from vertical output binding post and connect to horizontal output binding post. Readings should be the same, 1.7 volts AC RMS as above Step G.

3-2. OSCILLOSCOPE CONNECTIONS

Step A - Connect Model 443 Curve Tracer to General Purpose Oscilloscope with clip leads as follows:
Connect Curve Tracer - Vert. Output to Oscilloscope Vert. Input
Connect Curve Tracer - Horiz. Output to Oscilloscope Horiz. Input
Connect Curve Tracer - Ground Output to Oscilloscope Ground Input

Step B - Rotate Sync Selector or Horizontal Selector Switch on Oscilloscope to EXTERNAL HORIZONTAL Position.
Step C - Turn Oscilloscope On-Off Switch to "ON". Adjust focus and brightness for sharp trace.

NOTE 1
If the oscilloscope utilized has a selector switch for AC-DC input signals for horizontal and vertical amplifiers - they should be placed in the DC position.

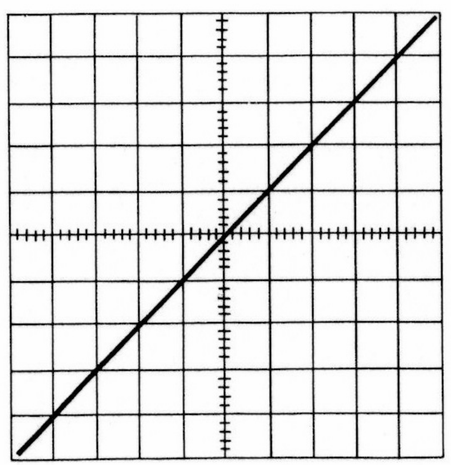
NOTE 2
Oscilloscopes with AC-DC signal input selector switches have the facility of SHORTING OUT the oscilloscope input series capacitor in the DC position. This feature which is available in the EICO Model 465 - 5" Oscilloscope eliminates the necessity of RE-POSITION the OSCILLOSCOPE TRACE when voltage is changed while performing tests on semiconductors.

If oscilloscope does not have the AC-DC selector switch for BOTH horizontal and vertical amplifiers, they may be modified by either shorting the input capacitors or by the addition of switches to short out the input capacitors when required.

3-3. DIODE - RECTIFIER PIV CALIBRATION

Step A - Slide power ON-Off switch to "ON".
Step B - Position HV - TEST - CAL Slide Switch to "CAL" position.
Step C - Rotate "FUNCTION" Switch to "REV" position.
Step D - Rotate "Voltage Adjust" fully counterclockwise (minimum).
Step E - Adjust oscilloscope horizontal and vertical gain controls until the calibration pattern (See Fig. 1) is observed.
Caution - Do not adjust horizontal or vertical controls on scope after the above calibration is completed. Only positioning adjustments are required to obtain the displays shown in Section 4.

NOTE 3
If this display cannot be obtained, it is because of uncommon AC Ground between the oscilloscope and curve tracer. Reverse either of the AC plugs on Curve Tracer or oscilloscope.



DIODE CALIBRATION

FIGURE 1

NOTE 4
An engraved graticule for a 5" oscilloscope is included with the Model 443 and may be substituted for the existing graticule. This graticule is divided into 10 divisions (boxes) vertically and 10 divisions (boxes) horizontally. By utilization of this 10 x 10 graticule, the calibration procedure just performed will be directly related to the positions of both the "VOLTS/DIV-PIV" Switch AND the "CURRENT" Switch.

EXAMPLE:
The VOLTS/DIV-PIV Switch to 50 V and adjust the "VOLTAGE ADJUST" control (while pressing the PIV Test Switch) for a horizontal line on the oscilloscope. If the line covers 10 HORIZONTAL divisions, the scope will read 50 volts per division x 10 divisions or 500 volts full scale.

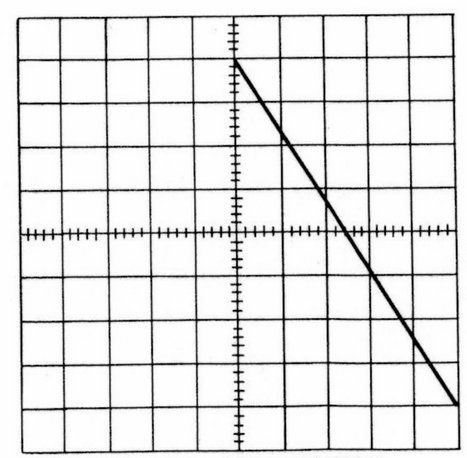
By setting the "CURRENT" Switch to 10 ua/DIV (I_r), the scope will read 10 ua per division x 10 Vertical Divisions or 100 ua full scale.

Step F - Reposition the "HV - TEST - CAL" Switch to "TEST" position. This completes calibration procedure for Diode - Rectifier PIV Tests.

3-4. TRANSISTOR TEST CALIBRATION PROCEDURE

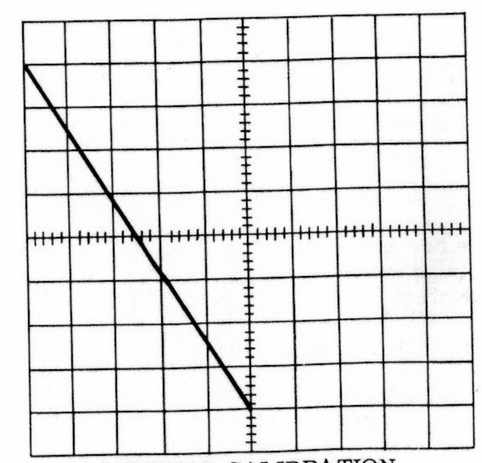
Step A - Connect Curve Tracer to Oscilloscope Power (ON-OFF) Switch to "OFF" position.
Function Switch - Appropriate position "Sig" or "Pwr".
Step B - Transistor Test Cal Switch to "CAL" position.
Step C - Power On-Off Switch - "ON".
Step D - Adjust BOTH Horizontal and Vertical Gain Controls of the oscilloscope until 8 vertical and 5 horizontal divisions are filled by the diagonal trace. (See Fig. No. 2 & 3).
Step E - Transistor TEST - CAL Switch to "TEST" position.
This completes transistor test calibration.

Horizontal Deflection = 10 volts - (10 boxes) 5 Boxes → 2 V/cm
Vertical Deflection = 12 MA - (8 boxes) Signal Transistors - 4 Boxes → 3 MA/cm
= 1 Amp - (8 boxes) Power Transistors - 4 Boxes → .25 A/cm



TRANSISTOR CALIBRATION
FOR NPN POWER TRANSISTORS
AND PNP SIGNAL TRANSISTORS

FIGURE 2



TRANSISTOR CALIBRATION
FOR PNP POWER TRANSISTORS
AND NPN SIGNAL TRANSISTORS

FIGURE 3

NOTE 5
If you are unable to obtain the 8 vertical and 5 horizontal boxes, it is probably due to the available gain of the oscilloscope vertical and horizontal amplifiers. Should this occur, adjust the Gain Control so that the Horizontal Deflection is 1/2 of the Vertical Deflection. Mark on the graticule these new calibrating points for reference to measurements.

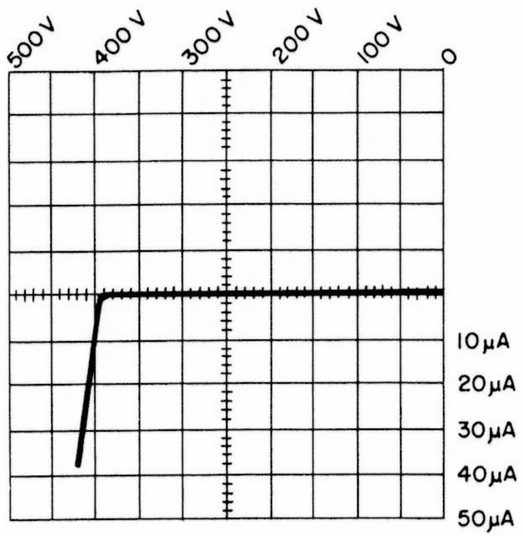
SECTION 4 - TEST PROCEDURES

4-1. DIODE - RECTIFIER TESTING PROCEDURE

Two basic tests are performed by the Model No. 443 on Diodes and Rectifiers.

The first test is PIV - PEAK INVERSE VOLTAGE. This test determines the maximum reverse bias voltage that can be applied across a Rectifier - Diode without breaking down (excessive current in the Reverse Direction). With a Sinusodial Wave Input, the PIV should be greater than the Peak Input Voltage with Resistive or Inductive loads. For Capacitive Loads, the PIV should be greater than twice the Peak Input Voltage.

Refer to Fig. 4 - This display quickly shows a typical Silicon Rectifier (IN4004) and its PIV at Breakdown. When the Rectifier reached its specific PIV of 400 volts (measured horizontally in VOLTS per DIV, it starts to draw current indicated by the term I_r (Reverse Current). This I_r is displayed in the VERTICAL PORTION of the curve shown in Fig. 4.



Diode/Rectifier
PIV TEST
Volts/Div. PIV Switch = 50V
Current Switch = 10ua

FIGURE 4

The second test is forward voltage drop. This test determines the maximum specified Forward Voltage Drop (V_f) of a Diode/Rectifier when it is conducting a specified current (I_f) in the forward direction.

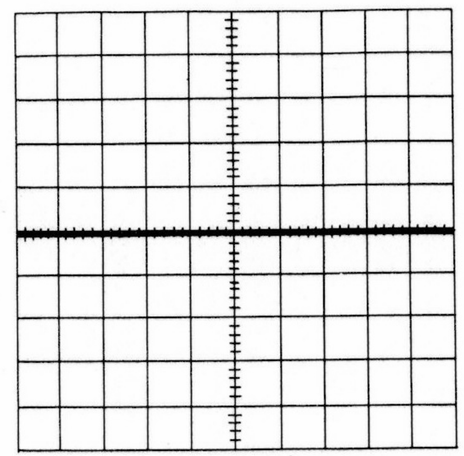
4-2. PIV TEST

Step A - Perform Diode/Rectifier PIV Calibration Procedure - Section 3-3.
Step B - Power On-Off Switch - "ON" position.
Step C - Function Switch - "REV" position.
Step D - HV - TEST - CAL Switch - "TEST" position.

NOTE 6
The HV "Neon Bulb" should now flash on and off. This is a caution light which indicates that dangerous high voltages are present at the Diode Test Clips when the PIV Test Push-button is pressed.

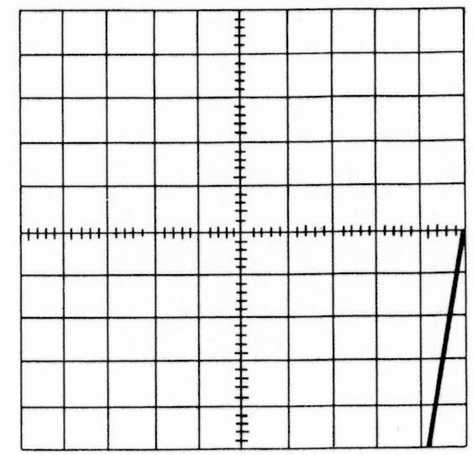
Step E - VOLTS Per DIV - PIV Switch - select appropriate range greater than the Diode being measured -
Step F - Current Switch - select appropriate range. This would be determined by the specified (I_r) - PIV) of the type Rectifier being measured.
Step G - Voltage Adjust - full counterclockwise minimum.
Step H - Insert Rectifier into Diode Test Clips
Step I - Press down PIV Test Pushbutton while rotating the voltage adjust control until breakdown of the Rectifier Diode is displayed. Position Vertical and Horizontal scope controls until a display as in Fig. 4 is obtained.

NOTE 7
Note Fig. 5. If a straight horizontal display line is seen then the breakdown voltage is greater than the full scale range in the selected (VOLTS/DIV PIV) Switch position. Therefore, this switch should be set to the next higher range. If breakdown is still not observed then the device may be OPEN. This condition will be apparent in the FORWARD Test which follows. Fig. 6 displays a device which is SHORTED.



OPEN DIODE/RECTIFIER OR
PIV GREATER THAN VOLTS/ DIV.

FIGURE 5



SHORTED DIODE/RECTIFIER

FIGURE 6

NOTE 8
For a 400 PIV Rectifier: Switch position = 50 VOLTS/DIV or 500 volts full scale horizontal deflection. -IF BREAKDOWN OCCURS at 400 volts a vertical line will form at the 400 volt division on the Graticule - See Fig. 4.

NOTE 9
A 400 volt PIV Rectifier may not show a breakdown condition at 400 PIV, but may be greater. This indicates that the Rectifier MAY be of better quality than rated and may be used at a higher PIV than specified. If Rectifier shows a breakdown condition lower than its rating then it is of poorer quality and must be derated accordingly to its lower PIV.

4-3. FORWARD TEST

Step A - FUNCTION Switch "FWD" position.
Step B - Set VOLT ADJ. Switch to min.
Step C - CURRENT Switch - 10 OR 100 MA (I_f) position - 10 ma x 10 horizontal DIV = 100 MA Full Scale Horizontal Deflection. 100 MA x 10 HORIZ/DIV = 1 Amp Full Scale Horiz. Deflection.
Step D - HV - TEST - CAL Switch to TEST position.
Step E - Insert Diode Rectifier into test clips observing polarity.

Step F - Increase VOLTAGE ADJ. control clockwise and position the trace on oscilloscope until a display similar to Fig. 7 is observed. It is not necessary to press the PIV TEST push-button in this test. The 10 Horiz. Divisions, may be used to read the maximum FWD current (I_f) passing through the device. The Vertical Divisions are pre-calibrated to read .5 volts per division.

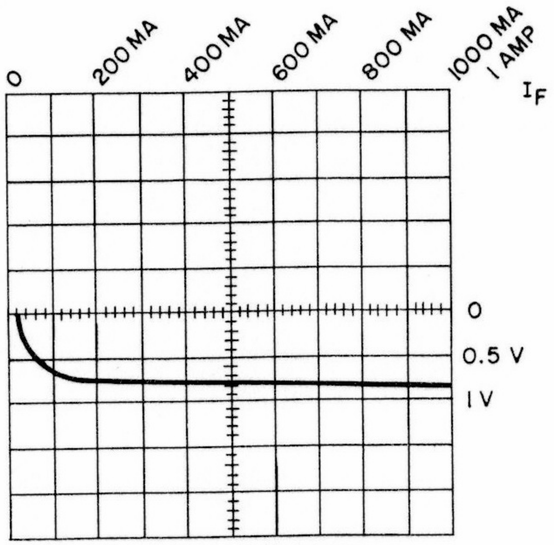
Step G - From the display in Fig. 5 (I_f) Forward Current at specific (V_f) Forward Voltage, may be determined.

NOTE 10
Specifications may be obtained from manufacturer's specification sheets.

NOTE 11
Specifications are indicated as MAX or MIN and exact figures are not indicated. Good devices will USUALLY EXCEED manufacturer's specs.

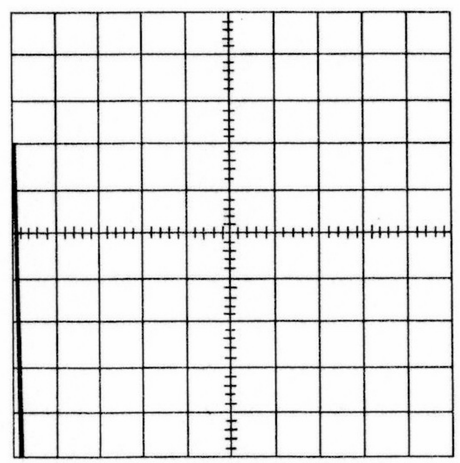
NOTE 12
Fig. 7 displays a typical 1 amp Rectifier showing a Max forward voltage drop (V_f) of .8 volts at forward current of 1 amp. Small Silicon Power Rectifiers of this type range from .7 volts to 1.2 volts at 1 amp.

NOTE 13
Fig. 8 displays an OPEN device. A shorted device may appear good due to some internal resistance, but can be detected in previous REVERSE PIV Test as indicated in Fig. 6.



TYPICAL ONE AMP RECTIFIER
DURING "FWD" (FORWARD) TEST
CURRENT SWITCH = 100MA (Vf)

FIGURE 7



OPEN DIODE/RECTIFIER
IN "FWD" (FORWARD) TEST

FIGURE 8

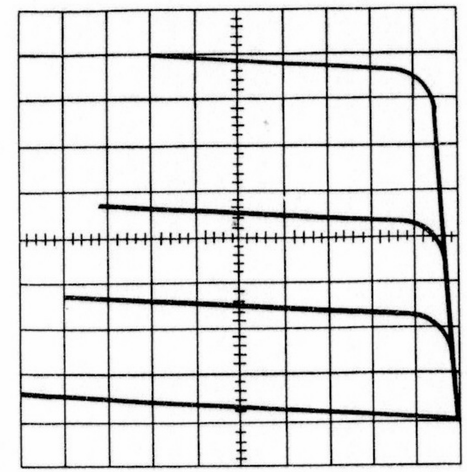
4-4. TRANSISTOR TESTING PROCEDURE

There are two basic types of transistors -
Low Current (Signal Transistors)
AND
Hi Current (Power Transistors)
Either type may be of Silicon or Germanimum Semiconductor material.

Determine the type of device to be measured.

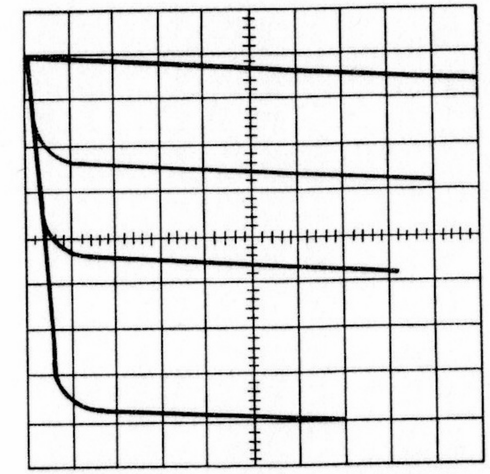
Step A - Perform Transistor Calibration Procedure - Section 3-4.
Step B - Set Function Switch to "SIG" OR "PWR".

Step C - Transistor TEST - CAL Switch to "TEST".
Step D - NPN-PNP Switch - depending on type.
Step E - Install the transistor in its appropriate socket.
Step F - Transistor A-B Switch selects the LEFT OR RIGHT SET of sockets. - And should be positioned to the appropriate set of sockets selected.
Step G - BETA Adjust - rotate the appropriate BETA Control (SIGNAL OR POWER) until 8 divisions of the Vertical Portion of the Oscilloscope Graticule is obtained. Position the trace on oscilloscope until a display as in Fig. 9, 10, 11, 12 is obtained.
Step H - BETA (H_{FE}) may now be read directly from the BETA Control.



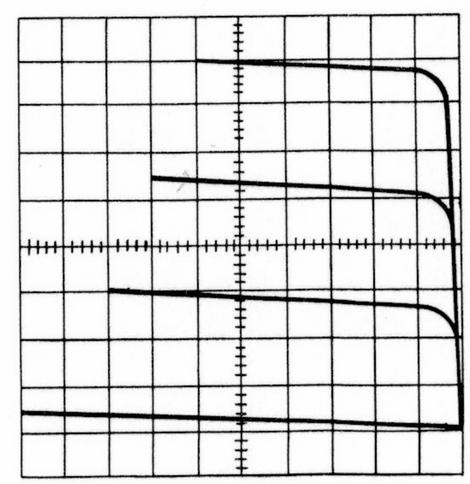
TYPICAL PNP SIGNAL TRANSISTORS
BETA H_{fe} CURVES

FIGURE 9



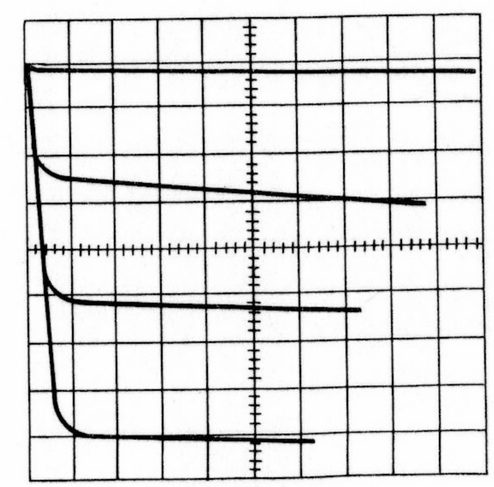
TYPICAL NPN SIGNAL TRANSISTORS
BETA H_{fe} CURVES

FIGURE 10



NPN POWER

FIGURE 11



PNP POWER

FIGURE 12

NOTE 14
H_{FE} measurements are made at two collector currents (I_C) ranges.
Signal Transistors I_C = 12 MA Max.
Power Transistors I_C = 1 Amp Max.
This is determined by the position of the "Function Switch".

NOTE 15
As Collector Currents in some devices cause internal heating, the trace may change. H_{FE} BETA readings should be read immediately.

4-5. H_{FE} BETA AND LINEARITY MEASUREMENT - (Refer to Fig. 13)

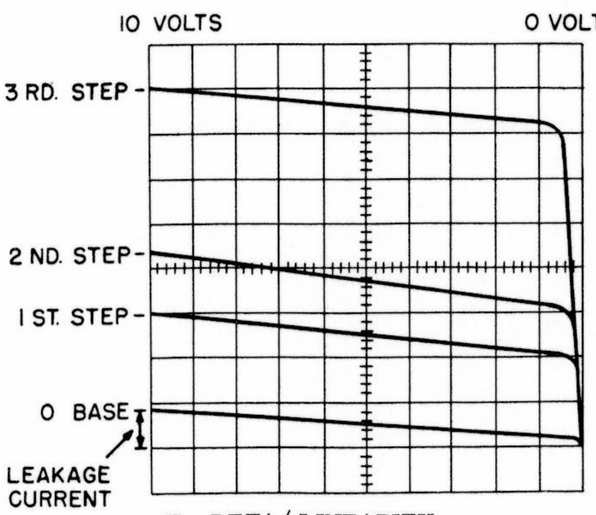
The EICO 443 Curve Tracer displays 3 base current steps in addition to a "0" Base Current Line. These 3 current steps indicate the differences of (H_{FE}) BETA with respect to base current. LINEARITY may be determined by noting the spacing between the first and second base steps, as compared to the 2nd and 3rd base steps.

Close spacing between 1st and 2nd steps and wider spacing between 2nd and 3rd step indicates lower BETA at low currents with increasing BETA at higher currents. Should the display show closer spacing between the 2nd and third steps then H_{FE} would be DECREASING at higher currents.

4-6. LEAKAGE - (Refer to Fig. 14)

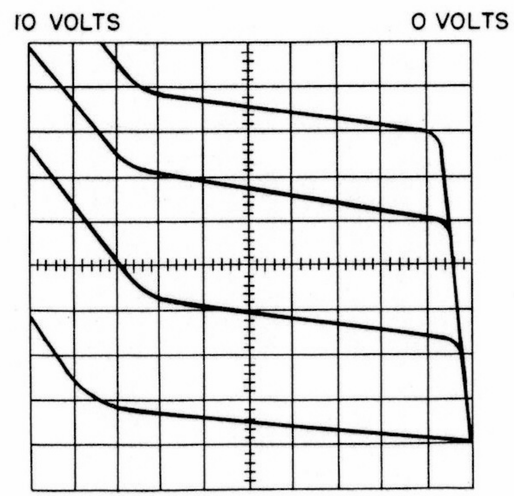
Leakage may be noted by observing the 1st line (0-current line). Fig. 13-14 -Displacement or sloping of this line indicates leakage (Iceo) between the collector and emitter of the device.

A sloping line indicates leakage, Breakdown Voltage between collector and emitter with base open (BVceo). As the maximum voltage in THIS test is 10 volts, the actual voltage may be interpreted directly from the oscilloscope graticule. If it is expected that the (BVceo) is greater than 10 volts, the transistor may be tested by placing the emitter and collector leads of the transistor into the DIODE Test Clips (observe proper polarities) and testing the device as a RECTIFIER DIODE PIV Test previously described -Section 4-2. Appropriate ranges of the VOLTS/DIV PIV and CURRENT Switches should be selected in accordance with manufacturer's ratings of the device being tested.



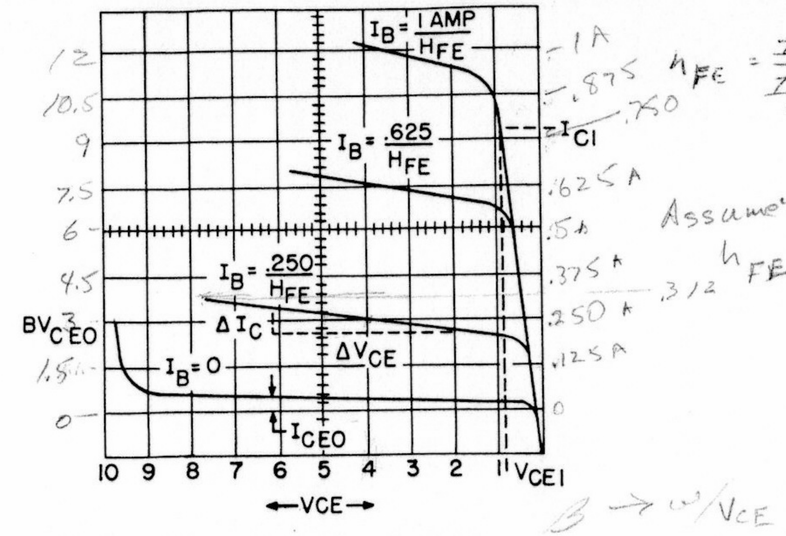
H_{fe} BETA/ LINEARITY
OF NPN POWER TRANSISTORS
AND PNP SIGNAL TRANSISTORS

FIGURE 13



LEAKAGE BREAKDOWN BV_{ceo}

FIGURE 14



The following parameters may be read from the display:

$$H_{oe} = \frac{\Delta I_c}{\Delta V_{ce}} = \frac{.075A}{4V} = 18.7 \times 10^{-3} \text{ mhos} = 53.4 \text{ ohms}$$

$$R_{cs} = \frac{V_{cei}}{I_{ci}} = \frac{.9V}{.77A} = 1.17 \text{ ohms}$$

FIGURE 15

PARTS LIST

RESISTORS

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
.08	10400	R29, 22, 37, 35	car., 10K, 1/2W, 10%	4
.08	10406	R33, 36	" 680Ω " "	2
.08	10426	R1	" 33K " "	1
.08	10432	R5	" 1K " "	1
.09	10433	R8	" 560Ω " "	1
.11	10438	R17	" 330Ω " "	1
.08	10440	R3	" 12K " "	1
.08	10441	R16, 39 41	" 150Ω " "	3
.08	10448	R15	" 68Ω " "	1
.08	10449	R32, 4, 18, 19, 20, 21, 48, 28, 30, 31, 34	" 5.6K " "	11
.11	10458	R40, 38	" 82Ω " "	2
.08	10505	R7	" 200K " 5%	
.80	10604	R9	" 200K 2W "	1
.80	10605	R10	" 220K " "	1
.50	11140	R13, 14	" dep., 1.050K, 1/2W, 1%	2
.74	11725	R25	" dep., 100K, 1W, 1%	1
.74	11726	R12	" dep., 2.2K, " 1%	1
.74	11727	R11	" " 15K " "	1
.74	11728	R24	" " 10K " "	1
.74	11729	R23	" " 1K " "	1
1.80	11909	R27	" " 20Ω, 2W, "	1
.37	14513	R46	W.W., 5K, 5W, 10%	1
1.20	14522	R42, 45	" 4Ω, " "	2
2.99	15004	R26	" 2.5Ω, " 5%	1

POTENTIOMETERS

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
1.03	18190	R47	150K	1
1.92	18191	R43, 44	2.5K, 5K, dual	1
7.56	19029	R2	10K, 50W	1
1.59	19030	R6	2.5K	1

CAPACITORS

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
.47	20057	C2, 4	mylar, .47mfd, 200V, 20%	2
.44	20085	C6	mylar, .22mfd, 200V, 10%	1
.90	23056	C3, 5	elec., 300mfd, 6V	2
.78	23073	C1	" 2mfd, 160V	1

TRANSFORMERS

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
3.70	30101	T1	6.3V, 1 amp	1
5.56	30102	T2	1000V, 10mA	1

HARDWARE

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
.01	40000		nut, hex, #6-32 x 1/4	4
.02	40001		" " 3/8-32 x 1/2	7
.01	40004		" " #2-56	4
.01	40007		" " #4-40 x 1/4	5
.07	40016		" " 1/2-24	1
.04	40034		" tinnerman, #4	10
.01	40045		" hex, #8-32 x 5/16	8
.01	41002		screw, #6 x 3/8, P.K. type A, b.h.	6
.01	41014		screw, #6-32 x 3/8, b.h.	4
.01	41075		screw, #4-40 x 3/8, b.h.	2
.01	41088		screw, #6-32 x 3/8, f.h.	4
.01	41091		screw, #4-40 x 1/4, f.h.	10
.02	41106		screw, #2-56 x 3/8, b.h.	4
.02	42000		washer, lock, 3/8	7
.01	42001		" flat, 3/8	7
.01	42002		" lock, #6	4
.04	42006		" fibre, shoulder, #6	4
.01	42007		washer, lock, #4	3
.01	42008		" " #8	2
.03	42029		" rubber, 1/2 I.D.	1
.03	42060		washer, shoulder	8
.01	42061		" flat, special, #8	4
.01	42062		washer, split, #8	4
.02	42511		retainer ring, plastic pilot light	2
.03	43019		lug, ground, #8	2

JACKS, KNOBS & TERMINAL STRIPS

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
.39	50044		jack, banana, black	7
.39	50045		" " red	1
.08	51502		test, clip	2
.34	52007		binding post, #8, shaft	4
.96	53109		knob, bar	4
.87	53113		knob, 3/4", w/indicator	3
.10	54008		term. strip, 4 post	1
.10	54018		term. strip, 4 post, w/gnd.	1

SWITCHES

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
7.63	60217	S1	rotary, 4 pos'n.	1
4.47	60218	S2	" 2 pos'n.	1
3.16	60219	S4	" 5 pos'n.	1
3.16	60220	S5	" 5 pos'n.	1
.48	62028	S3, 8	slide, DPDT	2
1.06	62031	S6, 9	" 3 PDT	2
.75	64008	S7	pushbutton, momentary	1

SHEET METAL & MISCELLANEOUS

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
4.75	80232		front panel	1
4.60	81561		bottom plate	1
.12	82105		linecord retainer	1
3.90	82579		p.c. board	1
7.40	88166		cabinet	1
.30	89421		label	1
.38	89834		transistor retainer clip	2
.09	46016		foot, rubber	4
2.10	57009		linecord	1
9.04	59013		graph screen	1
1.50	66207		manual, operating	1
2.00	66469		manual, assembly	1

FUSES, DIODES & TRANSISTORS

PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
.28	91020	F1	fuse, 250mA	1
3.04	93018	CR9	diode, zener, IN713	1
1.62	93022	CR5, 10, 11	" power, sil., 600PIV, 750mA	3
.82	93023	CR3, 4, 6, 7, 8, 1, 2	diode, power, sil., 400PIV, 750mA	7
.39	94044	Q3, 4, 5, 6	transistor, 2N2926	4
1.44	94067	Q1, 2, 7, 8	" 2N5355	4

SOCKETS & BULBS

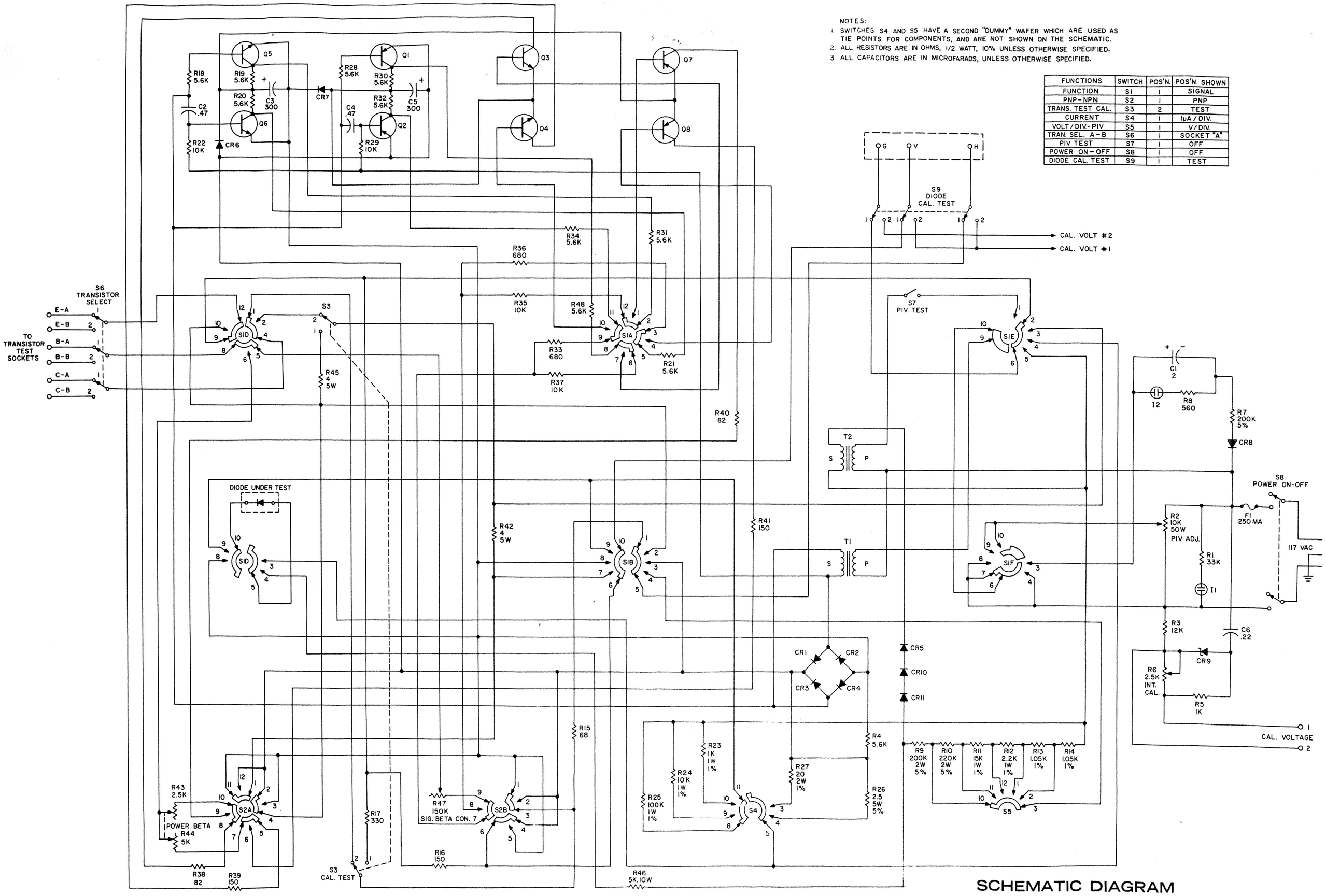
PRICE EA.	STOCK NO.	SYM. NO.	DESCRIPTION	QTY
.28	97043		transistor socket, 4 pin	2
.42	97082		transistor socket, molded	2
.54	97715	I2, 1	neon pilot light assembly	2
.99	97805		fuseholder, short type	1

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. SWITCHES S4 AND S5 HAVE A SECOND "DUMMY" WAFER WHICH ARE USED AS TIE POINTS FOR COMPONENTS, AND ARE NOT SHOWN ON THE SCHEMATIC.
2. ALL RESISTORS ARE IN OHMS, 1/2 WATT, 10% UNLESS OTHERWISE SPECIFIED.
3. ALL CAPACITORS ARE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.

FUNCTIONS	SWITCH	POS'N.	POS'N. SHOWN
FUNCTION	S1	1	SIGNAL
PNP-NPN	S2	1	PNP
TRANS. TEST CAL.	S3	2	TEST
CURRENT	S4	1	1μA / DIV.
VOLT/DIV.-PIV	S5	1	V/DIV.
TRAN. SEL. A-B	S6	1	SOCKET "A"
PIV TEST	S7	1	OFF
POWER ON-OFF	S8	1	OFF
DIODE CAL. TEST	S9	1	TEST



SCHEMATIC DIAGRAM

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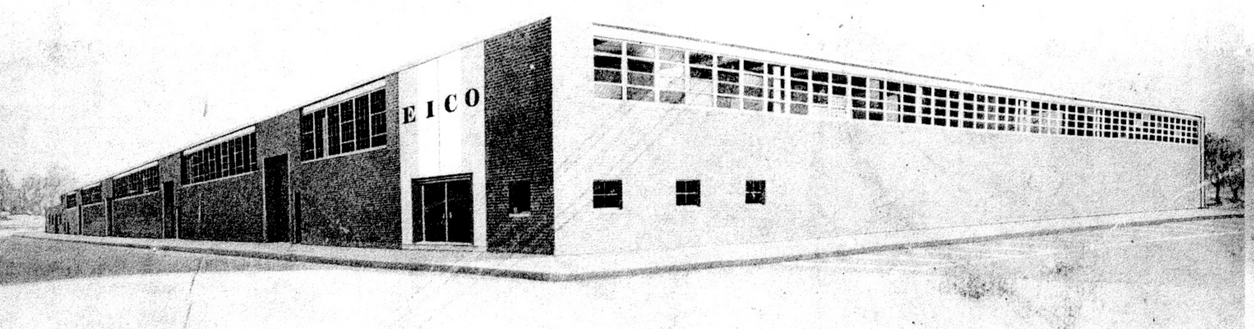

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OPERATING MANUAL