

X-Y TRACE GENERATOR

17950A



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OPERATING AND SERVICE MANUAL

MODEL 17950A
X-Y TRACE GENERATOR

Serial Prefix 812

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HEWLETT-PACKARD

1968

433 NO. FAIR OAKS AVENUE, PASADENA, CALIFORNIA

Printed MAY 1968

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FIGURE 1-1. MODEL 17950A X-Y TRACE GENERATOR

SECTION I GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. PURPOSE AND CAPABILITY. The Hewlett-Packard Model 17950A X-Y Trace Generator is a self-contained ramp and step-function generator for checking dynamic performance of Hewlett-Packard X-Y Recorders which have an input impedance NOT LESS THAN 20K ohms. This unit will drive any number of recorders simultaneously provided their combined parallel input impedance is NOT LESS THAN 20K ohms. The dynamic performance check supplements the basic calibration of recorders with a voltage standard, by sweeping both axes of the recorder simultaneously through their dynamic range. Five switch-selectable sweep rates and an 'OFF' position are provided. Sweeping is controllable by a momentary-contact push-button. Sweep direction is reversible by toggle switches.

A damping function provides an accurate, uniform step-function voltage at the 'x' output terminals for checking damping of any Hewlett-Packard Recorder. This function is selectable by a toggle-switch and controllable by a pushbutton.

The use of a field-effect transistor and an integrated circuit amplifier provides reliability and low current drain.

No external power source is required; power is supplied internally by two mercury batteries.

1-3. MANUAL IDENTIFICATION.

1-4. This manual applies to Model 17950A with serial prefix 812. The serial prefix is the first three digits of a two-part, eight-digit Serial Number (000-00000) used to identify each Hewlett-Packard instrument. If the Serial Number is higher than 812, a change sheet supplied with the manual will define the difference between that model and the one described in this manual. Corrections to the manual, due to any errors that existed when it was printed are called Eratta and appear on the change sheet (if any) supplied with the manual. For information

pertaining to manual coverage of any Hewlett-Packard instrument, contact the nearest Hewlett Packard Sales/Service Office.

1-5. SPECIFICATIONS.

SWEEP SPEEDS:

0.02, 0.1, 0.2, 1, and 2 inches per second, with recorder in 100/mv per inch range.

SWEEP ACCURACY:

±5% of recorder full scale.

LINEARITY:

±0.5% of full scale at room temperature (20°C to 30°C).

OUTPUT VOLTAGE:

Linear portion of output ramp begins at approx. 0 volts and extends to 1 volt (minimum).

POWER SOURCE:

Replaceable mercury batteries with minimum life of 100 operating hours.

REVERSIBLE TRACE:

Sweep direction reversible by toggle switch.

DAMPING FUNCTION:

+4V. Step output for checking recorder damping, pushbutton switch operated.

COMPATIBILITY:

Model 17950A is compatible with all Hewlett-Packard X-Y Recorders whose input impedance is not less than 20K ohms, having a 100mv/in. (40mv/cm or 50mv/cm) range.

WEIGHT:

Approximately 2 lbs. (net).

DIMENSIONS:

5.73 inches deep, 5.00 inches wide and 3.60 inches high.

SECTION II INSTALLATION AND INSPECTION

2-1. INCOMING INSPECTION.

2-2. **MECHANICAL CHECK.** If damage to the shipping carton is evident, ask that an agent of the carrier be present during unpacking. Inspect components for mechanical damage, scratches, dents, broken knobs, etc. Also check carton and cushioning material for signs of severe stress.

2-3. **PERFORMANCE INSPECTION.** Electrical performance should be verified as soon as possible after receipt. The incoming inspection chart (Figure 2-2) is suitable for this purpose.

2-4. **CLAIM FOR DAMAGE.** If the 17950A is damaged, or fails to operate properly, notify the carrier and nearest Hewlett-Packard field office immediately. A list of field offices is given in the rear of this manual. Retain the shipping carton and padding material for inspection by the carrier. The field office will arrange for repair or replacement without waiting for settlement of a claim against the carrier.

2-5. STORAGE.

2-6. Whenever the Model 17950A is not to be used for a considerable period of time, it should be turned "OFF", sealed in a moisture-proof covering and repackaged in the original shipping carton, or equivalent.

2-7. SHIPPING.

2-8. Before returning for any reason, notify the local field sales office of the difficulty encountered, along with all Model and Serial Numbers of instruments or components involved, and they will furnish shipping instructions. When repackaging for shipment, it is important to wrap the instrument in heavy paper or plastic and surround with 3 to 4 inches

of shock-absorbing material to cushion and prevent movement inside the shipping container. The outside container should be sufficiently durable to prevent damage during rough handling.

2-9. BATTERY INSTALLATION.

2-10. This instrument is shipped from the factory with batteries not installed. Install batteries according to the following instructions: Remove four screws, one at each corner of top plate. Remove bottom cover. (Refer to Figure 2-1). Looking at the bottom of the unit with the output jacks "up", insert a battery into each battery holder with positive (+) terminal toward the output jacks. Connect the red lead from the small circuit board mounted on the selector switch to the positive (+) terminal of the left hand battery; connect the black lead from the switch to the negative (-) terminal of the same battery. Connect the red lead from the switch to the positive (+) terminal of the right-hand battery; connect the black lead from the main (large) circuit board to the negative (-) terminal of the battery.

Perform battery check, paragraph 2-11, before replacing bottom cover, to avoid repetition of disassembly in case a weak or dead battery has been installed.

2-11. BATTERY CHECK.

2-12. Connect a voltmeter across the 17950A X- or Y- output terminals. Set the 17950A to the fastest sweep rate (2 in/sec), with "damping function" off. Hold "trace" button depressed and read highest output voltage reached with "trace reverse" switch in down position. If less than 1.75V, replace battery, (refer to paragraph 2-10), "right-hand" battery BT101, for positive sweep. If the voltage is 1.75V or more in positive mode, but less than 1.75V. in negative mode, replace "left-hand" battery, BT102 screws. Replace bottom cover and screws.

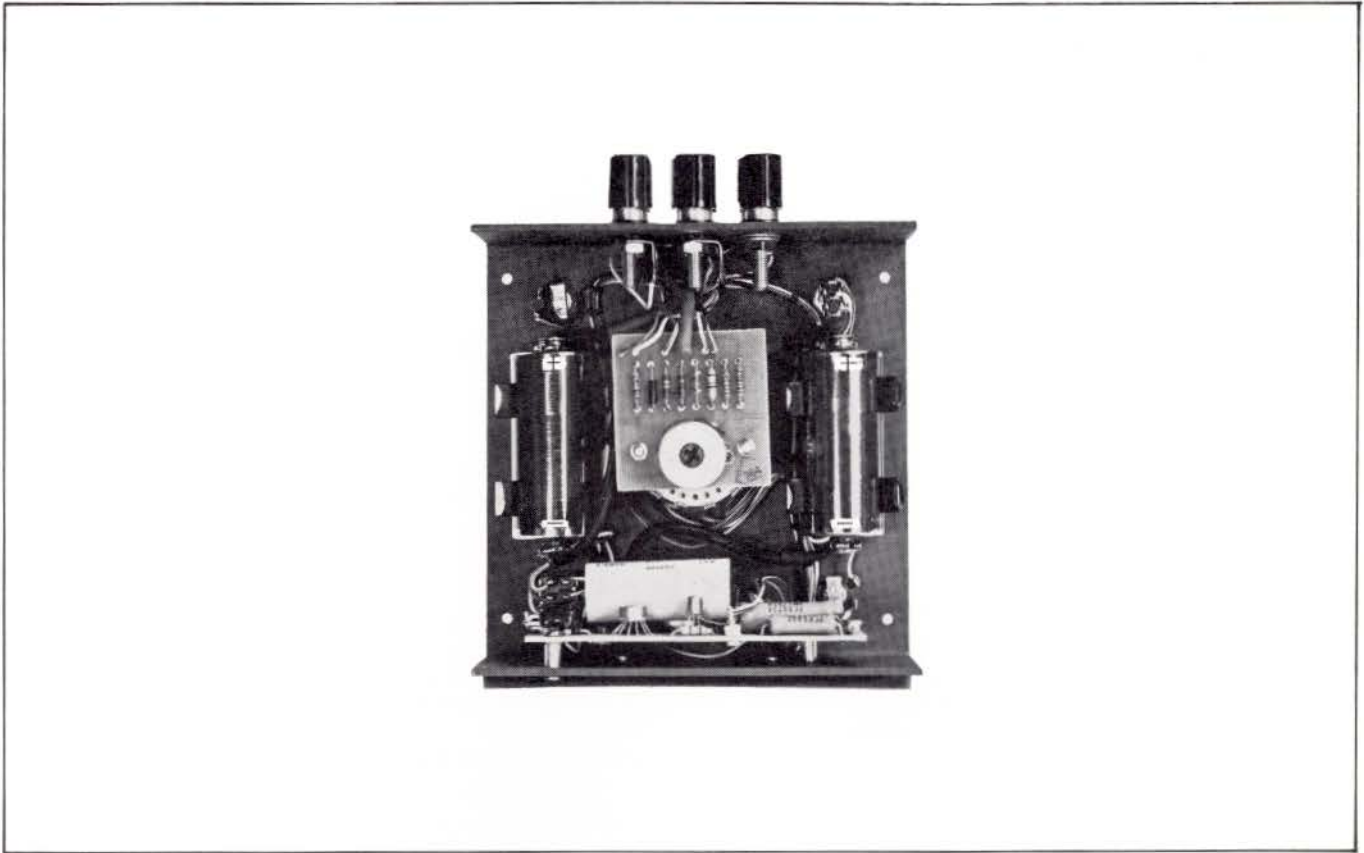


FIGURE 2-1. BATTERY INSTALLATION

Specification	Inst. Required	Performance Check
Sweep Speeds	<p>1/X-Y Recorder with 20K min. input impedance & 100mv/in range.</p> <p>2/Stop watch with 1/100 seconds stop</p>	<p>Connect X or Y output of 17950A to recorder 10" or 15" input, in 100mv/in. range. Switch 17950A Damping Function off, Trace Reverse down for positive sweep. With pen at left recorder margin, depress "trace" and sweep recorder, noting elapsed time for each sweep. Refer to calibration chart, figure 2-3.</p> <p>With "trace reverse" "up" for negative sweep, start recorder at right margin and sweep at any rate to check reverse sweep operation.</p>
Output Voltage	X-Y Recorder with 20K min. input impedance & 100mv/in range.	Connect 17950A X or Y output terminals to recorder 10"-axis input, in 100mv/in range. Switch 17950A to 2 in/sec speed, depress "trace" and hold. Recorder will sweep 10" (minimum).
Damping Function	X-Y Recorder with 20K min. input impedance & 1V/in range. (0.4v/cm or 0.5v/cm)	Connect 17950A X-output terminals to recorder input, in 1V/in range. Switch "Damping Function", 17950A, to "On". Depress "damping pulse" button. Pen will deflect 4" positive (overshoot not included).
Linearity	7101B Series Strip Chart Recorder, and 17500A Plug-In Module or equivalent.	<p>Connect X or Y output of 17950A to recorder input. Set recorder to 1V/in range and chart speed to 1 in/sec. Set 17950A to 1 in/sec. Start chart and depress "trace", holding until pen reaches full scale. Stop chart. Turn off or disconnect 17950A.</p> <p>Check linearity of trace with straight-edge. Maximum allowable deviation is 0.05" measured horizontally.</p>

FIGURE 2-2. INCOMING INSPECTION CHART

SECTION III OPERATION

3-1. INTRODUCTION.

3-2. The basic function of the 17950A is to provide a signal for compatible recorders allowing selfchecks of the recorder. Before operating, the user should become familiar with the recorder requirements and the various control functions as outlined in the recorder Instruction Manual. The user should also be thoroughly familiar with the information in the following paragraphs.

3-3. ELECTRICAL REQUIREMENTS.

3-4. The Model 17950A is a self-contained trace generator requiring no external electrical power. Within its case are two batteries with an operating life of 100 hours.

WARNING: Power is being drawn from the battery whenever the sweep selector is not set to "OFF".

3-5. OPERATING CONTROLS

3-6. Refer to figure 3-1 for complete description of operating controls.

3-7. OPERATION.

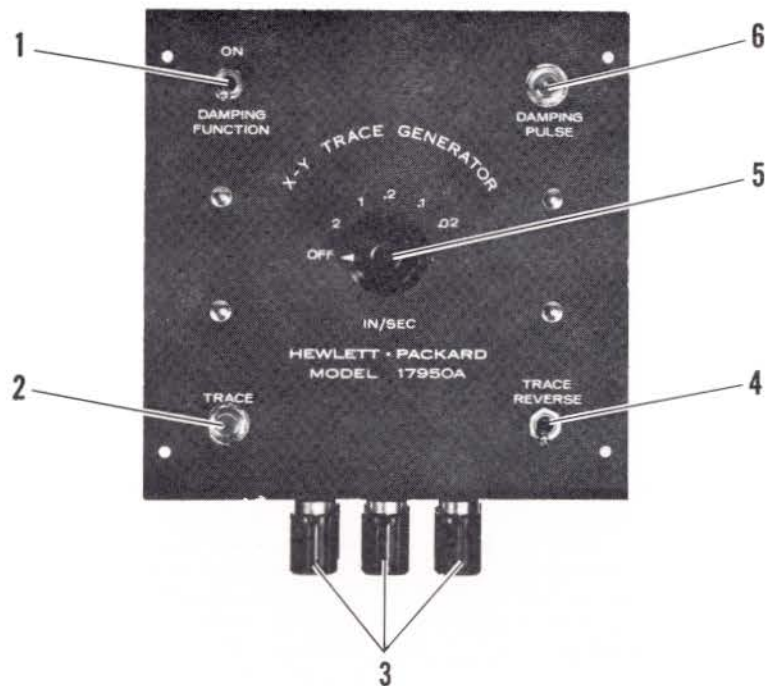
3-8. Connect Model 17950A to recorder inputs with two-conductor cables having banana plugs or pin plugs. The ground jacks on the 17950A are connected to its chassis only. Grounding the chassis to recorder ground is usually unnecessary, but may prevent pickup of noise in certain cases. Set the

recorder to 100 mv/in range in each axis. This setting will produce a trace at a 45° angle. Setting Y inputs range to 1V/in will decrease trace angle toward horizontal; setting X input range to IV/in will increase trace angle toward vertical. Turn Model 17950A sweep-rate selector switch to desired sweep-rate position; "zero" the recorder with recorder zero control. Move "trace reverse" switch "downward" for positive sweep, "upward" for negative sweep. Depress "trace" pushbutton to sweep. Release to stop sweep.

3-9. DAMPING FUNCTION.

3.10. To check recorder damping, turn 17950A sweep-rate selector switch to 1 in/sec or 2 in/sec position and move "damping function" switch to "ON". Set recorder axis to be checked to 1V/in (.4 v/cm or .5 v/cm); set other axis to 100 mv/in. (40 mv/cm or 50 mv/cm). Connect 17950A X-output terminals to recorder axis to be checked. Connect Y-output terminals to other axis. Depress "trace" button, and while sweeping, momentarily depress "damping pulse" button. The damping pulse will deflect the pen about 4" in a positive direction, producing, with the sweeping of the other axis, a "step". Recorder damping action will produce a "pulse" atop the leading edge of the step.

CAUTION: The circuit consumes battery power, sweeping or not, in all positions of the sweep-rate selector switch except "OFF". Turn the switch to "OFF" when not in use, for longest useful life of the batteries.



1. **DAMPING FUNCTION.** Switches the X output terminals to circuitry which produces a step-function output voltage when "damping pulse" button is depressed. (The Y output terminals remain connected to the sweep circuit.)
2. **TRACE.** Starts the sweep when depressed, stops sweep when released. The pen remains at the point where the "trace" button is released. (The pen returns to zero when the selector switch is turned to "OFF". The pen may also be returned by sweeping in reverse. See "Trace Reverse".)
3. **OUTPUT CONNECTORS.** These output terminals accept either open wires or banana type plugs. These terminals are connected.
4. **TRACE REVERSE.** The Trace Reverse switch reverses the input voltage polarity; the inverted output sweeps the recorder in the reverse direction when "trace" pushbutton is depressed.
5. **SWEEP-RATE SELECTOR SWITCH.** This six-position rotary switch selects "OFF" and "ON". Five sweep rates of 2, 1, 0.2, 0.1, and 0.02 in/sec are selectable.
6. **DAMPING PULSE.** When depressed, this button causes a step-function of + 4 volts to deflect recorder pen for checking recorder damping.

FIGURE 3-1. OPERATING CONTROLS

SECTION IV PRINCIPLES OF OPERATION

4-1. GENERAL CIRCUIT DESCRIPTION.

4-2. Model 17950A consists of a dual power supply, attenuator, operational amplifier, and a feedback capacitor. The dual power supply makes possible the reverse trace feature of this generator, by applying input voltage of reversed polarity. The sweep-rate selector switch selects a precision attenuator resistor which determines the charge rate of the feedback capacitor. When power is applied, the capacitor begins to charge through the resistor. The amplifier reacts to the charging action and sends current to the other side of the capacitor, increasing the voltage across it. The current through the resistor is constant, and so the voltage on the capacitor, the output voltage, rises linearly.

4-3. SIMPLIFIED CIRCUIT DESCRIPTION.

4-4. When S_1 is closed, C_1 begins to charge through R_1 . The amplifier senses the voltage caused by charging C_1 and produces an output, V_o , of opposite polarity, sending current into the other side of C_1 , tending to drive the amplifier input voltage back toward zero. The applied battery voltage continuously

draws current from C_1 through R_1 , constantly presenting a small voltage to the amplifier input. The amplifier continuously reacts, constantly raising the voltage across C_1 , which is the output voltage.

4-5. DETAILED CIRCUIT DESCRIPTION.

4-6. (Refer to schematic, Figure 6-5). CR101 and CR103 provide Zener-controlled voltage regulation for the calibration resistors R102, R104, R105, R120, R122 and R123. Diodes CR-102 and CR-104, with resistors R103 and R121 provide temperature compensation for the zener diodes. R106 through R110 are the precision attenuator resistors switched in individually to determine sweep-rates. C101 is the feedback capacitor. It discharges through R111 when sweep-selector switch is in "off" position. Q101 is a dual field-effect transistor whose high input impedance draws no current from the charging circuit. C102, C103, R114 and R115 provide frequency compensation to stabilize the operational amplifier. When S102, trace, is closed, a small voltage is applied to the ungrounded gate of Q101, increasing or decreasing conduction in that half of the FET, and in R112 in series, depending on the position of S103, positive

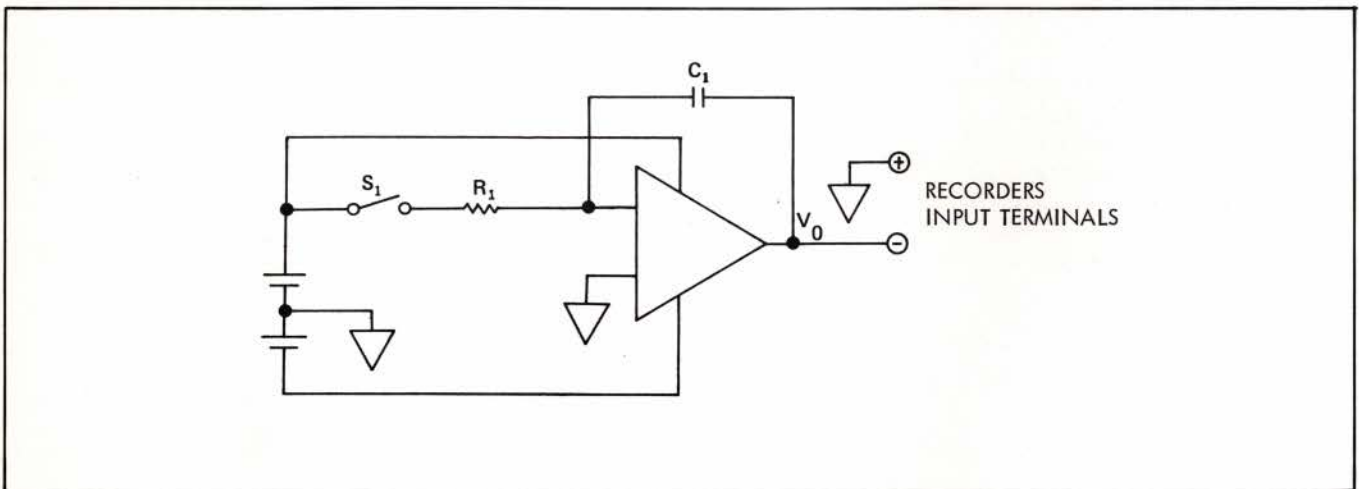


FIGURE 4-1. SIMPLIFIED CIRCUIT DIAGRAM

or negative sweep. The polarity of the voltage applied to resistors R106 through R110 is reversed when S103, trace reverse, is switched. The resulting change in voltage across R112 constitutes a differential input to IC101, which produces an inverted, amplified output to C101. Current flows through C101 in a direction which tends to drive the amplifier back to zero. The battery continues to

draw current from C101 through the selected attenuator resistor, keeping the amplifier input from actually reaching balance, i. e., zero volts differential, causing the amplifier to continue to charge C101. Inasmuch as the value of the current through the attenuator is constant, the output of the amplifier and therefore the change in voltage across 101, the output voltage, is linear.

SECTION V MAINTENANCE

5-1. PREVENTIVE MAINTENANCE.

5-2. GENERAL. Periodic checks on performance and battery condition will assure accurate, trouble-free operation.

5-3. BATTERY CHECK. Connect a voltmeter across the 17950A X or Y output terminals. Set the 17950A to the fastest sweep rate (2 inches/sec), with damping function off. Hold trace button depressed and read highest output voltage reached with trace reverse switch in down position. If less than 1.75V, replace battery, (refer to paragraph 2-8), right hand battery, BT101, for positive sweep. If the voltage is 1.75V or more on positive mode, but less than 1.75V on negative mode, replace left hand battery, BT102.

5-4. CALIBRATION.

5-5. Model 17950A is calibrated at the factory and will ordinarily not require recalibration. To compensate for any deviation from specifications, the unit is calibrated as follows:

Connect 17950A X or Y output terminals to X input terminals of a compatible recorder in the 100 mv/in range. Turn damping function off. Move the trace reverse switch downward to the positive sweep position, and the sweep rate selector to 0.2 in/sec. Hold trace button depressed and measure elapsed time of a ten-inch sweep. If elapsed time is other than 50 seconds ± 2.5 seconds, adjust R104, main circuit board calibration potentiometer (refer to Figure 6-4), CW to increase speed, CCW to decrease speed.

Move trace reverse switch upward to negative sweep position, zero the recorder upscale at 10 inches, and check elapsed sweep time as before. Adjust to specification as required by turning R123, calibration potentiometer on small, switch-mounted circuit board (refer to Figure 6-3), CCW to increase speed, or CW to decrease speed.

The calibration chart, Figure 5-1, shows elapsed time and allowable deviation for all ranges.

5-6. TROUBLESHOOTING.

5-7. The troubleshooting chart, Figure 5-2, outlines probable causes and corresponding remedies for several conditions which adversely affect operation or calibration of the unit.

Sweep Speed	Elapsed Time 10" Sweep (Seconds)	Maximum Deviation (Seconds)
.02 in/sec	500	± 25
.1 in/sec	100	± 5
.2 in/sec	50	± 2.5
1 in/sec	10	$\pm .5$
2 in/sec	5	$\pm .25$

FIGURE 5-1. CALIBRATION CHART

Condition	Probable Cause	Remedy
Less than full scale sweep	Discharged battery	Replace
Non-Linear near end of sweep	Discharged battery	Replace
No Output	Battery clips disconnected	Connect Clips
	Discharged Battery	Replace
Fast Sweeps calibrated; slow sweeps too slow	Leakage in Printed circuit board;	Clean
	Leakage in field-effect transistor	Replace
	Leakage in Capacitor	Replace

FIGURE 5-2. TROUBLESHOOTING CHART

SECTION VI REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains a replaceable parts list, an isolated spare parts list, component identification photographs, circuit diagram, and ordering information.

6-3. PARTS LIST.

6-4. Figure 6-1 lists all electrical parts by circuit symbol number.

6-5. RECOMMENDED SPARES.

6-6. Figure 6-2 lists all components with mortality experience. Recommended quantities to stock for maintaining the instrument for a one year period are designated in the RS column.

6-7. COMPONENT IDENTIFICATION.

6-8. Figures 6-3 and 6-4 are component location photographs that show the physical location of each component. It is accompanied by the Model 17950A schematic (Figure 6-5).

6-9. ORDERING INFORMATION.

6-10. Order all replacement parts from the local Hewlett-Packard Sales/Service Office (see addresses in back of this manual). The order should include part number and description from this section. If the required part is not listed in this section, provide the model and serial numbers of the instrument. Describe the part, including function and location.

Circuit Symbol	H-P Part No.	Description	Typical Mfr.	Mfr. Part No.
BT-101	1420-0032	Battery, Mercury, 12.6V	Mallory	TR-289
BT-102	1420-0032	Battery, Mercury, 12.6V	Mallory	TR-289
C-101	0160-2439	Capacitor, Metalized poly-carbonate, 4 μ f, 200 wvdc	S. E. I.	1228
C-102	0160-0179	Capacitor, Mica, 33pf	El Menco	RDM15E330JES
C-103	0160-0179	Capacitor, Mica, 33pf	El Menco	RDM15E330JES
CR-101	1902-0575	Diode, Zener, 6.5V	H-P	
CR-102	1901-0025	Diode, Silicon	Raytheon	RD 9028
CR-103	1902-0575	Diode, Zener, 6.5V	H-P	
CR-104	1901-0025	Diode, Silicon	Raytheon	RD 9028
J-101	1510-0008	Binding Post, red	H-P	5060-0683
J-102	1510-0009	Binding Post, black	H-P	5060-0684
J-103	1510-0009	Binding Post, black	H-P	5060-0684
J-104	1510-0008	Binding Post, red	H-P	5060-0683
J-105	1510-0009	Binding Post, black	H-P	5060-0684
J-106	1510-0009	Binding Post, black	H-P	5060-0684
Q-101	1855-0064	Transistor, Dual field,	Union-Carbide	FD-1093
R-101	0757-0440	Resistor, mf, 7.5K, 1%, 1/8W	Electra	MF5C T-0
R-102	0698-3449	Resistor, mf, 28.7K, 1%, 1/8W	Electra	MF5C-D-2872-F
R-103	0757-0349	Resistor, mf, 22.6K, 1%, 1/8W	Electra	MF5C T-0
R-104	2100-1581	Resistor, Variable, ww, 2K	Mel-Rain	HHH-2
R-105	0757-0427	Resistor, mf, 1.5K, 1%, 1/8W	Electra	MF5C T-0

FIGURE 6-1. MODEL 17950A REPLACEABLE PARTS LIST (Sheet 1 of 2)

Circuit Symbol	H-P Part No.	Description	Typical Mfr.	Mfr. Part No.
R-106	0698-3263	Resistor, mf, 500K, 1%, 1/8W	Electra	MF5C T-0
R-107	0757-0344	Resistor, mf, 1 meg., 1%, 1/4W	Electra	MF6C T-0
R-108	0698-3587	Resistor, mf, 5 meg., 1%, 1/2W	Pyrofilm	PME-70
R-109	0698-3592	Resistor, mf, 10 meg, 1%, 1/2W	Pyrofilm	PME-70
R-110	0698-5511	Resistor, mf, 50 meg, 1%, 1W	Pyrofilm	PME-75
R-111	0684-1011	Resistor, comp., 100 ohm, 10%, 1/4W	Allen-Bradley	CB 1011
R-112	0757-0446	Resistor, mf, 15K, 1/8W	Electra	MF5C T-0
R-113	0757-0446	Resistor, comp., 2K, 5%, 1/8W	Allen-Bradley	CB 2025
R-114	0683-2025	Resistor, comp., 2K, 5%, 1/4W	Allen-Bradley	CB 2025
R-115	0683-2025	Resistor, comp., 2K, 5%, 1/4W	Allen-Bradley	CB 2025
R-116				
R-117	0684-1531	Resistor, mf, 10%, 15K, 1/4W	Electra	MF5C T-0
R-118	0683-6825	Resistor, comp., 5%, 6.8K, 1/4W	Allen-Bradley	CB 6825
R-119	0757-0440	Resistor, mf, 1%, 7.5K, 1/8W	Electra	MF5C T-0
R-120	0698-3449	Resistor, mf, 1%, 28.7K, 1/8W	Electra	MF5C-D-2872-F
R-121	0757-0349	Resistor, mf, 1%, 22.6K, 1/8W	Electra	MF5C T-0
R-122	0757-0427	Resistor, mf, 1%, 1.5K, 1/8W	Electra	MF5C T-0
R-123	2100-1581	Resistor, variable, ww, 2K	Mel-Rain	HHH-2
S-101	3100-1516	Switch, rotary, 4-pole, 6-position	Centralab	PA 2010
S-102	3101-0148	Switch, pushbutton	Switchcraft	951
S-103	3101-0163	Switch, toggle, SPDT	Alco	MST 2050
S-104	3101-0148	Switch, pushbutton	Switchcraft	951
S-105	3101-0940	Switch, toggle, DPDT	Alco	MST-215N

FIGURE 6-1. MODEL 17950A REPLACEABLE PARTS LIST (Sheet 2 of 2)

Ckt. Symbol	H-P Part No.	Description	Typical Mfr.	Mfr's. Part No.	R/S
BT-101 BT-102	1420-0032	Battery, Mercury, 12.6V	Mallory	TR289	2
C-101	0160-2439	Capacitor, matelized, 4mfd/200V	S. E. I	1228	1
CR-101 CR-103	1902-0575	Diode, Zener, 6.5V,	H-P		1
CR-102 CR-104	1901-0225	Diode, silicon	Raytheon	RD9028	1
Q-101	1855-0064	Transistor, dual, field effect	UCC	FD 1093	1
R-104 R-123	2100-1581	Resistor, variable, ww, 2K	Mel-Rain	HHH-2	1
S-101	3100-1516	Switch, rotary, 4-pole, 6-position	Centralab	PA2010	1

FIGURE 6-2. ONE YEAR ISOLATED SPARE PARTS LIST

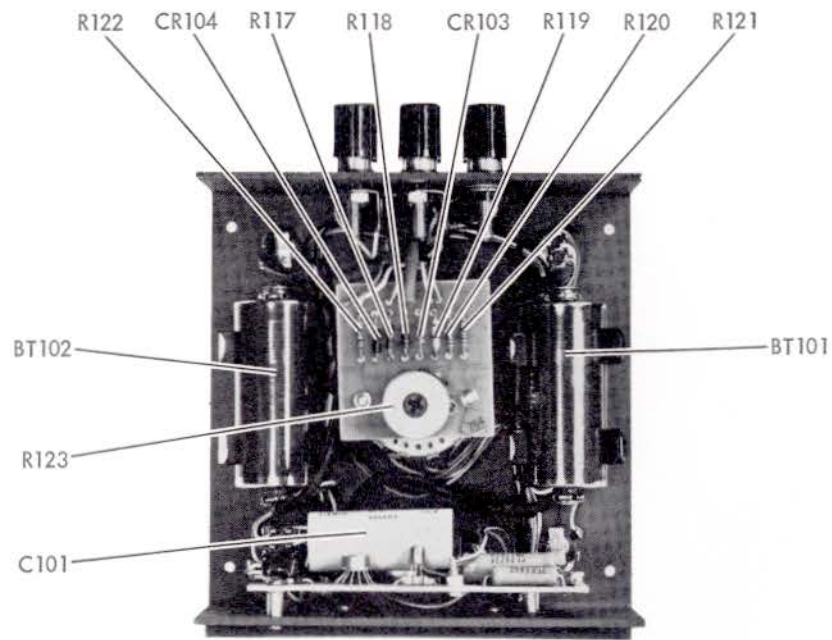


FIGURE 6-3. MODEL 17950A BOTTOM VIEW OF INTERIOR

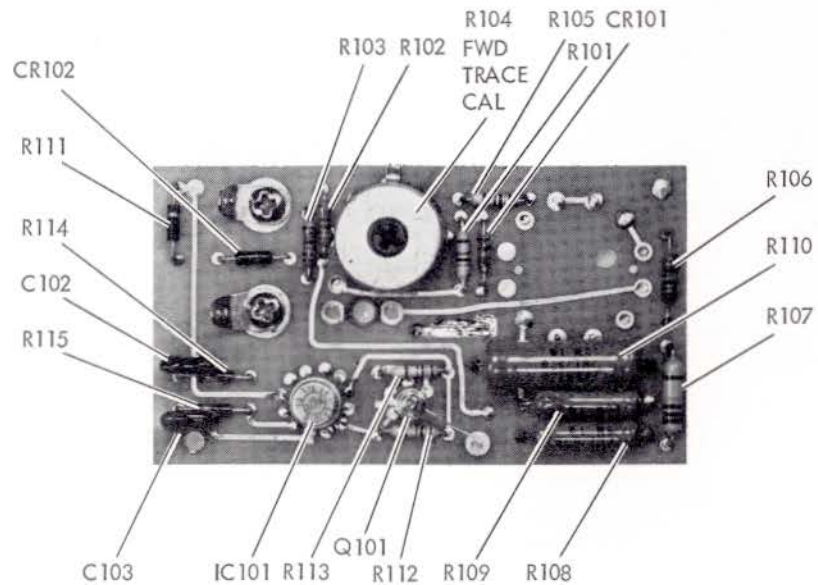
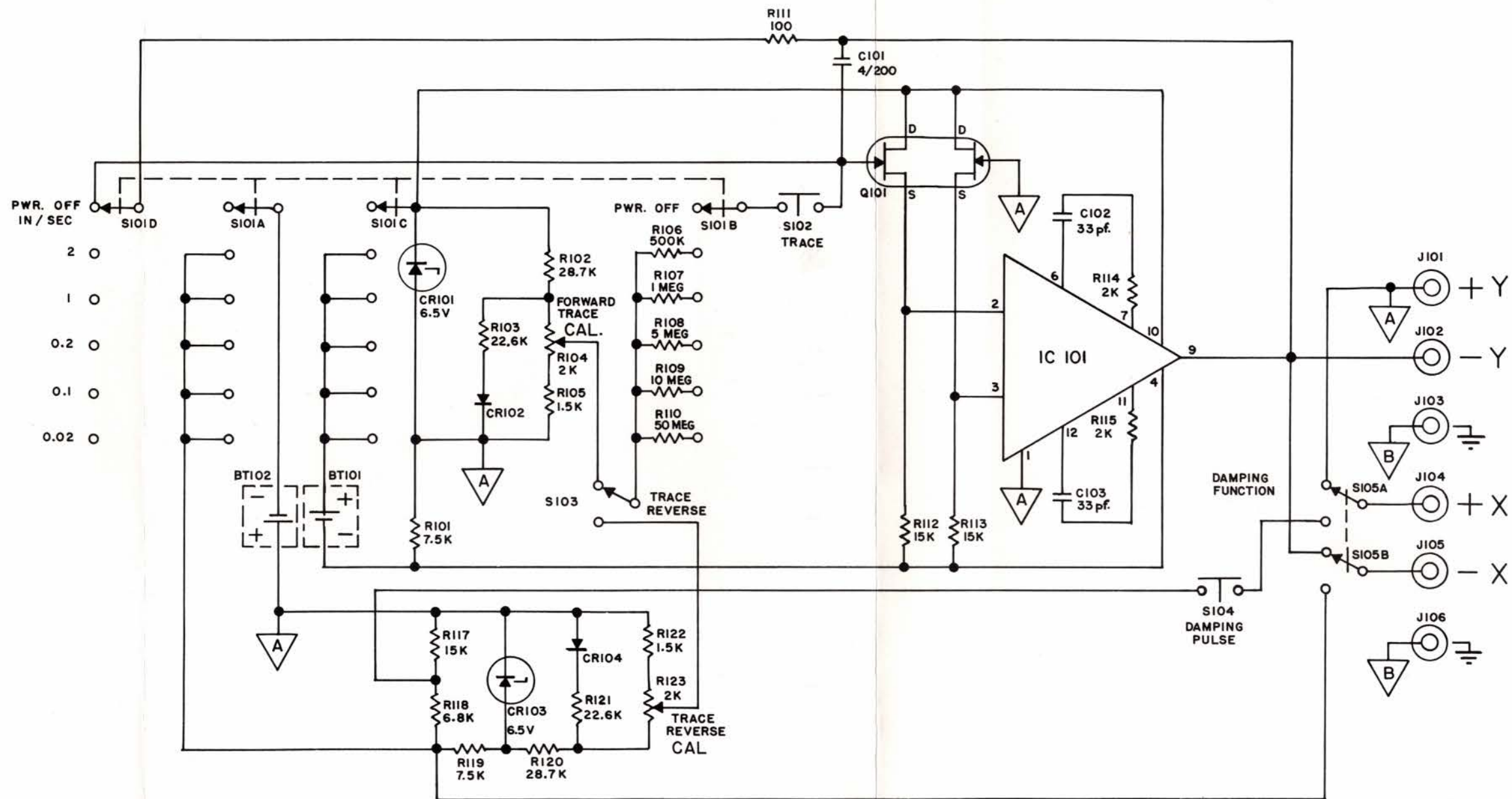



FIGURE 6-4. MODEL 17950A MAIN PRINTED CIRCUIT BOARD



2.  DENOTES CIRCUIT BOARD COMMON.

1.  DENOTES CHASSIS GROUND.

NOTES:

FIGURE 6-5. MODEL 17950A SCHEMATIC, C17950-00020-1