

Operating and Service Manual

Oscilloscope 140B

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OPERATING AND SERVICE MANUAL

MODEL 140B OSCILLOSCOPE

SERIALS PREFIXED: 908—

See 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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Table 1-1. Specifications

PLUG-INS

Accepts Model 1400-series plug-ins. Upper compartment for horizontal axis and lower compartment for vertical axis. Center shield may be removed to accommodate a single dual-axis Model 1400-series unit.

CATHODE-RAY TUBE

Type: Post-accelerator, 7300 volt accelerating potential, aluminized P31 phosphor standard; for other phosphors, see Modifications; etched safety glass face plate reduces glare.

Graticule: 8 x 10 cm parallax-free internal graticule, marked in centimeter squares; subdivisions of 2 mm on major horizontal and vertical axes, and 10-90° lines for 6 and 8 cm display.

Intensity Modulation: AC coupled; +20 volt signal will blank trace of normal intensity; input terminals and switch on rear panel.

Writing Rate: (Using HP Model 197A Camera with f/1.9 lens and Polaroid® 3000 speed film).

P31 Phosphor: 250 cm/usec.

P11 Phosphor: 430 cm/usec.

CALIBRATOR

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

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

“Polaroid”® by Polaroid Corporation

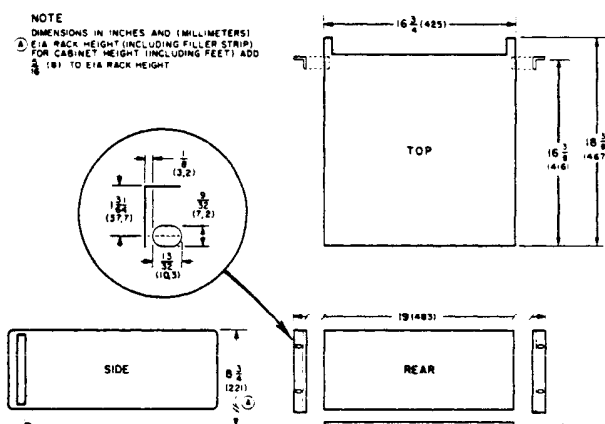
BEAM FINDER

Pressing BEAM FINDER control brings trace on CRT screen, regardless of settings of horizontal or vertical POSITION or INTENSITY controls.

GENERAL

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

Dimensions:



Weight: (without plug-ins)

Net, 37 lbs (16, 7 kg);

Shipping, 45 lbs (21 kg).

Modifications:

CRT Phosphors: (Specify by phosphor number)

P31 standard. P2, P7 and amber filter, P11 available.

SECTION I

GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The HP Model 140B, Figure 1-1, is a general purpose plug-in Oscilloscope. The deflection amplifiers are of the plug-in type and the Oscilloscope contains only the power supply, calibration, and CRT circuits. The plug-in amplifiers operate directly into the CRT, therefore the Oscilloscope characteristics depend upon the plug-ins used. Presently available plug-ins make possible high sensitivity, wide bandwidth, and single, dual, or four trace measurements in combination with normal, single, or delayed sweeps. Double-sized plug-ins are also available for special applications such as time domain reflectometry, swept frequency indication, and spectrum analysis.

1-3. The Model 140B provides power for the plug-ins and line-frequency square wave calibrating voltages of 10 volts and 1 volt peak-to-peak which are available on the front panel. The primary power switch and all CRT controls are on the Model 140B front panel, and the terminals and switch for Z-axis modulation are on the rear panel.

1-4. CATHODE-RAY TUBE.

1-5. The Model 140B has an internal graticule CRT that eliminates parallax error when observing the display. The CRT is equipped with a nonglare safety face plate.

1-6. A type P31 aluminized phosphor CRT is normally furnished with the Model 140B, however, P2 phosphor (general purpose), P7 phosphor (long persistence) with

amber filter, and P11 (fast writing rate) are also available at no extra cost.

1-7. CATHODE-RAY TUBE WARRANTY.

1-8. The CRT used in the Model 140B is covered by a warranty separate from the instrument warranty. The CRT warranty is included at the back of the manual for use in the event of CRT failure during the listed warranty period.

1-9. ASSOCIATED EQUIPMENT.

1-10. Some of the plug-ins available for the Model 140B Oscilloscope are listed in Table 1-2. The Model 140B normally is used with a vertical amplifier in the lower compartment and a sweep plug-in in the upper compartment. Arrangement of plug-ins can be selected to suit special applications; i.e. vertical amplifier and sweep plug-ins may be reversed so that the sweep is vertical and signal deflection is horizontal (minor electrical modification required--consult HP Field Engineer for details); a vertical plug-in can be used in each compartment to make X-Y measurements or two horizontal plug-ins can be used for raster displays. Double sized plug-ins such as the Model 1415A or 1416A can be inserted into the compartment after removal of the divider shield between the upper and lower compartments. Blank plug-ins, both single and double size, are available for customer fabrication of specialized amplifier and sweep plug-ins. Refer to Table 4-1 for power supply current limitations.

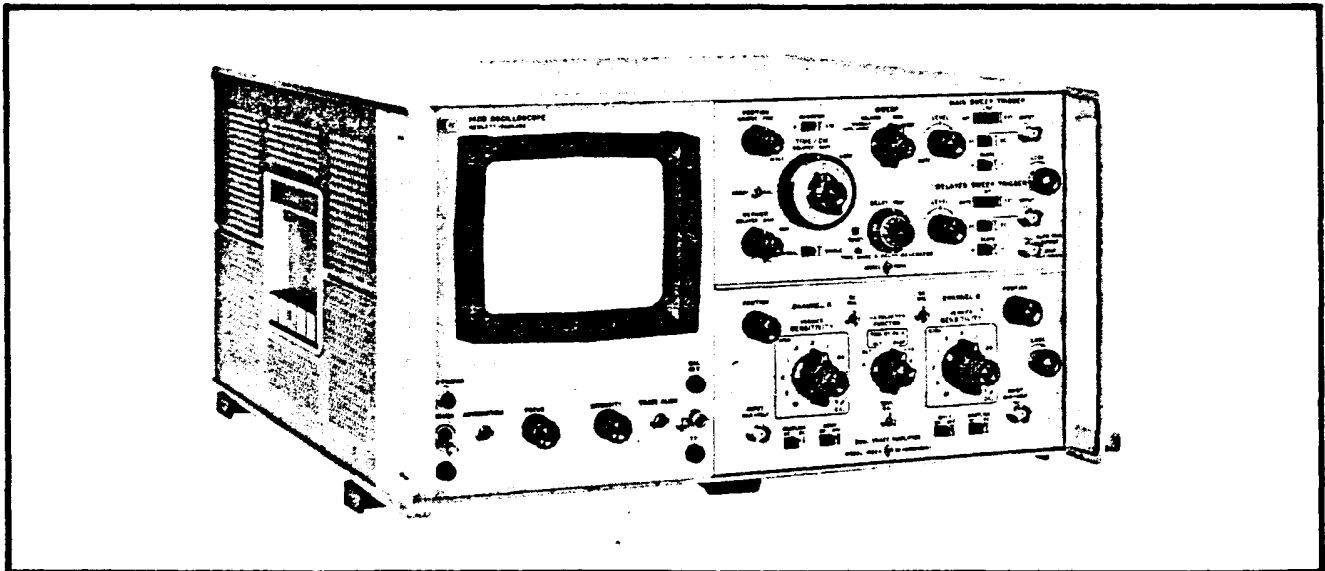


Figure 1-1. Model 140B Oscilloscope with Model 1402A Amplifier
and Model 1421A Time Base Plug-In Units

1-11. All HP Model 1400-series plug-ins can be used with the Model 140B Oscilloscope. Plug-in model numbers are grouped according to function as follows:

- a. Models 1400 to 1414 - Plug-ins normally used for vertical deflection.
- b. Models 1415 to 1419 - Double or full-sized plug-ins for special applications.
- c. Models 1420 to 1425 - Plug-ins normally used for sweep (horizontal) deflection.
- d. Models 1430 to 1432 - Sampling heads used in conjunction with sampling (vertical) plug-ins.

1-12. MANUAL IDENTIFICATION.

1-13. Information in this manual applies directly to Model 140B instruments with the serial prefix listed on the title page. The serial prefix is the first three digits of the eight digit serial number (000-0000) used to identify each

Hewlett-Packard instrument. If the serial prefix of a Model 140B is different than that on the title page, a change sheet supplied with the manual, or Section VII defines the difference between that Model 140B and the one described in this manual, or a different manual may provide the information. Corrections to this manual due to any errors which existed when the manual was printed, are called Errata and appear only on the change sheet supplied. For information pertaining to change sheets, contact the nearest Hewlett-Packard Sales/Service Office.

1-14. SCOPE OF MANUAL.

1-15. This manual supplies operating and maintenance instructions for the Model 140B Oscilloscope. This information is supplemented by the information contained in the 1400-series plug-in manuals. For operation and maintenance information of plug-in units, refer to the manual for that particular instrument.

Table 1-2. Plug-ins for Model 140B 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							
	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	
	1430A		x										x	
1431A		x										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	x			
	1424A		x		x						x		x	
	1425A		x		x			x			x		x	
DOUBLE SIZE PLUG-INS	1415A 1416A											x		x
BLANK PLUG-INS	10477A 10478A	Single-size for special purpose circuit. Double-size for special purpose circuit.												
SPECTRUM ANALYZER	8552A/ 8553L	Fixed or variable scan spectrum analysis.												

* Check latest literature for additional new plug-ins

** Time Domain Reflectometry.

SECTION II

INSTALLATION

2-1. INITIAL INSPECTION.

2-2. **MECHANICAL CHECK.** If external damage to the shipping carton is evident, ask the carrier's agent to be present when the instrument is unpacked. Check the instrument for external damage such as broken controls or connectors, and dents or scratches on the panel surface. If damage is evident, see Paragraph 2-23 for recommended claim procedure and repackaging information. If the shipping carton is not damaged, check the cushioning material and note any signs of severe stress as an indication of rough handling in transit. If the instrument appears undamaged, perform the electrical check (see Paragraph 2-3).

2-3. **ELECTRICAL CHECK.** Check the electrical performance of the Model 140B as soon as possible after receipt. Paragraphs 5-3 through 5-5 contain the performance check procedures that verify instrument operation within the specifications listed in Table 1-1. This check is also suitable for incoming quality control inspection. If the Model 140B does not perform within the specifications when received, refer to Paragraph 2-23 for recommended claim procedure and repackaging information.

2-4. PREPARATION FOR USE.

2-5. POWER REQUIREMENTS.

2-6. The Model 140B Oscilloscope requires a power source of either 115 or 230 volts ac, $\pm 10\%$, single phase, 50 to 60 Hz which can deliver approximately 300 watts. A rear panel switch provides selection of the line voltage to be used.



Be sure to set the rear panel switch for the line voltage to be used. The power supplies may be damaged if the switch is set to the wrong position.

2-7. 230 VOLT OPERATION.

2-8. If the instrument is to be operated from a 230-volt source, set the rear panel switch to 230. The line fuse, F401, is accessible by removing the bottom cover of the Model 140B. Remove the 4-amp slow-blow fuse and install a 2-amp 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. The Model 140B 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 the Model 140B from a two-contact outlet, use a three-conductor to two-conductor adapter and connect the green lead on the adapter to ground at the power outlet.

2-11. COOLING.

2-12. VENTILATION REQUIREMENTS.

2-13. The Model 140B uses forced-air cooling to maintain reasonable 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. When operating the Model 140B select a location that provides at least three inches of clearance around the rear and both sides of the instrument.

2-14. FAN AND AIR FILTER.

2-15. The fan requires periodic lubrication and the air filter should be cleaned, as required, to prevent clogging and restriction of air flow. Refer to Paragraph 8-20 for lubricating and cleaning procedures.

2-16. INSTRUMENT MOUNTING.

2-17. MODULAR CABINET.

2-18. The Model 140B is shipped from the factory as a bench instrument with the tilt stand, feet, and plastic trim in place. The top and bottom panel covers can be removed, giving complete accessibility to all adjustments. Leave space around the cabinet for air circulation.

2-19. RACK MOUNTING.

2-20. Prepare the cabinet for rack mounting as illustrated in Figure 2-1. All necessary hardware is in the shipping carton with the instrument. After preparation, lift the instrument into place, and secure the mounting flanges to the rack. Allow adequate ventilation for the instrument in the rack.

2-21. AMBER FILTER INSTALLATION.

2-22. An amber filter, HP Part No. 5020-0530, is supplied with Oscilloscopes that have a CRT with type P7 phosphor. This filter improves visibility of displays such as

single-shot or very low frequency phenomena. The filter improves the long persistency characteristics of the trace when making visual observations of this type display. Install the filter as follows:

- a. Remove front panel light shield.
- b. Position filter on bezel.
- c. Install light shield.

2-23. CLAIMS AND REPACKAGING.

2-24. If physical damage is evident, or if the instrument does not meet specifications when received, notify the carrier and the nearest Hewlett-Packard Sales/Service Office (see list at rear of manual). The Sales/Service Office

will arrange for repair or replacement without waiting for settlement of a claim with the carrier.

2-25. The original shipping carton and packaging material should be used for reshipment. The Hewlett-Packard Sales/Service Office will also provide information and recommendations about materials to be used if the original packaging material is not available or is not reusable. Materials used should include: (1) a double-walled carton (check with a freight carrier for test strength required), (2) heavy paper or sheets of cardboard to protect all instrument surfaces; use extra material around projecting parts of the instrument, (3) at least four inches of tightly packed shock-absorbing material surrounding the instrument. Close the carton securely with durable shipping tape. If the instrument is to be shipped to a Hewlett-Packard Sales/Service Office for repair, attach a tag showing owner, model, serial number and repairs required.

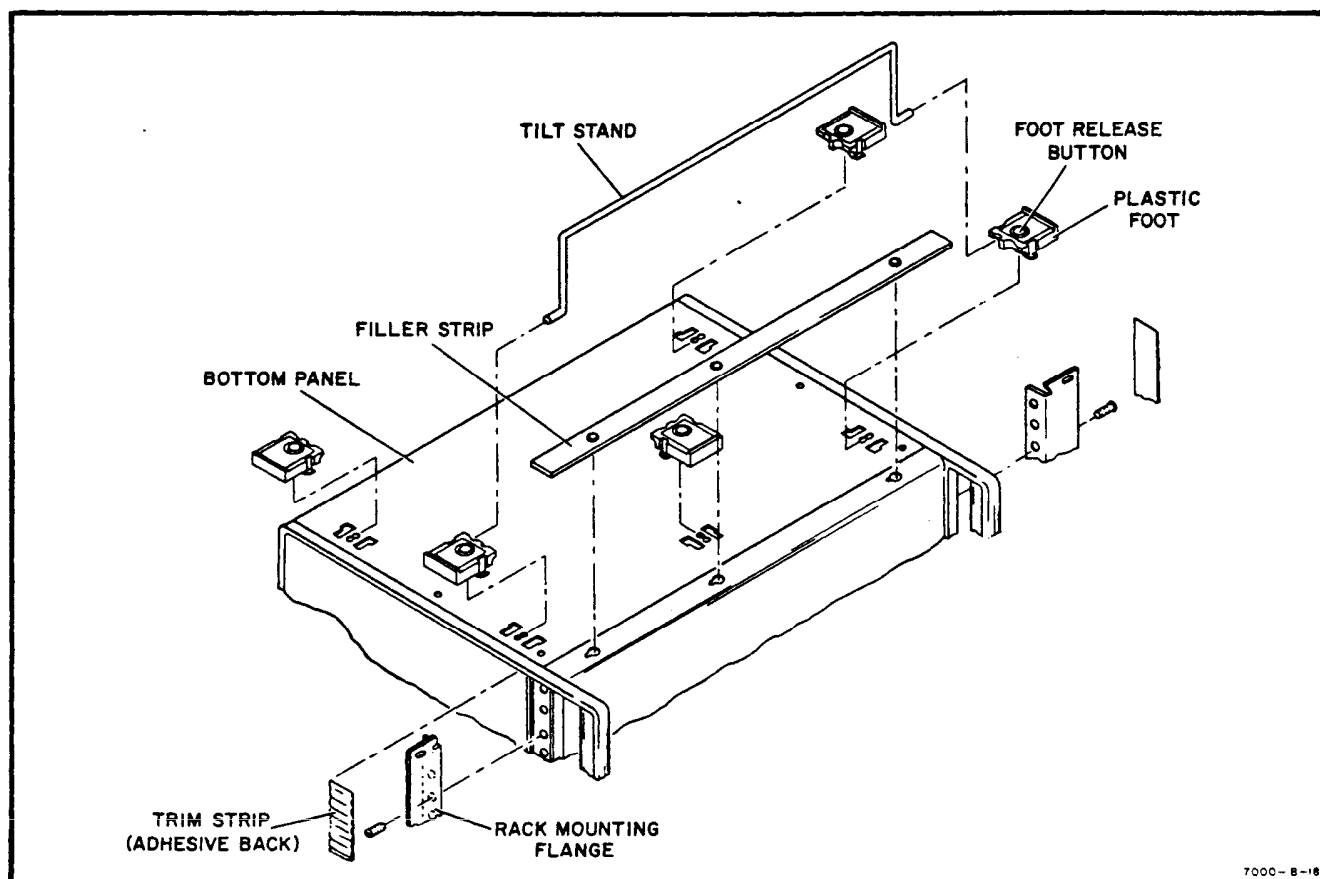


Figure 2-1. Rack Mounting Procedure

SECTION III

OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. The Model 140B Oscilloscope is a plug-in oscilloscope with a minimum number of functions on the main unit. Most of the controls are located on the plug-in units, and therefore detailed operating instructions are in the plug-in unit manuals. The Model 140B includes the cathode-ray tube with associated controls, power supplies, and a calibrator which is used for vertical-sensitivity and sweep-time calibration as well as probe compensation.

3-3. CONTROLS AND INDICATORS.

3-4. FRONT PANEL.

3-5. Figure 3-1 identifies the front panel controls, indicators, and terminals, and provides a short functional description.

3-6. BEAM FINDER OPERATION. Frequently the CRT trace can be driven off the CRT screen by excessive DC input levels or by misadjustment of plug-in position or balance controls. When the BEAM FINDER switch is pressed, the beam is intensified and confined to the CRT screen. If the trace is centered with the position and/or balance control while the BEAM FINDER is pressed (refer to plug-in manual for specific instruction), the trace will remain on screen when the BEAM FINDER is released. To prevent phosphor damage, instruments supplied with a P11 phosphor CRT do not intensify the beam when BEAM FINDER is pressed.

NOTE

At high amplifier sensitivities, a further slight adjustment of the balance control may be necessary. Failure of the BEAM FINDER to bring the trace on screen may generally be attributed to unusually high DC signal input. It should also be noted that when single-sweep operation is used with a time base plug-in, the spot at the end of a single sweep is blanked by termination of the gate.

3-7. TRACE ALIGN ADJUSTMENT. To compensate for slight manufacturing tolerances and external magnetic disturbances, a front panel screwdriver adjustment is provided to align the trace with the graticule. Check trace alignment after moving the instrument to a new operating location.

3-8. ASTIGMATISM ADJUSTMENT. To provide uniform focus of the trace over the display area, the

ASTIGMATISM control, a front panel screwdriver adjustment, is used in conjunction with the FOCUS control. For correct adjustment, adjust both FOCUS and ASTIGMATISM for sharpest display of signal. Because different plug-ins apply different DC potentials to the deflection plates, it is usually necessary to readjust ASTIGMATISM whenever plug-ins are changed.

3-9. REAR PANEL.

3-10. 115/230. This switch, located at the bottom of the rear panel, must be set to the correct line voltage before plugging the power cable into the service outlet.

3-11. Z-AXIS INPUT. The Z-AXIS INPUT terminals and selector switch are located on the instrument rear panel. To externally modulate the trace intensity, set selector switch to EXT, and apply modulating signal to Z-AXIS INPUT terminals. The pulse amplitude required to blank the trace depends upon the level of beam intensity, and is about 20 volts positive for average intensities. Conversely, a negative pulse can be applied to the Z-AXIS INPUT to intensify the trace. When not using the terminals, be sure that the ground strap is in place. When the oscilloscope is used with a dual channel plug-in, set the selector switch to the INT position. This connects the chopped blanking pulse to the CRT cathode so that switching transients are blanked when the plug-in is used in the chopped mode of operation.

3-12. PLUG-IN UNITS.

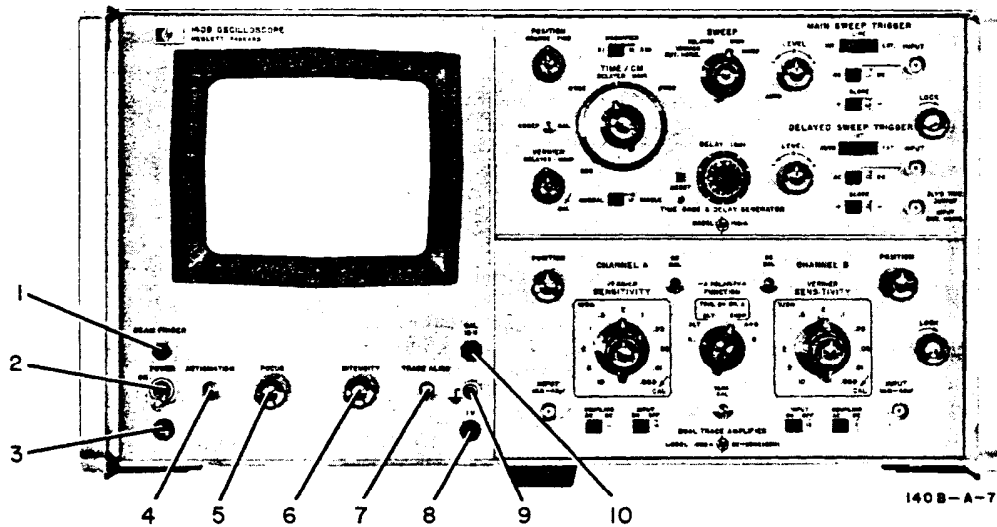
3-13. INSTALLATION. Insert vertical amplifier (or other unit desired to produce vertical deflection) into the lower compartment, and lock in place. Insert a time base plug-in (or amplifier) into upper compartment, and lock in place. For double-sized plug-ins, remove the dividing shield, insert plug-in, and lock.

Note

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

3-14. GAIN. Because of differences in cathode-ray tube sensitivities, it is usually necessary to readjust plug-in gain when units are interchanged or moved from one Model 140B to another.

3-15. PULSE RESPONSE. The pulse response of 1402A and 1404A plug-ins must be adjusted when moved from one Model 140B to another.



1. BEAM FINDER: Returns beam to CRT screen.
2. POWER: Applies AC line power to the instrument.
3. POWER: Indicates that the instrument is on.
4. ASTIGMATISM: Controls roundness of spot.
5. FOCUS: Adjusts focus of trace.
6. INTENSITY: Controls intensity of CRT display.
7. TRACE ALIGN: Aligns trace with graticule.
8. CAL 1V: 1-volt peak-to-peak calibrating signal (line frequency square wave).
9. GROUND: Provides reference for calibrating signal.
10. CAL 10 V: 10-volt peak-to-peak calibrating signal (line frequency square wave).

Figure 3-1. Model 140B Controls

SECTION IV

PRINCIPLES OF OPERATION

4-1. OVERALL FUNCTIONAL DESCRIPTION.

4-2. Refer to the Block Diagram, Figure 4-1, for this explanation. The Model 140B Oscilloscope has three main circuits: a low-voltage supply, a high-voltage supply, and a calibrator circuit. The horizontal and vertical amplifier circuits are in the plug-in units and operate directly into the CRT.

4-3. **LOW VOLTAGE SUPPLY.** The low voltage supply uses 115 or 230 volts ac (rear panel switch), single phase, 50 - 60 Hz. Output voltages are -12.6, -100, +100, and +250 volts dc; all outputs are fused and are electronically regulated. Voltages are distributed to the high voltage supply, the calibrator circuit, and to the horizontal and vertical plug-ins. 6.3 vac is supplied from the low voltage transformer to the filament of the CRT and as a signal to the calibrator.

4-4. **CALIBRATOR.** The 6.3 vac applied to the calibrator circuit is shaped into a line frequency square wave and applied to two front panel connectors, 10 V and 1 V (peak-to-peak amplitude). The 1 volt output is also applied

internally to the vertical and horizontal plug-ins for sensitivity calibration. Accuracy of the calibrating signal is $\pm 1\%$.

4-5. **HIGH VOLTAGE SUPPLY.** A transistorized oscillator and a step-up transformer are used to generate negative and positive high voltages for the CRT. Both the +5000 volt and -2350 volt supplies are electronically regulated.

4-6. CIRCUIT DESCRIPTION.

4-7. LOW-VOLTAGE SUPPLY.

4-8. The low-voltage supply consists of: +100 volt supply, -100 volt supply, +250 volt supply and -12.6 volt supply. The +100 volt supply is independent, and provides a reference voltage for the -100 volt supply. The +250 volt and -12.6 volt supplies are referenced to the +100 and -100 volt supplies.

4-9. Figure 4-2 is a simplified block diagram of a regulator used in the low voltage supply. The series regulator acts as a variable resistance in the regulated output. A sensor (or differential amplifier) compares the output voltage to a

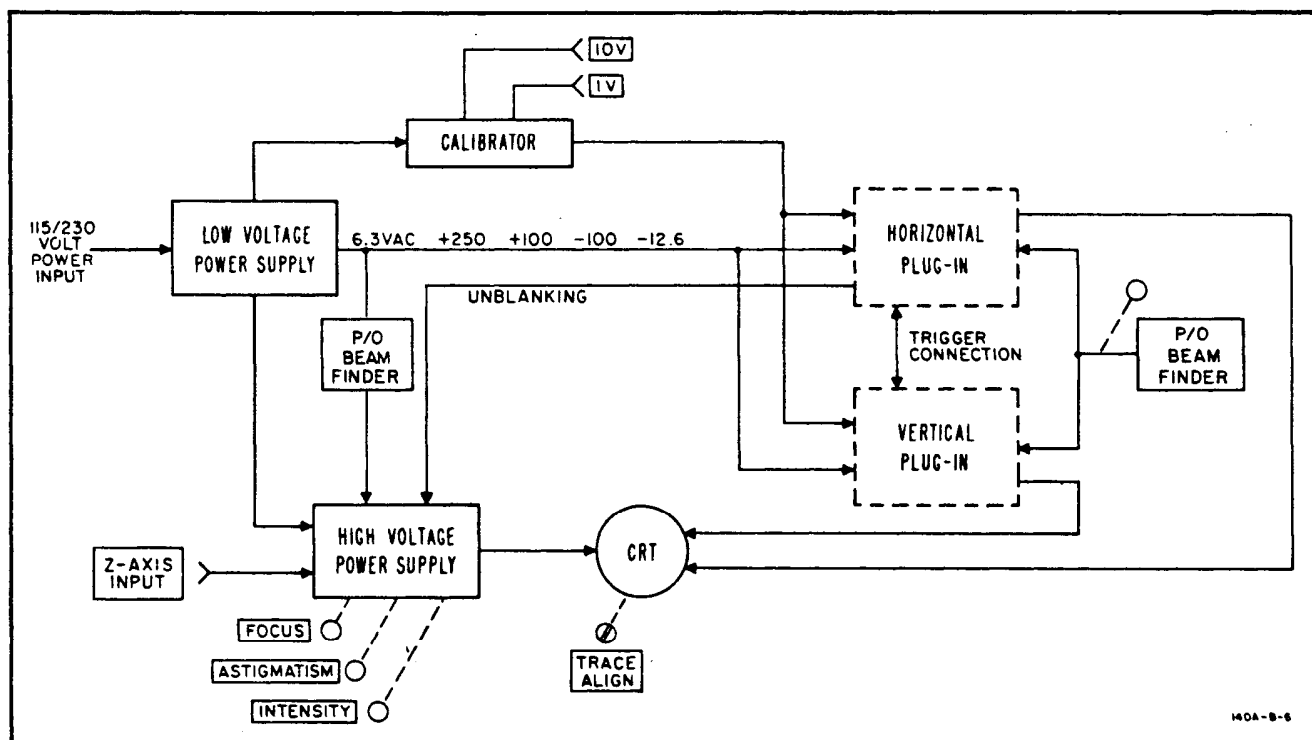


Figure 4-1. Model 140B Block Diagram

reference voltage (dc return for the supply). The driver (emitter follower or amplifier) controls the bias on the series regulator, which effectively controls the series resistance. Any change in output voltage is fed back to the series regulator. The change in series resistance and the resulting voltage drop is opposite to the output voltage change and maintains the output voltage at a constant level.

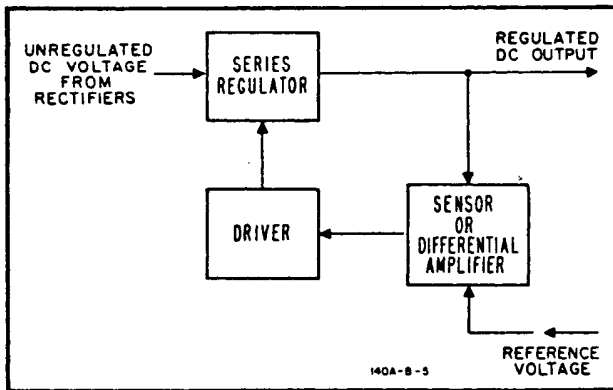


Figure 4-2. Regulated Power Supply Block Diagram

4-10. Figure 8-5 is a schematic diagram of the low voltage supply. The primary winding of transformer T401 is wired through a rear panel switch for conversion to either 115 or 230 vac operation. Line voltage is applied to the primary of T401 through an on-off switch, a fuse, and a thermal switch. A pilot lamp indicates when power is applied to T401.

4-11. + 100 VOLT SUPPLY. The ac voltage from the secondary of T401 is rectified by CR441-CR444 and partially filtered by C441 and R441. The resulting dc voltage is applied through the Series Regulator, Q441, to the output. Differential Amplifier Q443/Q444 compares the voltage across V441 with a sample of the output voltage. Any output voltage change is applied to the base of the Driver, Q442, which controls the bias of Series Regulator, Q441. Series Regulator, Q441, compensates for the change in output voltage by the change in series resistance and restores the output level to normal. The +100 volt output is adjusted by R453. Fuse F441 provides overload protection.

4-12. -100 VOLT SUPPLY. Reference voltage for the -100 volt supply is taken from the output of the +100 volt supply. The reference voltage across R467 and R473 is compared with a sample of -100 volt output across R471. The error voltage sensed by Differential Amplifier, Q463/Q464, is applied through the Driver, Q462, and Series Regulator, Q461. The Series Regulator brings the -100 volt supply back into proper balance with respect to the +100 volt supply. AC voltage from T401 is rectified by CR461-CR464, partially filtered by C461/C462/R461, and the resulting dc voltage is applied by the Series Regulator, Q461, to the -100 volt output. Regulation is obtained as in the +100 volt supply. R471 adjusts the -100 volt output and fuse F461 provides overload protection.

4-13. +250 VOLT SUPPLY. Sensor Amplifier, Q423, in the +250 volt supply senses any variation in the output voltage, with respect to -100 volts. The error voltage is amplified by Driver, Q422, which applies corrective bias to Series Regulator, Q421. R432 adjusts the +250 volt output and fuse F421 provides overload protection. CR427 provides temperature compensation for Q423 and is normally forward-biased. Two shunt resistors are connected to the +250 volt supply to reduce series regulator power dissipation when high-current plug-ins are used. The shunts are wired one to each rear panel plug and the internal wiring of the plug-in determines if the shunt is used.

4-14. -12.6 VOLT SUPPLY. Sensor Amplifier Q484, senses any variation of output voltage with respect to -100 volts and applies the error voltage to Driver Amplifier, Q482. The Driver increases signal current to the level required to control Series Regulator, Q481. The -12.6 volt output is adjusted by R488. Current Limiter, Q483, a protective circuit for the Series Regulator, is normally biased off. If an overload occurs across the -12.6 volt output, the base of Q483 goes positive by the voltage drop across R483 minus the forward voltage drop across CR483, and turns Q483 on. The decreased positive voltage on the collector of Q483 is applied through Q482 to the base of Series Regulator, Q481, reducing the current flowing through Q481. The current which then flows through the overload is limited to the current required to keep Q483 on. Additional overload protection is provided by fuse, F481.

4-15. CALIBRATOR.

4-16. The schematic diagram of the Calibrator circuit is shown in Figure 8-5. The circuit consists of three parts: a tunnel diode square wave generator, a transistor switch and a calibration network.

4-17. 6.3 volts ac is applied through R491 to tunnel diode CR490, which generates a square wave at line frequency. Transistor switch Q490 is off during the time of the positive half cycle of the square wave (when the voltage at the base is close to zero), and the collector voltage is at a level set by voltage divider R493, R495, and R496. When the negative-going portion of the square wave is applied to the base of Q490, the transistor conducts heavily, effectively shorting the collector to ground and calibrator output is zero volts. At the end of the negative input half cycle, the bias of Q490 returns to zero, the transistor is switched off, and the output returns to its previous value.

4-18. Tunnel diode bias current is supplied through R492. The bias current sets an operating level for the diode which affects the symmetry of the square wave output. Cal Adj, R494, is used to set the dc voltage at the collector of Q490 to -10 volts when the transistor is off. Breakdown diode CR491 reduces the output impedance, and provides temperature compensation for the circuit. Voltage divider R495/R496 reduces the 10 volt output to 1 volt. Both 10 and 1 volt outputs are available on the front panel and the 1 volt output is wired to both plug-in jacks.

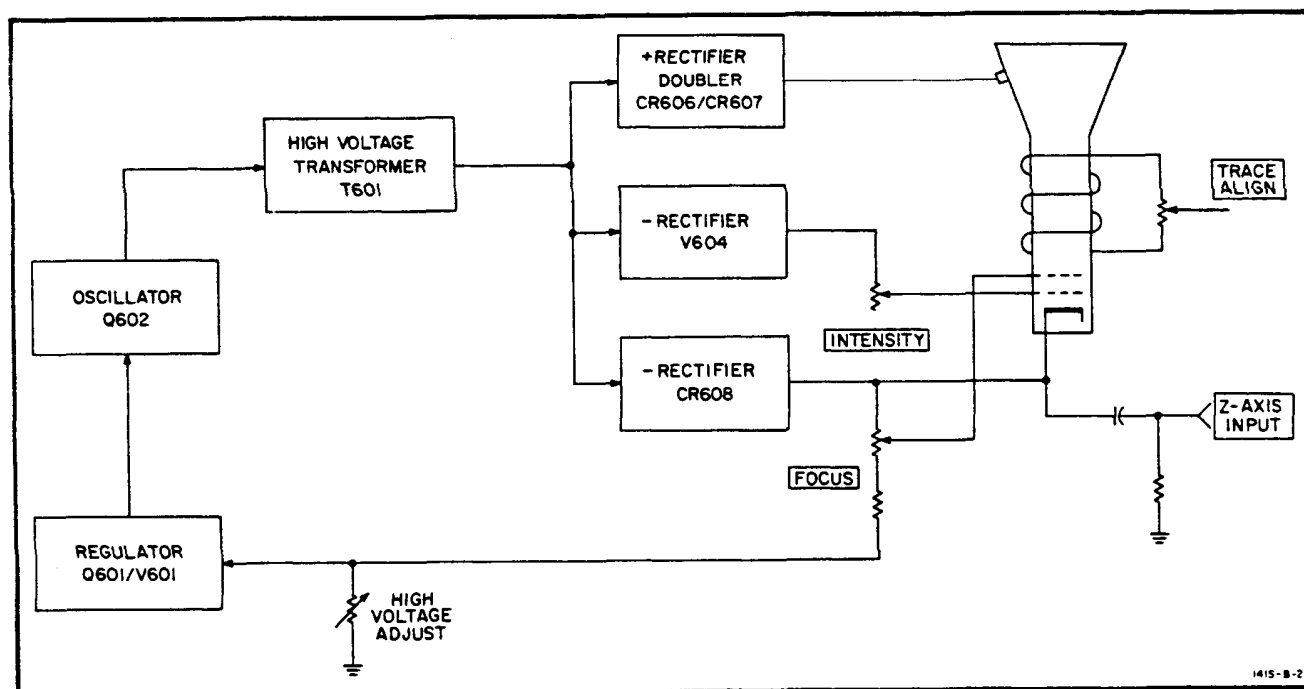


Figure 4-3. High-Voltage Power Supply Block Diagram

4-19. HIGH-VOLTAGE SUPPLY.

4-20. Figure 4-3 is a block diagram of the high voltage supply. The output of a regulated transistor oscillator is stepped up in voltage and applied to a series of high voltage rectifiers. The positive output of the voltage doubler is connected to the CRT post-accelerator. The negative output voltages are used in the gun assembly of the CRT and the associated controls. The Z-axis input can be used to apply intensity modulating signals to the CRT.

4-21.. Figure 8-9 is a schematic diagram of the high voltage supply and the CRT. Oscillator Q602 operates at a frequency of approximately 32 kHz. Any change in the output voltage is applied to the grid of V601, which converts the voltage change to a current change. This current change is applied by Emitter Follower, Q601, to the base of the oscillator transistor. The amplitude of oscillations is changed in a direction to oppose the original output voltage change. High Voltage Adjust, R619, sets the amplitude of oscillation to produce the correct output voltage.

4-22. Two separate negative supplies are used, one for the CRT control grid, and one to provide CRT cathode and focusing voltages. Both supplies use half wave rectifiers (V604 and CR608). The focusing voltage is derived from a resistive voltage divider connected to the -2350 V cathode supply. The unblanking gate from the horizontal plug-in (pin 1, J2) is applied to the return side of the grid supply, and changes the negative grid voltage by about +50 volts to unblank the trace. A positive pulse of about 20 volts will blank the trace when applied to Z-axis input. When Z-axis input is not used, set S601 to INT to receive chopped blanking from a dual-trace plug-in.

4-23. The Rectifier Doubler circuit, CR606/CR607,

provides the 5-kv CRT post-accelerating voltage.

4-24. The ASTIGMATISM adjustment, R641, adjusts the roundness of the spot, and the Geometry adjustment, R643, is used to adjust pattern shape.

4-25. TRACE ALIGN.

4-26. The Trace Align coil, L602, is located around the CRT neck near the screen. Adjustment of Trace Align, R650A/B, changes the magnitude and direction of current through the coil, rotates the trace, and aligns it with the CRT graticule.

4-27. PLUG-IN KIT FABRICATION.

4-28. The HP Model 10477A and Model 10478A Accessory Plug-ins are blank plug-in units for the Model 140B-Series Oscilloscope. These two units permit the user to design his own special-purpose circuits. Current available from each power supply is listed in Table 4-1. Circuit power requirements should not exceed the capabilities in the table.

Table 4-1. Current Capability

Supply Voltage and J1/J2 pin number		Current Available At Each Jack (J1 and J2)
+250 vdc	9	0-50 ma
+250 vdc	9	50-100 ma (pin 2 must be wired to pin 3 in the plug-in.)
+100 vdc	2	137.5 ma
-100 vdc	6	10-200 ma
-12.6 vdc	21	0-0.9 amp
6.3 vac	13-14	0-3.25 amp

Table 5-1. Recommended Test Equipment

Recommended Instrument	Model	Required For	Ref Para	Required Characteristics
Voltmeter Calibrator	HP 738AR or 738BR	Calibrator check; High Voltage Adjustment Calibrator Adjustment	5-5 5-13 5-17	Outputs of 1 V and 10 V pk-pk; -300 V DC; $\pm 0.2\%$
DC Voltmeter	HP 412A	Low- Voltage Adjustment	5-11	-100 to +250 volts, $\pm 1\%$
DC VTVM	HP 410B	High-Voltage Adjustment	5-13	May be adapted for high voltage (-2500 volts $\pm 3\%$) measurement. Provision for changing calibration.
Voltage Divider	HP 11044A	High-Voltage Adjustment	5-13 5-13	Provide 100:1 division for vtm (item 3); 2500 volts rating.
Audio Oscillator	HP 200CD	Geometry Adjustment	5-16	400 kHz $\pm 2\%$ 600 ohms output impedance

SECTION V

PERFORMANCE CHECK AND ADJUSTMENTS

5-1. INTRODUCTION.

5-2. This section contains the Performance Check and Adjustment Procedures for the Model 140B. Troubleshooting, schematics, and component identification information are in Section VIII.

5-3. PERFORMANCE CHECK.

5-4. CRT CONTROLS.

a. Install a single large plug-in or two small plug-in units in the Model 140B (vertical plug-in in the lower compartment, horizontal in the upper compartment).

b. Set controls as follows:

POWER ON
AMPLIFIER coupling (if present) AC
POSITION controls Centered

c. If a time base plug-in is being used, set controls as follows:

SWEEP TIME 1 MSEC/CM
TRIGGER SOURCE +INT
LEVEL FREE RUN
NORMAL/SINGLE NORMAL

d. A trace should be on screen. If necessary, turn INTENSITY control clockwise.

e. Remove trace from screen with POSITION controls. Press BEAM FINDER. The trace should return to screen.

f. The INTENSITY control should change the intensity of the display from extinguished to brighter than normal intensity.

g. The FOCUS and ASTIGMATISM controls should defocus the display at the extreme of each control, and focus the display at approximately midrange. Adjust FOCUS and ASTIGMATISM for sharpest over-all display.

h. Adjust TRACE ALIGN to set the trace parallel to the horizontal graticule lines. If the horizontal plug-in is not a time base, connect the calibrator output signal to the horizontal amplifier input to produce a straight-line trace.

5-5. CALIBRATOR.

a. Set Plug-in controls as follows:

Vertical SENSITIVITY 0.20 V/CM
INPUT coupling DC

b. Connect 1 VOLT P-P from the Voltmeter Calibrator to vertical INPUT.

c. Adjust vertical SENS. CAL for exactly 5 cm deflection.

d. Disconnect the Voltmeter Calibrator and connect the 1V CALIBRATOR output to the vertical INPUT.

e. Deflection should be 5 cm \pm 0.1 cm.

f. Repeat steps a through e, using 2.0 V/CM vertical SENSITIVITY, 10 volts from the Voltmeter Calibrator, and the 10 V calibrator output.

5-6. ADJUSTMENTS.

5-7. The following paragraphs (5-11 through 5-17) give a complete adjustment procedure for the Model 140B Oscilloscope. A condensed adjustment procedure is in Table 5-3. If difficulty is encountered in making any adjustment, refer to Section VIII for troubleshooting procedures.

5-8. EQUIPMENT NEEDED FOR ADJUSTMENTS. Test equipment recommended for the adjustment procedure is listed in Table 5-1. Similar instruments having the listed characteristics may be substituted.

5-9. LOCATION OF ADJUSTMENTS. Figure 5-1 shows the location of internal adjustments in the Model 140B.

5-10. PRELIMINARY PROCEDURE. Plug-ins should be installed in both compartments whenever power supply voltage adjustments or measurements are made; proper regulation may not occur if insufficient loading is provided. Set line voltage to 115 volts (230 volts if the 115/230 volt switch is in the 230-volt position).

5-11. ADJUSTMENTS OF LOW-VOLTAGE SUPPLIES.

5-12. Measure the output of each low-voltage supply, and adjust to the value in Table 5-2 (adjust in sequence given). Measurement may be made on any wire with the indicated color code. Paragraph 8-8 gives allowable ripple.

Table 5-2. Low-Voltage Adjustments

Supply (Volts)	Wire Color Code	Adjustment
+100	White/Red (92)	+100 V Adj R453
-100	Violet (7)	-100 V Adj R471
-12.6	White/Violet (97)	-12.6 V Adj R488
+250	Red (2)	+250 V Adj R432

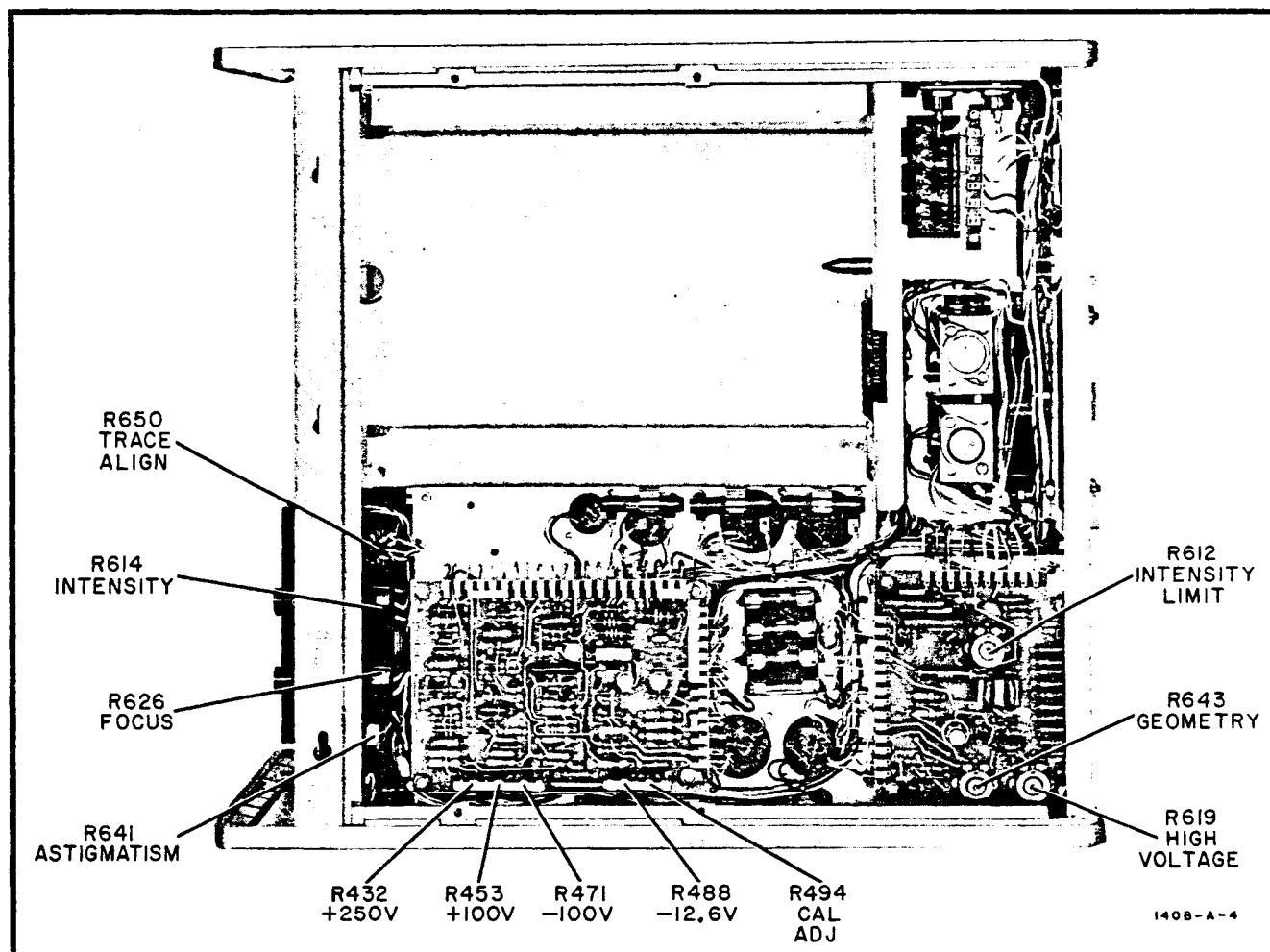


Figure 5-1. Adjustment Locations, Bottom View

5-13. ADJUSTMENTS OF HIGH-VOLTAGE SUPPLIES.

- a. Connect a Model 11044A 100:1 Voltage Divider to the DC probe of a Model 410B Voltmeter.
- b. Set Voltmeter to 3-volt -DC range.
- c. Set the Voltmeter Calibrator for -300 volts DC output, and connect divider tip to the output.
- d. Set the gain adjustment of the Model 410B (located at the rear of the instrument) for a reading of exactly 3 volts.
- e. Set the Voltmeter to the 30-volt range, and measure the high voltage supply. This may be done at the junction of R651 and R652.
- f. Set High Voltage Adjust R619 for -2350 volts.
- g. Recalibrate the Model 410B.

5-14. INTENSITY LIMIT ADJUSTMENT.

- a. Remove plug-ins; short pins 1 and 2 of J2.
- b. Set R612, Intensity Limit, full cw.
- c. Set INTENSITY control to 10 o'clock.
- d. Adjust R612 until spot is just visible. Remove short and reinstall plug-ins.

5-15. ASTIGMATISM ADJUSTMENT.

- a. Center a low-intensity spot on CRT.
- b. Adjust FOCUS and ASTIGMATISM for a small, round, sharply-focused spot.

5-16. GEOMETRY ADJUSTMENT.

- a. Set Plug-in controls as follows:

TRIGGER LEVEL	AUTO
SWEEP TIME	0.2 MSEC/CM

b. Connect a 400-kHz signal from the Audio Oscillator to the plug-in vertical INPUT.

c. Adjust vertical and horizontal controls to obtain a pattern 8 cm high.

d. Adjust Geometry, R643, to obtain the straightest edges possible on the rectangular pattern.

5-17. CALIBRATOR ADJUSTMENT.

a. Connect a 10 VOLT P-P signal from the Voltmeter Calibrator to the vertical amplifier INPUT.

b. Set amplifier SENSITIVITY to 2.0/CM, INPUT coupling to DC.

c. Adjust vertical SENS. CAL for exactly 5 cm deflection.

d. Disconnect the Voltmeter Calibrator, and connect the 10 V CALIBRATOR output to the amplifier INPUT.

e. Set Cal Adj, R494, for exactly 5 cm deflection.

Table 5-3. Condensed Adjustment Procedure

Test	External Equipment Required	Procedure	Adjust
Low Voltage Supplies	DC Voltmeter	Measure: -12.6 V (White/Violet) -100 V (Violet) +100 V (White/Red) +250 V (Red)	R488 R471 R453 R432
High Voltage Supply	DC VTVM; 100:1 Divider; Voltmeter Calibrator	a. Calibrate Divider - Voltmeter combination. b. Measure -2350 volts	R619 for -2350 volts
Intensity Limit	None	Refer to procedure of Paragraph 5-14	
Astigmatism	None	Center a low-intensity spot.	FOCUS and ASTIGMATISM for sharp spot.
Geometry	Audio Oscillator	a. TRIGGER LEVEL: AUTO SWEEP TIME: ... 0.2 MSEC/CM b. Connect 400-kHz sine wave to vertical INPUT. c. Obtain pattern 8 cm high.	R643 for straightest edges.
Calibrator	Voltmeter Calibrator	a. SENSITIVITY: 0.2 V/CM b. Apply 10 V pk-pk from Voltmeter Calibrator to vertical INPUT. c. Adjust vertical SENS. CAL. for 5 cm deflection. d. Connect 10 V CALIBRATOR to vertical INPUT.	Cal Adj. R494 for 5 cm deflection.

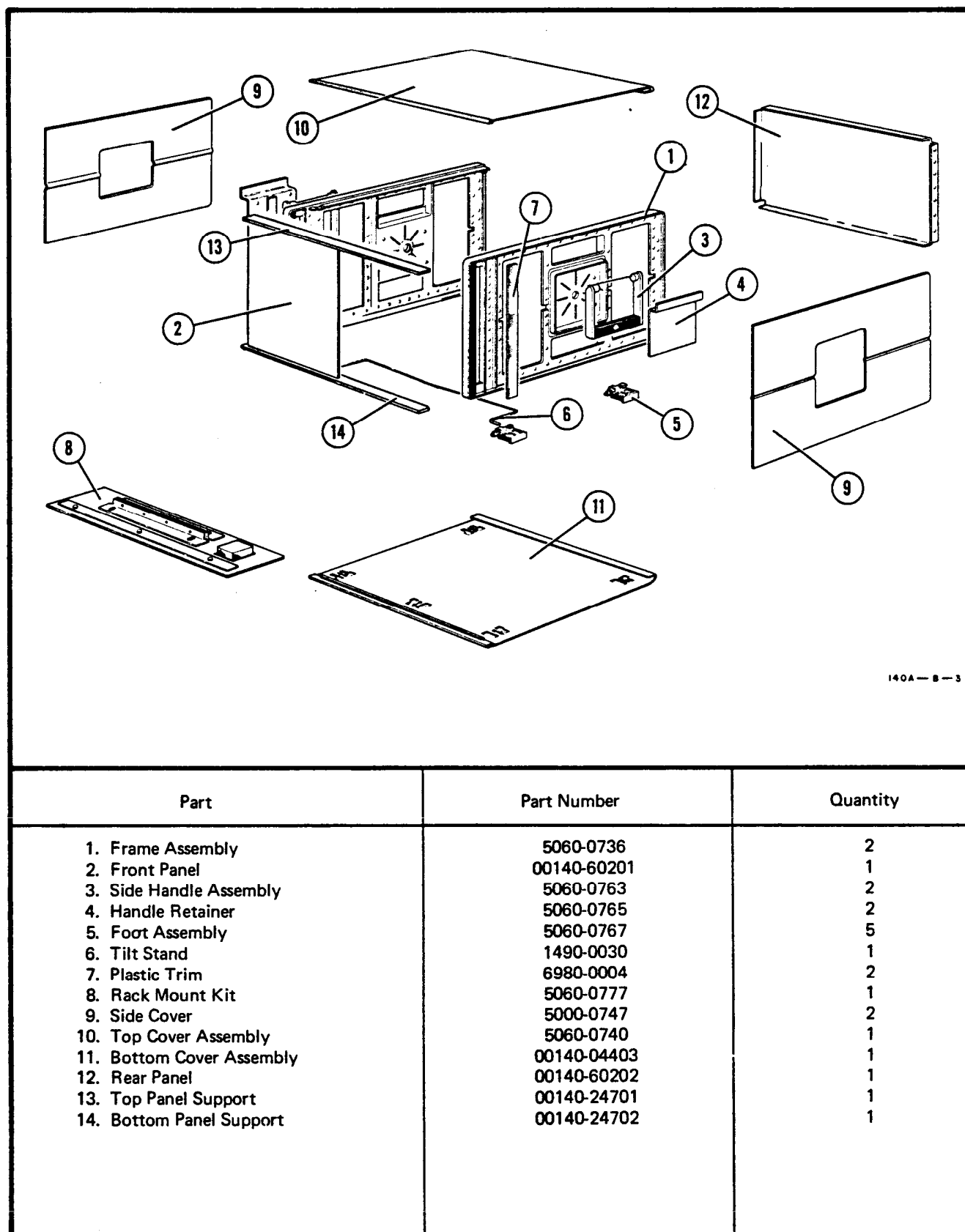


Figure 6-1. Cabinet Parts, Exploded View

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains the information necessary for ordering replaceable parts. Table 6-2 provides the following information:

- a. HP Part Number.
- b. Total Quantity (TQ) used in the instrument; given only the first time a part number is listed.
- c. Description of part; see Table 6-1 for a list of the reference designators and abbreviations used.

6-3. Miscellaneous parts are listed at the end of Table 6-2.

6-4. ORDERING INFORMATION.

6-5. To order replacement part(s), direct the order or inquiry to the nearest Hewlett-Packard Sales/Service Office (see list at back of this manual). Provide the following information:

- a. HP Part Number of item(s).
 - b. Model number and eight-digit serial number of instrument.
 - c. Quantity of part(s) desired.
- 6-6. To order a part not listed or identifiable in the table, provide the following information:

- a. Model number and eight-digit serial number of instrument.
- b. Part description, including function and location.

Note

Upon request, information will be supplied to allow ordering of applicable parts from manufacturers other than Hewlett-Packard. Contact the HP Sales/Service Office for details.

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
B	= motor, fan	FL	= filter	P	= plug	U	= microcircuit(non-repairable)
C	= capacitor	H	= hardware	PS	= power supply	V	= vacuum tube, neon bulb, photocell, etc.
CP	= coupling	IC	= integrated circuit	Q	= transistor	VR	= voltage regulator (diode)
CR	= diode	J	= jack	R	= resistor	W	= cable
DL	= delay line	K	= relay	RT	= thermistor	X	= socket
DS	= device signaling (lamp)	L	= inductor	S	= switch	Y	= crystal
		LS	= speaker	T	= transformer		

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

Table 6-2. Replaceable Parts

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
A401	00140-66508	1	A: low voltage supply board
A402	2100-1589	1	A: r var type v, 3 sect 7000, 3000, 5000 ohms 20%
A403	2100-1588	1	A: r var type v, 2 sect 1500 ohms 30% (each)
A601	00140-66509	1	A: high voltage rectifier board
	00140-66404	1	A: high voltage deck (includes A601 and Q602)
A602	00141-66508	1	A: high voltage regulator board
B401	3160-0056	1	B: fan assembly
C420	0150-0052	4	C: fxd cer 0.05 uF 20% 400 wVdc
C421	0180-0154	1	C: fxd elect. 430 uF -10 +100% 250 wVdc
C422A/B	0180-0012	1	C: fxd elect. 2 x 20 uF -10 +100% 450 wVdc
C423	0160-0168	4	C: fxd my. 0.1 uF 10% 200 wVdc
C424	0160-0168		C: fxd my. 0.1 uF 10% 200 wVdc
C425 -			
C439			Not assigned
C440	0150-0052		C: fxd cer 0.05 uF 20% 400 wVdc
C441	0180-0046	1	C: fxd elect. 600 uF -10 +75% 200 wVdc
C442	0160-0168		C: fxd my. 0.1 uF 10% 200 wVdc
C443	0180-0100	2	C: fxd elect. 4.7 uF 10% 35 wVdc
C444 -			
C459			Not assigned
C460	0150-0052		C: fxd cer 0.05 uF 20% 400 wVdc
C461	0180-0214	1	C: fxd elect. 275 uF -10 +50% 200 wVdc
C462	0180-0093	1	C: fxd elect. 20 uF -10 +100% 150 wVdc
C463	0160-0168		C: fxd my. 0.1 uF 10% 200 wVdc
C464	0180-0100		C: fxd elect. 4.7 uF 10% 35 wVdc
C465 -			
C480			Not assigned
C481	0180-0213	1	C: fxd elect. 5000 uF -10 +75% 25 wVdc
C482	0160-0207	1	C: fxd my. 0.01 uF 5% 200 wVdc
C483	0180-0097	1	C: fxd elect. 47 uF 10% 35 wVdc
C484 -			
C600			Not assigned
C601	0150-0052		C: fxd cer 0.05 uF 20% 400 wVdc
C602	0180-0138	1	C: fxd elect. 100 uF -10 +100% 40 wVdc
C603	0170-0040	1	C: fxd my. 0.047 uF 10% 200 wVdc
C604 -			
C609			Not assigned
C610	0160-0151	6	C: fxd cer 4700 pF -20 +80% 4000 wVdc
C611	0150-0036	2	C: fxd cer 470 pF 20% 6000 V

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

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
C612	0150-0036	2	C: fxd cer 470 pF 20% 6000 V
C613	0160-0151		C: fxd cer 4700 pF -20 +80% 4000 wVdc
C614	0160-0151		C: fxd cer 4700 pF -20 +80% 4000 wVdc
C615	0160-0151		C: fxd cer 4700 pF -20 +80% 4000 wVdc
C616	0160-0907		C: fxd cer 0.01 uF -20 +80% 5000 wVdc
C617 - C620			Not assigned
C621	0160-0151		C: fxd cer 4700 pF -20 +80% 4000 wVdc
C622	0160-0151		C: fxd cer 4700 pF -20 +80% 4000 wVdc
C623	0160-0907		C: fxd cer 0.01 uF -20 +80% 5000 wVdc
CR421	1901-0028	12	CR: Si
CR422	1901-0028		CR: Si
CR423	1901-0028		CR: Si
CR424	1901-0028		CR: Si
CR425	1910-0016		CR: Ge
CR426	1902-0034	1	CR: breakdown 5.76 V 10% 400 mW
CR427	1901-0096	1	CR: Si
CR428	1902-3402	1	CR: breakdown 80.6 V 2% 400 mW
CR429	1901-0040	8	CR: Si
CR430	1901-0040		CR: Si
CR441	1901-0028	2	CR: Si
CR442	1901-0028		CR: Si
CR443	1901-0028		CR: Si
CR444	1901-0028		CR: Si
CR445	1902-3385		CR: breakdown 69.8 V 2% 400 mW
CR446	1901-0026	2	CR: Si
CR447	1901-0040		CR: Si
CR448	1901-0040	1	CR: Si
CR449	1902-3104		CR: breakdown 5.62 V 5% 400 mW
CR461	1901-0028		CR: Si
CR462	1901-0028		CR: Si
CR463	1901-0028	2	CR: Si
CR464	1901-0028		CR: Si
CR465	1902-3385		CR: breakdown 69.8 V 2% 400 mW
CR466	1901-0026		CR: Si
CR467	1901-0040		CR: Si
CR468	1901-0040		CR: Si
CR481	1901-0032		CR: rect Si 15 A 1N3209
CR482	1901-0032		CR: rect Si 15 A 1N3209
CR483	1901-0025	1	CR: Si
CR484	1910-0016		CR: Ge
CR485	1901-0040		CR: Si

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

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
CR490	1912-0006	1	CR: Ge tunnel 1N3718
CR491	1902-0064	1	CR: breakdown 7.50 V 400 mW
CR492 - CR601			Not assigned
CR602	1901-0487	2	CR: Si
CR603	1901-0487		CR: Si
CR604	1901-0049	2	CR: Si
CR605	1901-0049		CR: Si
CR606	1880-0025	2	CR: Se
CR607	1880-0025		CR: Se
CR608	1901-0341	1	CR: Si
CR609	1901-0040		CR: Si
DS401	1450-0048	1	DS: Ne
F401	2110-0014	1	F: cartridge 4 A s-b (115 V Operation)
	2110-0006	1	F: cartridge 2 A s-b (230 V Operation)
F402 - F420			Not assigned
F421	2110-0004	1	F: cartridge 0.25 A 250 V
F422 - F440			Not assigned
F441	2110-0033	1	F: 0.75 A 250 V
F442 - F460			Not assigned
F461	2110-0012	1	F: cartridge 0.5 A 250 V
F462 - F480			Not assigned
F481	2110-0003	1	F: cartridge 3 A 3 AG
J1	1251-0054	2	J: 24 contact
J2	1251-0054		J: 24 contact
J3 - J400			Not assigned
J401	1251-0148		J: receptacle ac power
J402	1251-0202	2	J: calibrator
J403	1251-0202		J: calibrator
L601	9140-0171	1	L: fxd 40 uH 10% 1 A
L602	5060-0435	1	L: alignment, trace
L603	9140-0179	1	L: fxd 22 uH 10%

Model 140B

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

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
Q421	1850-0422	1	Q: Ge pnp
Q422	1854-0005	1	Q: Si npn 2N708
Q423	1853-0036	1	Q: Si pnp 2N3906
Q424 - Q440			Not assigned
Q441	1854-0294	3	Q: Si npn
Q442	1854-0022	2	Q: Si npn
Q443	1854-0087	1	Q: Si npn 2N3417
Q444	1854-0071	4	Q: Si npn
Q445 Q460			Not assigned
Q461	1854-0294		Q: Si npn
Q462	1854-0022		Q: Si npn
Q463	1854-0071		Q: Si npn
Q464	1854-0071		Q: Si npn
Q465 - Q480			Not assigned
Q481	1854-0294		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
Q485 - Q489			Not assigned
Q490	1850-0062	1	Q: Ge pnp 2N404
Q491 - Q600			Not assigned
Q601	1853-0016	1	Q: Si pnp
Q602	1853-0084	1	Q: Si pnp 2N4918
R401	0687-3331	1	R: fxd comp 33 k ohms 10% 1/2 W
R402			Not assigned
R420			Not assigned
R421	0687-1041	1	R: fxd comp 100 k ohms 10% 1/2 W
R422A/B	0815-0031	1	R: fxd ww 2400 ohms CT 5%
R423	0764-0033	1	R: fxd metox 33 ohms 5% 2 W
R424	0761-0007	1	R: fxd metox flm 27 k ohms 5% 1 W
R425	0757-0401	3	R: fxd metflm 100 ohms 1% 1/8 W
R426	0757-0413	1	R: fxd metflm 392 ohms 1% 1/8 W
R427	0757-0044	1	R: fxd metflm 33.2 k ohms 1% 1/2 W
R428	0757-0401		R: fxd metflm 100 ohms 1% 1/8 W
R429	0757-0465	2	R: fxd metflm 100 k ohms 1% 1/8 W
R430	0757-0273	2	R: fxd metflm 3010 ohms 1% 1/8 W
R431	0757-0370	1	R: fxd metflm 49.9 k ohms 1% 1/2 W
R432			NSR: p/o A402

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

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
R433	0757-0367	1	R: fxd metflm 100 k ohms 1% 1/2 W
R434	0761-0006	1	R: fxd metflm 10 k ohms 5% 1 W
R435	0684-1021	3	R: fxd comp 1000 ohms 10% 1/4 W
R436 - R440			Not assigned
R441	0687-5631	4	R: fxd comp 56 k ohms 10% 1/2 W
R442	0811-2030	2	R: fxd ww 14 ohms 5% 10 W
R443	0687-5631		R: fxd comp 56 k ohms 10% 1/2 W
R444			Not assigned
R445	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W
R446	0757-0399	2	R: fxd metflm 82.5 ohms 1% 1/8 W
R447	0684-5621	1	R: fxd comp 5600 ohms 10% 1/4 W
R448			Not assigned
R449	0757-0764	2	R: fxd metflm 33.2 k ohms 1% 1/4 W
R450 - R451			Not assigned
R452	0757-0436	2	R: fxd metflm 4320 ohms 1% 1/2 W
R453			NSR: p/o A402
R454	0757-0846	3	R: fxd metflm 22.1 k ohms 1% 1/2 W
R455	0766-0033	1	R: fxd metflm 2000 ohms 1% 3 W
R456	0757-0434	1	R: fxd metflm 3650 ohms 1% 1/2 W
R457	0757-0388	3	R: fxd metflm 30.1 ohms 1% 1/8 W
R461	0687-5631		R: fxd comp 56 k ohms 10% 1/2 W
R462	0811-2030		R: fxd ww 14 ohms 5% 10 W
R463			Not assigned
R464	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W
R465	0687-5631		R: fxd comp 56 k ohms 10% 1/2 W
R466	0757-0399		R: fxd metflm 82.5 ohms 1% 1/8 W
R467	0757-0848	1	R: fxd metflm 30.1 k ohms 1% 1/8 W
R468	0757-0772	1	R: fxd metflm 68.1 k ohms 1% 1/4 W
R469	0757-0764		R: fxd metflm 33.2 k ohms 1% 1/4 W
R470	0757-0436		R: fxd metflm 4320 ohms 1% 1/2 W
R471			NSR: p/o A402
R472	0757-0846		R: fxd metflm 22.1 k ohms 1% 1/2 W
R473	0757-0190	2	R: fxd metflm 20 k ohms 1% 1/2 W
R474	0757-0388		R: fxd metflm 30.1 ohms 1% 1/8 W
R475	0727-0431	1	R: fxd metflm 2690 ohms 1% 1/2 W
R481	0687-2221	1	R: fxd comp 2200 ohms 10% 1/2 W
R482	0687-4731	1	R: fxd metflm 47 k ohms 1% 1/2 W
R483	0811-1746	2	R: fxd ww 0.36 ohms 5% 2 W
R484	0757-0388		R: fxd metflm 30.1 ohms 1% 1/8 W
R485	0757-0190		R: fxd metflm 20 k ohms 1% 1/2 W

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

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
R486	0757-0480	1	R: fxd metflm 432 k ohms 1% 1/8 W
R487	0757-0273	-	R: fxd metflm 3010 ohms 1% 1/8 W
R488			NSR: p/o A403
R489	0757-0846		R: fxd metflm 22.1 k ohms 1% 1/2 W
R490	0811-1746		R: fxd ww 0.36 ohms 5% 2 W
R491	0757-0421	1	R: fxd metflm 825 ohms 1% 1/8 W
R492	0757-0428	1	R: fxd metflm 1620 ohms 1% 1/8 W
R493	0757-0844	1	R: fxd metflm 16.2 k ohms 1% 1/2 W
R494			NSR: p/o A403
R495	0698-3555	1	R: fxd metflm 4437 ohms 1/2% 1/2 W
R496	0698-3554	1	R: fxd metflm 493 ohms 1/2% 1/2 W
R497 -			
R600			Not assigned
R601	0757-0401		R: fxd metflm 100 ohms 1% 1/8 W
R602 -			
R604			Not assigned
R605 -	0757-0438	1	R: fxd metflm 5110 ohms 1% 1/8 W
R606 -			
R609			Not assigned
R610	0683-2245	1	R: fxd comp 220 k ohms 5% 1/4 W
R611	0683-1535	1	R: fxd comp 15 k ohms 5% 1/2 W
R612	2100-0096	2	R: var comp 1 megohm 30% lin 1/5 W
R613	0757-0280		R: fxd metflm 1000 ohms 1% 1/8 W
R614	2100-0756	1	R: var comp 1.5 megohm
R615	0698-6666	1	R: fxd depc 33 megohms 5% 1 W
R616	0757-0344	2	R: fxd metflm 1 megohm 1% 1/4 W
R617	0757-0449	1	R: fxd metflm 20 k ohms 1% 1/8 W
R618	0757-0768	2	R: fxd metflm 47.5 k ohms 1% 1/4 W
R619	2100-0096		R: var comp 1 megohm 30% lin 1/5 W
R620	0727-0845	3	R: fxd car flm 1.78 megohms 1% 1/2 W
R621	0727-0845		R: fxd car flm 1.78 megohms 1% 1/2 W
R622	0757-0768		R: fxd metflm 47.5 k ohms 1% 1/4 W
R623			Not assigned
R624	0687-2241	1	R: fxd comp 220 k ohms 10% 1/2 W
R625	0727-0845		R: fxd car flm 1.78 megohms 1% 1/2 W
R626	2100-0374	1	R: var comp 5 megohms 30% lin 1/2 W
R627	0698-3553	8	R: fxd car flm 2.49 megohms 1% 1/2 W
R628	0698-3553		R: fxd car flm 2.49 megohms 1% 1/2 W
R629	0698-3553		R: fxd car flm 2.49 megohms 1% 1/2 W
R630	0698-3553		R: fxd car flm 2.49 megohms 1% 1/2 W
R631	0698-3553		R: fxd car flm 2.49 megohms 1% 1/2 W
R632	0698-3553		R: fxd car flm 2.49 megohms 1% 1/2 W

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

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
R633	0698-3553		R: fxd car flm 2.49 megohms 1% 1/2 W
R634	0698-3553		R: fxd car flm 2.49 megohms 1% 1/2 W
R635 - R640			Not assigned
R641	2100-0212	1	R: var comp 100 k ohms 10% lin 2 W
R642	0757-0454	1	R: fxd metflm 33.2 k ohms 1% 1/8 W
R643	2100-0095	1	R: var comp 100 k ohms 30% lin 1/5 W
R644	0757-0772	1	R: fxd metflm 68.1 k ohms 1% 1/4 W
R645	0757-0437	1	R: fxd metflm 4750 ohms 1% 1/8 W
R646 - R649			Not assigned
R650A/B	2100-0445	1	R: var comp 2 x 2000 ohms 30% lin
R651	0757-0452	1	R: fxd metflm 27.4 k ohms 1% 1/8 W
R652	0757-0465		R: fxd metflm 100 k ohms 1% 1/8 W
R653	0757-0344		R: fxd metflm 1 megohm 1% 1/4 W
S401	3101-0030	1	S: tgl
S402	3101-0033	1	S: sl
S403	3103-0009	1	S: thermal
S404 - S600			Not assigned
S601	3101-0011	1	S: sl
S602	3101-0048	1	S: pushbutton
T401	9100-0184	1	T: power
T402 - T600			Not assigned
T601	00140-86001	1	T: high voltage
TB601	0360-0104	1	Terminal strip, Z-Axis
V441	1940-0013	1	V: reference 82.0 \pm 1.0 V
V442 - V600			Not assigned
V601	1921-0013	1	V: 6CW4
V602 - V603			Not assigned
V604	1920-0001	1	V: 5642
V605			Not assigned
V606	2140-0008	1	V: neon NE2
V607	2140-0014	2	V: neon NE96
V608	2140-0014		V: neon NE96
V609			Not assigned
V610	5083-2352	1	V: cathode-ray
W401	8120-0078	1	W: power cord
XV601	1200-0086	1	XV: nuvistor 5 pin

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

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			MISCELLANEOUS
	5020-0476	1	Bezel: CRT
	175A-91	2	Spring: CRT contact
	0360-0362	1	Strip: diode terminal
	0370-0084	2	Knob: intensity and focus w/arrow
	0510-0123	1	Clamp: pilot light retainer
	0905-0016	1	Gasket: felt
	1200-0037	1	Socket: CRT
	1200-0043	4	Insulator: anodized aluminum
	1200-0050	7	Pin: CRT socket
	1200-0063	2	Clip: transistor
	1200-0085	1	Cover: CRT socket
	1200-0088	4	Insulator: anodized aluminum
	1251-0207	45	Connector: edge-on, 1/16 inch
	1520-0042	4	Mount: vibration
	2950-0034	2	Nut: hex, 11/16 inch
	4320-0007	7	Extrusion: rubber
	5000-0408	3	Bracket: coil
	5040-0400	4	Support: cap
	5040-0401	4	Support: cap
	5040-0430	2	Mount: transformer
	5040-0421	2	Insulator: potentiometer
	5040-0440	1	Cover: CRT socket access
	5060-0428	1	Filter: air
	7123-0092	1	Label: CRT shield
	8159-0001	1	Lead: electrical CRT anode
	00140-00602	1	Shield: plug-in
	00140-00109	1	Deck: vertical
	00140-00111	1	Gusset: center
	00140-00104	1	Gusset: side
	00140-60101	1	Deck: main
	00140-01201	1	Bracket: latch
	00140-01202	1	Bracket: diode
	00140-01206	2	Bracket: fan
	00140-01208	4	Bracket: panel
	00140-01209	2	Bracket: gusset
	00140-01210	2	Bracket: transistor
	00140-24703	4	Support: panel bracket
	00140-44701	2	Spacer: cable, foam
	00140-44702	5	Spacer: cable, foam

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

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
	00140-60603	1	Shield: CRT
	00140-61606	1	Cable: high voltage
	00140-61607	1	Cable: primary power
	00140-61618	1	Cable: main, internal
	5040-0444	1	Shield, Light
	01200-44703	1	Support, CRT shield
	0340-0451	1	Washer, Mica (under Q602)
	00140-29902	1	Front Panel Support and Trim Strip

SECTION VII

MANUAL CHANGES AND OPTIONS

7-1. MANUAL CHANGES.

7-2. This manual applies directly to the standard Model 140B with the serial prefix as listed on the title page. The following paragraphs provide instructions and information for adapting this manual to cover newer or older instruments. Refer to the Manual Changes sheet supplied with this manual for Errata.

7-3. OLDER INSTRUMENTS.

7-4. Table 7-1 contains information to adapt this manual to cover an older instrument (lower serial prefix). Check Table 7-1 for your instrument serial prefix and make the indicated changes to this manual. These changes adapt the manual to instruments as manufactured and do not apply to field modified instruments.

Table 7-1. Manual Changes

Serial Prefix	Make Changes
No backdating changes are required at this time.	

7-5. NEWER INSTRUMENTS.

7-6. As changes and improvements are made to the Model 140B, subsequent instruments may have a higher serial

prefix than that listed on the title page. If the serial prefix of your instrument does not match that on the title page, a Manual Changes sheet supplied with the manual provides the information to adapt this manual to cover the newer instrument.

7-7 If the serial prefix of your instrument and that on the title page of this manual do not agree and no Manual Changes sheet was supplied, contact the nearest Hewlett-Packard Sales/Service Office.

7-8. OPTIONS.

7-9. Options for an HP instrument are standard factory installed modifications. At the present time, no options are offered for the Model 140B.

7-10. SPECIAL INSTRUMENTS.

7-11. Special instruments are instruments that are modified to meet special specifications. To cover the modifications in a special instrument, an insert sheet is supplied with the manual for that instrument. This insert sheet contains the instructions for operating, adjusting, and maintaining the special instrument.

SECTION VIII

SCHEMATICS AND TROUBLESHOOTING

8-1. GENERAL.

8-2. The schematic diagrams in this section are drawn to show the circuit electronic functions, not the physical wiring of the instrument. The circuits on one schematic may include all or part of one or several assemblies. Chassis parts and assemblies are identified in Figures 8-2 and 8-3. Component identification figures are adjacent to the schematic of that circuit. Table 8-3 provides schematic diagram notes related to the schematic symbols, conventions, and conditions for dc voltages.

8-3. The troubleshooting information in this section is based on the following conditions: the plug-in units are operating properly, the interconnecting wiring is intact, and only one malfunction has occurred.

8-4. TROUBLESHOOTING.

8-5. LOW-VOLTAGE SUPPLIES.

8-6. TRANSISTORS. The series regulator transistors are located on the fan assembly. Each is easily replaced by removing the two screws and pulling the transistor from its socket. All other low voltage power supply transistors are located on the low-voltage circuit board.

8-7. DC voltages shown on the low voltage schematic diagram were measured, to ground, with Model 1402A and 1421A plug-ins installed. Voltages may vary slightly when other plug-ins are used. Voltages for points not marked for voltage are generally obvious by being connected (directly or indirectly) to a supply output. Transistor base voltage, in most cases, should not measurably differ from emitter voltages when measured with respect to ground. Voltage drops across breakdown diodes are indicated on the schematic.

8-8. EXCESSIVE RIPPLE. Excessive 120 Hz ripple on any supply can be traced to either input filter or regulator circuits by comparing ripple voltages at the rectifier outputs with values on the schematic. For ripple above specified value, check C421, C441, C461, or C481. 60 Hz ripple above specified value at these points indicates an open rectifier or low-gain amplifier transistors. Maximum ripple on supply outputs (at 115 Vac with maximum load on supply) is: 10 mV at +250 V; 7 mV at +100 V and -100 V; and 2 mV at -12.6 V.

8-9. FUSES. If the -12.6, -100, +100, or +250 volts supply is accidentally shorted to ground, the fuse for that particular supply will open. This cuts off current in the supply and protects the transistors.

8-10. The -12.6 volt supply is fused, and employs a current limiter, Q483, for protection against brief output overloads. The supply should immediately function normally upon removal of the overload, provided the fuse did not open.

8-11. ISOLATING TROUBLES. Trouble in the +100 volt supply can be reflected in the operation of all other low voltage power supply outputs. If +100 volt supply is incorrect, circuit repair may eliminate the trouble. If +100 volt is correct, follow these steps in order:

a. Check the -100 volt supply. The +250 volt and -12.6 volt supplies are referenced to this supply and a fault in the -100 volt supply can cause apparent malfunction of both. If the -100 volt supply is incorrect, circuit repair may eliminate trouble in the +250 volt or -12.6 volt supply. If the -100 volt supply is correct, proceed to the next step.

b. The +250 volt supply is referenced to the -100 volt supply. If trouble here has not been eliminated by checking the -100 volt supply, the trouble is in this circuit and can be located by making the circuit and component checks as described in Paragraph 8-7.

c. A trouble that appeared to be in the 12.6 volt supply may have been eliminated by the above procedures. If not, it is necessary to make voltage and component checks of the supply.

8-12. HIGH-VOLTAGE SUPPLY.

8-13. If one high-voltage supply output is zero but other outputs are normal, one of the rectifiers is likely at fault. Normal DC voltages are on the high voltage schematic.

8-14. If there is no high-voltage output, observe the waveform at the collector of Q602 (blue wire). If an approximately 30 kHz 20-volt peak-to-peak sine wave appears for short intervals, the trouble is probably a defective component in the rectifier filter/divider networks. If there is no waveform, refer to Table 8-1.

8-15. If the high-voltage output is incorrect and cannot be adjusted to the correct value, refer to Table 8-2.

8-16. If the -2350 volt supply is operating properly, the +5 k V post-accelerator potential may be checked by removing the left side instrument cover and measuring the 5 k V voltage at the board termination of the thick red lead.

Table 8-1. Troubleshooting High Voltage Supply, No Voltage

1. Check Q602, L601, and the associated transformer primary for open circuits or shorts. Replace any bad components.		
Procedure	Indication	Conclusion
2. Disconnect the edge-on connector to the emitter of Q601 (yellow wire). Connect this lead through a 2000 ohm resistor to -12.6 volts (any white-violet wire).	Rectifier (V604) filament lights.	Proceed to step 3.
	Filament does not light.	Proceed to step 4.
3. Replace edge-on connector, and change V601.	Filament lights.	Q601 failed.
	Filament does not light.	Check biasing circuit of V601. Then check Q601 and associated circuit.
4. Check T601 and rectifier load circuit for opens or shorts. Then lift one lead of C613, C614, C616, C617, C621, and turn instrument on again.	Filament lights.	Put capacitors back one at a time until the bad one causes the filament to go out.
	Filament does not light.	Trouble is probably transformer T601.

8-17. PERIODIC MAINTENANCE.

8-18. ELECTRICAL MAINTENANCE.

8-19. Perform the electrical adjustments once every 6 months and after repair or component replacement.

8-20. MECHANICAL MAINTENANCE.

8-21. AIR FILTER. Inspect the air filter at rear of instrument and clean before it becomes clogged and restricts air flow. To clean the filter, wash thoroughly in warm water and detergent, and dry thoroughly before installing on the instrument.

8-22. FAN MOTOR LUBRICATION. Lubricate the fan motor with SAE number 10 machine oil once every six months. The fan motor lubrication point is accessible from the front of instrument after removing the plug-in units. Using a hypodermic syringe, oil the bearings with two or three drops of oil.

8-23. INSTRUMENT REPAIR.

8-24. Chassis-mounted components are identified in Figures 8-2 and 8-3. Components on circuit boards are identified in figures near the applicable schematic (also refer to Table 8-3).

8-25. Figure 6-1 is an exploded-view drawing of the Model 140B frame. The parts are identified by description and HP part number.

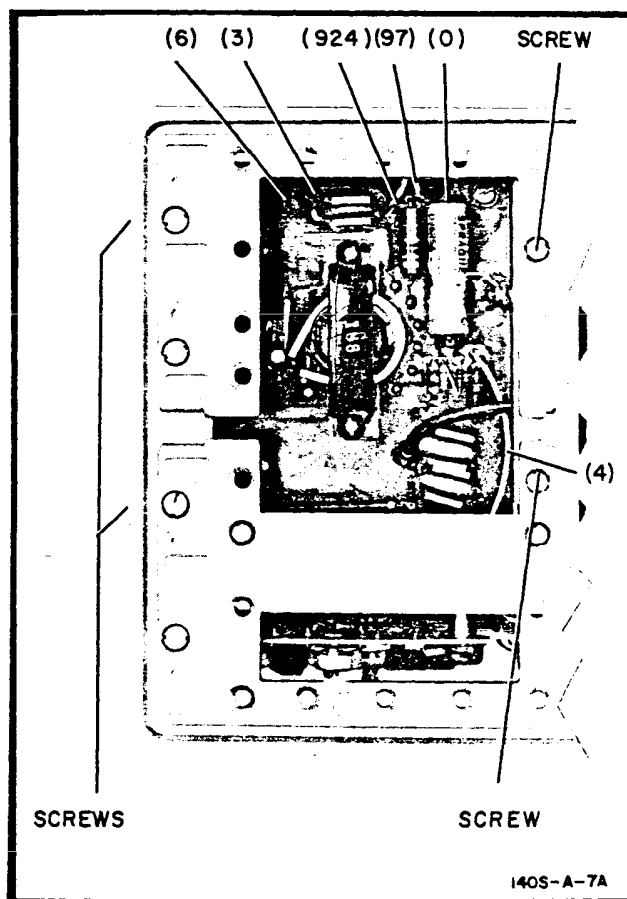


Figure 8-1. High Voltage Rectifier Deck Removal

8-26. MAJOR COMPONENT REPAIR.

8-27. CRT REMOVAL AND REPLACEMENT. To remove the CRT, proceed as follows:

WARNING

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

- a. Remove top cover of instrument.
- b. Discharge post-accelerator lead and its CRT connection to chassis ground. Remove post-accelerator lead from CRT.
- c. Disconnect clip-on leads from CRT neck.
- d. Remove CRT light shield and bezel from front panel.
- e. Loosen clamp at CRT socket.
- f. Carefully remove socket from CRT base.
- g. Place one hand on CRT face and, with the other hand, slide CRT forward and out of the instrument.
- h. To replace the CRT, reverse the procedure.
- i. Check the trace alignment and geometry adjustments, Paragraphs 3-7 and 5-16 respectively.

8-28. FAN REMOVAL AND REPLACEMENT. Use the following procedure for removing and reverse the procedure for replacing the cooling fan.

- a. Remove the top and bottom covers.
- b. Disconnect white-gray and white-green-gray (958) wires from fan terminals.
- c. Remove two transistor heat sinks from fan assembly and move them out of the way.
- d. Remove four fan mounting nuts from instrument rear panel.
- e. Lift out fan assembly.

8-29. H- V DECK REMOVAL AND REPLACEMENT. Most of the components on the high voltage deck can be replaced without removing the assembly. Other components can be replaced by moving the deck part way out (without disconnecting wires). Refer to Figure 8-1 for mounting screw and wire identification; use the following procedure for removing the high voltage deck.

- a. Remove left side and top covers.
- b. Disconnect 6 wires from the board and remove the 4 board mounting screws; see Figure 8-1 for wire and screw identification.
- c. Disconnect the post-accelerator lead from CRT as described in Paragraph 8-27 b.
- d. Push the wires aside, tilt deck away from the left side of instrument and lift out.

8-30. SERVICING CIRCUIT BOARDS.

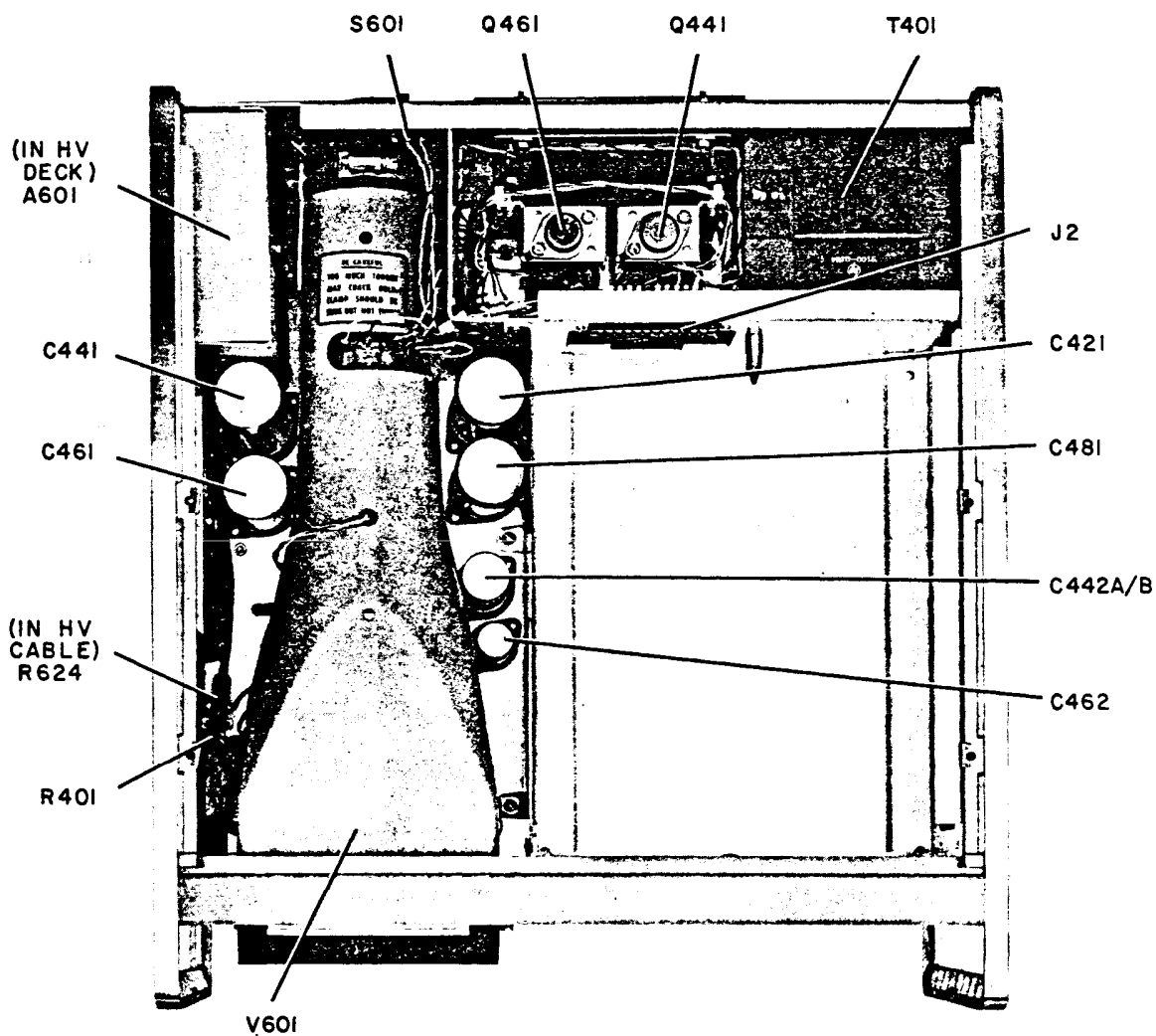
8-31. The Model 140B etched circuit boards are the plated-through type. When servicing this type board, components can be removed and replaced by applying a soldering iron tip to the component connection on either side of the board. When removing a component with multiple leads, such as potentiometers, move the soldering iron tip from lead to lead while applying moderate pressure to the component to lift it from the board. Excess solder can be removed by applying heat and rotating a wooden toothpick in the hole. Hewlett-Packard Service Note M-20D contains additional information about the repair of circuit boards; important considerations are as follows:

- a. Do not apply excessive heat.
- b. Apply heat to component leads and remove component with a straight pull away from the board.
- c. Do not force replacement component leads into a hole.

8-32. If the metal conductor lifts from the board, it can be cemented back with a quick-drying acetate base cement having good insulating properties. If the metal conductor is broken, solder a wire to the conductor to bridge the break.

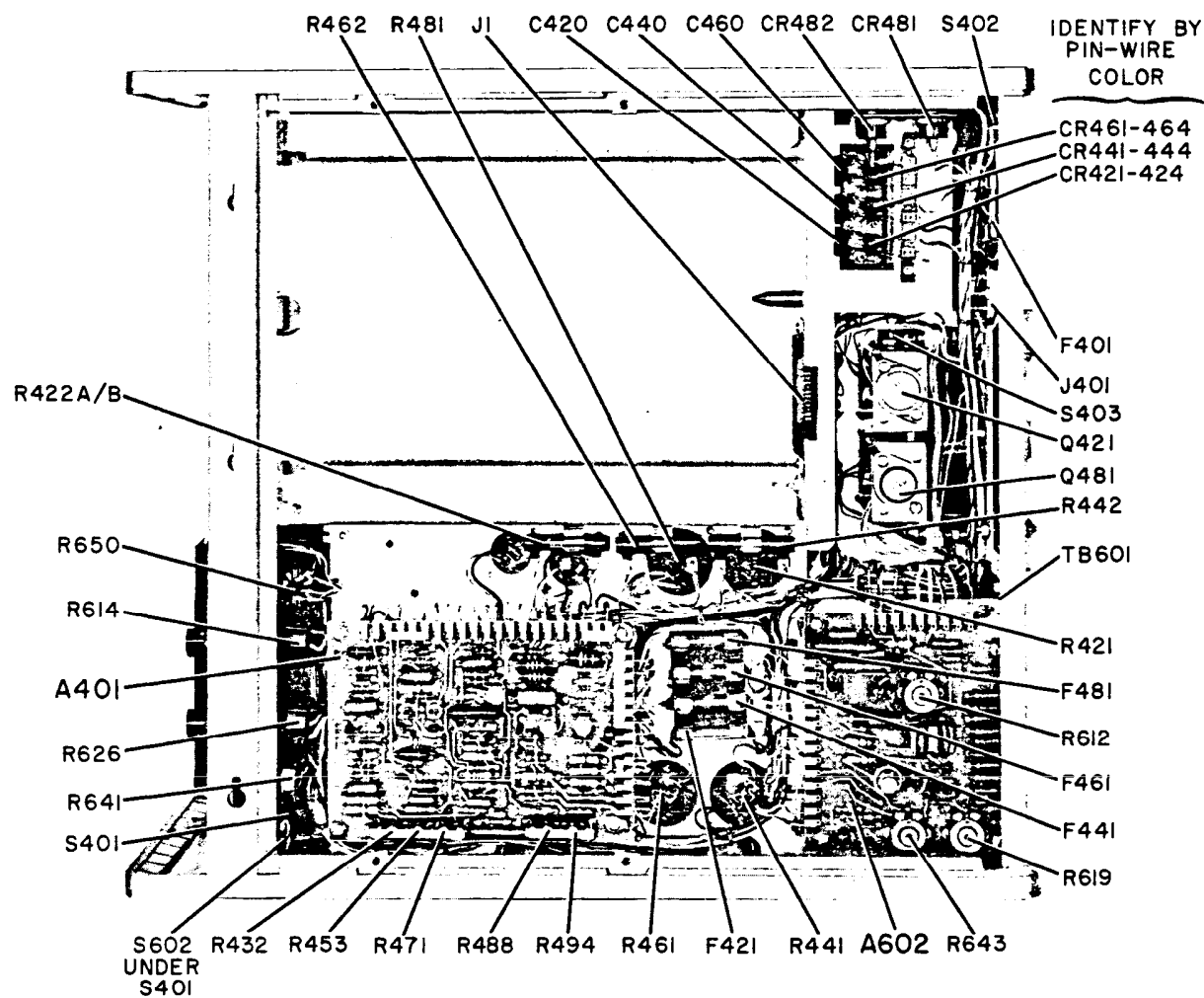
Table 8-2. Troubleshooting High-Voltage Supply, Incorrect Voltage

Procedure	Effect	Conclusion
1. Remove Nuvistor V601 from socket.	Output drops to zero.	Proceed to step 2.
	Output remains at an incorrect value.	Q601 shorted.
2. Replace V601 in socket, and lift end of R601.	Output drops.	Trouble is probably in resistor divider network R611, R619 - R634.
	Output remains at an incorrect value.	V601 bad.



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Figure 8-2. Component Locations, Top View



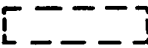





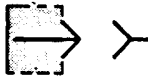









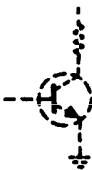
140B-A-3

Figure 8-3. Component Locations, Bottom View

Table 8-3. Schematic Diagram Notes

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.

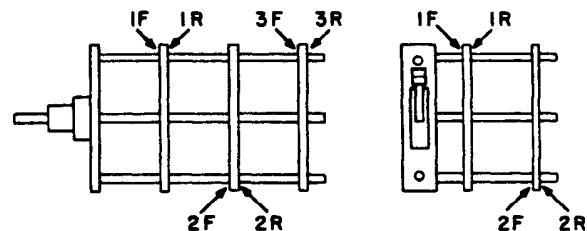
	= Field effect transistor (N-channel)
	= Breakdown diode
	= Tunnel diode
	= Step recovery diode
	= Circuits or components drawn with dashed lines (phantom) show function only and are not intended to be complete. The circuit or component is shown in detail on another schematic.

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].

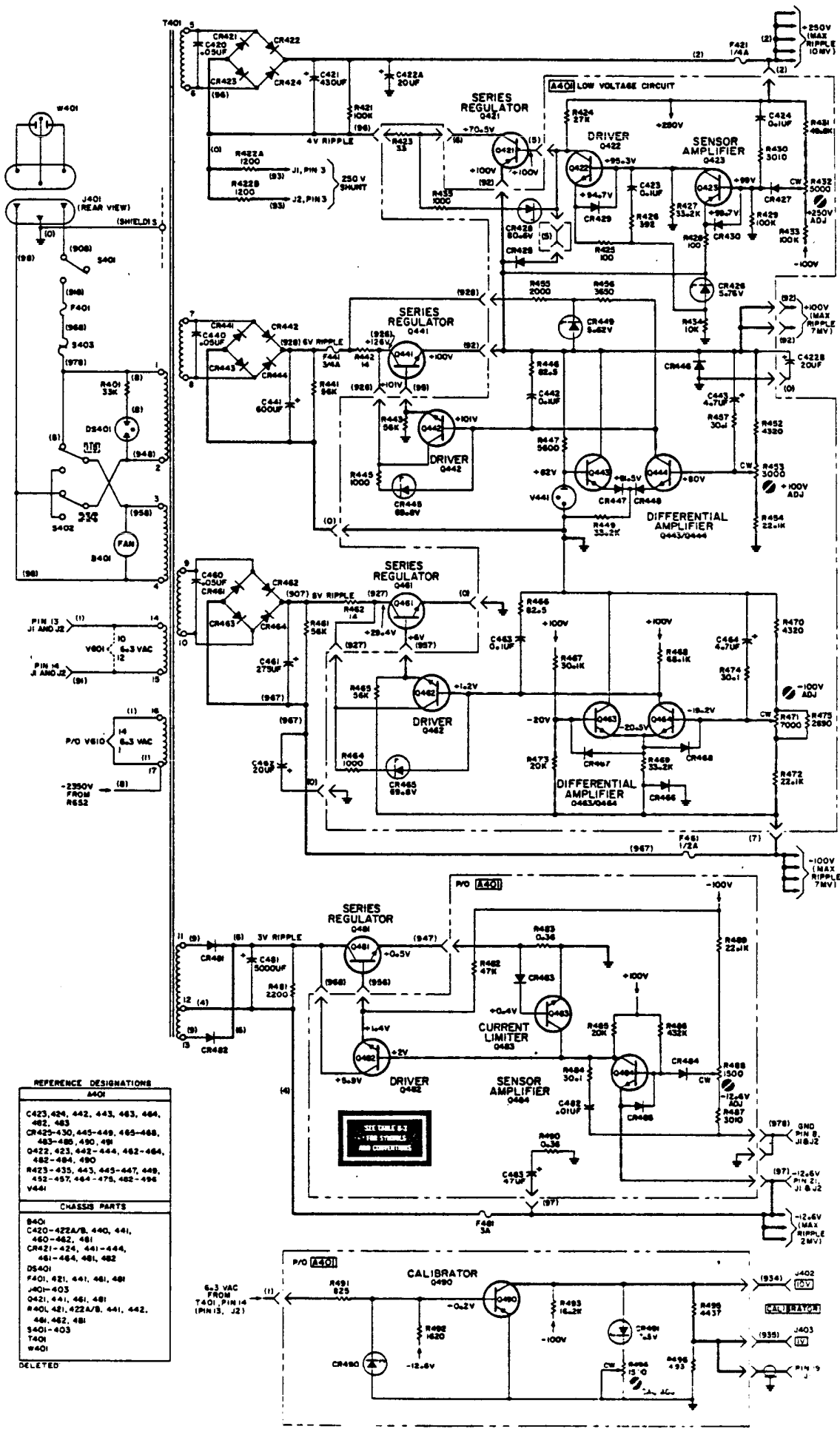
0 - Black	5 - Green
1 - Brown	6 - Blue
2 - Red	7 - Violet
3 - Orange	8 - Gray
4 - Yellow	9 - White

Switch wafers are identified as follows:



Conditions for DC Voltage Measurement

DC Voltages on the schematic diagrams were measured, to ground, using a vacuum tube Voltmeter, with a Model 1421A and a Model 1421A and a Model 1402A installed. Voltages shown are typical, $\pm 10\%$.



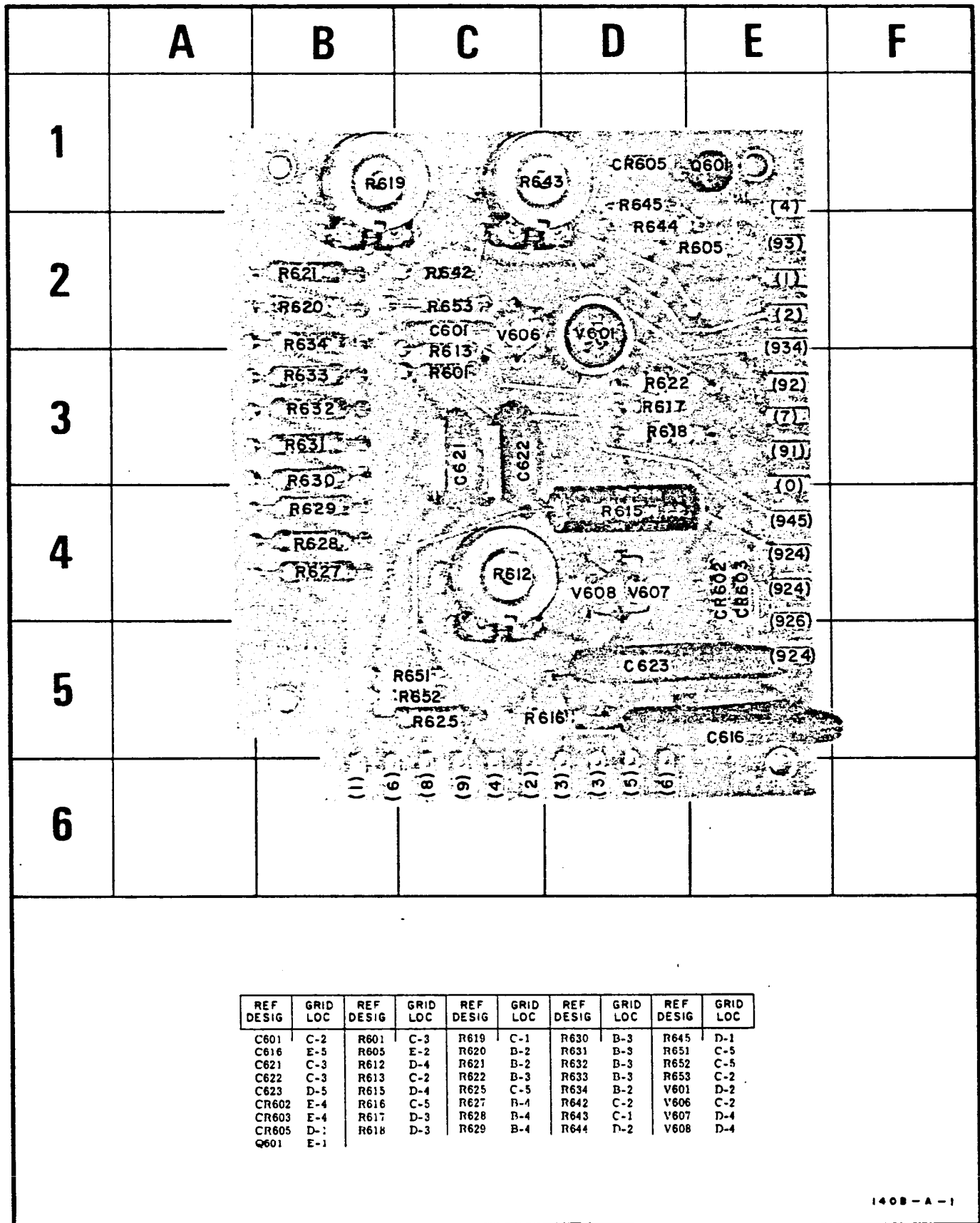


8-8



02650-1

[illegible]



140B-A-1

Figure 8-8. Component Identification, High Voltage Regulator Board A602

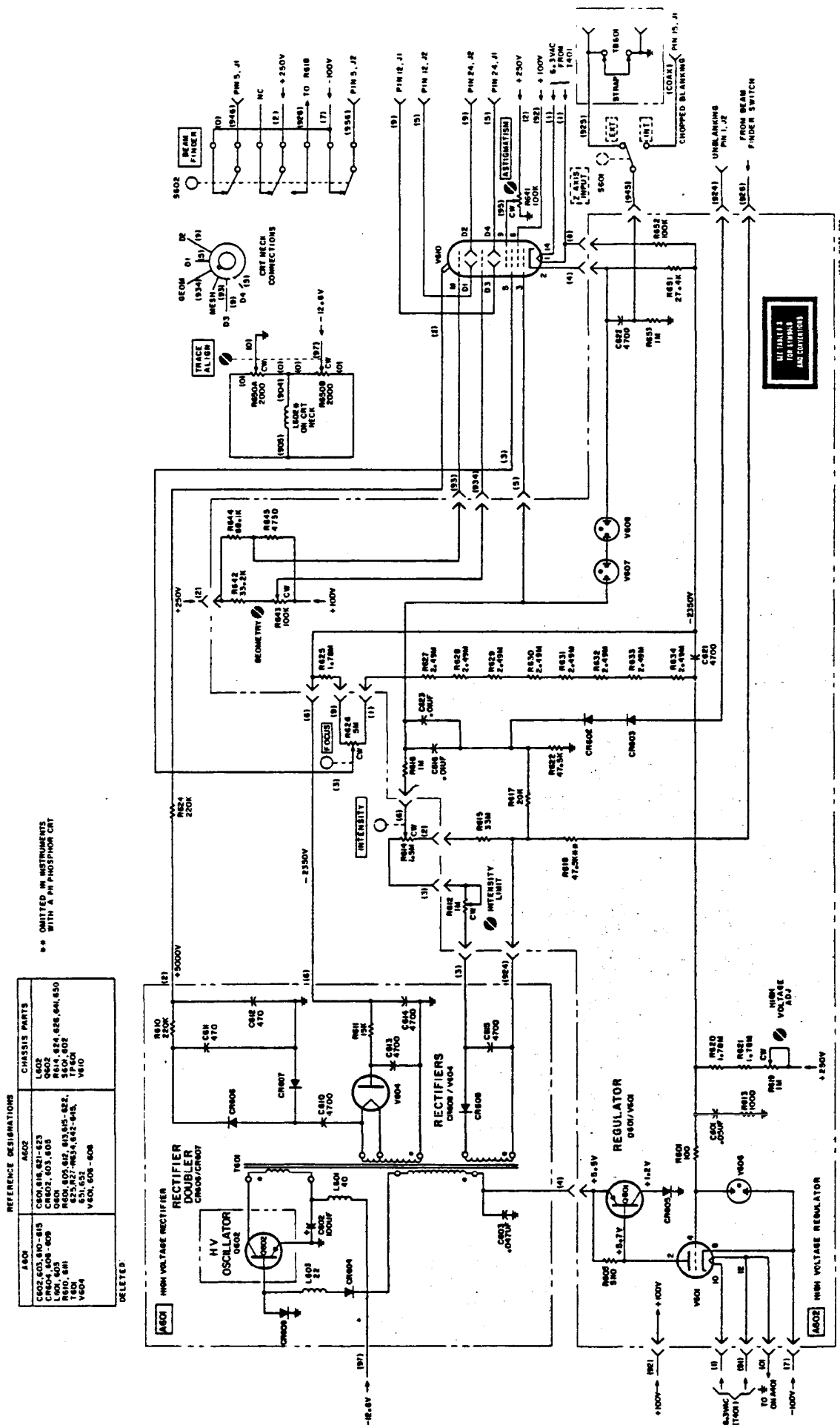
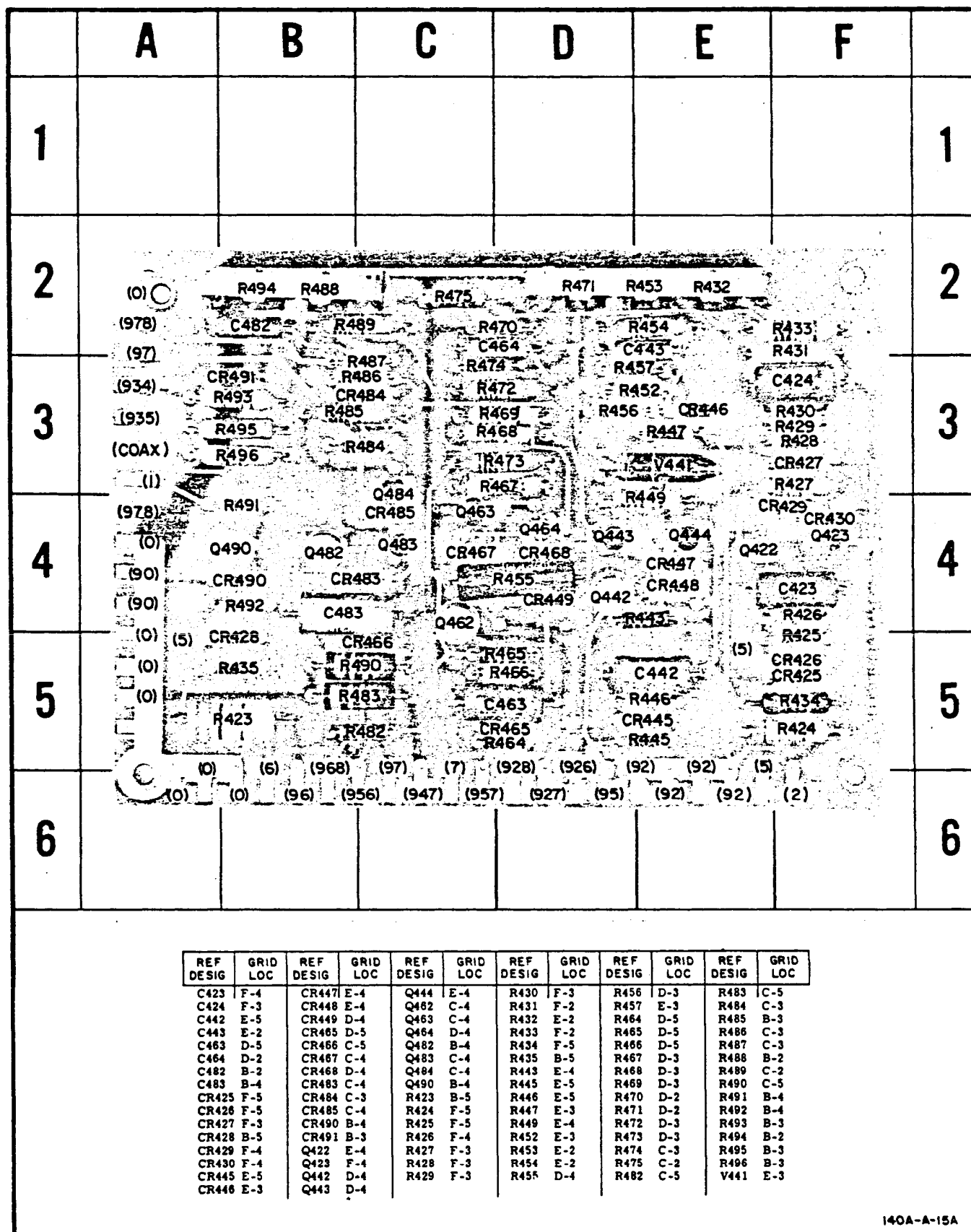


Figure 8-9. High Voltage Power Supply Schematic



140A-A-15A

Figure 8-4. Component Identification, Low Voltage Power Supply Board A401



MANUAL CHANGES

MODEL 140B

OSCILLOSCOPE

Manual Serials Prefixed: 908—

Manual Printed: FEB 1969

Make all changes listed below as Errata. Check the following table for your instrument serial prefix and/or serial number and make listed change(s) to the manual:

Serial Prefix or Number	Make Changes	Serial Prefix or Number	Make Changes
1119A	1		
1124A	1		
1321A	1		

ERRATA

- △ Add the following cautionary statement after the last paragraph in Section III:

CAUTION

This instrument is fitted with a plexiglass CRT safety faceplate (HP Part No. 5020-8728) for operator protection. To clean the CRT faceplate, use a soft cloth or tissue. Never use coarse or abrasive tissues because these will scratch the plexiglass.

Page 6-0, Figure 6-1,

Part 3: Change to Part Number 5060-0222.

Part 13: Change to Part Number 00140-24704.

Part 14: Change to Part Number 00140-24705.

Page 6-2, Table 6-2,

A601: Change HP Part No. 00140-66404 to 00140-60404.

C603: Change to HP Part No. 0160-0168, C: fxd my 0.1 uF 10% 200 wVdc.

△ Page 6-4, Table 6-2,

F401 (2110-0006): Change to HP Part No. 2110-0303, F: cartridge 2A 250V s-b (230V operation).

F421: Change to HP Part No. 2110-0067, F: cartridge 0.3A 250V.

Page 6-5, Table 6-2,

Q421: Change to HP Part No. 1853-0252, Q: Si pnp.

△ Page 6-6, Table 6-2,

R467: Change to HP Part No. 0757-0370, R: fxd metfilm 49.9k ohms 1% 1/2W.

R473: Change to HP Part No. 0757-0044, R: fxd metfilm 10.1k ohms 1% 1/2W.

△ Page 6-7, Table 6-2,

R619: Change to HP Part No. 2100-2108, R: var comp 1.5 megohm 30% lin 1/2W.

△ Page 6-8, Table 6-2,

R641: Change to HP Part No. 2100-0827, R: var comp 100k ohms 20% lin 2W.

S402: Change to HP Part No. 3101-1234, S: slide dpdt.

W401: Change to HP Part No. 8120-1545, W: power cord.

Page 6-9, Table 6-2, MISCELLANEOUS,

0905-0016: Change to HP Part No. 0460-0114, Tape industrial.

1200-0085: Change to HP Part No. 1200-0408.

00140-00602: Change to HP Part No. 00140-00601.

△ Page 6-10, Table 6-2,

Add: HP Part No. 4320-0095, Channel: rubber on main deck.

Add: HP Part No. 0400-0001, TQ4, Grommet: rubber.

01200-44703: Change to HP Part No. 00140-27412,

Support: CRT shield.

00140-61607: Change to HP Part No. 8120-1545,

Cable: primary power.

00140-60603: Change to HP Part No. 00140-60602,

Shield assy: CRT and 00140-61216, Bracket assy: CRT.

Page 8-9, Figure 8-9,

C603: Change value to 0.1 uf.

△ R619: Change value to 1.5M.

△ Page 8-7, Figure 8-5,

R467: Change value to 49.9K.

R473: Change value to 10.1K.

F421: Change value to 0.3A.

27 August 73

△ = Latest additions to this change sheet.

This change sheet supersedes all prior change sheets for this manual.

Supplement A for
00140-90909

CHANGE 1

Model 140B, Front Panel,

POWER: Change to LINE wherever applicable in manual.

Page 6-0, Figure 6-1,

Part 12: Change to HP Part Number 00140-60207.

Page 6-4, Table 6-2,

DS401: Change to HP Part No. 1450-0419.

J401: Change to HP Part No. 1251-2357.

Page 6-8, Table 6-2,

S402: Change to HP Part No. 3101-1234.

OPTIONS

Page 7-1/7-2,

Para. 7-9: Delete and replace with the following:

7-9. Options are factory installed modifications to the standard instrument. This manual applies to the modified equipment when amended as indicated

Page 7-1/7-2, (Cont'd)

below. For additional information concerning options, contact the nearest Hewlett-Packard Sales/Service Office listed in the rear of the manual.

OPTION 001

Factory set for operation from a 230 volt power source.

HP Part No.

2110-0006

Description

F: cartridge, 2 amp slow-blow

OPTION 002

This option replaces the standard CRT with one having type P2 phosphor.

HP Part No.

5083-2322

Description

V: general purpose CRT P2 phosphor aluminized with internal graticule.

OPTION 007

This option replaces the standard CRT with one having type P7 phosphor and an external amber filter.

HP Part No.

5020-0530

5083-2332

Description

Filter: amber.

V: long persistence CRT P7 phosphor aluminized with internal graticule.

OPTION 011

This option replaces the standard CRT with one having type P11 phosphor. When a P11 phosphor CRT is installed, R618 on the High Voltage Regulator assembly is removed to disable the intensification function of the beam finder circuit to prevent damage to the CRT.

HP Part No.

5083-2342

Description

V: fast writing rate CRT P11 phosphor aluminized with internal graticule.

OPTION 602

This option replaces the standard CRT with one having type P2 phosphor and no internal graticule.

HP Part No.

5083-2321

Description

V: general purpose CRT P2 phosphor aluminized without internal graticule.

OPTION 607

This option replaces the standard CRT with one having type P7 phosphor and no internal graticule. An external amber filter is also supplied.

HP Part No.

5020-0530

5083-2331

Description

Filter: amber.

V: long persistence CRT P7 phosphor aluminized without internal graticule.

OPTION 611

This option replaces the standard CRT with one having type P11 phosphor and no internal graticule. When a P11 phosphor CRT is installed, R618 on the High Voltage Regulator assembly is removed to disable the intensification function of the beam finder circuit to prevent damage to the CRT.

HP Part No.

5083-2341

Description

V: fast writing rate CRT P11 phosphor aluminized without internal graticule.

OPTION 631

This option replaces the standard CRT with one having type P31 phosphor and no internal graticule.

HP Part No.

5083-2351

Description

V: standard CRT P31 phosphor aluminized without internal graticule.

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Zona 9
GUATEMALA CITY
Tel: 316627, 314786, 664715
Telex: 4192 Teltro Gu
A,C,E,M,P

HONG KONG

Hewlett-Packard Hong Kong, Ltd.
Room 105, Austin Center
1st Floor
21 Austin Avenue
TST P.O. Box 98524
KOWLOON, Hong Kong
Tel: 3-721143/8
Telex: 36678 HEWPA HX
Cable: PASIALTO Hong Kong
E,CP,P

Hewlett-Packard Hong Kong, Ltd.
11th Floor, Four Seas Building
212 Nathan Road
P.O. Box 795
KOWLOON, Hong Kong
Tel: 3697446
Telex: 36678 HEWPA HX
Cable: HEWPACK Hong Kong
E,CP,P

Schmidt & Co. (Hong Kong) Ltd.
Wing On Centre, 28th Floor
Connaught Road, C.
HONG KONG
Tel: 5-455644
Telex: 74766 SCHMX HX
A,M

ICELAND

Elding Trading Company Inc.
Hafnarvok-Tryggvagolu
P.O. Box 895
IS-REYKJAVIK
Tel: 1-58-20, 1-63-03
M

INDIA

Blue Star Ltd.
Bhavdeep
Stadium Road
AHMEDABAD 380 014
Tel: 42932
Telex: 012-234
Cable: BLUEFROST
E

Blue Star Ltd.
11 Magarath Road
BANGALORE 560 025
Tel: 55668
Telex: 0845-430
Cable: BLUESTAR
A,CM,C,E

Blue Star Ltd.
Band Box House
Prabhadevi
BOMBAY 400 025
Tel: 45-73-01
Telex: 011-3751
Cable: BLUESTAR
A,M

Blue Star Ltd.
Sahas
414/2 Vir Savarkar Marg
Prabhadevi
BOMBAY 400 025
Tel: 46 65 55
Telex: 011-4093
Cable: FROSTBLUE
A,CM,C,E,M

Blue Star Ltd.
7 Hare Street
CALCUTTA 700 001
Tel: 12-01-31
Telex: 021-7655
Cable: BLUESTAR
A,M

Blue Star Ltd.
Meenakshi Mandiram
XXXXV/1379-2 Mahatma Gandhi
Road
COCHIN 682-016
Tel: 32069
Telex: 085-514
Cable: BLUESTAR
A*

Blue Star Ltd.
133 Kodambakkam High Road
MADRAS 600 034
Tel: 82057
Telex: 041-379
Cable: BLUESTAR
A,M

Blue Star Ltd.
Bhandari House, 7th/8th Floors
91 Nehru Place
NEW DELHI 110 024
Tel: 682547, 682970
Telex: 031-2463
Cable: BLUESTAR
A,CM,C,E,M

Blue Star Ltd.
1-1-117/1 Seropini Devi Road
SECUNDERABAD 500 033
Tel: 70126
Telex: 0155-459
Cable: BLUESTAR
A,E

Blue Star Ltd.
T.C. 7/603 Poornima
Maruthankuzhi
TRIVANDRUM 695 013
Tel: 65799
Telex: 0884-259
Cable: BLUESTAR
E

SALES & SUPPORT OFFICES

Arranged alphabetically by country



INDONESIA

BERCA Indonesia P.T.
P.O. Box 496/Jk1
J.L. Abdul Mus 62
JAKARTA
Tel: 373009
Telex: 46748 BERSAL IA
Cable: BERSAL
A,E,M,P
BERCA Indonesia P.T.
J.L. Jimento 23
SURABAYA
Tel: 42027
Telex: 31146 BERSAL S.D.
Cable: BERCACON
A*,E,M,P

IRAQ

Hewlett-Packard Trading S.A.
Mansoor City 98/3/7
BAGHDAD
Tel: 5514973
Telex: 2455 HEPARAO 1k
CP

IRELAND

Hewlett-Packard Ltd.
Kestrel House
Clanwilliam Place
Lower Mount Street
DUBLIN 2, Eire
Tel: 680424, 680426
Telex: 30439
A,E,P*
Hewlett-Packard Ltd.
2C Avonberg Ind. Est.
Long Mile Road
DUBLIN 12, Eire
Tel: 514322, 514224
Telex: 30439
A*,CP,E,MS,P*
Cardiac Services Ltd.
Kilmore Road
Artane
DUBLIN 5, Eire
Tel: (01) 315820
M

ISRAEL

Electronics & Engineering Div.
Motorola Israel Ltd.
16 Kremenetski Street
P.O. Box 25016
TEL-AVIV
Tel: 338973
Telex: 33569
Cable: BASTEL Tel-Aviv
A,CM,C,E,M,P

ITALY

Hewlett-Packard Italiana S.p.A.
Via Martin Luther King, 38/III
I-40132 BOLOGNA
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Telex: 511630
CM,CS,E,MS
Hewlett-Packard Italiana S.p.A.
Via G. Di Vittorio 9
I-20063 CERNUSCO SUL NAVIGLIO
Tel: (2) 903691
Telex: 334632
A,CM,CP,E,MP,P
Hewlett-Packard Italiana S.p.A.
Via Nuova san Rocco A
Capadimonte, 62A
I-80135 NAPOLI
Tel: (081) 7413544
A,CM,CS,E

Hewlett-Packard Italiana S.p.A.
Via Turazza 14
I-35100 PADOVA
Tel: (49) 664888
Telex: 430315
A,CM,CS,E,MS
Hewlett-Packard Italiana S.p.A.
Via G. Armellini 10
I-00143 ROMA
Tel: (06) 546961
Telex: 810514
A,CM,CS,E,MS,P*
Hewlett-Packard Italiana S.p.A.
Corso Giovanni Lanza 94
I-10133 TORINO
Tel: (011) 682245, 659308
Telex: 221079
CM,CS,E

JAPAN

Yokogawa-Hewlett-Packard Ltd.
Inoue Building
1348-3, Asahi-cho
ATSUGI, Kanagawa 243
Tel: (0462) 24-0451
CM,C*,E
Yokogawa-Hewlett-Packard Ltd.
Kumagaya Ashai Building
4 Tsuchikubo, 3-chome
KUMAGAYA, Saitama 360
Tel: (0485) 24-6563
CM,CS,E
Yokogawa-Hewlett-Packard Ltd.
Mito Mitsui Building
4-73, San-no-manu, 1-chome
MITO, Ibaragi 310
Tel: (0292) 25-7470
CM,CS,E
Yokogawa-Hewlett-Packard Ltd.
Sunitomo Seimei Bldg.
11-2 Shimo-sasajima-cho
Nakamura-ku
MAGOYA, Aichi 450
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CM,CS,E,MS
Yokogawa-Hewlett-Packard Ltd.
Chuo Bldg., 4TH FLOOR
54-20 Nishinakajima, 5-chome
Yodogawa-ku, Osaka-shi
OSAKA, 532
Tel: (06) 304-6021
Telex: 523-3624 YHPOSA
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2-24-1 Tsuruya-cho
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Telex: 382-3204 YHP YOK
CM,CS,E

JORDAN

Moussher Cousins Company
P.O. Box 1387
AMMAN
Tel: 21456, 24907, 39907
Telex: 21456 SABCO JO
E,M,P

KENYA

International Aeradio (E.A.) Ltd.
P.O. Box 95221
MOMBASA
M
ADCOM Ltd., Inc.
City House, Wabera Street
P.O. Box 30635
NAIROBI
Tel: 331955
Telex: 22639
A*,E,M
International Aeradio (E.A.) Ltd.
P.O. Box 19012
Nairobi Airport
NAIROBI
Tel: 336055, 336056
Telex: 22201, 22301
M

KOREA

Samsung Electronics
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SEOUL
Tel: 8334311, 8330002, 8330006
Telex: SAMSAN 27364
A,C,E,M,P

KUWAIT

Al-Khaldiya Trading & Contracting
P.O. Box 830 Safat
KUWAIT
Tel: 42-4910, 41-1726
Telex: 2481 Areeg kl
A,E,M
Photo & Cine Equipment
P.O. Box 270 Safat
KUWAIT
Tel: 42-2846, 42-3801
Telex: 2247 Malin
P

LUXEMBOURG

Hewlett-Packard Belgium S.A./N.V.
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Telex: 23-494 paloben bru
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MALAYSIA

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Bangunan Angkasa Raya
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KUALA LUMPUR
Tel: 483544
Telex: MA31011
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Protel Engineering
P.O. Box 1917
Lot 319, Salok Road
Kuching, SARAWAK
Tel: 53544
Telex: MA 70904 PROMAL
Cable: PROTELENG
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C.V.
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A,CP,E,MS,P

Hewlett-Packard Mexicana, S.A. de
C.V.
Rio Volga #600 Colonia del Valle
MONTERREY, N.L.
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Telex: 038-410
CS

MOROCCO

Doibau
81 rue Karatchi
CASABLANCA
Tel: 3041-82, 3068-38
Telex: 23051, 22822
E
Gerep
2 rue d'Agadir
Boite Postale 156
CASABLANCA
Tel: 272093, 272095
Telex: 23 739
P

MOZAMBIQUE

A.N. Goncalves Ltd.
162, 1° Apt. 14 Av. D. Luis
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MAPUTO
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Telex: 6-203 NEGON Mo
Cable: NEGON
A,E,M,P

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Hewlett-Packard Nederland B.V.
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Telex: 21261 hepac nl
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Northrop Instruments & Systems
Ltd.

Eden House, 44 Khyber Pass Road
P.O. Box 9682
Newmarket, AUCKLAND
Tel: 794-091
A,M

Northrop Instruments & Systems
Ltd.

Terrace House, 4 Oxford Terrace
P.O. Box 8388
CHRISTCHURCH
Tel: 64-165
A,M

Hewlett-Packard (N.Z.) Ltd.
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Kilbirnie, WELLINGTON 3
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CM,CP,E,P

Northrop Instruments & Systems
Ltd.

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WELLINGTON
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Telex: NZ 31296
A,M

NIGERIA

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Ltd.
N6B/770 Oyo Road
Olusun House
P.M.B. 5402
IBADAN
Tel: 461577
Telex: 31231 TEL NG
A,E,M,P
The Electronics Instrumentations
Ltd.
144 Agege Motor Road, Mushin
P.O. Box 6645
Mushin, LAGOS
A,E,M,P

NORTHERN IRELAND

Cardiac Services Company
95A Finaghy Road South
BELFAST BT 10 0BY
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Telex: 747626
M

NORWAY

Hewlett-Packard Norge A/S
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N-5013 Nygaardspaten, BERGEN
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Telex: 16621 hpnas n
CM,CS,E
Hewlett-Packard Norge A/S
Oestendalen 18
P.O. Box 34
N-1345 OESTERNAAS
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Telex: 16621 hpnas n
A*,CM,CP,E,MS,P

OMAN

Khimji Ramdas
P.O. Box 19
MUSCAT
Tel: 72-22-17, 72-22-25
Telex: 3289 BROKER MB MUSCAT
P

PAKISTAN

Mushko & Company Ltd.
10, Bazar Road
Sector G-6/4
ISLAMABAD
Tel: 28624
Cable: FEMUS Rawalpindi
A,E,M,P
Mushko & Company Ltd.
Oostman Chambers
Abdullah Haroon Road
KARACHI 0302
Tel: 511027, 512927
Telex: 2894 MUSHKO PK
Cable: COOPERATOR Karachi
A,E,M,P*



SALES & SUPPORT OFFICES

Arranged alphabetically by country

PANAMA

Electronica Balboa, S.A.
Apartado 4929
Panama 5
Calle Samuel Lewis
Edificio "Alfa" No. 2
CIUDAD DE PANAMA
Tel: 64-2700
Telex: 3480380
Cable: ELECTRON Panama
A,E,M,P
Foto Internacional, S.A.
P.O. Box 2068
Free Zone of Colon
COLON 3
Tel: 45-2333
Telex: 3485126
Cable: IMPORT COLON/Panama
P

PERU

Companie Electro Medica S.A.
Los Flamencos 145, San Isidro
Casilla 1030
LIMA I
Tel: 41-4325
Telex: Pub. Booth 25424 SISIDRO
Cable: ELMED Lima
A,E,M,P

PHILIPPINES

The Online Advanced Systems
Corporation
Rico House, Amoroso Cor. Herrera
Street
Legaspi Village, Makati
P.O. Box 1510
Metro MANILA
Tel: 85-35-81, 85-34-91, 85-32-21
Telex: 3274 ONLINE
A,C,E,M
Electronic Specialists and
Proponents Inc.
890-B Epitacio de los Santos
Avenue
Cubao, QUEZON CITY
P.O. Box 2649 Manila
Tel: 98-96-81, 98-96-82, 98-96-83
Telex: 742-40287
Cable: ESPINC MANILA
P

POLAND

Buro Informacji Technicznej
Hewlett-Packard
Ul Stawki 2, 6P
P.O. 950 WARSZAWA
Tel: 39-59-62, 39-67-43
Telex: 81 24 53
A,C*,E*,M*,P*

PORTUGAL

Telectra-Empresa Tecnica de
Equipamentos Electronicos S.a.r.l.
Rua Rodrigo de Fonseca 103
P.O. Box 2531
P-LISBON 1
Tel: (19) 68-60-72
Telex: 12598
A,C,E,P
Mundinter
Intercambio Mundial de Comercio
S.a.r.l.
P.O. Box 2761
Avenida Antonio Augusto de Aguiar
138
P-LISBON
Tel: (19) 53-21-31, 53-21-37
Telex: 16691 munter p
M

PUERTO RICO

Hewlett-Packard Puerto Rico
Calle 272
#203 Urb. Country Club
RIO PIEDRAS, Puerto Rico 00924
Tel: (809) 762-7255
Telex: 345 0514
A,CP

QATAR

Business Communications Qatar
P.O. Box 3656
DOHA
Tel: 5851
Telex: 4454
P
Nasser Trading & Contracting
P.O. Box 1563
DOHA
Tel: 22170
Telex: 4439 NASSER
M

RHODESIA

Field Technical Sales
45 Kelvin Road North
P.O. Box 3548
SALISBURY
Tel: 705231
Telex: RH 4122
A,E,M,P

ROMANIA

Hewlett-Packard Reprezentanta
Boulevard Nicolae Balcescu 16
BUCURESTI
Tel: 130725
Telex: 10440
C*,E*

SAUDI ARABIA

Modern Electronic Establishment
P.O. Box 193
AL-KHOBAR
Tel: 44-678, 44-813
Telex: 670136
Cable: ELECTA AL-KHOBAR
C,E,M,P
Modern Electronic Establishment
P.O. Box 1228, Baghdadiah Street
JEDDAH
Tel: 27-798
Telex: 401035
Cable: ELECTA JEDDAH
C,E,M,P
Modern Electronic Establishment
P.O. Box 2728
RIYADH
Tel: 62-596, 66-232
Telex: 202049
C,E,M,P

SCOTLAND

Hewlett-Packard Ltd.
Royal Bank Buildings
Swan Street
BRECHIN, Angus, Scotland
Tel: 3101, 3102
CM,CS
Hewlett-Packard Ltd.
SOUTH QUEENSFERRY
West Lothian, EH30 9TG
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Tel: (031) 3311000
Telex: 72682
CM,CP,E,MS

SINGAPORE

Hewlett-Packard Singapore (Pte.)
Ltd.
6th Floor, Inchcape House
450-452 Alexandra Road
SINGAPORE 0511
P. O. Box 58 Alexandra Post Office
Singapore 9115
Tel: 631788
Telex: HPSGSO RS 32409
Cable: HEWPACK, Singapore
A,CP,E,MS,P

SOUTH AFRICA

Hewlett-Packard South Africa (Pty.)
Ltd.
Pine Park Center
Forest Drive, Pinelands
CAPE PROVINCE, 7405
P.O. Box 120
Howard Place
CAPE PROVINCE 7450
Tel: 53-7955, 53-7956, 53-7957,
53-7958, 53-7959
Telex: 57-0006
A,CM,CS,E,MS,P
Hewlett-Packard South Africa (Pty.)
Ltd.
P.O. Box 37068
Overport
DURBAN 4067
Tel: 28-4178, 28-4179, 28-4110
CM,CS
Hewlett-Packard South Africa (Pty.)
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Hewlett-Packard Centre
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A,CM,CP,E,MS,P

SPAIN

Hewlett-Packard Espanola S.A.
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E-BARCELONA 29
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Telex: 52603 hpbe e
A,CM,CP,E,MS,P
Hewlett-Packard Espanola S.A.
c/San Vicente s/n
Edificio Albia II, 7°B
E-BILBAO 1
Tel: 423-62-06, 423-83-06
A,CM,E,MS
Hewlett-Packard Espanola S.A.
Calle Jerez 3
E-MADRID 16
Tel: (1) 458-2600
Telex: 23515 hpe
A,CM,E,MP,P
Hewlett-Packard Espanola S.A.
Colonias Miraserra
Edificio Juban
c/o Costa Brava 13
E-MADRID 34
Tel: (1) 734-8061, 734-1162
CM,CP
Hewlett-Packard Espanola S.A.
Av Ramon y Cajal 1
Edificio Sevilla 1, Planta 9
E-SEVILLA 5
Tel: (954) 64-44-54, 64-44-58
A,CM,CS,MS,P
Hewlett-Packard Espanola S.A.
C/Ramon Gorrillo 1 (Entlo.)
E-VALENCIA 10
Tel: (96) 361-1354
CM,CS,P

SRI LANKA

Metropolitan Agencies Ltd.
209/9 Union Place
COLOMBO 2
Tel: 35947
Telex: 1377METROLTD CE
Cable: METROLTD
A,E,M,P

SUDAN

Radison Trade
P.O. Box 921
KHARTOUM
Tel: 44048
Telex: 375
A,E,M

SURINAM

Surtel Radio Holland N.V.
Grote Hofstr. 3-5
P.O. Box 155
PARAMARIBO
Tel: 72118, 77880
Cable: Surtel
E,M

SWEDEN

Hewlett-Packard Sverige AB
Enighetsvagen 3
S-16120 BROMMA
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Telex: (854) 10721 MESSAGES
Cable: MEASUREMENTS
A,CM,CP,E,MS,P
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Sunnarvagen 14K
S-22226 LUND
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CM,CS
Hewlett-Packard Sverige AB
Vestra Vintergatan 9
S-70344 OREBRO
Tel: (019) 14-07-20
CM,CS
Hewlett-Packard Sverige AB
Frotallsgatan 30
S-42132 VASTRA-FROLUNDA
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Telex: 85410721
CM,CS,E,P

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A,CM
Hewlett-Packard (Schweiz) AG
Bahnhofstrasse 44
3018 BERN
Tel: (031) 56-24-22
CM
Hewlett-Packard (Schweiz) AG
47 Avenue Blanc
CH-1202 GENEVA
Tel: (022) 32-30-05, 32-48-00
CM,CP
Hewlett-Packard (Schweiz) AG
29 Chemin Chateau Bloc
CH-1219 LE LIGNON-Geneva
Tel: (022) 96-03-22
Telex: 27333 hpag ch
Cable: HEWPACKAG Geneva
A,CM,E,MS,P
Hewlett-Packard (Schweiz) AG
Zurichstrasse 20
P.O. Box 307
CH-8952 SCHLIEREN-Zurich
Tel: (011) 730-5240, 730-1821
Telex: 53933 hpag ch
Cable: HPAG CH
A,CM,CP,E,MS,P

SYRIA

General Electronic Inc.
Nuri Basha-Ahmad Ebn Kays Street
P.O. Box 5781
DAMASCUS
Tel: 33-24-87
Telex: 11215 ITRAL
Cable: ELECTROBOR DAMASCUS
E
Sawah & Co.
Place Azme
Boite Postale 2308
DAMASCUS
Tel: 16-367, 19-697, 14-268
Telex: 11304 SATACO SY
Cable: SAWAH, DAMASCUS
M
Suleiman Hial El Mawi
P.O. Box 2528
Mamoun Bilar Street, 56-58
DAMASCUS
Tel: 11-46-63
Telex: 11270
Cable: HILAL DAMASCUS
M

TAIWAN

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CS,E,MS,P
Hewlett-Packard Far East Ltd.
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TAIPEI
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Cable: HEWPACK Taipei
A*,CP,E,MS,P
San Kwang Instruments Co., Ltd.
20 Yung Sui Road
TAIPEI
Tel: 361-5446, 361-5447,
361-5448, 361-5449
Telex: 22894 SANKWANG
Cable: SANKWANG Taipei
A

TANZANIA

International Aeradio (E.A.) Ltd.
P.O. Box 861
DAR ES SALAAM
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Telex: 41030
M

THAILAND

UNIMESA Co. Ltd.
Ecom Research Building
2538 Sukhumvit Ave.
Bangchak, BANGKOK
Tel: 393-2387, 393-0338
Telex: TH81160, 82938, 81038
Cable: UNIMESA Bangkok
A,E,M
Bangkok Business Equipment Ltd.
5/5-6 Dejo Road
BANGKOK
Tel: 234-8670, 234-8671,
234-8672, 234-8673
Cable: BUSIOUPT Bangkok
P

TRINIDAD & TOBAGO

CARTEL
Caribbean Telecoms Ltd.
P.O. Box 732
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PORT-OF-SPAIN
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A,E,M,P

SALES & SUPPORT OFFICES

Arranged alphabetically by country

5



TUNISIA

Tunis Electronique
31 Avenue de la Liberté
TUNIS
Tel: 280-144
E,P

Corema
1 ter. Av. de Carthage
TUNIS
Tel: 253-821
Telex: 12319 CABAM TH
M

TURKEY

Tekrim Company Ltd.
Rıza Sah Pehlivi
Caddesi No. 7
Kavaklıdere, ANKARA
Tel: 275800
Telex: 42155
E

UNITED ARAB EMIRATES

Emiac Ltd.
P.O. Box 2711
ABU DHABI
Tel: 331370, 331371
E,M,P

Emiac Ltd.
P.O. Box 1641
SHARJAH
Tel: 354121, 354123
Telex: 68136
E,M,P

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UNITED STATES OF AMERICA

Alabama

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