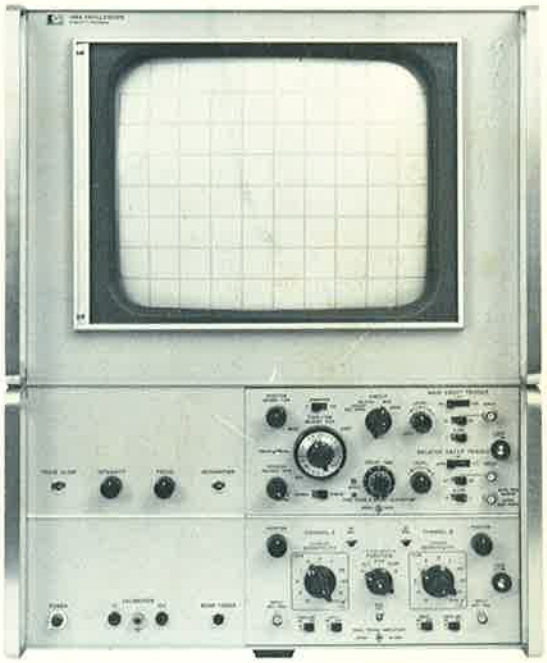
OPERATING AND SERVICE MANUAL

OSCILLOSCOPE
143A



HEWLETT hp PACKARD

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

This Hewlett-Packard product is warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

OPERATING AND SERVICE MANUAL

MODEL 143A
OSCILLOSCOPE

SERIALS PREFIXED: 925–

Refer to Section I For Instruments With Other Serial Prefixes

HEWLETT-PACKARD COMPANY/COLORADO SPRINGS DIVISION
1900 GARDEN OF THE GODS ROAD, COLORADO SPRINGS, COLORADO, U.S.A.

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Figure 1-1. Model 143A Oscilloscope

SECTION I

GENERAL INFORMATION

1-1. INSTRUMENT DESCRIPTION.

1-2. The HP Model 143A (shown in Figure 1-1) is a general purpose, wide-screen, plug-in type oscilloscope. All power supplies, a calibrator signal generator circuit and the CRT are contained in this instrument; vertical and horizontal circuits are of the plug-in type and operate directly into the CRT.

1-3. Presently available plug-ins provide a choice of operating characteristics such as wide bandwidth (including sampling), high gain, and single, dual or four channel operation in combination with normal, single or delayed sweeps. In addition, two single or multi-channel vertical amplifiers can be used simultaneously for X-Y display since both vertical and horizontal deflection sensitivities are identical. By removing the partition between upper and lower compartments, double size plug-ins can be used for time domain reflectometry and swept frequency measurements.

1-4. A large display area, 8 by 10 inches, permits viewing from a distance or by several people. Other features include a parallax-free internal graticule, a beam finder push-button to quickly locate trace position, a Z-axis input for intensity modulation and line-frequency square-wave calibrating voltages of 1 and 10 volts peak-to-peak. Except for the CRT, all active components are solid-state devices. Complete instrument specifications are listed in Table 1-1.

1-5. CATHODE-RAY TUBE.

1-6. The standard CRT supplied with this instrument has an internal graticule and an aluminized P31 phosphor. Due to the internal graticule, parallax errors are eliminated when viewing a display. Following are other phosphors available as options at no extra cost: P2 general purpose, P7 long persistence with an amber filter and P11 fast writing.

1-7. An aquadag painted fiberglass cloth jacket surrounds the CRT from the face-plate to a point just before the neck. This coating provides implosion protection for operating and maintenance personnel.

1-8. WARRANTY.

1-9. This instrument is certified and warranted as stated on the inside front cover of this manual. The CRT, however, is covered by a separate warranty located at the rear of the manual. Should the CRT fail within the time specified in the warranty, fill out the failure report form on the reverse side of the warranty statement and return with the CRT.

1-10. ASSOCIATED EQUIPMENT.

1-11. Some of the plug-ins available for the Model 143A are listed in Table 3-1. Normally a vertical plug-in is used in the lower compartment, and a time base plug-in is used in the upper compartment. However, other combinations are possible. Refer to Section III for a detailed explanation of applications and operating information.

1-12. MANUAL IDENTIFICATION AND CHANGES.

1-13. This manual applies directly to Model 143A instruments with a serial prefix as shown on the title page. The serial prefix is the first three digits of the eight-digit (000-00000) serial number located on a plate at the rear of the instrument. For instruments with a serial prefix other than the one on the title page, refer to either an enclosed Manual Changes sheet or to Section VII for information necessary to make this manual correspond to the instrument.

1-14. Manual printing errors are called Errata, and are corrected on an enclosed Manual Changes sheet (if any). Refer any questions regarding the instrument, manual or change sheet to the nearest HP Sales/Service Office listed at the rear of this manual. Be sure to identify the instrument by both model and eight-digit serial number in all correspondence.

1-15. SCOPE OF MANUAL.

1-16. This manual contains complete operating and service information for the HP Model 143A Oscilloscope and supplements the information presented in the Model 1400-series plug-in manuals. All aspects of the instrument are covered in eight sections, each of which can easily be referred to for specific data by use of the table of contents. Schematics are located at the rear of the manual on fold-out pages to permit reference to the text, and an over-all block diagram is in Section IV.

Table 1-1. Specifications

PLUG-INS:

Accepts standard Model 1400-series plug-ins. Upper compartment for horizontal axis and lower compartment for vertical axis. Center shield may be removed to provide double-sized compartment for use with a single dual axis plug-in. Plug-in units operate directly into the CRT horizontal and vertical deflection plates.

Plug-in panel nomenclature of centimeter divisions translates directly to inch divisions on the Model 143A display. For example, 5 V/cm sensitivity is displayed as 5 V/inch, and time/cm is displayed as time/inch.

CATHODE-RAY TUBE:

Type:
Post accelerator, 20 kV accelerating potential, aluminized P31 phosphor (other phosphors available on order). Etched safety glass faceplate reduces glare.

Graticule:
8 x 10-inch parallax-free internal graticule, marked in one inch squares. Subdivisions of 0.2 inch on major horizontal and vertical axes.

Intensity Modulation:
AC coupled (down 3 dB at 4 kHz), +20 volt pulse will blank trace of normal intensity; input terminal and switch on rear panel.

CALIBRATOR

Type:
Line-frequency rectangular signal, approximately 0.5 usec risetime.

Voltage:
Two outputs: 1 volt and 10 volts peak-to-peak, ±1% from 15° C to 35° C; ±3% from 0° C to 55° C.

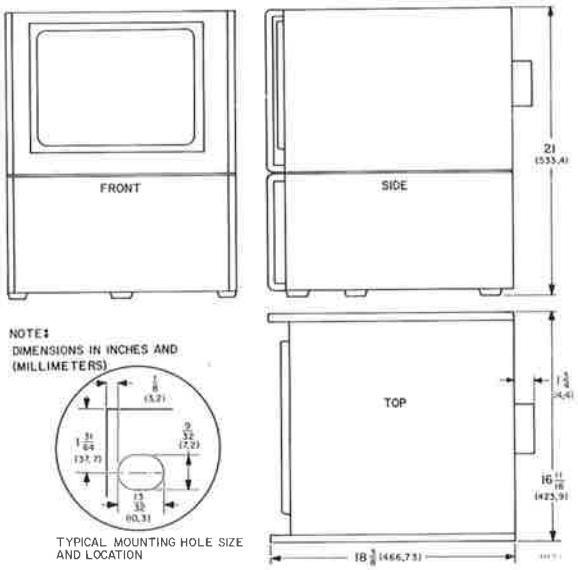
BEAM FINDER:

Pressing control brings trace on CRT screen regardless of settings of horizontal, vertical or intensity control settings.

GENERAL:

Power Requirements:
115 or 230 volts ±10%, 50 to 60 Hz, normally less than 285 watts (varies with plug-in units used).

Dimensions:



Weight:
Without plug-ins, net 63 lbs. (28,6 kg); shipping 80 lbs. (36,3 kg).

Accessories Furnished:
Rack mounting hardware for conversion to a standard EIA rack configuration.

SECTION II

INSTALLATION

2-1. INITIAL INSPECTION.

2-2. VISUAL CHECK. Inspect the instrument upon arrival for shipping damage. Check for external defects such as broken or bent parts and dents or scratches. If damage is found, refer to the CLAIMS paragraph in this section for the recommended claims procedure.

2-3. ELECTRICAL CHECK. Check the electrical performance (see Section V PERFORMANCE CHECK) as soon as possible. This check will indicate whether or not the instrument is capable of operating within the specifications listed in Table 1-1. The initial performance and accuracy of this instrument is certified as stated on the inside front cover of this manual. If operation is not as specified, refer to the CLAIMS paragraph in this section.

2-4. PREPARATION FOR USE.

2-5. POWER REQUIREMENTS.

2-6. The Model 143A Oscilloscope requires a power source of either 115 or 230 volts ac, ±10%, single phase, 50 to 60 Hz, that can deliver approximately 300 watts. Selection of line voltage is by a rear-panel switch.

CAUTION

Be sure to set the rear-panel switch to the correct line voltage. Otherwise, the power supplies may be damaged.

2-7. 230-VOLT OPERATION.

2-8. When operating from a 230-volt source, set the rear-panel switch to 230 and replace the line fuse. Line fuse F1 is accessible by removing the bottom cover. Remove the 4-A slow-blow fuse and replace it with a 2-A slow-blow fuse.

2-9. THREE CONDUCTOR POWER CABLE.

2-10. For the protection of operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a detachable, three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset (round) pin on the power cable connector is the ground pin. To preserve the protection feature when operating this instrument from a two-contact outlet, use a three-conductor to two-conductor adapter and connect the green lead on the adapter to the power outlet ground.

2-11. COOLING.

2-12. VENTILATION REQUIREMENTS.

2-13. Forced-air cooling is used to maintain required operating temperatures within the cabinet. The air intake and filter are located on the rear of the instrument; warm air is exhausted through the side-panel perforations. For best results, select a location that provides at least three inches of clearance around the rear and sides of the instrument.

2-14. FAN AND AIR FILTER.

2-15. The fan requires periodic lubrication and the filter should be cleaned, as required, to prevent clogging and restriction of air flow. Refer to Section VIII for lubricating and cleaning instructions.

2-16. INSTRUMENT MOUNTING.

2-17. MODULAR CABINET. The Model 143A is shipped from the factory as a bench instrument with the tilt stand, feet and plastic trim in place. Top and bottom panel covers can be removed, giving access to all components and adjustments. Leave sufficient space around the cabinet for air circulation.

2-18. RACK MOUNTING. A kit for converting the modular cabinet to a rack mount is included. Refer to Figure 2-1 and the following instructions:

a. Detach tilt stand by pressing away from front feet; remove all plastic feet by pressing metal button and sliding each foot free.

b. Aluminum trim strips (behind each front handle) on sides of instrument have an adhesive back; use a thin-bladed tool to remove trim strips.

c. Attach a rack-mounting flange, using screws provided in kit, in each space where trim strip was removed; position large notch of flange at instrument bottom.

d. If Model 143A is placed in a rack above or below another HP instrument, attach filler strip provided in kit between front panels of instruments.

2-19. CLAIMS.

2-20. If either physical damage is found or operation is not within specifications when the instrument is received,

notify the carrier and the nearest Hewlett-Packard Sales/Service Office immediately. The Sales/Service Office will arrange for repair or replacement of the instrument without waiting for the carrier to settle a claim.

2-21. The warranty statement for all Hewlett-Packard products is on the inside front cover of this manual. Contact the nearest Sales/Service Office about warranty claims.

2-22. REPACKAGING FOR SHIPMENT.

2-23. When shipping an instrument to a Hewlett-Packard Sales/Service Office, attach a tag describing required service, and include model number, eight-digit serial number, and return address.

2-24. Use the original shipping carton and packaging materials, except for the accordion pleated pads, for reshipment. If the original material is neither available or reusable, use the following:

a. A double-walled carton, see Table 2-1 for test strength required.

Table 2-1. Shipping Carton Test Strength

Gross Weight (lbs)	Carton Test Strength (lbs)
up to 10	200
10 to 30	275
30 to 120	350
120 to 140	500
140 to 160	600

b. Heavy paper or sheets of cardboard to protect all instrument surfaces; use a nonabrasive material such as a polyurethane or cushioned paper such as Kimpak around all projecting parts.

c. At least 4 inches of tightly-packed, industry-approved, shock-absorbing material such as extra-firm polyurethane foam.

d. Heavy-duty shipping tape for securing outside of carton.

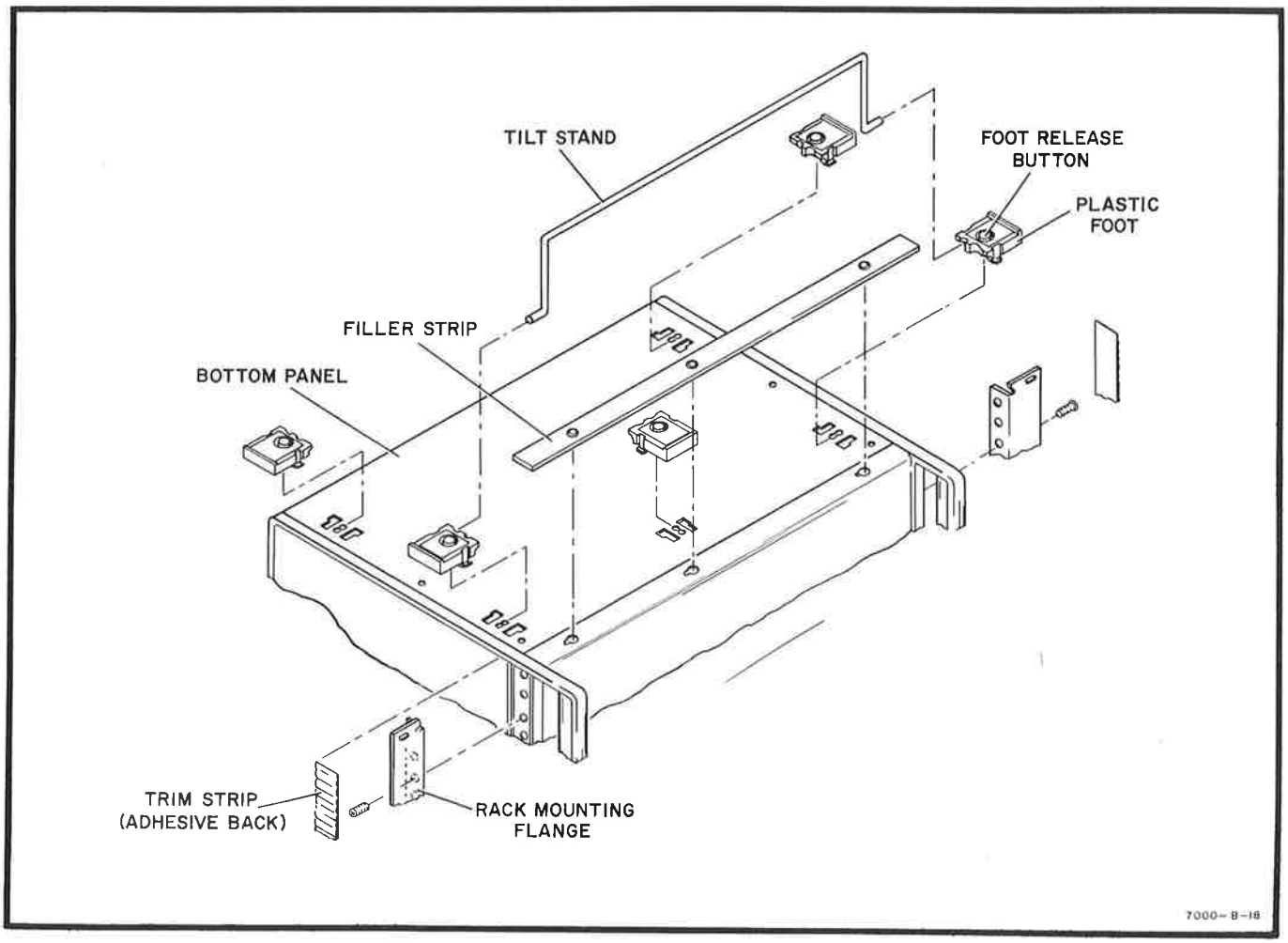


Figure 2-1. Rack Mounting Procedure Exploded View

SECTION III

OPERATION

3-1. INTRODUCTION.

3-2. Front-panel control information and operating instructions are contained in this section. Since a variety of different plug-in combinations can be used with the Model 143A, operating information for only this instrument is given. If necessary, refer to the specific plug-in manual for supplementary data.

3-3. CONTROLS AND CONNECTORS.

3-4. As a brief reference, Figures 3-1 and 3-2 show the instrument's front and rear panel with a condensed description of controls and connectors. Some controls are explained below in detail.

3-5. TRACE ALIGN. This screwdriver adjustment is used to compensate for external magnetic fields which may affect alignment of horizontal trace with the graticule. If the instrument is moved to a new location, recheck trace alignment and readjust, if required.

3-6. ASTIGMATISM. When used in conjunction with the focus control, this screwdriver adjustment helps to provide a display of uniform focus. Adjust both controls for the sharpest display possible. Since operating voltages differ according to the plug-ins used, it may be necessary to readjust astigmatism after installing a new plug-in.

3-7. BEAM FINDER. Off-screen positioning of the CRT beam may occur do to improper control settings or an excessive dc input level. If this occurs, press the BEAM FINDER push-button, and the electron beam will return to the display area. Adjust the vertical and horizontal position controls to center the beam. If the INTENSITY control is properly set, the beam will remain visible when the BEAM FINDER push-button is released.

CAUTION

BEAM FINDER should be pressed only momentarily and then released. Otherwise, the CRT may be damaged.

3-8. At high amplifier sensitivites, it may be necessary to adjust the dc balance control on the vertical plug-in after releasing the BEAM FINDER. During single sweep operation, or when using frequency domain plug-ins, the BEAM FINDER is inoperative.

3-9. CALIBRATOR. Two power line frequency, square wave signals are available at the front panel CALIBRATOR jacks. These signals have 1% accurate amplitudes of 1V and 10V pk-pk and are useful, for example, when checking the sensitivity of a Model 1400-series vertical plug-in.

CAUTION

To prevent over-drive damage to spectrum analyzer plug-ins, do not apply the CALIBRATOR signals.

3-10. 115/230. This switch, located at the bottom of the rear panel, must be set to match line voltage prior to connecting the power cable to the service outlet. Change main power fuse F1 before switching line voltage (4A slow-blow for 115 VAC, and 2A slow-blow for 230 VAC operation).

3-11. Z-AXIS INPUT. The Z-AXIS input connector and selector switch are operative only when this instrument is used as an oscilloscope. To externally modulate trace intensity, set the selector switch to EXT, and apply the modulating signal to the Z-AXIS input connector.

3-12. Pulse amplitude required to blank the trace depends on the beam intensity and is about 20V positive for average intensities. If desired, a negative pulse can be used to intensify the trace.

3-13. When the Z-AXIS input isn't in use, switch the selector to INT. This completes the chopped blanking pulse circuitry for use with multi-channel vertical plug-ins.

3-14. PLUG-IN UNITS.

3-15. Currently available plug-ins for the Model 143A are listed in Table 3-1. This instrument is normally used with a vertical amplifier in the lower compartment and a time base plug-in in the upper compartment.

3-16. Arrangement of plug-ins can be selected to suit special applications. For example, a vertical amplifier and time base plug-in can be reversed so that sweep is vertical and signal deflection is horizontal. Or, a vertical plug-in can be used in each compartment to take X-Y measurements.

3-17. Double-sized plug-ins, such as the Model 1415A or 1416A, can be inserted into the instrument after removal of the divider shield between lower and upper compartments. Blank plug-ins, both single and double size, are available for customer fabrication of specialized vertical amplifier and time base plug-ins. Refer to Table 3-2 for power supply current limitations.

NOTE

For proper operation, the divider shield must be in place when using standard size plug-ins.

Table 3-1. Plug-ins for Model 143A Oscilloscope *

FUNCTION	HP MODEL NUMBER	CAPABILITIES												
		Wide Band	Sampling	High Gain Differential	Dual Trace	Four Trace	X-Y	Delayed Sweep	No Drift	High CMR	Algebraic Addition	TDR**	Wide Band TDR	Swept Frequency
VERTICAL PLUG-INS	1400A			x			x							
	1401A				x		x				x			
	1402A	x			x		x				x			
	1403A			x			x			x	x			
	1404A	x				x	x				x			
	1405A	x			x		x				x			
	1406A			x			x		x	x				
	1407A			x			x		x	x				
	1410A		x		x		x				x			
	1411A		x		x		x				x		x	
SAMPLERS	1430A		x										x	
	1431A		x											
	1432A		x											
COMPATIBLE TIME BASES	1420A	x		x	x				x	x	x			
	1421A	x		x	x			x	x	x	x			
	1422A			x	x			x	x	x	x			
	1423A	x		x	x				x	x	x			
	1424A		x		x						x		x	
	1425A		x		x			x			x		x	
DOUBLE SIZE PLUG-INS	1415A											x		
	1416A													x
BLANK PLUG-INS	10477A	Single-size for special purpose circuit.												
	10478A	Double-size for special purpose circuit.												
SPECTRUM ANALYZER	8552A/ 8553L/ 8554L	Fixed or variable scan spectrum analysis.												

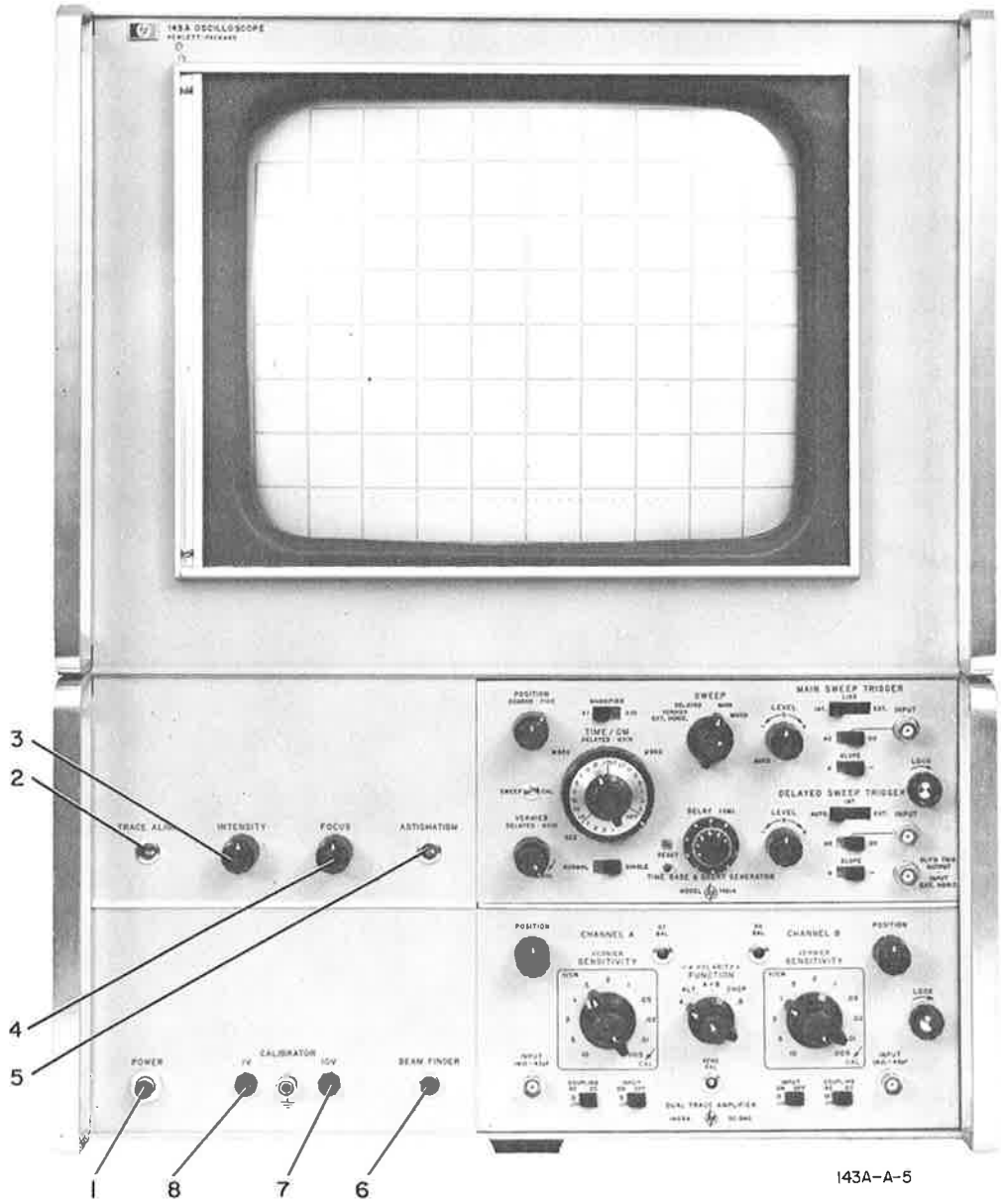
* Check latest literature for additional new plug-ins.
** Time Domain Reflectometry.

Table 3-2. Current Capability

Supply Voltage at J1 and J2 Pin No.		Current Available at Each Jack
+250 Vdc	9	0 to 50 mA
+250 Vdc	9	50 - 100 mA (pin 3 must be wired to pin 2 in plug-in)
+100 Vdc	2	0 - 137.5 mA
−100 Vdc	6	10 - 200 mA
−12.6 Vdc	21	0 - 0.9 A
6.3 Vac	13 & 14	0 - 3.25 A

3-18. The Model 143A also accepts Model 8500-series IF and RF Section Plug-ins for spectrum analysis. No modifications are necessary since all circuit changes are designed into the plug-in units.

3-19. Due to slight differences in CRT sensitivities, it may be necessary to readjust the sensitivity calibration of plug-ins installed in the Model 143A for the first time, or when moved from one oscilloscope main-frame to another. Refer to the plug-in's Operating and Service Manual for the required adjustment procedure.



1. POWER - Switch with indicator. Controls AC line power to instrument.

2. TRACE ALIGN - Screwdriver adjustment that aligns trace with graticule.

3. INTENSITY - Adjust display intensity.

4. FOCUS - Adjust focus of trace.

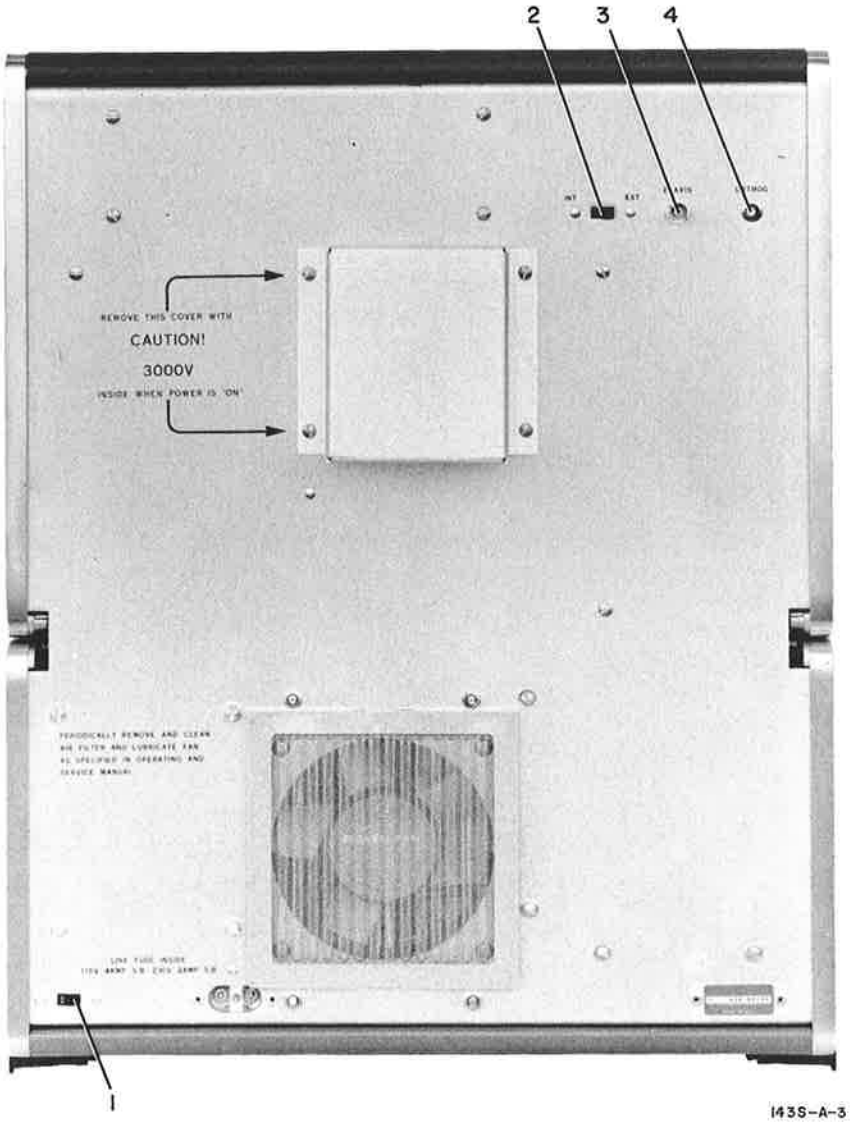
5. ASTIGMATISM - Screwdriver adjustment that focuses the trace.

6. BEAM FINDER - Returns beam to CRT screen.

7. 10V CALIBRATOR - 10-volt peak-to-peak calibrating signal (line frequency square wave).

8. 1V CALIBRATOR - 1-volt peak-to-peak calibrating signal (line frequency square wave).

Figure 3-1. Front-panel Controls



1. LINE VOLTAGE SELECT - A slotted slideswitch that changes the power transformer input connections for 115 or 230 volt primary power.

2. INT - EXT - Slide switch that switches the Z-axis input to BNC connector or to the vertical plug-in.

3. Z-AXIS - BNC connector for connecting blanking signals directly to the CRT cathode. Signal is AC coupled and +20V blanks the trace.

4. ORTHOG - Screwdriver adjustment that sets a vertical trace perpendicular to the horizontal trace.

Figure 3-2. Rear-panel Controls

SECTION IV

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains both an over-all and detailed explanation of circuit theory. Refer to the over-all block diagram and figures in this section and the schematics in Section VIII while reading the text.

4-3. OVER-ALL DESCRIPTION.

4-4. Following is an over-all explanation of circuit operation based on the block diagram in Figure 4-1. This data is presented to create a basic understanding of the instrument in preparation for the detailed theory that follows.

4-5. As an aid to quick over-all understanding, the block diagram is drawn for function and doesn't necessarily show all details of the schematics.

4-6. All horizontal and vertical circuits are in the plug-in units and operate directly into the CRT. Refer to the manuals of these other instruments for related information, if necessary. Basically, this instrument consists of a CRT and three main circuits: a low-voltage power supply, a high-voltage power supply and a calibrator circuit. These function as follows.

4-7. LOW-VOLTAGE POWER SUPPLY.

4-8. By means of a rear-panel switch, either 115 or 230 Vac (50-60 Hz, single phase) can be selected for use as primary power. Input voltage is then transformed, rectified and filtered into five fused and regulated outputs: −12.6V, +15V, −100V, +100V and +250V. These voltages are then distributed to the high-voltage supply, calibrator circuit and plug-ins as operating power. Also, 6.3 Vac from the low-voltage power supply is applied to the CRT filament, calibrator circuit and plug-ins.

4-9. HIGH-VOLTAGE POWER SUPPLY.

4-10. An oscillator and a step-up transformer are used to generate regulated negative and positive high-voltages. Further, the high-voltage supply is pulsed to unblank the CRT whenever an unblanking gate signal is applied from the horizontal plug-in. External signals can be applied, to the Z-AXIS INPUT, to intensity modulate the CRT. The high-voltage supply also contains circuitry to adjust CRT intensity, focus and other characteristics.

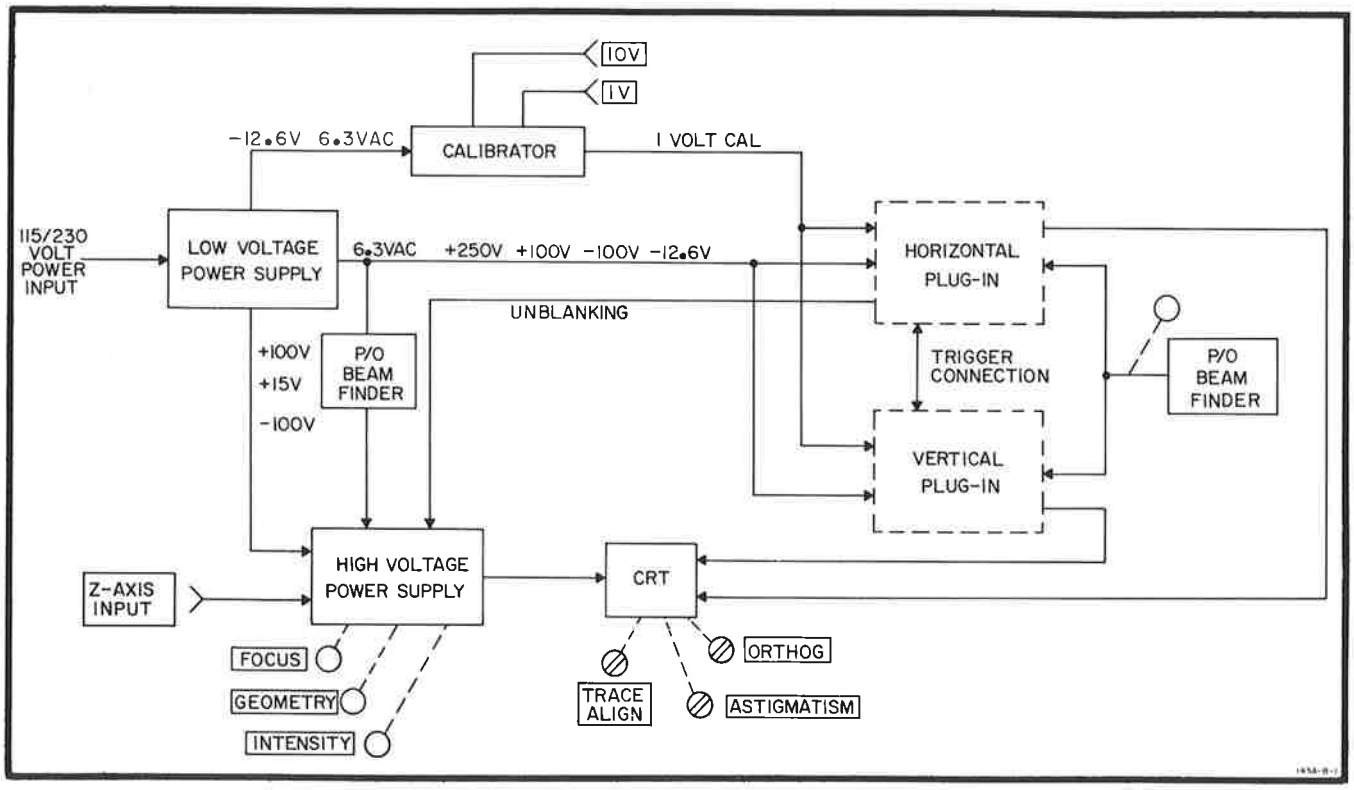


Figure 4-1. Over-all Block Diagram

4-11. CALIBRATOR.

4-12. From the low-voltage power supply, 6.3 Vac is applied to the calibrator circuit input. This voltage is then shaped into a 1% accurate line frequency square wave with an amplitude of 10V pk-pk. The 10V square wave is then divided down to 1V pk-pk, and both signals are applied to the front panel. Both plug-ins also receive the 1V signal for use when calibrating sensitivity.

4-13. DETAILED CIRCUIT THEORY.

4-14. The following detailed theory is based on the schematics in Section VIII and is categorized according to the three main circuits in the instrument.

4-15. LOW-VOLTAGE POWER SUPPLY.

4-16. BASIC REGULATED POWER SUPPLY. A simplified block diagram of the type regulator used in the low-voltage power supply is shown in Figure 4-2. In effect, this circuit is simply a self-adjusting voltage divider. Its purpose is to keep output voltage constant.

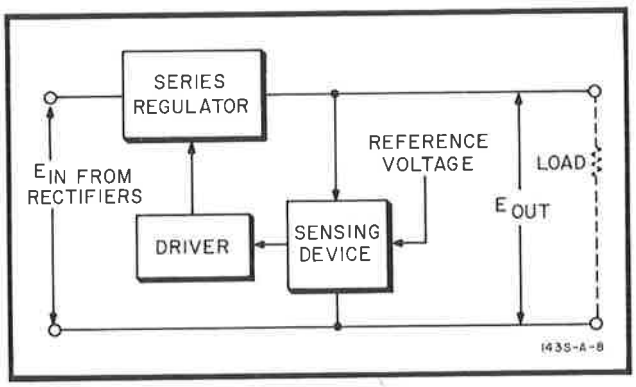


Figure 4-2. Regulated Power Supply Block Diagram.

4-17. Input voltage, from the rectifiers, is dropped proportionately across the series regulator and the parallel combination of load and sensing device. Changes in output voltage are detected by the sensing device (either a differential amplifier or common emitter amplifier) and are then compared against a reference voltage. If sensor voltage doesn't agree with the reference voltage, a difference voltage is created and applied to the driver.

4-18. The driver, in turn, controls series regulator bias. Since the series regulator acts as a variable resistance, it either increases or decreases conduction. The resulting voltage drop opposes the output voltage change and, thus, output voltage remains at a constant level.

4-19. PRIMARY POWER. Either 115 or 230 Vac can be applied to J3 for operating power, depending on the setting of rear-panel slide switch S2. When power switch S1 is pressed, lamp DS1 (inside the switch) lights to indicate the presence of primary power, and fan B1 starts circulating air throughout the instrument. Fuse F1 prevents excessive input current from damaging the instrument, and thermal switch S3 serves as a protective device to remove primary power if the instrument's temperature exceeds a safe operating limit.

4-20. If 115 Vac is used as primary power and S2 is in the position shown on the schematic, then one side of the line voltage is applied to pins 1 and 3 of T1, and the other side is connected to pins 2 and 4. Thus, the two primary windings are connected in parallel. This is done so that primary current is divided between the two windings, and neither is as susceptible to breakdown. When S2 is switched to the 230V setting, windings 1 to 2 and 3 to 4 are both connected in series. This is done to decrease the transformer step-up ratio by a factor of 50% so that secondary voltages remain the same as when 115 Vac is applied.

4-21. SECONDARY POWER. AC voltage across each secondary winding (except filament voltage) is full-wave rectified by a bridge circuit. The resulting dc voltage is filtered and applied to the following circuits for regulation. Since the +100V supply acts as a reference source for the other supplies, it is explained first.

4-22. +100 VOLT SUPPLY. From pins 7 and 8 of T1, secondary ac voltage is full-wave bridge rectified by CR5 thru CR8. The resulting dc voltage, pulsating at 120 Hz, is filtered by the RC combination of C5 and Q2. Resistor R3 is a bleeder, placed at the input as a protective device to discharge C5 if fuse F3 opens. High frequency noise is bypassed from the supply by shunt capacitor C6, and resistor R4 serves as a current limiter. In case F3 blows, A4CR446 protects C3B from reverse charging.

4-23. Part of the output voltage is taken from voltage divider A4R22/R23/R24 and is applied to the differential amplifier. This voltage, applied to the base of A4Q444, is compared against a reference voltage set by A4V441 at the base of A4Q443. A voltage difference is then amplified and applied to the driver, A4Q442. In turn, the driver changes the bias applied to the series regulator. This, in effect, changes the series resistance of the regulator and keeps output voltage constant.

4-24. −100 VOLT SUPPLY. Except for the reference voltage, the −100V supply operates in the same manner as the +100V supply. Reference voltage is obtained from voltage divider A4R28/R29 and is dependent on the +100V supply output.

4-25. If the −100V output changes, both the reference and comparison voltages change. However, a greater percentage of the change is felt by A4Q464, and an error voltage is developed at its collector. The supply is protected against overload by F4, and A4R34 adjusts output voltage.

4-26. +250 VOLT SUPPLY. Basically, the +250V supply consists of a +150V supply added onto the +100V supply. Reference voltage comes from the −100V supply.

4-27. A change in output voltage is sensed at the base of A4Q423, amplified and then applied to the base of driver A4Q422. The driver then applies corrective bias to regulator Q1.

4-28. Fuse F2 provides overload protection, and output voltage is adjustable by A4R12. To reduce Q1 power dissipation when high current plug-ins are used, two shunt resistors (R2A and R2B) are connected at the junction of CR1 and CR3. These resistors are wired to rear-panel jacks J1 and J2, and the internal wiring of the selected plug-ins automatically determines whether or not they are used.

4-29. −12.6 VOLT SUPPLY. Reference voltage is taken from the −100V supply, via voltage divider A4R42/R43/R44. A change in output voltage is sensed at the base of A4Q484, amplified and then applied to the base of driver A4Q482. In turn, the driver applies corrective bias to regulator Q4.

4-30. Current limiter A4Q483 is an overload protection circuit for the series regulator. Normally it is biased off. If the −12.6V supply output is shorted, the base of A4Q483 goes positive by the amount of voltage drop across A4R38 minus the forward voltage drop across A4CR483 (about 0.6V). The current limiter then starts to conduct, with a resultant decrease in positive collector voltage. This negative-going voltage is applied to the driver. As a result, regulator current decreases. Thus, current flowing through the short circuit is limited to the current through A4R38 that keeps A4Q483 conducting. Additional overload protection is provided by F5.

4-31. +15 VOLT SUPPLY. From pins 14 and 15 of T1, 6.3 Vac is stepped up to approximately 28 Vac by T2. This voltage is then full-wave bridge rectified by A5CR1 thru CR4. The resulting dc voltage, pulsating at 120 Hz, is filtered by the RC combination of C11, A5Q5 and A5C2. Resistor R1 is a bleeder, placed at the input as a protective device to discharge C11 if fuse A5F1 opens. Output voltage of this supply is not adjustable.

4-32. Reference voltage is taken from the −100V supply through A5R7. A change in output voltage is sensed at the base of A5Q2, amplified and then applied to the base of driver A5Q1. The driver then applies corrective bias to regulator Q5 to compensate for the output voltage change.

4-33. CALIBRATOR.

4-34. The purpose of the calibrator circuit is to generate both a 1 and 10V pk-pk square wave signal. This circuit consists of three parts: a tunnel diode square-wave generator, a transistor switch and a calibration network.

4-35. When 6.3 Vac is applied from T1, tunnel diode CR490 generates a line frequency square wave. Bias current for the tunnel diode and, thus, operating level, is set by A4R47.

4-36. During the positive half-cycle of the square wave, A4Q490 is cut-off and its collector voltage is set at −10V by voltage divider A4R48/CR491/R49. When the negative alternation of the signal is applied to the base of A4Q490, the transistor conducts heavily and collector voltage drops to zero. Thus, output voltage at the collector of the transistor is a square-wave signal alternating between 0 and −10V.

4-37. Another output signal is taken from the junction of A4R50 and R51. These resistors form a 10:1 voltage divider and yield an output signal alternating between 0 and −1V. Both square-wave output signals are applied to the front panel for use as a test signal. Also, the 1V pk-pk square-wave signal is applied to both plug-in jacks.

4-38. HIGH-VOLTAGE POWER SUPPLY.

4-39. The high-voltage power supply consists of three assemblies: a high-voltage regulator (A1), high-voltage rectifiers (A2), and a high-voltage quadrupler (A3). Each of these is explained separately, as follows.

4-40. HIGH-VOLTAGE REGULATOR. High-voltage oscillator A1Q4 produces a sine wave signal of approximately 20 kHz. To sustain oscillations, regenerative feedback is coupled from collector-to-base via the mutual inductance of A2T1. This signal is then stepped-up in amplitude by the transformer and later rectified and filtered by the secondary circuits.

4-41. High-voltage is regulated as follows. Rectified and filtered high-voltage from A2T1 pin 10 is fedback to high-input-impedance source follower A1Q1 by A2R8. In combination with A1R1/R2, A2R8 forms a 30:1 voltage divider. Since the top end of A1R1 is connected to the +100V supply, the gate of A1Q1 is close to ground potential. Bias for A1Q1 is set by A1R1. Since this adjustment sets the bias of the input source follower, it also controls the conducting levels of A1Q2 and Q3 and sets the bias of high-voltage oscillator A1Q4.

4-42. A variation in feedback voltage at the base of A1Q1 is amplified by A1Q2/Q3 and applied to the base of A1Q4 to re-establish output voltage. The purpose of high-frequency roll-off network A1R8/C2 is to reduce the gain of A1Q2 at frequencies above 100 Hz. Diode A1CR3 prevents A1Q2 from saturating immediately after initial application of power. If this transistor saturated, it would cut-off A1Q3 which would then cut-off the high-voltage oscillator. Diodes A1CR1/CR2 prevent the emitter of A1Q2 from going more negative than approximately −1.2V.

4-43. HIGH-VOLTAGE RECTIFIERS. CRT cathode voltage is taken from A2T1 pins 6 and 10. AC voltage from the transformer is then half-wave rectified by A2CR1 and filtered by A2R13 and A2C2 thru C6. A portion of this high-voltage is returned to the high-voltage regulator by means of A2R8 to provide a regulated −2850V cathode potential.

4-44. FOCUS control R11, in combination with A2R9, R10 and R15, forms a voltage divider connected to the −2850V supply and provides CRT focusing potential.

4-45. CRT grid voltage is developed by the voltage divider string across pins 5 and 11 of high-voltage transformer A2T1. AC voltage from pin 11 is half-wave rectified by A2CR2 and filtered by A2C7 and R5 before it is applied to the voltage divider. Intensity Limit control A2R6 is used to adjust current through the divider and, thus, limit the control of INTENSITY potentiometer R10. Both intensity controls adjust CRT beam intensity by changing the voltage drop across A2R7.

4-46. The Z-AXIS INPUT is an ac-coupled input jack connected to the CRT cathode. A +20V signal applied to this connector unblanks the CRT for intensity modulation control. When this connector is not used, S4 should be set to INT. This permits reception of chopped blanking signals when a multi-trace plug-in is used.

4-47. Astigmatism, roundness of the spot, is adjusted by R12, and Geometry adjustment A1R13 optimizes the display pattern.

4-48. The trace align coil, L1, and orthogonality coil, L2, are located under the CRT shield and control alignment of the trace with the graticule. Adjustment of R13A/B and R14A/B changes the magnitude and/or direction of current flow through the coils and rotates the trace.

4-49. HIGH-VOLTAGE QUADRUPLER. The sine-wave signal developed by high-voltage oscillator A1Q4 is stepped-up by transformer A2T1 to a peak-to-peak voltage of about 5 kV between pins 6 and 8. This signal is then applied to high-voltage quadrupler assembly A3. The quadrupler rectifies and multiplies the input voltage to approximately +17 kVdc to drive the CRT post accelerator (anode).

Table 5-1. Recommended Test Equipment

Recommended Instrument		Required for	Required Characteristics
Type	Model		
Voltmeter Calibrator	HP Model 738AR or 738BR	Calibrator Check; Calibrator Adjustment; High Voltage Adjustment	Outputs of 1V and 10V pk-pk; −300 Vdc; ±0.2%
D. C. Voltmeter	HP Model 412A	L. V. Adjustment	−100V to +250V, ±1%
VTVM	HP Model 410B	H. V. Adjustment	May be adapted for high voltage (−3 kV) measurement.
Voltage Divider	HP Model 11044A	H. V. Adjustment	Provide 100:1 division for VTVM (item 3); 3 kV rating
Oscillator	HP Model 200 CD	Geometry Adjustment; Orthogonality Check and Adjustment	400 kHz Output

SECTION V

PERFORMANCE CHECK AND ADJUSTMENTS

5-1. INTRODUCTION.

5-2. Instrument performance checks and adjustment procedures are contained in this section. The purpose of this information is to indicate whether or not instrument operation is within the specifications given in Table 1-1 and, if not, how to calibrate the instrument. Troubleshooting information, component location photographs and schematic diagrams are in Section VIII.

5-3. TEST EQUIPMENT.

5-4. Test equipment required to check and maintain instrument performance is listed in Table 5-1. Equivalent test equipment can be substituted if necessary. For proper results, make sure that all test equipment have been recently calibrated. Use a non-metallic screwdriver when making adjustments.

5-5. PERFORMANCE CHECK.

5-6. The objective of the performance check is to indicate whether or not the instrument is operating within the specifications of Table 1-1. This check can be used as part of an incoming quality assurance inspection, as a periodic operational test, or to check calibration after repairs or adjustments are made.

5-7. It is preferable to do the performance check in the given sequence since succeeding steps depend on the control settings and results of earlier steps. However, steps may be done individually or out of sequence by referring to the preliminary control settings and the steps prior to the desired one.

5-8. Enter the results of the initial performance check on the Performance Check Record at the end of the procedure. Then remove the form from the manual and file it for future reference (be sure to include the instrument serial number for identification).

5-9. PRELIMINARY SET-UP.

5-10. Install a Model 1400-series double-size plug-in or two standard size plug-in units in the Model 143A (vertical plug-in in the lower compartment, time base in the upper compartment). Since operation of this instrument is dependent on the performance of the plug-ins, make certain that these instruments have been recently calibrated before proceeding.

5-11. INTITIAL CONTROL SETTINGS.

a. Model 143A Oscilloscope:

TRACE ALIGN ..... mid-range
ASTIGMATISM ..... mid-range
FOCUS ..... mid-range
INTENSITY ..... ccw
INT/EXT ..... INT

b. Vertical plug-in:

Input ..... on
Coupling ..... ac
Position ..... mid-range

c. Time Base plug-in:

Position ..... mig-range
Trigger Source ..... internal
Trigger Slope ..... positive
Level ..... free-run or auto
Sweep Mode ..... normal
Time/Div ..... 1 msec

d. Apply power and allow a fifteen minute warm-up.

5-12. BEAM FINDER.

a. Adjust INTENSITY for a visible trace.

Note

If the horizontal plug-in is not a time base type, connect the CALIBRATOR signal to the horizontal amplifier input to obtain a straight line trace.

b. Remove trace from screen by rotating the vertical and horizontal position controls.

c. Set INTENSITY fully counterclockwise.

d. Press the BEAM FINDER pushbutton.

e. Note that a bright, although defocused, trace returns to the screen.

5-13. INTENSITY.

a. Readjust INTENSITY and the position controls to return the trace on screen.

b. Rotate the INTENSITY control from stop to stop.

c. Note that the trace intensity varies smoothly from extinguished to brighter than normal.

5-14. FOCUS AND ASTIGMATISM.

a. Adjust INTENSITY for a just visible trace.

b. Rotate the FOCUS and ASTIGMATISM controls.

c. Note that each control focuses the display at approximately mid-range.

Note

It may be necessary to slightly readjust FOCUS and ASTIGMATISM whenever the intensity level is changed.

5-15. TRACE ALIGN.

a. Using the position controls, set the trace on the horizontal axis.

b. Adjust TRACE ALIGN, and note that the trace can be aligned parallel to the horizontal axis.

5-16. ORTHOGONALITY.

a. Connect the Oscillator output to the input of the vertical plug-in, and adjust signal amplitude for a full-scale display.

b. Disable the sweep by setting the Trigger Source switch on the time base plug-in to external. If the horizontal plug-in doesn't have external input capabilities, disable the sweep by setting the Level control just out of the Auto detent. (A slight increase of intensity may be necessary).

CAUTION

Keep the beam intensity low when the sweep is disabled. Otherwise, the CRT phosphor may be damaged.

c. Using the position controls, set the vertical trace in line with the center vertical graticule line.

d. Adjust the rear-panel ORTHOG. control, and note that the trace can be aligned parallel to the vertical axis.

e. Disconnect the Oscillator, and reset the sweep controls.

5-17. CALIBRATOR.

a. Set Volts/Div to 0.2.

b. Connect a 60 Hz, 1V pk-pk signal from the Voltmeter Calibrator to the vertical input.

c. Adjust Time/Div to obtain a satisfactory display, and adjust vertical amplifier sensitivity calibration for 5 vertical divisions.

d. Disconnect the Voltmeter Calibrator, and connect the 1V CALIBRATOR signal from the Model 143A front panel to the vertical input.

e. Note a display of 5 vertical divisions ±0.25 minor divisions.

f. Remove the 1V CALIBRATOR signal, and set Volts/Div to 2.

g. Connect a 60 Hz, 10V pk-pk signal from the Voltmeter Calibrator to the vertical input.

h. Adjust vertical amplifier sensitivity calibration for 5 vertical divisions of display.

i. Disconnect the Voltmeter Calibrator, and connect the 10V CALIBRATOR signal from the Model 143A front panel to the vertical input.

j. Note a display of 5 vertical divisions ±0.25 minor divisions.

k. Disconnect the CALIBRATOR signal.

5-18. ADJUSTMENTS.

5-19. Procedures to calibrate this instrument so that it will perform as specified in Table 1-1 are presented in the following paragraphs. Due to the construction of the Model 143A, special adjustment information is necessary for a plug-in installed in the upper compartment. This information is provided at the end of the adjustment procedure.

5-20. It is preferable to do the adjustment procedure in the given sequence since succeeding steps depend on the control settings and results of earlier steps. However, steps may be done individually or out of sequence by referring to the steps prior to the desired one.

5-21. Physical location of all internal adjustments is shown in the photographs of Section VIII, and recommended test equipment is listed in Table 5-1. After adjustments are completed, check operation by doing the performance check in the previous paragraphs.

5-22. PRELIMINARY SET-UP.

5-23. Install a Model 1400-series double-size plug-in or two standard size plug-in units in the Model 143A (vertical plug-in in the lower compartment, time base in the upper compartment). This instrument must be properly loaded during the adjustment procedure to ensure correct power regulation.

a. Remove the top, bottom and side covers.

b. Apply power and allow a fifteen minute warm-up.

c. Set the plug-in controls to obtain a trace.

d. Adjust INTENSITY and the position controls for a mid-screen trace of normal intenisty.

e. Adjust FOCUS, ASTIGMATISM and the plug-in controls for a sharply focused trace.

5-24. LOW-VOLTAGE POWER SUPPLIES.

5-25. a. With the DC Voltmeter, monitor each low voltage supply output to ground. Make the appropriate adjustment according to Table 5-2, following the given sequence. Measurements may be taken from any wire bearing the indicated color code.

Table 5-2. Low-voltage Power Supply Adjustments

Supply Voltage	Wire Color Code	Adjustments
+100V	White/Red	A4R23
−100V	Violet	A4R34
−12.6V	White/Violet	A4R43
+250V	Red	A4R12

b. Check the +15V supply output for +15V ±0.45V (+15V ±3%). If the +15V supply is not within tolerance, components may have changed value and require replacement.

5-26. HIGH-VOLTAGE POWER SUPPLY.

5-27. The VTVM, Voltmeter Calibrator and 100:1 Voltage Divider are required for this check.

WARNING

Voltages present in the high-voltage power supply are dangerous to life.

a. Connect the 100:1 Voltage Divider to the VTVM dc probe.

b. Set VTVM to −3 Vdc range.

c. Set Voltmeter Calibrator output to −300 Vdc, and touch with divider tip.

d. Adjust the VTVM gain to provide a reading of −3 Vdc.

e. Set the VTVM to the −30 Vdc range, and measure the voltage at high voltage test point A2TP1.

f. Adjust A1R1 for −28.5 Vdc indication on the VTVM.

g. Disconnect the VTVM and remove the Voltage Divider.

5-28. INTENSITY LIMIT.

5-29. No test equipment is required for this adjustment.

CAUTION

Keep the beam intensity low to prevent the CRT phosphor from being damaged.

a. Set the INTENSITY control to the 10 o'clock position.

b. Adjust A2R6 to just extinguish a focused spot.

5-30. ASTIGMATISM.

5-31. No test equipment is required for this adjustment.

a. Position a low intensity spot at mid-screen.

b. Adjust FOCUS and ASTIGMATISM for a small, round, sharply-focused spot.

5-32. TRACE ALIGNMENT.

5-33. The Oscillator is required for this adjustment.

a. Position a trace on a horizontal graticule line.

b. Adjust TRACE ALIGN, R13A/B, located on the front panel, to position the trace parallel to the horizontal graticule line.

c. Connect the Oscillator to the vertical plug-in and obtain a vertical trace.

d. Adjust ORTHOG, R14A/B, located on the rear panel, to align the vertical trace parallel to the vertical graticule lines.

e. Disconnect the Oscillator.

5-34. GEOMETRY.

5-35. The Oscillator is required for this adjustment.

a. Center a trace on the CRT.

b. Connect the Oscillator output to the vertical plug-in.

c. Adjust the Oscillator amplitude and frequency to obtain an 8-inch by 10-inch pattern on the screen.

d. Check the displayed pattern for excessive pincushioning or barreling as shown in Figure 5-1. If either effect is present, adjust A1R13 to obtain a rectangular pattern with straight vertical and horizontal edges.

e. Disconnect the Oscillator.

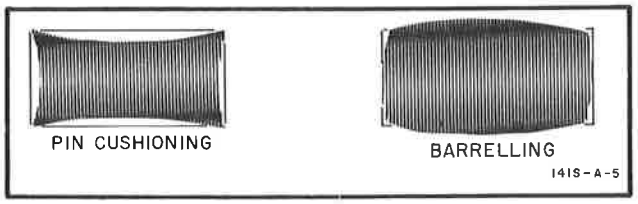


Figure 5-1. Pincushioning and Barreling.

5-36. CALIBRATOR.

a. Set Volts/Div to 2.

b. Connect a 60 Hz, 10V pk-pk signal from the Voltmeter Calibrator to the vertical input.

c. Adjust Time/Div to obtain a satisfactory display, and adjust vertical amplifier sensitivity calibration for 5 vertical divisions.

d. Disconnect the Voltmeter Calibrator, and connect the 10V CALIBRATOR signal from the Model 143A front panel to the vertical input.

e. Adjust A4R49 for exactly 5 divisions of vertical deflection.

5-37. PLUG-IN ADJUSTMENTS.

5-38. Adjustment information for upper compartment plug-ins which can't be calibrated while installed in a Model 143A is contained in the following paragraphs. Lower compartment plug-ins can be adjusted after the bottom cover is removed, and complete adjustment information is included in the applicable plug-in's Operating and Service Manual.

5-39. When a Model 1402A plug-in is installed in this instrument, the high frequency response must be adjusted to obtain proper bandwidth and risetime. Refer to the Model 1402A Operating and Service Manual for the required procedure. When operated in this instrument, the bandwidth specification of the Model 1402A is reduced from 20 MHz to 15 MHz.

5-40. The Models 1400A through 1407A and 1416A plug-ins can be adjusted after removing the bottom cover. When two vertical plug-ins are used for X-Y operation, adjust each unit in the lower compartment and then install each in the instrument as desired.

5-41. To adjust Models 1420A through 1423A and 1415A plug-ins, use a Model 10406A extender cable. Sweep calibration is inaccurate on the 0.2 usec/div range when the extender cable is used. Therefore, recheck this range when the plug-in is later installed into the oscilloscope.

5-42. Two Model 10406A extender cables are needed when the Model 1410A, 1411A, 1424A and 1425A plug-ins are calibrated. All adjustments can be accurately made except for horizontal peaking. Do this adjustment with the plug-ins out of the oscilloscope. Re-insert the plug-ins and check the results. The procedure may have to be repeated several times for optimum results.

PERFORMANCE CHECK RECORD

Serial Number: _____

Paragraph	Check	Min	Reading	Max
5-12 step e	BEAM FINDER	bright, defocused spot	_____	
5-13 step c	INTENSITY	extinguished	_____	brighter than normal
5-14 step c step c	FOCUS AND ASTIGMATISM focus astigmatism	 focuses at mid-range focuses at mid-range	 _____ _____	
5-15 step b	TRACE ALIGN	horizontal trace	_____	
5-16 step d	ORTHOGONALITY	vertical trace	_____	
5-17 step e step j	CALIBRATOR 1V CAL. signal 10V CAL. signal	 4 div +0.75 minor div 4 div +0.75 minor div	 _____ _____	 5 div +0.25 minor div 5 div +0.25 minor div

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-2 lists all parts in alphabetical/numerical order according to reference designators. Chassis mounted parts (those not included on any assembly) are listed first and are followed by a listing of assemblies with a breakdown of all separately replaceable items.

6-3. Reference designations for chassis mounted parts are complete as shown in the table. To complete the designation of parts on assemblies, prefix the part with the assembly reference designator. For example, R3 listed under assembly A2 should be referred to as A2R3.

6-4. ORDERING INFORMATION.

6-5. Most parts listed in Table 6-2 can be ordered locally by description. However, many parts are custom made according to HP specifications and are available only from HP. A complete documentation package including actual manufacturer and manufacturer's part numbers for all parts is available. Contact the nearest HP Sales/Service Office for further information or to order parts.

6-6. To obtain replacement parts, contact the nearest HP Sales/Service Office listed at the rear of this manual, and supply the following information:

a. HP Part No. of item(s).

b. Quantity desired.

c. Instrument Model and eight-digit serial numbers.

d. Reference designator of part(s).

6-7. To order a part not listed in the table, provide the following information:

a. Instrument Model and eight-digit serial numbers.

b. Description of part, including function and location.

c. Quantity desired.

6-8. Parts not in inventory at the HP Sales/Service Office are ordered through Hewlett-Packard's nationwide computer system and are normally shipped from the regional service center or factory within 24 hours after the order is received.

Table 6-1. Reference Designators And Abbreviations

REFERENCE DESIGNATORS

A	= assembly	E	= misc. electronic part	M	= meter	TB	= terminal board
AT	= attenuator, resistive termination	F	= fuse	MP	= mechanical part	TP	= test point
		FL	= filter	P	= plug	U	= microcircuit(non-repairable)
B	= motor, fan	H	= hardware	PS	= power supply	V	= vacuum tube, neon bulb, photocell, etc.
C	= capacitor	IC	= integrated circuit	Q	= transistor		
CP	= coupling	J	= jack	R	= resistor	VR	= voltage regulator (diode)
CR	= diode	K	= relay	RT	= thermistor	W	= cable
DL	= delay line	L	= inductor	S	= switch	X	= socket
DS	= device signaling (lamp)	LS	= speaker	T	= transformer	Y	= crystal

ABBREVIATIONS

A	= ampere(s)	Ge	= germanium	minat	= miniature	s-b	= slow-blow
ampl	= amplifier(s)	G	= giga (10^9)	mom.	= momentary	Se	= selenium
assy	= assembly	gl	= glass	mtg	= mounting	sect	= section(s)
		grd	= ground(ed)	my.	= mylar	semicon	= semiconductor(s)
bd	= board(s)					Si	= silicon
bp	= bandpass	H	= henry(ies)	n	= nano (10^{-9})	sil	= silver
		Hg	= mercury	n/c	= normally closed	sl	= slide
c	= centi (10^{-2})	hr	= hour(s)	Ne	= neon	sp	= single pole
car.	= carbon	HP	= Hewlett-Packard	n/o	= normally open	spl	= special
ccw	= counterclockwise	Hz	= hertz	npo	= negative positive zero (zero temperature coefficient)	st	= single throw
cer	= ceramic					std	= standard
coax.	= coaxial	if.	= intermediate freq				
coef	= coefficient	impg	= impregnated	nsr	= not separately replaceable	Ta	= tantalum
com	= common	incd	= incandescent			td	= time delay
comp	= composition	incl	= include(s)			TD	= tunnel diode(s)
conn	= connector(s)	ins	= insulation(ed)	obd	= order by description	tgl	= toggle
CRT	= cathode-ray tube	int	= internal	ox	= oxide	Ti	= titanium
cw	= clockwise					tol	= tolerance
		k	= kilo (10^3)	p	= pico (10^{-12})	trim	= trimmer
d	= deci (10^{-1})			pc	= printed (etched) circuit(s)		
depc	= deposited carbon	lb	= pound(s)	PGM	= program	u	= micro (10^{-6})
dp	= double pole	lev	= lever	piv	= peak inverse voltage(s)		
dt	= double throw	lin	= linear taper	p/o	= part of	V	= volt(s)
		log.	= logarithmic taper	poly	= polystyrene	var	= variable
elect.	= electrolytic	lpf	= low-pass filter(s)	porc	= porcelain		
encap	= encapsulated			pos	= position(s)	W	= watt(s)
ext	= external	m	= milli (10^{-3})	pot.	= potentiometer(s)	w/	= with
		M	= mega (10^6)	pk-pk	= peak-to-peak	w/o	= without
F	= farad(s)	metflm	= metal film	rect	= rectifier(s)	wVdc	= dc working volt(s)
fet	= field-effect transistor(s)	metox	= metal oxide	rf	= radio frequency	ww	= wirewound
fxd	= fixed						

Table 6-2. Replaceable Parts

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			CHASSIS PARTS
A1	00143-66503	1	A: high voltage regulator
A2	00143-66501	1	A: high voltage power supply
A3	00143-61102	1	A: high voltage quadrupler
A4	00140-66508	1	A: low voltage power supply
A5	00143-66502	1	A: +15 Vdc power supply
A6	01300-66513	1	A: CRT protection
B1	3160-0056	1	B: fan assy
C1	0150-0052	3	C: fxd cer 0.05 uF ±20% 400 wVdc
C2	0180-0154	1	C: fxd elect 430 uF −10 +100% 250 wVdc
C3A/B	0180-0012	1	C: fxd dual elect 20 uF 450 wVdc
C4			Not assigned
C5	0180-0046	1	C: fxd elect 600 uF −10 +75% 200 wVdc
C6	0150-0052		C: fxd cer 0.05 uF ±20% 400 wVdc
C7	0150-0052		C: fxd cer 0.05 uF ±20% 400 wVdc
C8	0180-0214	1	C: fxd elect 275 uF −10 +50% 200 wVdc
C9	0180-0093	1	C: fxd elect 20 uF −10 +100% 150 wVdc
C10	0180-0213	1	C: fxd elect 5000 uF −10 +75% 25 wVdc
C11	0180-0129	1	C: fxd elect 975 uF −10 +50% 40 wVdc
CR1	1901-0028	12	CR: Si
CR2	1901-0028		CR: Si
CR3	1901-0028		CR: Si
CR4	1901-0028		CR: Si
CR5	1901-0028		CR: Si
CR6	1901-0028		CR: Si
CR7	1901-0028		CR: Si
CR8	1901-0028		CR: Si
CR9	1901-0028		CR: Si
CR10	1901-0028		CR: Si
CR11	1901-0028		CR: Si
CR12	1901-0028		CR: Si
CR13	1901-0032	2	CR: Si 15A 1N3209
CR14	1901-0032		CR: Si 15A 1N3209
DS1	2140-0244		DS: Lamp - neon (p/o nsr S1)
E1	0360-0362	1	Strip: diode terminal
E2	1200-0043	5	Insulator: transistor mounting
E3	1200-0050	7	Pin: CRT socket
E4	1200-0088	4	Insulator: diode
E5	1510-0038	1	Post: binding
E6	2110-0073	1	Holder: fuse (F2 thru F5)

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			CHASSIS PARTS (Cont'd)
F1	2110-0014	1	F: cartridge 4A slow-blow (115V operation)
	2110-0006	1	F: cartridge 2A slow-blow (230V operation)
F2	2110-0004	1	F: cartridge 0.25A 250V
F3	2110-0033	3	F: cartridge 0.75A 250V
F4	2110-0012	1	F: cartridge 0.5A 250V
F5	2110-0003	1	F: cartridge 3A 3 AG
J1	1251-0054	2	J: 24 contact
J2	1251-0054		J: 24 contact
J3	1251-0148	1	J: receptacle ac power
J4	1251-0202	2	J: calibrator 10V
J5	1251-0202		J: calibrator 1V
J6	1250-0001	1	J: BNC
L1	5060-0457	1	L: trace align coil
L2	5060-0442	1	L: orthogonality coil
MP1	0160B-110B	2	Guide: plug-in
MP2	0370-0084	2	Knob: black
MP3	1200-0408	1	Cover ring: socket
MP4	1400-0008	1	Holder: fuse (F1)
MP5	1490-0030	1	Stand: tilt
MP6	1520-0042	4	Mount: vibration
MP7	4040-0254	1	Mask: CRT
MP8	5000-0053	2	Plate: fluted, A1
MP9	5000-0055	2	Plate: fluted, A1
MP10	5000-0747	2	Cover: side lower
MP11	5000-0751	2	Cover: side upper
MP12	5040-0421	2	Cover: potentiometer (INTENSITY and FOCUS)
MP13	5040-0430	2	Mount: transformer
MP14	5060-0428	1	Assembly: air filter
MP15	5060-0736	2	Frame: 8 x 18 side assembly
MP16	5060-0743	1	Cover: top
MP17	5060-0752	1	Cover: bottom
MP18	5060-0222	2	Assembly: handle
MP19	5060-0767	5	Assembly: foot
MP20	5060-0807	2	Frame: 12 x 18 side assembly
MP21	00120-04103	2	Plate: handle
MP22	00140-00102	2	Deck: vertical
MP23	00140-00103	1	Deck: main
MP24	00140-00601	1	Shield: plug-in
MP25	00140-01201	1	Bracket: latch
MP26	00140-01202	1	Bracket: diode
MP27	00140-01206	2	Bracket: fan
MP28	00140-01208	1	Bracket: panel
MP29	00140-01209	2	Bracket: gusset
MP30	00140-01210	2	Bracket: transistor

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			CHASSIS PARTS (Cont'd)
MP31	00140-24701	1	Support: top panel
MP32	00140-24702	1	Support: bottom panel
MP33	00140-24703	6	Support: panel bracket
MP34	00143-00101	1	Gusset: center
MP35	00143-00102	1	Deck: CRT
MP36	00143-00104	1	Gusset: side
MP37	00143-00201	1	Panel: front top
MP38	00143-00202	1	Panel: front bottom
MP39	00143-00205	1	Panel: rear
MP40	00143-01201	1	Bracket: CRT, left-hand
MP41	00143-01202	1	Bracket: H.V. mounting
MP42	00143-01203	1	Bracket: CRT, right-hand
MP43	00143-01204	2	Bracket: joining
MP44	00143-01205	2	Bracket: panel
MP45	00143-24701	1	Support: top panel
MP46	00143-60103	1	Deck: bottom assembly
MP47	01300-02701	1	Filter: CRT
MP48	01300-04101	1	Cover: CRT rear panel
MP49	01300-22001	1	Block: A1, mounting
MP50	01300-22201	1	Bezel: filter
MP51	01300-22202	1	Bezel: mask
MP52	01300-22203	1	Bezel: side
MP53	01300-22204	1	Bezel: bottom
MP54	01300-22205	1	Bezel: top
MP55	01300-60601	1	Assembly: CRT, shield
MP56	01300-61201	2	Strap: T-bolt assembly
MP57	00143-68701	1	Kit: rack mounting
			Consists of:
	2510-0038	14	Screw: machine 8-32 0.312 in.
	00143-20501	1	Strip: filler
	00143-21201	1	Bracket: left
	00143-21202	1	Bracket: right
Q1	1850-0422	1	Q: Ge pnp
Q2	1854-0294	3	Q: Si npn
Q3	1854-0294		Q: Si npn
Q4	1854-0294		Q: Si npn
Q5	1854-0063	1	Q: Si npn 2N3055
R1	0687-1041	2	R: fxd car 100k ohms 10% 1/2W
R2A/B	0815-0031	1	R: fxd ww 2400 ohms CT 5% 10W
R3	0687-5631	8	R: fxd car 56k ohms 10% 1/2W
R4	0811-2030	2	R: fxd ww 14 ohms 5% 10W
R5	0811-2030		R: fxd ww 14 ohms 5% 10W

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			CHASSIS PARTS (Cont'd)
R6	0687-5631		R: fxd car 56k ohms 10% 1/2W
R7	0687-2221	1	R: fxd car 2200 ohms 10% 1/2W
R8			Not assigned
R9	0687-1041		R: fxd car 100k ohms 10% 1/2W
R10	2100-0979	1	R: var car lin 1 megohm 30% 1/2W
R11	2100-1627	1	R: var lin 5 megohms 20% 1/2W
R12	2100-0063	1	R: var car lin 100k ohms 20% 1/3W
R13A/B	2100-0445	2	R: var dual car lin 2k ohms 30%
R14A/B	2100-0445		R: var dual car lin 2k ohms 30%
R15			Not assigned
R16			Not assigned
R17	0687-6531		R: fxd car 56k ohms 10% 1/2W
R18	0683-2705	2	R: fxd comp 27 ohms 5% 1/4W
R19	0683-2705		R: fxd comp 27 ohms 5% 1/4W
S1	3101-0100	1	S: power spst pushbutton
S2	3101-0033	1	S: slide dpdt
S3	3103-0009	1	S: thermal
S4	3101-0011	1	S: slide dpdt
S5	3101-0048	1	S: pushbutton
T1	9100-0184	1	T: power
T2	9100-1104	1	T: 6.3 Vac
V1	5083-1752	1	V: CRT (P31 Phosphor)
W1	8120-0078	1	W: power cord 3 cond 18 gauge 7-1/2 ft
W2	00143-61601	1	Cable: main
W3	00143-61602	1	Cable: sub
W4	01300-01208	1	Strap: ground
XC1	1520-0001	5	Socket: capacitor (C2, C5, C8, C10, C11)
XC2	1520-0002	1	Socket: capacitor (C3)
XC3	1520-0003	1	Socket: capacitor (C9)
XQ1	1200-0041	4	Socket: transistor (Q1 through Q4)
XV1	1200-0037	1	XV: socket, CRT
			A1
A1	00143-66503		A: high voltage regulator
C1	0160-0168	6	C: fxd my 0.1 uF 10% 200 wVdc
C2	0180-0291	1	C: fxd Ta elect 1 uF 10% 35 wVdc
C3	0180-0058	2	C: fxd elect 50 uF −20 +100% 25 wVdc
C4	0180-0195	1	C: fxd Ta elect 0.33 uF 20% 35 wVdc
C5	0170-0064	1	C: fxd my 0.47 uF 10% 100 wVdc

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A1 (Cont'd)
C6	0170-0040	1	C: fxd my 0.047 uF 10% 200 wVdc
C7	0180-0049	1	C: fxd alum elect 20 uF −10 +100% 50 wVdc
C8	0180-0089	1	C: fxd elect 10 uF −10 +100% 150 wVdc
CR1	1901-0040	12	CR: Si
CR2	1901-0040		CR: Si
CR3	1901-0040		CR: Si
F1	2110-0001		F: 1A
MP1	2110-0269	2	Fuse clip
MP2	01300-61103	1	Heat sink assembly
Q1	1855-0057	1	Q: Si N chan
Q2	1854-0071	6	Q: Si npn 2N3391
Q3	1853-0036	2	Q: Si pnp 2N3906
Q4	1854-0072	1	Q: Si npn 2N3054
R1	2100-0426	1	R: var comp lin 250k ohms 20% 1/4W
R2	0757-0059	1	R: fxd metflm 1 megohm 1% 1/2W
R3	0757-0442	2	R: fxd metflm 10k ohms 1% 1/8W
R4	0757-0442		R: fxd metflm 10k ohms 1% 1/8W
R5	0757-0465	3	R: fxd metflm 100k ohms 1% 1/8W
R6	0757-0465		R: fxd metflm 100k ohms 1% 1/8W
R7	0757-0044	2	R: fxd metflm 33.2k ohms 1% 1/2W
R8	0757-0430	1	R: fxd metflm 2210 ohms 1% 1/8W
R9	0757-0385	2	R: fxd metflm 22.1 ohms 1% 1/8W
R10	0757-0282	1	R: fxd metflm 221 ohms 1% 1/8W
R11	0757-0463	1	R: fxd metflm 82.5k ohms 1% 1/8W
R12			Not assigned
R13	2100-0836	1	R: var comp lin 100k ohms 20% 1/4W
R14	0757-0395	1	R: fxd metflm 56.2 ohms 1% 1/8W
R15	0757-0385		R: fxd metflm 22.1 ohms 1% 1/8W
R16	0757-0401	3	R: fxd metflm 100 ohms 1% 1/8W
R17	0687-4731	1	R: fxd comp 47k ohms 10% 1/2W
VR1	1902-3203	1	VR: breakdown 14.7V 5% 400 mW
VR2	1902-3357	1	VR: breakdown 56V
			A2
A2	00143-66501		A: high voltage rectifier
C1	0160-3007	12	C: fxd cer 4700 pF 20% 4k wVdc
C2	0160-3007		C: fxd cer 4700 pF 20% 4k wVdc
C3	0160-3007		C: fxd cer 4700 pF 20% 4k wVdc
C4	0160-3007		C: fxd cer 4700 pF 20% 4k wVdc
C5	0160-3007		C: fxd cer 4700 pF 20% 4k wVdc

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A2 (Cont'd)
C6	0160-3007		C: fxd cer 4700 pF 20% 4k wVdc
C7	0160-3007		C: fxd cer 4700 pF 20% 4k wVdc
C8	0160-3007		C: fxd cer 4700 pF 20% 4k wVdc
C9	0160-3007		C: fxd cer 4700 pF 20% 4k wVdc
C10	0160-3007		C: fxd cer 4700 pF 20% 4k wVdc
C11	0160-2403	1	C: fxd cer 1500 pF 20% 5k wVdc
C12	0160-3007		C: fxd cer 4700 pF 20% 4k wVdc
C13	0160-3007		C: fxd cer 4700 pF 20% 4k wVdc
CR1	1901-0142	2	CR: Si
CR2	1901-0142		CR: Si
CR3	1901-0436	2	CR: Si
CR4	1901-0436		CR: Si
R1	0757-0427	1	R: fxd metflm 1500 ohms 1% 1/8W
R2	0757-0847	1	R: fxd metflm 27.4k ohms 1% 1/2W
R3	0757-0833	1	R: fxd metflm 5110 ohms 1% 1/2W
R4	0757-0367	3	R: fxd metflm 100k ohms 1% 1/2W
R5	0757-0367		R: fxd metflm 100k ohms 1% 1/2W
R6	2100-0981	1	R: var comp lin 1 megohm 20% 1/4W
R7	0836-0005	1	R: fxd carflm 33 megohms 10% 1W
R8	0698-6239	1	R: fxd carflm 30 megohms 2% 1W
R9	0698-6277	1	R: fxd carflm 8 megohms 10% 1W
R10	0698-6278	1	R: fxd carflm 18 megohms 10% 1W
R11	0757-0871	1	R: fxd metflm 1.21 megohms 1% 1/2W
R12	0757-0852		R: fxd metflm 47.5k ohms 1% 1/2W
R13	0757-0190	3	R: fxd metflm 20k ohms 1% 1/2W
R14	0757-0852		R: fxd metflm 47.5k ohms 1% 1/2W
R15	0686-3055	1	R: fxd comp 3 megohms 5% 1/2W (select value to focus spot at mid-range of focus pot, R11)
T1	01300-61102	1	T: high voltage transformer
TP1	1251-0206	1	TP: test point jack
			A3
A3	00143-61102		A: high voltage quadrupler assembly (potted assembly components are not separately replaceable.)
	0160-2401	3	C: fxd 390 pF 15k wVdc
	0160-2402	1	C: fxd 1000 pF 6k wVdc
	0687-2241	1	R: fxd 220 k ohms 10% 1/2W
	1880-0026	4	CR: Se rect
	00191-00103	1	Deck: HV

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A4
A4	00140-66508		A: low voltage power supply
C1	0160-0168		C: fxd my 0.1 uF 10% 200 wVdc
C2	0160-0168		C: fxd my 0.1 uF 10% 200 wVdc
C3	0160-0168		C: fxd my 0.1 uF 10% 200 wVdc
C4	0180-0100	2	C: fxd elect 4.7 uF 10% 35 wVdc
C5	0160-0168		C: fxd my 0.1 uF 10% 200 wVdc
C6	0180-0100		C: fxd elect 4.7 uF 10% 35 wVdc
C7	0160-0207	1	C: fxd my 0.01 uF 5% 200 wVdc
C8	0180-0097	1	C: fxd elect 47 uF 10% 35 wVdc
CR425	1910-0016	2	CR: Ge
CR426	1902-0034	1	CR: breakdown 5.8V 10% 400 mW
CR427	1901-0096	1	CR: Si
CR428	1902-3402	1	CR: breakdown 80.6V 2% 400 mW
CR429	1901-0040		CR: Si
CR430	1901-0040		CR: Si
CR445	1902-3385	2	CR: breakdown 69.8V 2% 400 mW
CR446	1901-0026	6	CR: Si
CR447	1901-0040		CR: Si
CR448	1901-0040		CR: Si
CR449	1902-3104	1	CR: breakdown 5.62V 5% 400 mW
CR465	1902-3385		CR: breakdown 69.8V 2% 400 mW
CR466	1901-0026		CR: Si
CR467	1901-0040		CR: Si
CR468	1901-0040		CR: Si
CR483	1901-0025	1	CR: Si
CR484	1910-0016		CR: Ge
CR485	1901-0040		CR: Si
CR490	1912-0006	1	CR: Ge tunnel
CR491	1902-0064	1	CR: breakdown 7.5V 5% 400 mW
Q422	1854-0005	1	Q: Si npn 2N708
Q423	1853-0036		Q: Si pnp 2N3906
Q442	1854-0022	2	Q: Si npn
Q443	1854-0087	1	Q: Si npn
Q444	1854-0071		Q: Si npn
Q462	1854-0022		Q: Si npn
Q463	1854-0071		Q: Si npn
Q464	1854-0071		Q: Si npn
Q482	1854-0039	1	Q: Si npn 2N3053
Q483	1854-0215	1	Q: Si npn 2N3904
Q484	1854-0071		Q: Si npn
Q490	1850-0062	1	Q: Ge pnp

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A4 (Cont'd)
R1	0764-0033	1	R: fxd metox 33 ohms 5% 2W
R2	0757-0338	1	R: fxd metflm 1000 ohms 1% 1/4W
R3	0761-0007	1	R: fxd metox 27k ohms 5% 1W
R4	0757-0401		R: fxd metflm 100 ohms 1% 1/8W
R5	0757-0413	1	R: fxd metflm 392 ohms 1% 1/2W
R6	0757-0044		R: fxd metflm 33.2k ohms 1% 1/2W
R7	0761-0006	1	R: fxd metflm 10k ohms 5% 1W
R8	0757-0401		R: fxd metflm 100 ohms 1% 1/8W
R9	0757-0465		R: fxd metflm 100 k ohms 1% 1/8W
R10	0757-0273	2	R: fxd metflm 3010 ohms 1% 1/2W
R11	0757-0370	1	R: fxd metflm 49.9k ohms 1% 1/2W
R12	2100-1589	1	R: var lin 5k ohms 20% nsr p/o R23/R34
R13	0757-0367		R: fxd metflm 100k ohms 1% 1/2W
R14	0766-0033	1	R: fxd metflm 2000 ohms 1% 1/2W
R15	0757-0434	1	R: fxd metflm 3650 ohms 1% 1/2W
R16	0687-5631		R: fxd comp 56k ohms 10% 1/2W
R17	0757-0280	2	R: fxd metflm 1000 ohms 1% 1/8W
R18	0757-0399	2	R: fxd metflm 82.5 ohms 1% 1/8W
R19	0684-5621	1	R: fxd metflm 5600 ohms 1% 1/8W
R20	0757-0764	2	R: fxd metflm 33.2k ohms 1% 1/4W
R21	0757-0388	3	R: fxd metflm 30.1 ohms 1% 1/8W
R22	0757-0436	2	R: fxd metflm 4320 ohms 1% 1/2W
R23	2100-1589		R: var lin 3k ohms 20% nsr p/o R12/R34
R24	0757-0846	3	R: fxd metflm 22.1k ohms 1% 1/2W
R25	0687-5631		R: fxd comp 56k ohms 10% 1/2W
R26	0757-0280		R: fxd metflm 1000 ohms 1% 1/8W
R27	0757-0399		R: fxd metflm 82.5 ohms 1% 1/8W
R28	0757-0190		R: fxd metflm 20k ohms 1% 1/2W
R29	0757-0848	1	R: fxd metflm 30.1k ohms 1% 1/8W
R30	0757-0764		R: fxd metflm 33.2k ohms 1% 1/4W
R31	0757-0772	1	R: fxd metflm 68.1k ohms 1% 1/4W
R32	0757-0388		R: fxd metflm 30.1 ohms 1% 1/8W
R33	0757-0436		R: fxd metflm 4320 ohms 1% 1/2W
R34	2100-1589		R: var lin 7k ohms 20% nsr p/o R12/R23
R35	0727-0431	1	R: fxd metflm 2690 ohms 1% 1/2W
R36	0757-0846		R: fxd metflm 22.1k ohms 1% 1/2W
R37	0687-4731	1	R: fxd metflm 47k ohms 1% 1/4W
R38	0811-1746	2	R: fxd ww 0.36 ohms 5% 2W
R39	0757-0388		R: fxd metflm 30.1 ohms 1% 1/8W
R40	0757-0190		R: fxd metflm 20k ohms 1% 1/2W

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			A4 (Cont'd)
R41	0757-0480	1	R: fxd metflm 432k ohms 1% 1/8W
R42	0757-0846		R: fxd metflm 22.1k ohms 1% 1/2W
R43	2100-1588	1	R: var lin 1.5k ohms 30% nsr p/o R49
R44	0757-0273		R: fxd metflm 3010 ohms 1% 1/8W
R45	0811-1746		R: fxd ww 0.36 ohms 5% 2W
R46	0757-0421	1	R: fxd metflm 825 ohms 1% 1/8W
R47	0757-0428	1	R: fxd metflm 1620 ohms 1% 1/8W
R48	0757-0844	1	R: fxd metflm 16.2k ohms 1% 1/2W
R49	2100-1588		R: var lin 1.5k ohms 30% nsr p/o R43
R50	0698-3554	1	R: fxd metflm 493 ohms 1/2% 1/2W
R51	0698-3555	1	R: fxd metflm 4437 ohms 1/2% 1/2W
V441	1940-0013	1	V: reference 82.0 ±1.0V
			A5
A5	00143-66502		A: +15 volt power supply
C1	0160-0168		C: fxd my 0.1 uF 10% 200 wVdc
C2	0180-0058		C: fxd elect 50 uF −10 +75% 25 wVdc
CR1	1901-0026		CR: Si
CR2	1901-0026		CR: Si
CR3	1901-0026		CR: Si
CR4	1901-0026		CR: Si
CR5	1901-0040		CR: Si
CR6	1901-0040		CR: Si
F1	2110-0033		F: 3/4A
MP1	2110-0269	2	Fuse clip
Q1	1854-0022		Q: Si npn
Q2	1854-0071		Q: Si npn 2N3391
R1	0687-5631		R: fxd car 56k ohms 10% 1/2W
R2	0687-5631		R: fxd car 56k ohms 10% 1/2W
R3	0757-0388	1	R: fxd metflm 30.1 ohms 1% 1/8W
R4	0757-0461	1	R: fxd metflm 68.1k ohms 1% 1/8W
R5	0757-0477	1	R: fxd metflm 332k ohms 1% 1/2W
R6	0757-0435	1	R: fxd metflm 3920 ohms 1% 1/8W
R7	0757-0060	1	R: fxd metflm 24.3k ohms 1% 1/2W
			A6
A6	01300-66513	1	A: CRT protection
CR1	1901-0096	1	CR: Si
R1	0757-0442	1	R: fxd metflm 10k ohms 1% 1/8W

SECTION VII

MANUAL CHANGES AND OPTIONS

7-1. MANUAL CHANGES.

7-2. This manual applies directly to all standard Model 143A Oscilloscopes with a serial prefix (see Section I for explanation) as listed on the title page of this manual. If the serial prefix of your instrument is not the same as the one on the title page, refer to Table 7-1 for the changes necessary to back date this manual to your particular instrument. Refer to an enclosed Manual Changes sheet for updating information if the serial prefix of your instrument is not listed either on the title page or in Table 7-1. Also, if a Manual Changes sheet is supplied, make all indicated errata corrections.

7-3. OPTIONS.

7-4. Options for a Hewlett-Packard instrument are standard modifications installed at the factory. No options are offered for the Model 143A at this time.

7-5. SPECIAL INSTRUMENTS.

7-6. Special instruments are standard HP instruments that are modified at the factory according to customer specifications. These instruments are designated by a letter-number combination (such as C05-) preceding the standard model number. A tag, adjacent to the serial number tag, is used for identification.

7-7. A separate insert sheet is included in the manual of each special instrument and includes all modification information that affects the manual. Revise the manual according to the insert sheet for proper instrument coverage. Modifications such as fungus proofing or special paint are not listed in the insert sheet. If an insert sheet is not included, modifications do not affect the standard manual.

Table 7-1. Manual Changes

Serial Prefix	Make Changes
908–	1
838–	1 & 2
834--	1 thru 3
829–	1 thru 4
810–	1 thru 4

CHANGE 1

Table 6-2, Replaceable Parts,
Delete: A6
Page 8-13/8-14, Figure 8-10,
Delete A6 connected between the cathode and grid of the CRT.

CHANGE 2

Page 8-11, Figure 8-7
Modify the Low-voltage Power Supply schematic according to Figure 7-1.

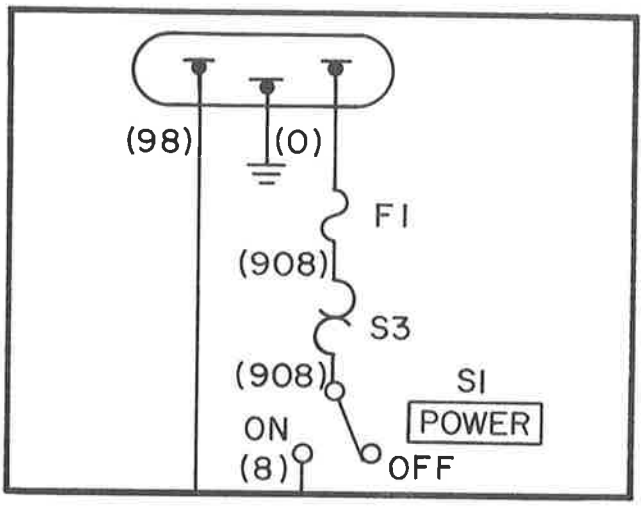


Figure 7-1. Low Voltage Power Supply Input Circuit

CHANGE 3

Table 6-2, Replaceable Parts,
R18, R19: Delete.
Page 8-8, Figure 8-3,
R18, R19: Delete and replace with a straight wire.

CHANGE 4

Page 4-3, Paragraph 4-43,
Change –2850 V reference to –2650 V.
Page 4-4, Paragraph 4-44,
Change –2850 V reference to –2650 V.
Page 5-3, Paragraph 5-27,
Step f: Change –28.5 Vdc to –26.5 Vdc.
Table 6-2, Replaceable Parts,
A1R2: Change HP Part No. to 0757-0139; R: fxd metflm 1.1 megohms 1% 1/2 W.
A2T1: Change HP Part No to 00143-61101.
Page 8-5, Table 8-3,
Change the second entry under the symptom column to read: –2650 V to 3000 V.
Change the third entry under the symptom column to read: 0 to –2650 V.
Page 8-13/8-14, Figure 8-10,
A1R2: Change value to 1.1 M.
Change: Voltage at V1 pin 2 from –2850 V to –2650 V.

SECTION VIII

SCHEMATICS AND TROUBLESHOOTING

8-1. INTRODUCTION.

8-2. This section contains schematics and component location photographs along with troubleshooting, repair and replacement information. All schematics are on pull-out pages to allow reference to the text and figures in other sections. Schematic symbols and conventions are explained in Table 8-3 and Figure 8-3 shows plug-in jack connections. An over-all block diagram is in Section IV.

8-3. COMPONENT IDENTIFICATION.

8-4. All components within the shaded areas of the schematics are physically located on an etched circuit board. There are six assemblies listed in the replaceable parts list of this manual. To distinguish among the different assemblies, each is designated on the schematics with the letter "A" followed by a number between "1" and "6".

8-5. Component designation begins with the number "1" for each type of component on each assembly and ascends in sequence (e. g. C1, C2 . .R1, R2 . . .). Since component designation follows the same sequence on each assembly, designators are duplicated on different assemblies. Therefore, for distinction, the complete description of resistor R1 on assembly A1 is A1R1, and resistor R1 on assembly A2 is called A2R1.

8-6. Components not physically located on an assembly are shown in the white area of the schematics and have only the basic component designator, such as C1 or R1. These parts are listed in the replaceable parts list under Chassis Parts.

8-7. A reference designation box on each schematic indicates all schematic components. Components not included in the designation sequence are shown deleted below each box.

8-8. COMPONENT LOCATION.

8-9. To find a component on the schematics, first check the reference designation boxes. These boxes are located in the lower right-hand corner of schematics whenever compatible with circuit lay-out and indicate which components are on a particular schematic. To find the physical location of components, refer to the appropriate photograph. Assembly components are shown, with a grid locator, near each schematic for ease of physical location. Chassis mounted components are shown in the photographs following this text.

8-10. OVER-ALL TROUBLESHOOTING.

8-11. Troubleshooting is much easier if more than one symptom of a trouble is evident. Observe the instrument and note all indications of faulty operation. If symptoms indicate more than one trouble, treat each problem individually and locate one trouble at a time. Don't waste time making random checks. Instead, follow the logical procedure presented here, and refer to other areas of information in this manual if necessary.

8-12. FRONT-PANEL CONTROLS.

8-13. Equipment troubles are frequently due simply to improper front-panel control settings. Refer to the operating instructions in Section III for a complete explanation of each control's function along with typical operating instructions if in doubt. Also, refer to the operating information in the plug-in manuals. Possibly the intensity control isn't turned up, or the level control on a time base plug-in is misadjusted. Use the controls as a guide to help isolate a trouble to a specific area.

8-14. TROUBLESHOOTING TABLES.

8-15. After observing symptoms of trouble, refer to the following troubleshooting tables for the low and high voltage power supplies. The troubleshooting tables may not pin-point a trouble, but they can help localize it to a specific area of the instrument. Use the text in conjunction with the tables to further localize the trouble.

8-16. VISUAL CHECKS.

8-17. After localizing the trouble to a specific area of the instrument, make a good visual check of that area. Check for burned or broken components, loose wires or circuit board connections, faulty switch contacts, or any similar condition suggesting a source of trouble. If everything appears normal, proceed to the next step.

8-18. VOLTAGE CHECKS.

8-19. Allow the instrument to warm-up for about fifteen minutes. DC voltages are shown on the schematics near active components such as transistors. To avoid creating a short circuit, use a probe with a needle tip when taking voltage measurements. Check voltages at J1 and J2, as shown in the plug-in jack drawing, to ensure that the proper voltages are being applied to the plug-ins. As an aid to locating measurement points, note a small dot etched on the circuit boards near the emitter of transistors, source of field effect transistors, cathode of diodes and positive lead of electrolytic capacitors.

8-20. DETAILED TROUBLESHOOTING.

8-21. The following troubleshooting tips are categorized according to the various areas of the instrument. These tips can be helpful only after a trouble is localized to one of these areas. Therefore, refer to the above information before reading further. Also, read the theory of operation in Section IV to learn how a circuit should operate. With the aid of this infromation, it is easier to discover why a defective circuit is inoperative. Finally, make resistance checks to uncover the faulty component. If it appears necessary to calibrate the instrument, refer to Section V for the proper procedures.

8-22. LOW-VOLTAGE POWER SUPPLY.

8-23. TROUBLE ISOLATION. When troubleshooting the low-voltage power supply, for any or all output voltages, first check the +100 V supply. All other supplies are referenced either directly or indirectly to the +100 V supply. Thus, incorrect operation of one of the other supplies may be only a symptom of a defective +100 V supply. Next, check the −100 V supply. The +250 V, +15 V and −12.6 V supplies are referenced directly to the −100 V supply, and a trouble in the −100 V supply could make the other supplies appear defective. If trouble persists at this point, make detailed checks of the +250 V, +15 V and −12.6 V supplies using the low-voltage power supply troubleshooting table in this section.

8-24. EXCESSIVE RIPPLE. Excessive 120 Hz power supply ripple can be traced to either an input filter or regulator circuit. Check peak-peak ripple at the rectifiers' output, and compare with the values shown on the schematics. For ripple above the specified values, check C2, C5, C8, C10 or C11. A symptom of an open rectifier or low gain amplifier transistor is 60 Hz ripple above the specified values at these points.

8-25. Maximum ripple on supply outputs (at 115 Vac primary power with maximum load on supply) is: 10 mV at +250 V, 7 mV at +100 V and −100 V, 2 mV at −12.6 V and +15 V.

8-26. HIGH-VOLTAGE POWER SUPPLY AND REGULATOR.

8-27. High-voltage power supply problems are usually indicated by no display, a display that is too bright, an arcing sound, slow trace shift or blooming or sudden shifts in display intensity. Regulator problems may result in no high-voltage or excessive high-voltage.

8-28. Check the waveform at the collector of High-voltage Oscillator A1Q4 if there is no high voltage. Normally, the oscillator output should be a 20 kHz sine wave at approximately 20 V pk-pk. If only one high voltage is absent, check the appropriate rectifier and filter circuit in the secondary of A2T1. Refer to the high-voltage troubleshooting table if high voltage is present but not properly adjustable by A1R1 or if trouble persists.

8-29. REPAIR AND REPLACEMENT.

8-30. The following paragraphs contain recommended procedures for repair and replacement of defective components. A complete list of components, with Hewlett-Packard part numbers and ordering information, can be found in Section VI. Contact the nearest HP Sales/Service Office at the rear of this manual if satisfactory repair or operation cannot be achieved.

8-31. PERIODIC MAINTENANCE.

8-32. ELECTRICAL MAINTENANCE. Perform the electrical adjustment procedure, given in Section V, once every six months and after repair or component replacement.

8-33. MECHANICAL MAINTENANCE. Inspect and clean the air filter at the rear of the instrument before it becomes clogged and restricts air flow. To clean, wash the air filter throughly in warm water and detergent, and dry before installing in the instrument. Oil the fan (one point) with light machine oil such as SAE No. 10 every 6 months.

8-34. ASSEMBLY REMOVAL AND INSTALLATION.

8-35. CIRCUIT BOARDS. Many components can be replaced from the component side of a circuit board without removing the entire board from the instrument. Refer to the paragraph headed Servicing Etched Circuit Boards in the following text for further information.

8-36. If it becomes necessary to remove a circuit board, remove the clip-on wires and retaining screws. Refer to the applicable component identification photograph for the proper wire-to-pin connections.

8-37. HIGH-VOLTAGE QUADRUPLER ASSEMBLY. High-voltage Quadrupler assembly A3 is a potted assembly and can be replaced only as a complete unit. Replace this assembly as follows:

WARNING

The post accelerator lead may have a high-voltage charge even after the instrument has been turned off for a long time.

a. Using a thin-bladed screwdriver, ground the post accelerator at the CRT connection.

b. Disconnect the high-voltage lead from the CRT, and ground the lead again.

c. Unsolder red lead from high-voltage transformer A2T1.

d. Remove the six screws securing the high-voltage aluminum plate to the instrument's side frame.

e. Remove the three screws that secure the quadrupler to the high-voltage aluminum plate.

f. To install a new High-voltage Quadrupler assembly, reverse the above procedure.

8-38. CATHODE-RAY TUBE. Follow the procedures below, and refer to the chassis component and location photographs in this section to remove the CRT.

WARNING

To prevent personal injury, always wear a face mask or goggles when handling the CRT. Wear protective gloves and handle carefully.

8-39. Remove the CRT as follows:

a. Remove top and side covers.

b. Using a thin-bladed screwdriver, ground the post accelerator at the CRT connection.

c. Disconnect the high-voltage lead from the CRT, and ground the lead again.

d. Disconnect wires from the CRT neck. Unsolder the trace align and orthog control wires from R13A/B and R14A/B (remove only the wires that are threaded into the CRT shield). Disconnect the shield ground lead from the rear panel.

e. Remove the CRT socket cover from the rear panel.

f. Carefully remove the CRT socket from the CRT.

g. Remove the two nuts securing the two CRT brackets to the CRT strap.

h. Remove the two CRT brackets by removing the screws securing them to the side castings.

CAUTION

Support the CRT neck when removing the top CRT strap.

i. Remove the top CRT strap by removing the nuts from the two strap bolts.

j. Move the CRT far enough to the rear to rotate the screen end upward. Remove the CRT from the chassis.

CAUTION

When removing the CRT shield, be careful that the neck pins do not catch against the coils in the shield.

k. Position the CRT neck vertically, and loosen the clamp at the base of the CRT. Carefully lift the shield off the CRT neck.

m. To install a CRT, do the following plus the reverse of the above procedure: position the shield securely against the CRT neck, align the shield cut-out with the CRT neck pin connectors, and don't over-tighten the shield clamp. Position the thickest edge of the CRT top strap toward the rear of the CRT, and align the CRT graticule with the front-panel bezel before tightening the strap. Remove the old RTV from the post accelerator connector, and replace with new RTV 891 (HP Part No. 0470-0012) supplied with new CRT.

n. Adjust the Intensity Limit, Trace Align, Orthog and High-voltage Supply adjustments as indicated in the procedure in Section V.

8-40. FAN REPLACEMENT. Use the following procedure for fan removal, and reverse the procedure for fan installation:

a. Remove the top and bottom covers.

b. Disconnect wires from fan terminals.

c. Remove transistor heat sinks from fan assembly.

d. Remove the four fan mounting bolts, and then remove fan assembly.

8-41. SERVICING ETCHED CIRCUIT BOARDS.

8-42. Circuit boards in this instrument have plated through holes with conductive surfaces on both sides. Components can be removed or replaced by unsoldering from either side of a board. When removing a large component, such as a potentiometer, rotate the soldering iron from lead to lead while pulling upward on the part. The following extract from HP Service Note M-20E is a further aid for repairing etched circuit boards:

a. Don't apply excessive heat. Use a 37 to 48 watt soldering iron.

b. Clip the leads of the damaged component. Remove the component and then unsolder the leads from the board.

c. Use a toothpick or other pointed object to clean the circuit board holes while heating with a soldering iron.

d. Shape the leads of replacement components to fit the circuit board holes. Don't use force.

e. If the metal plated conductive surface lifts from the board, cement it back with a small amount of quick-drying acetate-base cement with good insulating properties. Or, solder a wire along the damaged area.

Table 8-1. Low Voltage Power Supply Troubleshooting

Power Supply	Symptom	Possible Fault
+100V	No Output	F3, Q2 open
	+101 to 150 volts	A4Q444, or V411 open A4Q442, A4Q443, or CR445 shorted.
	0 to +99 volts	Q2, A4Q442, or A4Q443 open A4Q444 shorted.
−100V	No Output	F4 or Q3 open
	−100 to −150V	+100V supply trouble A4Q464 open
		A4Q463, A4Q462, or Q3 shorted
	0 to −99V	+100V supply trouble A4Q464 shorted
		A4Q463 or A4Q462 open
+250V	No Output	F2 or Q1 open
	+256 to 300V	+100V or −100V supply trouble A4Q423 or CR426 open A4Q422 or Q1 shorted
	0 to 249V	+100V or −100V supply trouble A4Q423 or CR426 shorted A4Q422 open
−12.6V	No Output	F5 or Q4 open
	−12.7V to −15V	+100V or −100V supply trouble Q4 or A4Q482 shorted A4Q484 open
	0 to −12.4V	+100V or −100V supply trouble A4Q482 open A4Q483 or A4Q484 shorted
+15V	No Output	A5F1 or Q5 open
	+15V to +30V	+100V or −100V supply trouble Q5 or A5Q1 shorted A5Q2 open
	0 to +14V	+100V or −100V supply trouble A5Q1 or A5Q2 shorted.

Table 8-2. High Voltage Power Supply Troubleshooting

Symptom	Possible Fault	Check
No High Voltage	+15V, +100V, or −100V power supply malfunction	Check A1 input voltages
	A1Q1, Q2, Q3, Q4, or CR3 open	Check DC voltages on A1.
−2850V to −3300V	Feedback loop open	Check feedback circuit on boards A1 and A2.
	A1Q1, Q2, or Q3 shorted	Check DC voltages on board A1.
0 to −2850V	A1CR1, CR2, Q1, Q2, Q3 open	Check DC voltages on board A1.

Table 8-3. Symbols and Conventions

Refer to MIL-STD-15-1A for schematic symbols not listed in this table.

= Etched circuit board

= Front panel marking

= Rear panel marking

= Front panel control

= Screwdriver adjustment

P/O = Part of

CW = Clockwise end of variable resistor

N C = No connection

= Waveform test point (with number)

= Common electrical point (with letter) not necessarily ground

= Single pin connector on board

= Pin of a plug-in board (with letter or number)

= Main signal path

= Primary feedback path

= Secondary feedback path

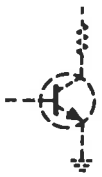
* = Optimum value selected at factory, average value shown; part may have been omitted.

= Field effect transistor (N-channel)

= Breakdown diode

= Tunnel diode

= Step recovery diode



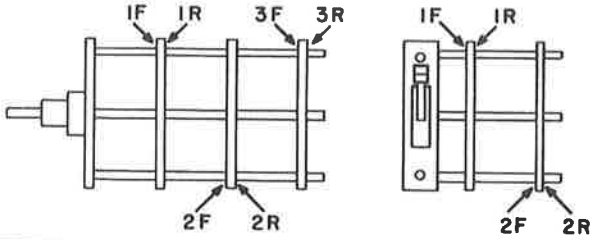
= Circuits or components drawn with dashed lines (phantom) show function only and are not intended to be complete. The circuit or component is shown in detail on another schematic.

Unless otherwise indicated:
resistance in ohms
capacitance in picofarads
inductance in microhenries

Wire colors are given by numbers in parentheses using the resistor color code [(925) is wht-red-grn].

0 - Black	5 - Green
1 - Brown	6 - Blue
2 - Red	7 - Violet
3 - Orange	8 - Gray
4 - Yellow	9 - White

Switch wafers are identified as follows:



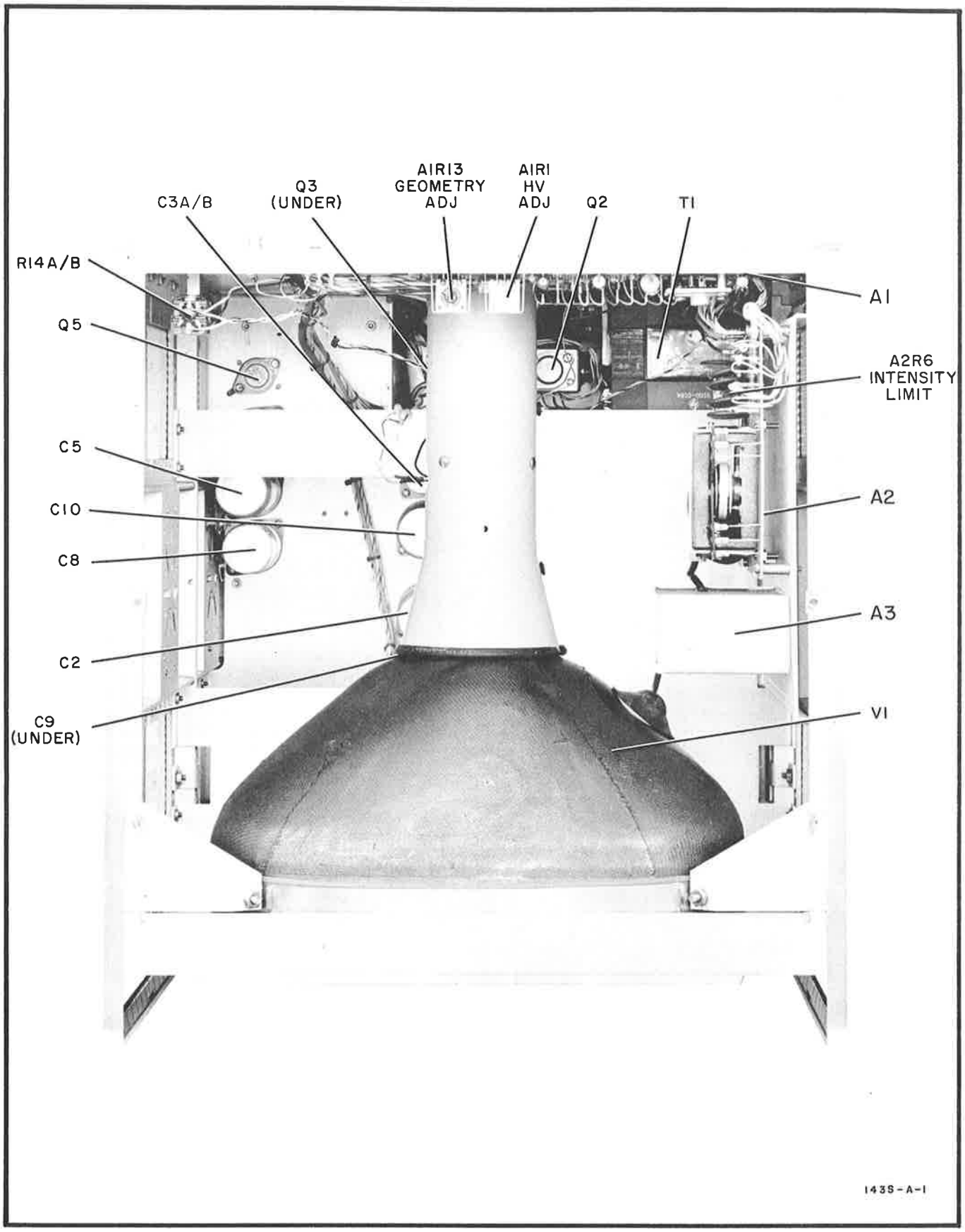


Figure 8-1. Chassis Components and Assembly Locations, Top View

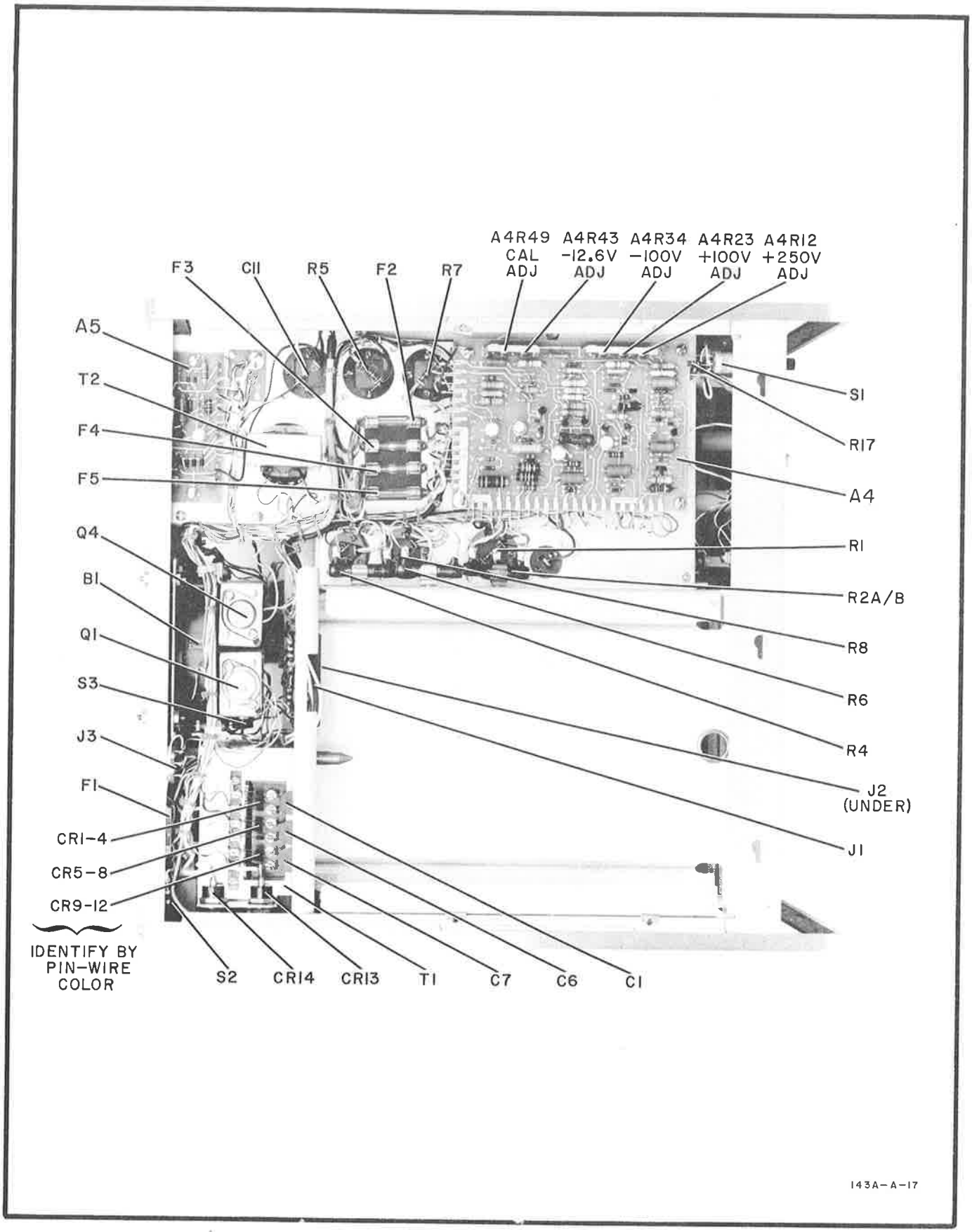


Figure 8-2. Chassis Components and Assembly Locations, Bottom View

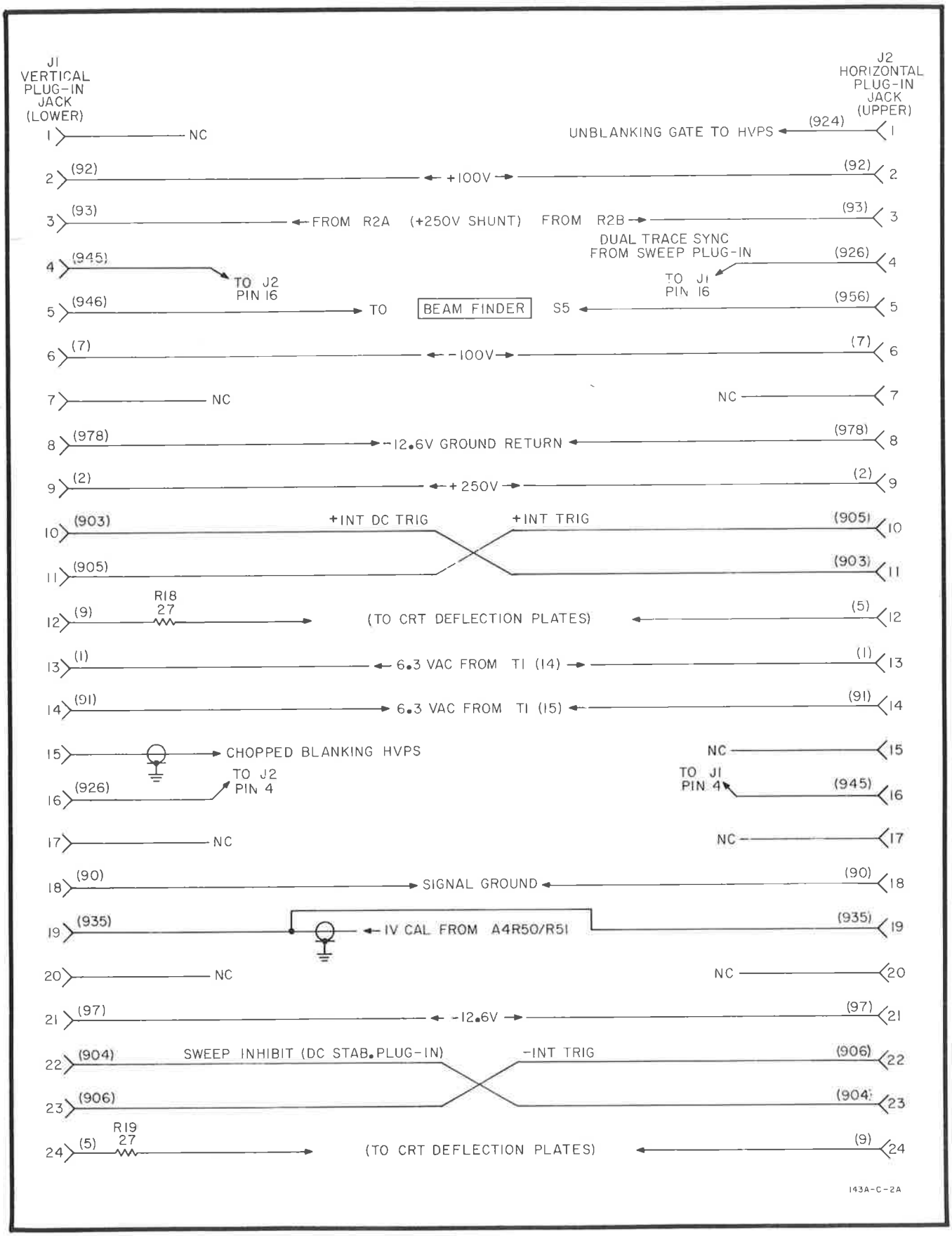
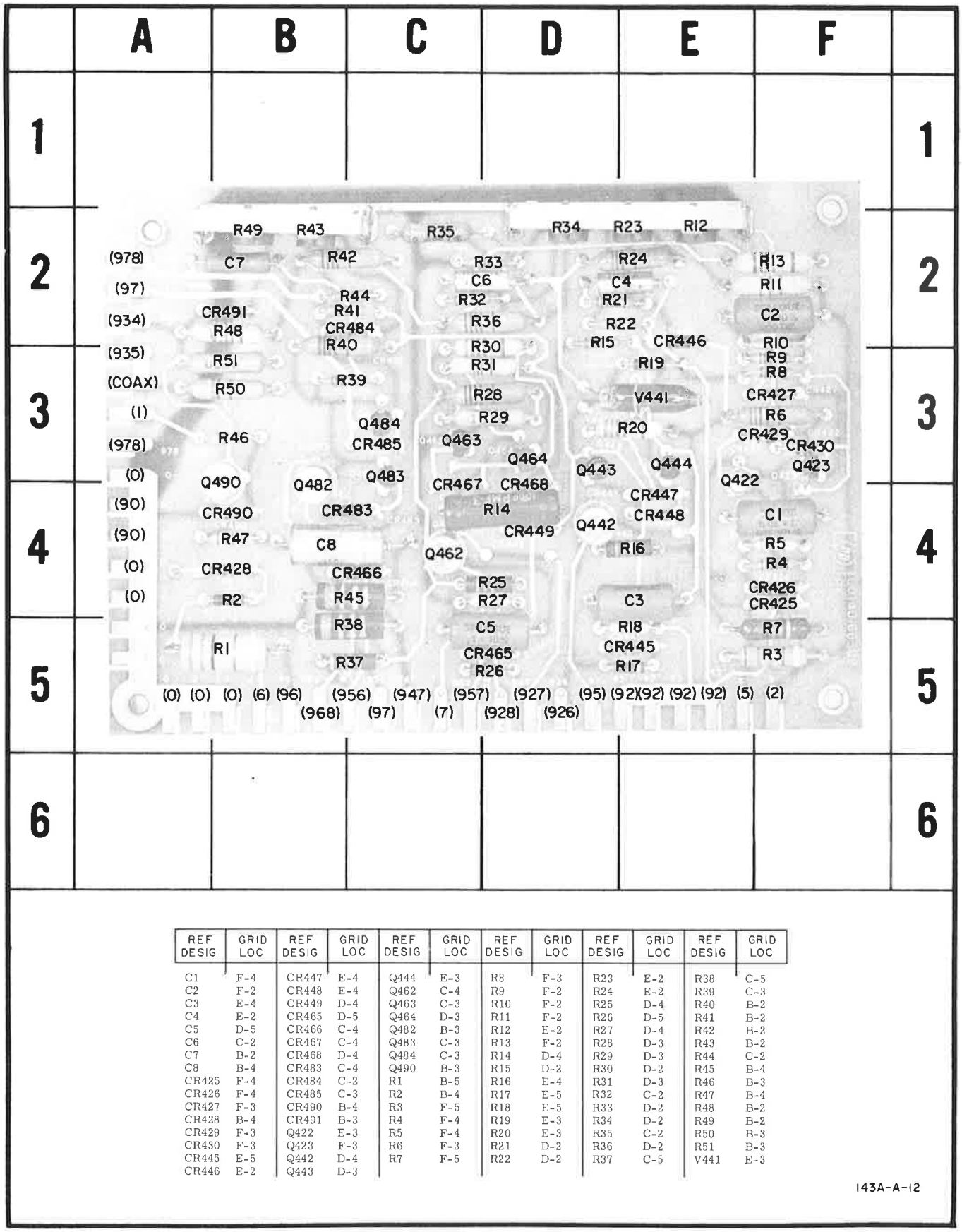


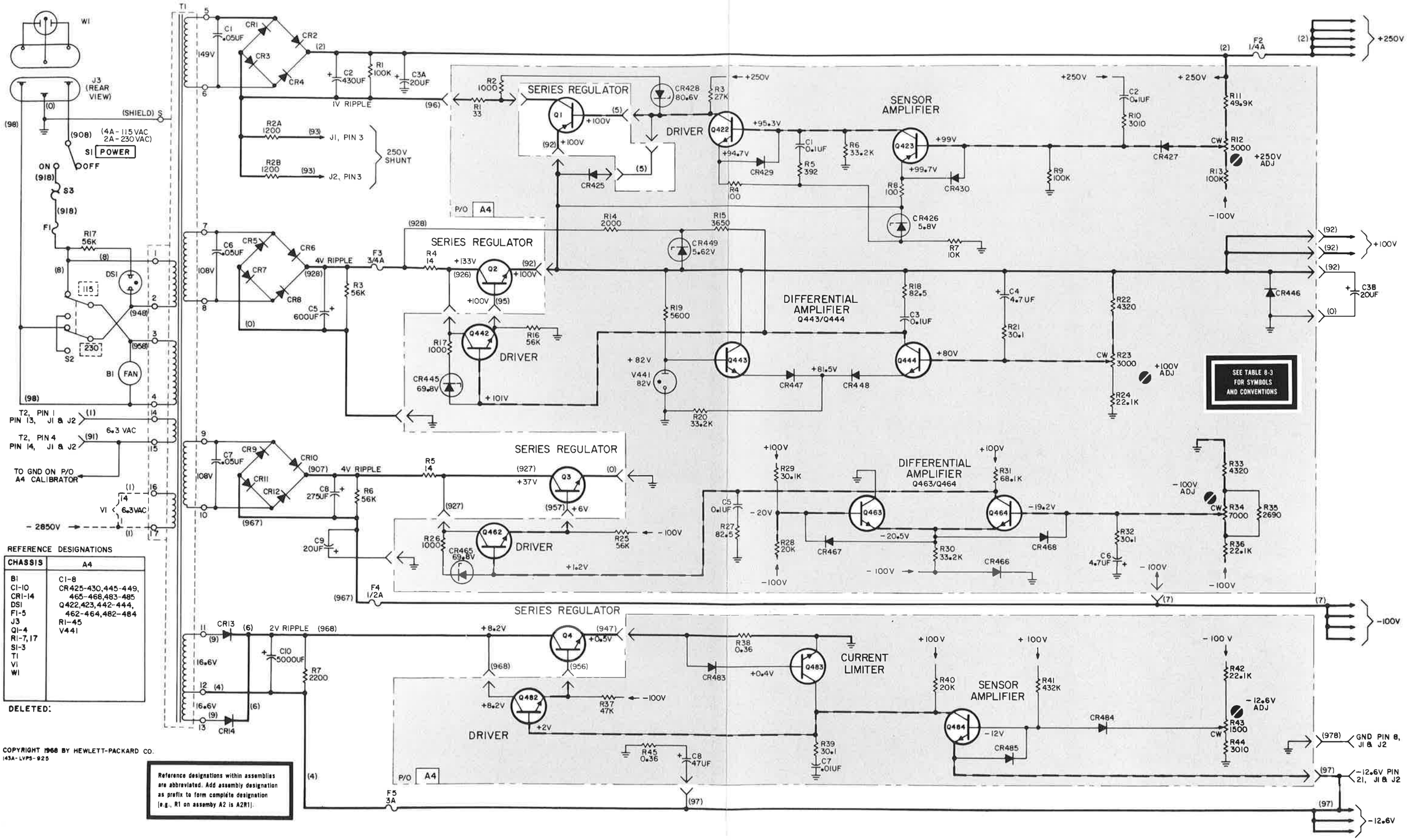
Figure 8-3. Plug-in Jack Connections



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	F-4	CR447	E-4	Q444	E-3	R8	F-3	R23	E-2	R38	C-5
C2	F-2	CR448	E-4	Q462	C-4	R9	F-2	R24	E-2	R39	C-3
C3	E-4	CR449	D-4	Q463	C-3	R10	F-2	R25	D-4	R40	B-2
C4	E-2	CR465	D-5	Q464	D-3	R11	F-2	R26	D-5	R41	B-2
C5	D-5	CR466	C-4	Q482	B-3	R12	E-2	R27	D-4	R42	B-2
C6	C-2	CR467	C-4	Q483	C-3	R13	F-2	R28	D-3	R43	B-2
C7	B-2	CR468	D-4	Q484	C-3	R14	D-4	R29	D-3	R44	C-2
C8	B-4	CR483	C-4	Q490	B-3	R15	D-2	R30	D-2	R45	B-4
CR425	F-4	CR484	C-2	R1	B-5	R16	E-4	R31	D-3	R46	B-3
CR426	F-4	CR485	C-3	R2	B-4	R17	E-5	R32	C-2	R47	B-4
CR427	F-3	CR490	B-4	R3	F-5	R18	E-5	R33	D-2	R48	B-2
CR428	B-4	CR491	B-3	R4	F-4	R19	E-3	R34	D-2	R49	B-2
CR429	F-3	Q422	E-3	R5	F-4	R20	E-3	R35	C-2	R50	B-3
CR430	F-3	Q423	F-3	R6	F-3	R21	D-2	R36	D-2	R51	B-3
CR445	E-5	Q442	D-4	R7	F-5	R22	D-2	R37	C-5	V441	E-3
CR446	E-2	Q443	D-3								

143A-A-12

Figure 8-4. Low-voltage Power Supply, A4, Component Identification



REFERENCE DESIGNATIONS

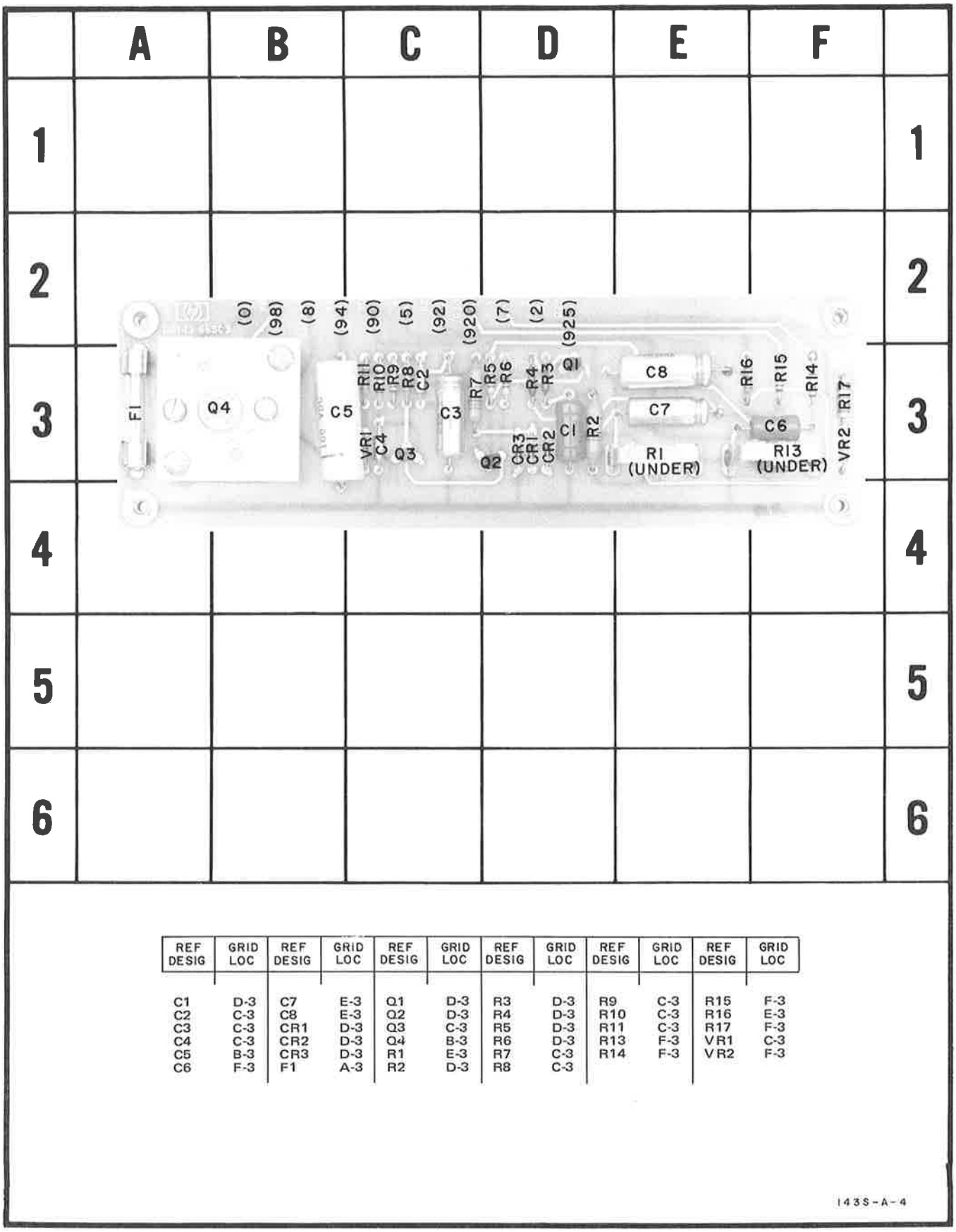
CHASSIS	A4
B1	C1-8
C1-10	CR425-430,445-449, 465-468,483-485
CR1-14	Q422,423,442-444, 462-464,482-484
DS1	R1-45
F1-5	V441
J3	
Q1-4	
R1-7,17	
S1-3	
T1	
V1	
W1	

DELETED:

143A-LVPS-925

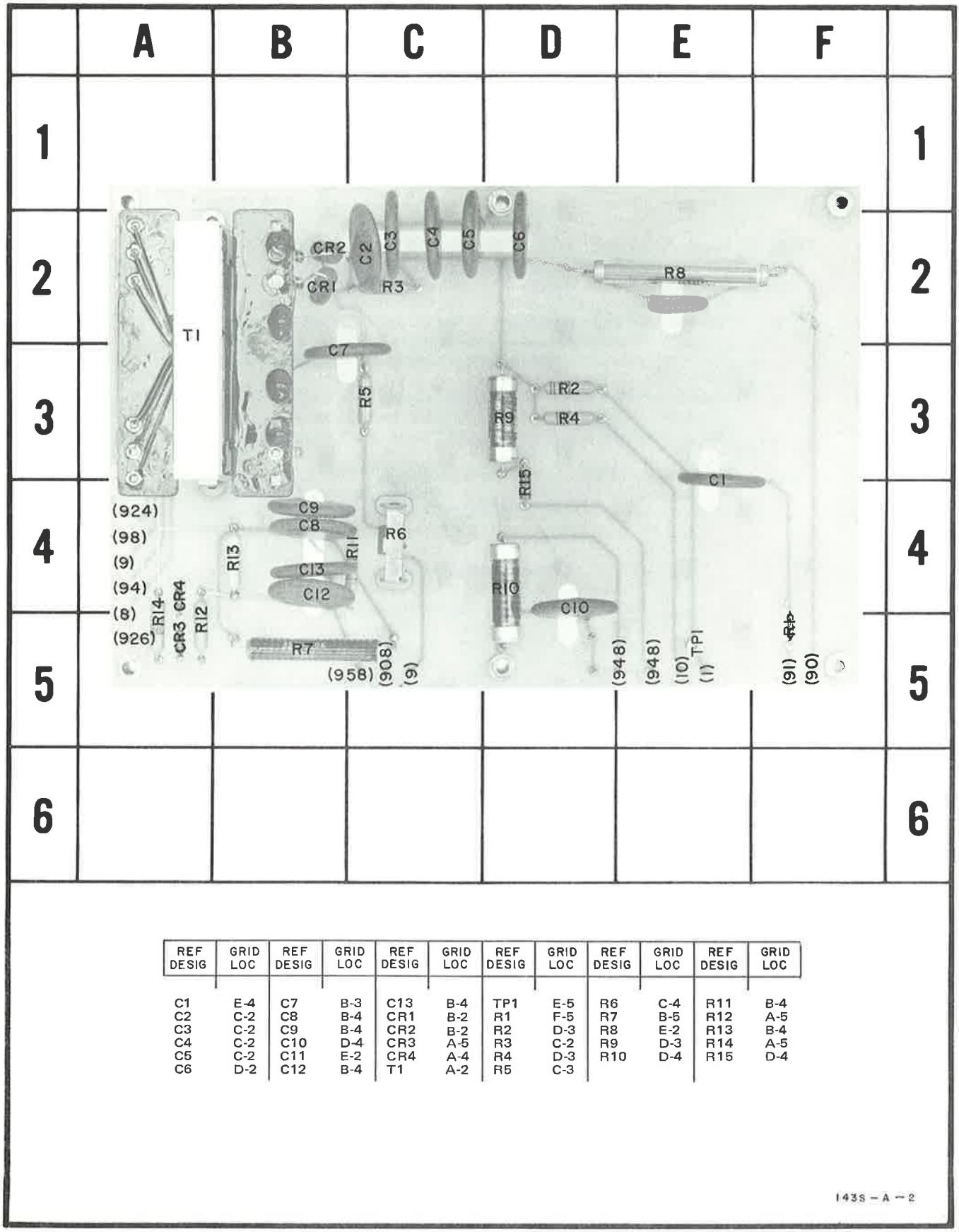
Reference designations within assemblies are abbreviated. Add assembly designation as prefix to form complete designation [e.g., R1 on assembly A2 is A2R1].

Figure 8-5. Low-voltage Power Supply Schematic



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	D-3	C7	E-3	Q1	D-3	R3	D-3	R9	C-3	R15	F-3
C2	C-3	C8	E-3	Q2	D-3	R4	D-3	R10	C-3	R16	E-3
C3	C-3	CR1	D-3	Q3	C-3	R5	D-3	R11	C-3	R17	F-3
C4	C-3	CR2	D-3	Q4	B-3	R6	D-3	R13	F-3	VR1	C-3
C5	B-3	CR3	D-3	R1	E-3	R7	C-3	R14	F-3	VR2	F-3
C6	F-3	F1	A-3	R2	D-3	R8	C-3				

Figure 8-8. High-voltage Regulator, A1, Component Identification



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	E-4	C7	B-3	C13	B-4	TP1	E-5	R6	C-4	R11	B-4
C2	C-2	C8	B-4	CR1	B-2	R1	F-5	R7	B-5	R12	A-5
C3	C-2	C9	B-4	CR2	B-2	R2	D-3	R8	E-2	R13	B-4
C4	C-2	C10	D-4	CR3	A-5	R3	C-2	R9	D-3	R14	A-5
C5	C-2	C11	E-2	CR4	A-4	R4	D-3	R10	D-4	R15	D-4
C6	D-2	C12	B-4	T1	A-2	R5	C-3				

Figure 8-9. High-voltage Rectifier, A2,
Component Identification

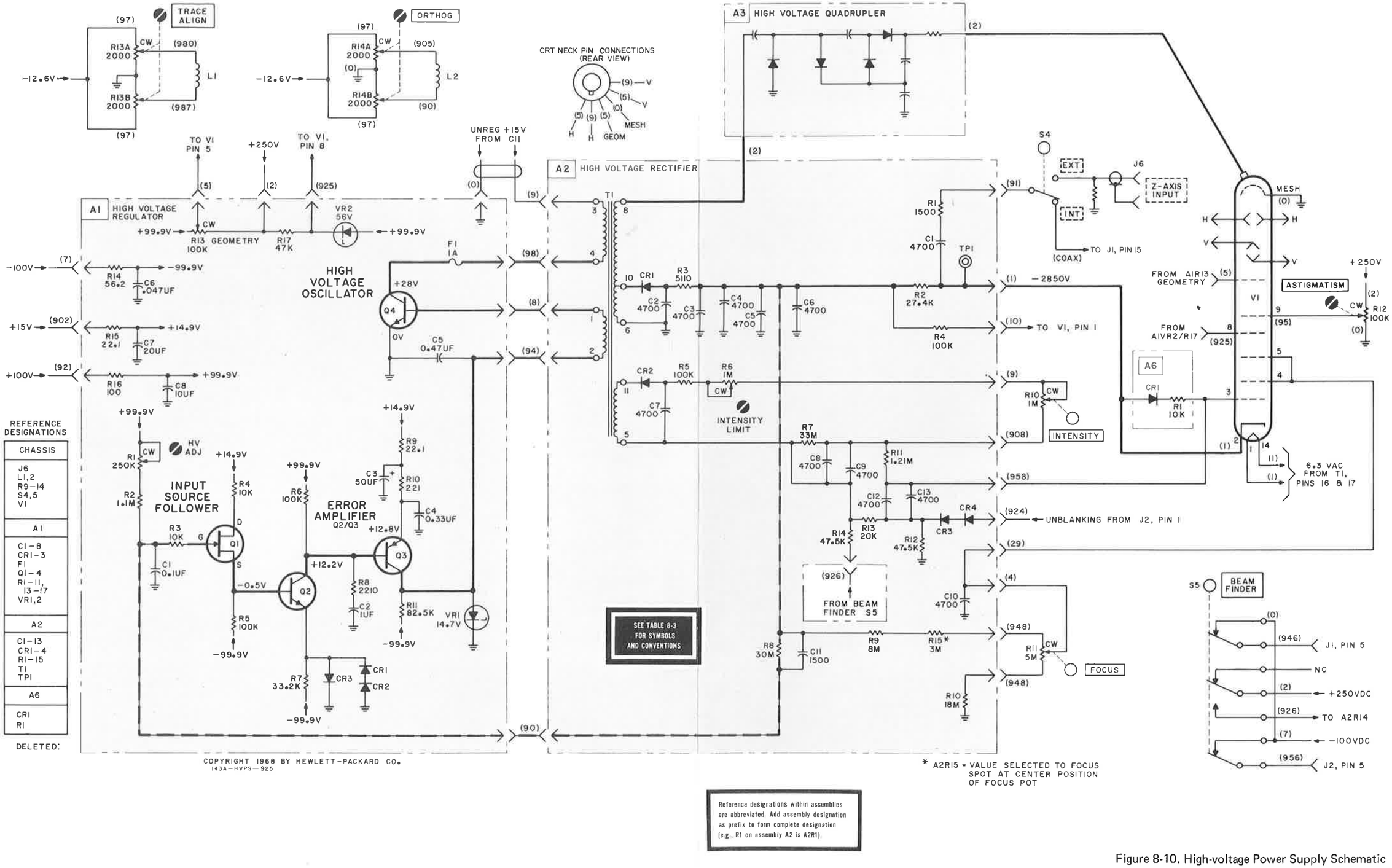


Figure 8-10. High-voltage Power Supply Schematic

CATHODE-RAY TUBE WARRANTY

The cathode-ray tube (CRT) supplied in your Hewlett-Packard Oscilloscope and replacement CRT's purchased from hp are warranted by the Hewlett-Packard Company against electrical failure for a period of one year from the date of sale. Broken tubes and tubes with phosphor or mesh burns are not included under this warranty. If the CRT is broken when received, a claim should be made with the responsible carrier.

Your nearest Hewlett-Packard Sales/Service Office (listed at rear of instrument manual) maintains a stock of replacement tubes and will assist in processing the warranty claim.

We would like to evaluate every defective CRT. This engineering evaluation helps us to provide a better product for you. Please fill out the CRT Failure Report on the reverse side of this sheet and return it with the defective CRT to:

Hewlett-Packard Company
1900 Garden of the Gods Road
Colorado Springs, Colorado 80907

Attention: CRT QA

To avoid damage to the tube while in shipment, please follow the shipping instructions below; warranty credit is not allowed on broken tubes.

SHIPPING INSTRUCTIONS

It is preferable that the defective CRT be returned in the replacement CRT carton. If the carton or packaging material is not available, pack the CRT according to the instructions below:

1. Carefully wrap the tube in 1/4 inch thick cotton batting or other soft padding material.
2. Wrap the above in heavy kraft paper.
3. Pack wrapped tube in a rigid container which is at least 4 inches larger than the tube in each dimension.
4. Surround the tube with at least 4 inches of packed excelsior or similar shock absorbing material; be sure the packing is tight all around the tube.

Thank you,

CRT Department

CATHODE-RAY TUBE FAILURE REPORT

DATE _____

FROM:

NAME _____

COMPANY _____

ADDRESS _____

1. hp INSTRUMENT MODEL NO. _____
2. hp INSTRUMENT SERIAL NO. _____
3. CRT SERIAL NO. _____
4. Please describe the failure and, if possible, show the trouble on the appropriate CRT face below.

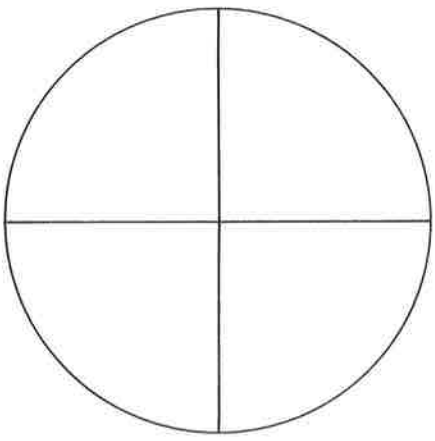
_____

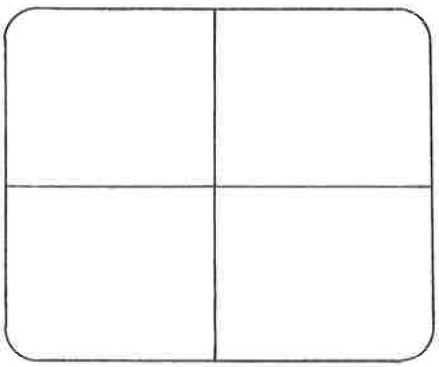
_____

_____

_____

_____





5. Is the CRT within warranty? Yes_____ No_____
6. hp Sales/Service Office _____ Repair Order No. _____

CUT ALONG DOTTED LINE

02537-4

HEWLETT hp PACKARD

00143-90903

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