Errata

Title & Document Type: **180ER Oscilloscope Operating and Service Manual**

Manual Part Number: **00180-90002**

Revision Date: **March 1970**

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HP References in this Manual

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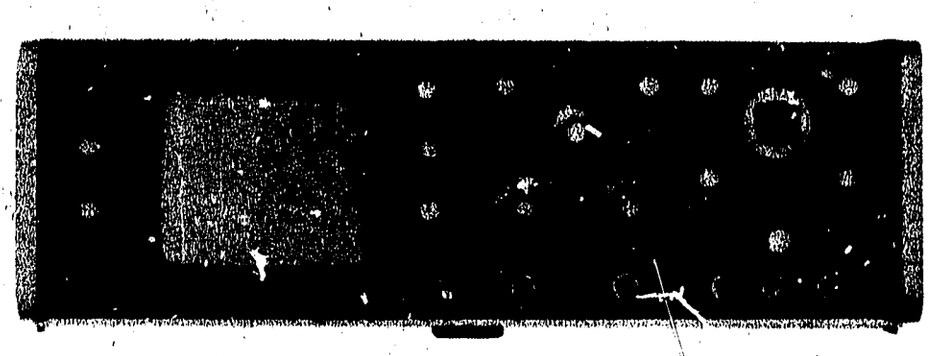
OPERATING AND SERVICE MANUAL

OSCILLOSCOPE

180ER



HEWLETT hp PACKARD

HP 180ER

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 180ER
OSCILLOSCOPE

SERIALS PREFIXED: 915-

Refer to Section VII for instruments with other Serial Prefixes.

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

PRINTED: MAR 1970

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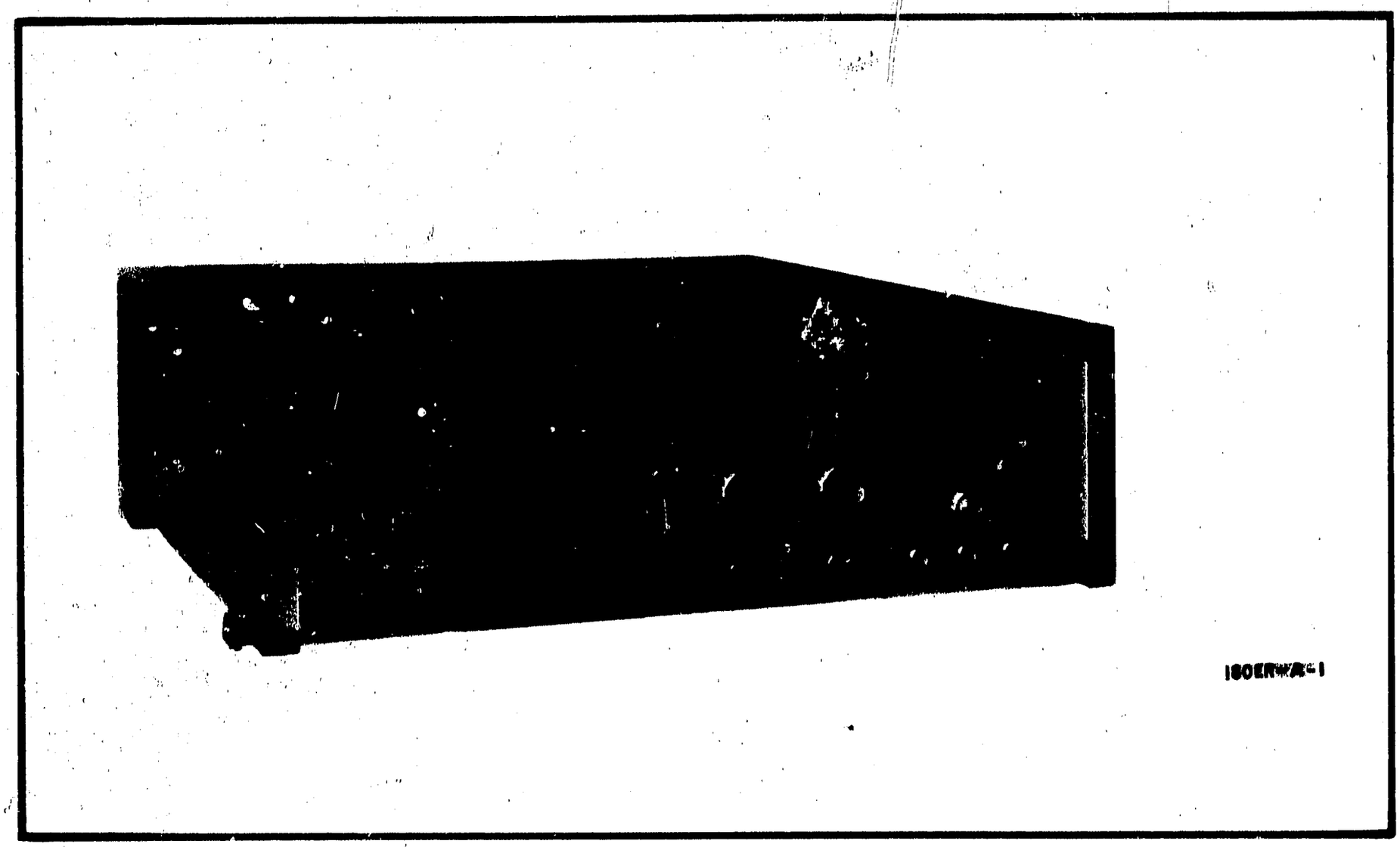


Figure 1-1. Model 180ER Oscilloscope

SECTION I

GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Model 180ER, Figure 1-1, is a light-weight, general-purpose oscilloscope with plug-in capabilities that may be rack mounted as described in Section II.

1-3. All active components in the Model 180ER are solid state devices (no vacuum tubes except the CRT). The model 180ER is convection cooled and operates from −28°C to +65°C.

1-4. The horizontal amplifier bandwidth is dc to 5 MHz with direct coupling and 5 Hz to 5 MHz with capacitive coupling. A BNC connector is provided to attach an external deflection signal. The amplifier's dynamic range is ±5V. The deflection factor is adjustable between 0.1 V/div to 1 V/div.

1-5. A BNC connector is provided to connect an external intensity modulation signal. The input resistance is 5100 ohms. Approximately +2 Vdc to 15 MHz blanks a beam of normal intensity.

1-6. Four other BNC connectors are provided to couple signals from the plug-ins to external equipment. Since these outputs are dependent upon the specific plug-ins, refer to applicable plug-in manuals for identification. The outputs can supply 3 mA and will drive impedances as low as 1 kilohm without distortion.

1-7. A 1 kHz square wave signal at two amplitudes, 250 mV and 10V, is available at the front panel. Its amplitude is accurate to 1% and its risetime is 3 usec. The signal may be used to adjust horizontal and vertical deflection factors and to compensate divider probes.

1-8. CATHODE-RAY TUBE.

1-9. The Model 180ER uses an internal graticule CRT which eliminates display parallax. The CRT is furnished with P31 aluminized phosphor and is equipped with a safety faceplate. P2, P7, and P11 phosphors are also available.

1-10. WARRANTY.

1-11. This instrument is certified and warranted as stated on the inside front cover of this manual. The CRT, however, is covered by a warranty separate from the rest of the instrument. The CRT warranty and warranty claim forms are located at the rear of this manual. Should the CRT fail within the time specified on the warranty, return the CRT with the warranty form completed.

1-12. INSTRUMENT IDENTIFICATION.

1-13. Hewlett-Packard uses a two-section eight-digit serial number to identify instruments. The first three digits (preceding the dash) are the serial prefix which identifies a series of instruments; the last five digits identify a particular instrument in the series. The serial number appears on a plate located on the rear panel. All correspondence with a Hewlett-Packard Sales/Service Office in regard to an instrument should reference the complete serial number.

1-14. MANUAL CHANGES.

1-15. This manual provides operating and service information for the HP Model 180ER Oscilloscope. Information in this manual applies directly to instruments (as manufactured) with serial numbers prefixed by the three digits indicated on the title page. If the serial prefix of the instrument is different from that on the title page, a MANUAL CHANGES sheet supplied, or Section VII of this manual, will describe changes which will adapt this manual to provide correct coverage. Technical corrections (if any) to this manual, due to known errors in print, are called Errata and are shown on the change sheet. For information on manual coverage of any HP instrument, contact the nearest HP Sales/Service Office (addresses are listed at the rear of this manual).

1-16. ACCESSORIES FURNISHED.

1-17. The Model 180ER Oscilloscope is equipped with a mesh contrast filter, and a detachable power cord. Also included with the Model 180ER is a rack mounting kit.

1-18. The mesh contrast filter snaps into place under the light shield and provides increased display visibility. All parts and hardware required to convert the Model 180ER for rack mounting are provided in the kit supplied.

1-19. AVAILABLE ACCESSORIES.

1-20. A series of mobile test stands are available for the Model 180ER. The Model 1119A/B Testmobiles are intended for use with the rack mounted model 180ER. The Model 1119-series Testmobiles are general purpose test stands designed for maximum utility while requiring a minimum of floor space. These testmobiles allow the instrument to be tilted at least 40 degrees above and below horizontal in 10 degree steps.

1-21. A front-panel cover of fiberglass material, HP Model No. 5060-0437, can be used to provide front-panel protection for the Model 180ER.

1-22. For ease of calibration and maintenance, an HP Model 10407A Plug-in Extender is available. It provides for removal of the plug-ins from the frame and exposes components and adjustments for servicing.

1-23. Cameras, probes, viewing hoods, terminations, and other accessory items are available for specilized requirements. Information on these and the above described accessories may be obtained from HP Sales/Service Offices listed in the rear of this manual.

Table 1-1. Specifications

CATHODE-RAY TUBE AND CONTROLS

Type: Post accelerator, 12 kV accelerating potential; aluminized P31 phosphor (other phosphors available) NESA coated conductive safety glass face plate.

Graticule: 8x10 cm parallax-free internal graticule.

Display Area: Meets MIL-0-24311 (EC) for 10 cm horizontal and 6 cm vertical display area, ±3 cm about the center horizontal graticule line. The additional centimeter at the top and bottom of the graticule provides additional viewing area.

Beam Finder: FIND BEAM control brings trace to CRT screen regardless of horizontal, vertical, or intensity control settings.

Intensity Modulation: Approximately +2V ⩾ 50 ns pulse width (X10 MHz cw) blanks trace of normal intensity. Input resistance approximately 5100 ohms.

Intensity: Adjusts beam intensity from extinguished to a point that overrides the unblanking gate.

Focus: Adjusts spot for minimum size within the 6x10 cm CRT graticule area.

Astigmatism: A front-panel screwdriver control provides circular adjustment of spot.

Trace Align: A front-panel screwdriver control to align the trace with the horizontal graticule within ±2°.

Calibrator: 1 kHz square wave, <3 usec risetime, 10V and 250 mV amplitude, ±2%.

HORIZONTAL AMPLIFIER

Bandwidth: DC to 5 MHz dc-coupled; 5 Hz to 5 MHz ac-coupled.

Deflection Factor: Adjustable from 0.1 V/div to 1.0 V/div.

Input Impedance: 1 megohm ±2% shunted by <35 pF.

Positioning Controls: Coarse and fine positioning controls position the start of a trace over any horizontal point on the screen.

Horizontal Magnifier: X1, X5, X10, ±5%, (for 3% accuracy time base plug-ins).

Outputs: Four rear-panel emitter follower outputs for main and delayed gates, main and delayed sweeps; maximum current available ±3 mA. Will drive impedances as low as 1000 ohms without distortion.

Accessories Furnished: Mesh Contrast Filter and Rack Mounting Kit.

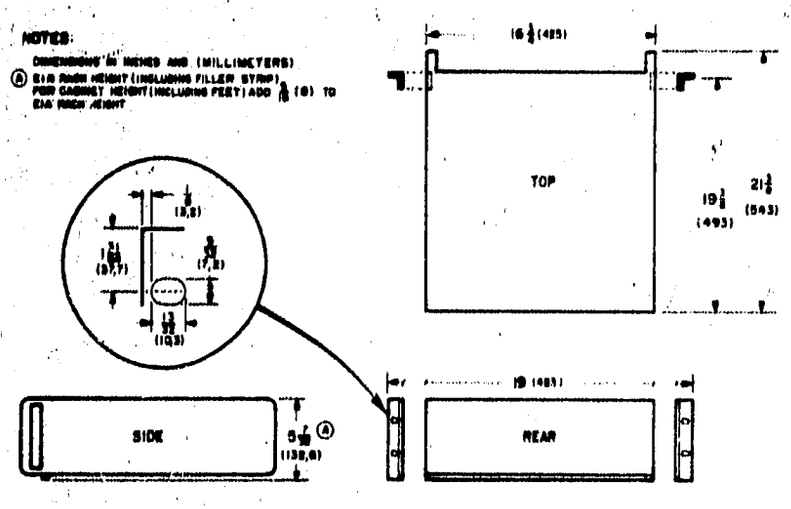
GENERAL

Weight: 28 lbs 8 oz without plug-ins. (12,9 kg). Shipping 43 lbs (19,5 kg).

Power: 115V or 230V ±10%, 50 to 400 Hz, 125 watts max.

Case: Instrument is enclosed in a removable, louvered combination cover and case.

Dimensions: See outline drawing.



ENVIRONMENTAL

Temperature: Non-operating –62°C to +75°C (storage). Operating –28°C to +65°C.

Humidity: Operating 0 to 95% relative humidity over entire specified temperature range.

Altitude: Non-operating – Sea level to 50,000 ft. Operating – Sea level to 25,000 ft.

Vibration: Operating -5 Hz to 15 Hz .030 ± 0.006 inches, 16 Hz to 25 Hz .020 ± 0.004 inches, 26 Hz to 33 Hz 0.010 ± 0.0002 inches.

Shock: 10 Gs for 11±1 msec to each of the 6 sides method as per MIL-E-7940A Procedure 11 (sand-box).

Inclination: Operating – Per MIL-E-16400.

Electromagnetic Interference: Per MIL-STD-462 performed by MIL-STD-461 for the following test:

a. CE01 30 Hz to 20 kHz power leads
b. CE03 0.02 Hz to 50 MHz power leads
c. CS01 0.03 Hz to 50 kHz power leads
d. CS02 0.05 Hz to 400 MHz power leads
e. CS06 Spike power leads
f. RE01 0.03 Hz to 30 kHz, Mag. Field
g. RE02 14 kHz to 10 GHz, Elect. Field
h. RS01 0.03 Hz to 30 kHz, Mag. Field
i. RS03 14 kHz to 10 GHz, Elect. Field

Reliability: Tested per MIL-0-23411 (EC). Instruments operated for total of 2630 operating hours at 40°C. and vibrated at 25 Hz with an amplitude of 0.020 inch for 10 minutes of each hour of "ON" time during each day of the eight hour manned cycle. The input power was removed for 10 minutes of each 4 hours during the same manned test schedule. Proven MTBF of 600 hours with 99% confidence level.

SECTION II

INSTALLATION

2-1. INITIAL INSPECTION.

2-2. MECHANICAL CHECK. Check the shipping carton for damage immediately after receipt. If it is damaged, ask the carrier's agent to be present when the instrument is unpacked. Inspect the Model 180ER for physical damage such as bent or broken parts and dents or scratches. If damage is found, refer to Paragraph 2-4 for recommended claim procedure. If the Model 180ER appears undamaged, perform the electrical check below. Retain the packaging material for possible future use.

2-3. ELECTRICAL CHECK. The performance check is given in Section V. This check will determine whether or not the instrument is operating within its specifications as listed in Table 1-1. The initial performance and accuracy of this instrument are certified as stated on the inside front cover of this manual. If the Model 180ER does not operate as specified, refer to Paragraph 2-4 for recommended claim procedure.

2-4. CLAIMS.

2-5. If physical damage is found or if the instrument is not within specifications when 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 a claim to be settled with the carrier.

2-6. The warranty statement for all Hewlett-Packard products is on the inside front cover of this manual. Contact the nearest Sales/Service Office for information about warranty claims.

2-7. REPACKAGING FOR SHIPMENT.

2-8. If the instrument is to be shipped to a Hewlett-Packard Sales/Service Office, attach a tag to it showing owner's name and address, instrument's model number and eight-digit serial number, and a description of service required.

2-9. The original shipping carton and packaging materials should be used for reshipment. If they are not available or reusable, the instrument should be repackaged with the following materials:

a. A double-walled carton (refer to Table 2-1 for test strength required).

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

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

d. Heavy duty shipping tape to secure outside of carton.

Table 2-1. Shipping Carton Test Strength

Gross Weight (lbs)	Carton Test Strength (lbs)
up to 20	200
10 to 30	275
30 to 120	350
120 to 140	500
140 to 160	600

2-10. PREPARATION FOR USE.

2-11. POWER REQUIREMENTS.

2-12. The standard Model 180ER requires either a 115 or 230V ±10%, single phase, 50 to 400 Hz power source that can deliver 110 watts. Options 003 and 004 provide for 100/200V or 110/220V operation respectively (refer to Section VIII).

a. 115V OPERATION. This instrument, as shipped, is ready for operation on 115 Vac. Refer to the following paragraph for 230 Vac operation.

CAUTION

Before applying power, check the rear-panel slide switch for proper position (115 or 230).

b. 230V OPERATION. If the instrument is to be operated on 230 Vac, set the rear-panel switch to 230. It is not necessary to replace the 115V fuse. Positioning the 115/230 switch selects the proper fuse for the desired voltage.

2-13. THREE-CONDUCTOR POWER CABLE.

2-14. The National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and

cabinet be grounded to protect the operating personnel. The Model 180ER is equipped with a three-conductor power cord which, when plugged into an appropriate outlet, grounds the instrument through the round offset pin. When operating the Model 180ER from a two-contact outlet, use a three-conductor to two-conductor adapter. Preserve the safety feature by grounding the adapter lead.

2-15. INSTRUMENT MOUNTING.

2-16. BENCH USE. The Model 180ER, as shipped from the factory, is intended for bench use. The instrument, however, may be rack mounted as described below.

2-17. RACK MOUNTING. A kit for converting the Model 180ER to a rack mount configuration is supplied with each instrument. Instructions for making the conversion are given below. See Figure 2-1 for parts identification.

a. Detach tilt stand by pressing it away from the front feet. Remove all plastic feet by depressing metal button and sliding feet free.

b. Remove aluminum trim strip from each side of instrument with a thin blade tool.

c. Attach rack mounting flange in space where trim strip was removed (use screws provided with kit). Large notch of flange should be positioned at bottom of instrument.

2-18. INSTRUMENT COOLING.

2-19. The Model 180ER does not require forced-air cooling when operated in an ambient temperation of –28 to +65 degrees centigrade. Normal air circulation will maintain a reasonable temperature within the instrument.

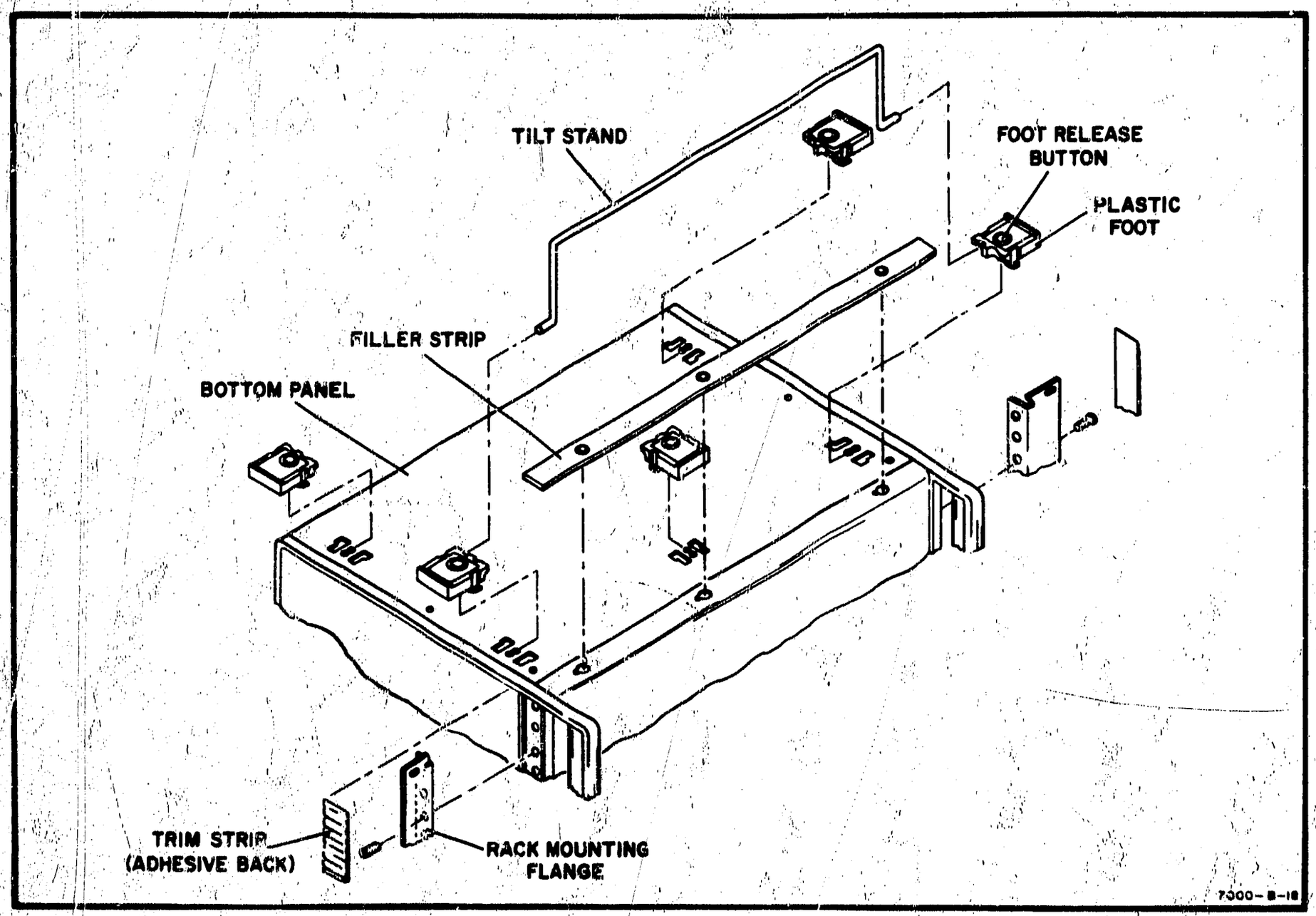
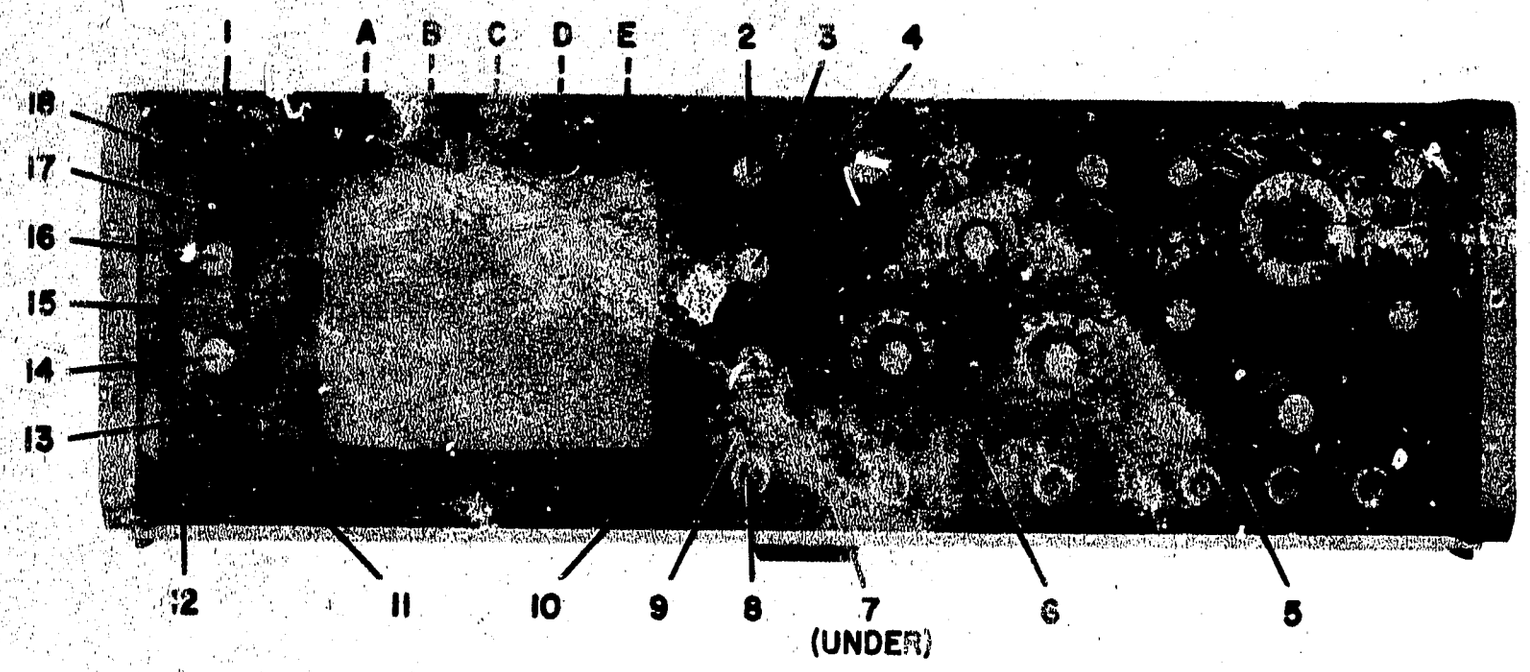


Figure 2-1. Rack Mount Procedure

OPERATION



180ER-A-2

1. FIND BEAM. Returns display to CRT.
2. POSITION. Coarse adjustment of display's horizontal position.
3. FINE. Fine adjustment of display's horizontal position.
4. MAGNIFIER. Magnifies horizontal display.
5. HORIZONTAL PLUG-IN.
6. VERTICAL PLUG-IN.
7. PHASE/BANDWIDTH. Selects between normal operation (BANDWIDTH) and X-Y operation (PHASE).
8. EXT INPUT. BNC connector for applying an external horizontal input signal to the oscilloscope.
9. AC/DC. Selects AC or DC coupling for the external horizontal input signal.
10. DISPLAY. Selects source of horizontal input signal.
11. POWER. Toggle switch for turning oscilloscope on and off.
12. CALIBRATOR. Provides a 1 kHz square wave at two amplitudes; 250 mV and 10V pk-pk.
13. INDICATOR. Power on/off.
14. SCALE. Controls overall brightness of CRT face.
15. TRACE ALIGN. Rotates trace around center of CRT face.
16. FOCUS. Controls sharpness of writing beam.
17. ASTIGMATISM. Adjusts roundness of writing spot.
18. INTENSITY. Controls brightness of display.

REAR PANEL

A. Z-AXIS INPUT. BNC for applying an external intensification or blanking signal to the oscilloscope.

B. MAIN SWEEP OUTPUT. BNC for connecting main sweep signal to external equipment.

C. DELAYED SWEEP OUTPUT. BNC for connecting delayed sweep signal to external equipment.

D. DELAYED GATE OUTPUT. BNC for connecting delayed gate signal to external equipment.

E. MAIN GATE OUTPUT. BNC for connecting main gate signal to external equipment.

Figure 3-1. Controls and Connectors

SECTION III

OPERATION

3-1. INTRODUCTION.

3-2. The Model 180ER is a light-weight, general-purpose oscilloscope with plug-in capabilities. The plug-in compartment is located to the right of the CRT. The horizontal plug-in goes into the right side of the compartment and the vertical into the left. The plug-ins must be locked together before being inserted into the compartment (see plug-in manuals).

3-3. CONTROLS AND CONNECTORS.

3-4. Location of controls and connectors is shown in Figure 3-1 along with a brief description of their functions. The following paragraphs explain some functions in more detail.

3-5. FRONT PANEL.

3-6. CALIBRATOR. The 10V and 250 mV, 1 kHz square-wave outputs of the CALIBRATOR may be used for vertical and horizontal sensitivity calibration, and for divider probe compensation. The amplitude is accurate to ±1% from −28°C to +65°C (−82°F to 149°F). Risetime of the signal is 3 usec

3-7. SCALE. This control adjusts the over-all brightness of the CRT face. It should be adjusted for good contrast between the background and the graticule. The SCALE control is especially useful when using a hood to view the display or when photographing waveforms. Rotate SCALE to OFF when scale illumination is not needed.

3-8. TRACE ALIGN. The TRACE ALIGN adjustment compensates for external magnetic fields that may affect the alignment of the horizontal trace with the graticule. The alignment should be checked when the instrument is moved to a new location and adjustment made whenever necessary.

3-9. FOCUS AND ASTIGMATISM. Both of these controls are used to obtain the sharpest display. Normally, once set, ASTIGMATISM will not need to be readjusted. It may need readjustment however, when the vertical plug-in is changed.

3-10. FIND BEAM. Occasionally the CRT beam may be driven off screen by large dc input levels or by improper control settings. The beam may be brought back on screen by depressing the FIND BEAM control and adjusting the horizontal and vertical (see vertical plug-in manual) position controls to center the beam. If INTENSITY is properly set, the beam will remain visible when FIND BEAM is released.

3-11. MAGNIFIER. This control varies the gain of the horizontal amplifier. When switched from X1 to X5 or X10 the gain increases five or ten times respectively. For example, one volt into the vertical amplifier plug-in Ext Input jack produces 1 div of deflection in X1, 5 div of deflection in X5, and 10 div of deflection in X10.

3-12. DISPLAY. This control determines the origin of the input signal applied to the horizontal amplifier. With the DISPLAY control positioned to EXT CAL, the external horizontal input is coupled directly to the horizontal amplifier. As DISPLAY is rotated ccw, the external signal is increasingly attenuated. When DISPLAY is fully ccw (INT), the external input signal is disconnected and the internal sweep is coupled directly to the horizontal amplifier.

3-13. REAR PANEL.

3-14. OUTPUTS. Four BNC connectors on the rear panel of the Model 180ER are provided to supply signals from the plug-ins to external equipment. Refer to the plug-in manuals for signal identification. These outputs can supply 3 mA and will drive impedances as low as 1000 ohms without distortion.

3-15. Z-AXIS INPUT. This BNC connector allows application of an external intensity modulation signal directly to the gate amplifier. Approximately +2V, dc to 15 MHz, blanks a beam of normal intensity. Conversely, a negative signal will intensify the beam.

3-16. INTERNAL.

3-17. Positioning the PHASE/BANDWIDTH switch to PHASE causes the horizontal input signal to be delayed the same amount of time as the vertical input signal. This delay allows the Model 180ER to be used for phase measurements. Channel A of multi-channel vertical plug-ins should be used when making phase measurements. Refer to Paragraph 5-29e for calibration procedures when a different channel (other than A) is used, or when changing from one vertical plug-in to another.

Note

Make certain that the switch is placed to BANDWIDTH after making phase measurements. This will allow normal operation.

THEORY

SECTION IV

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. The Model 180ER Oscilloscope is comprised of four basic circuits. These are: a gate amplifier, a horizontal amplifier, a high-voltage power supply, and a low-voltage power supply. Two associated circuits, also contained, are a calibrator and an output amplifier. Figure 4-2 shows the interrelationship of these circuits.

4-3. FUNCTIONAL DESCRIPTION.

4-4. Three input signals; intensity, horizontal deflection, and vertical deflection; are necessary to obtain a usable display on the CRT. The circuitry for the intensity and horizontal deflection signals is explained in the following paragraphs which are referenced to Figure 4-2. The vertical deflection signal is coupled directly to the CRT from the Vertical Plug-in.

4-5. INTERNAL. Positioning the HORIZONTAL DISPLAY switch to INT applies −100 volts to the Horizontal Plug-in. This voltage allows the plug-in to operate normally and to produce the unblanking gate and the internal sweep signal.

4-6. The unblanking gate is coupled from the Horizontal Plug-in to the gate amplifier where it is summed with the Z-axis input and chopped blanking signals (if they are applied). The resulting signal is amplified, and coupled through the high voltage power supply to the control grid of the CRT to control the intensity of the display.

4-7. The alternate trigger signal is a negative pulse produced by the gate amplifier at the end of each unblanking gate. It is coupled directly to the Vertical Plug-in (refer to Vertical Plug-in manual for signal function).

4-8. The internal sweep signal from the Horizontal Plug-in is coupled through the HORIZONTAL DISPLAY switch to the output amplifier. Here it is converted to a differential signal, amplified, and applied to the CRT horizontal deflection plates.

4-9. EXTERNAL. Positioning the HORIZONTAL DISPLAY switch to EXT removes the internal display voltage from the Horizontal Plug-in, eliminating both the unblanking gate and the internal sweep signal.

4-10. The gate amplifier operates as it did when INT was selected. There are; however, only two inputs to the gate amplifier: an externally applied intensity modulation signal (Z-axis input) and the chopped blanking signal from the Vertical Plug-in. The alternate trigger signal will be produced only if the externally applied signal is similar to the normal unblanking gate.

4-11. The externally applied deflection signal is coupled through the horizontal preamplifier to the output amplifier where it is amplified and converted to a differential signal and then applied to the CRT horizontal deflection plates.

4-12. CIRCUIT DETAILS.

4-13. The following paragraphs contain a detailed explanation of each circuit in the Model 180ER.

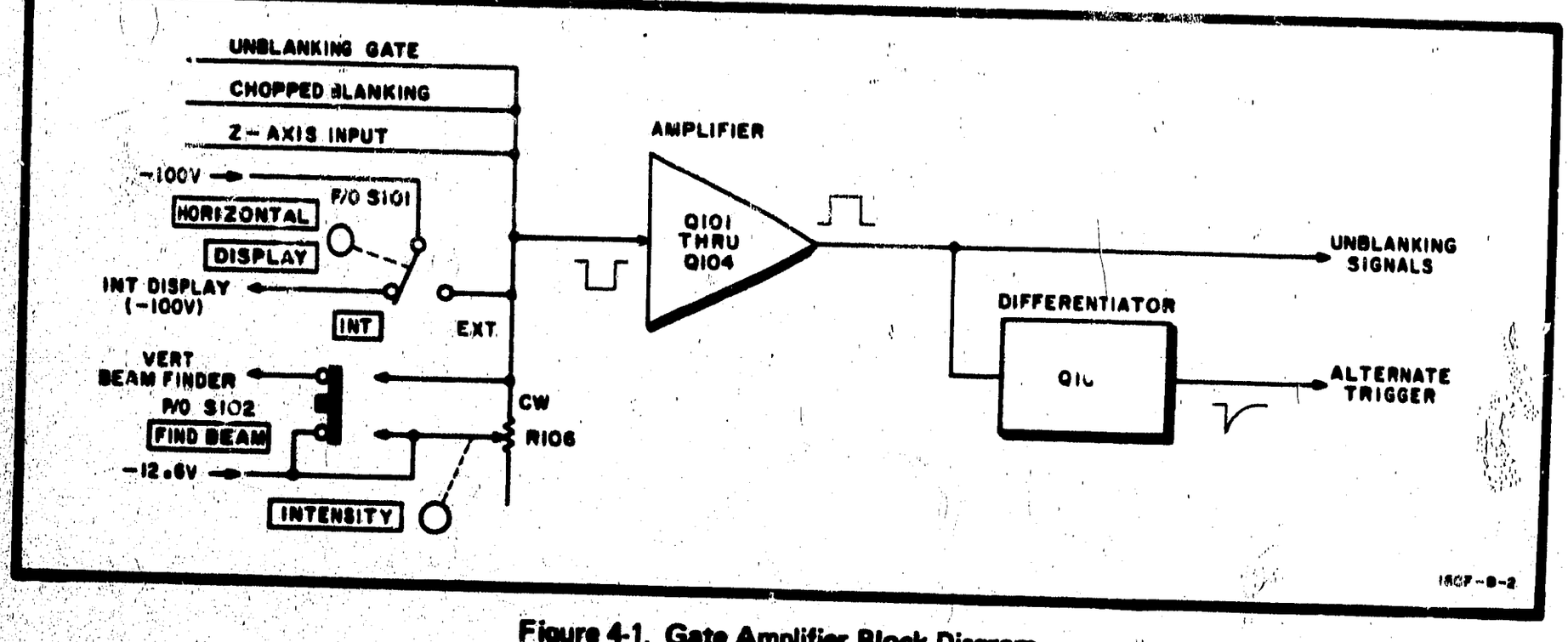


Figure 4-1. Gate Amplifier Block Diagram

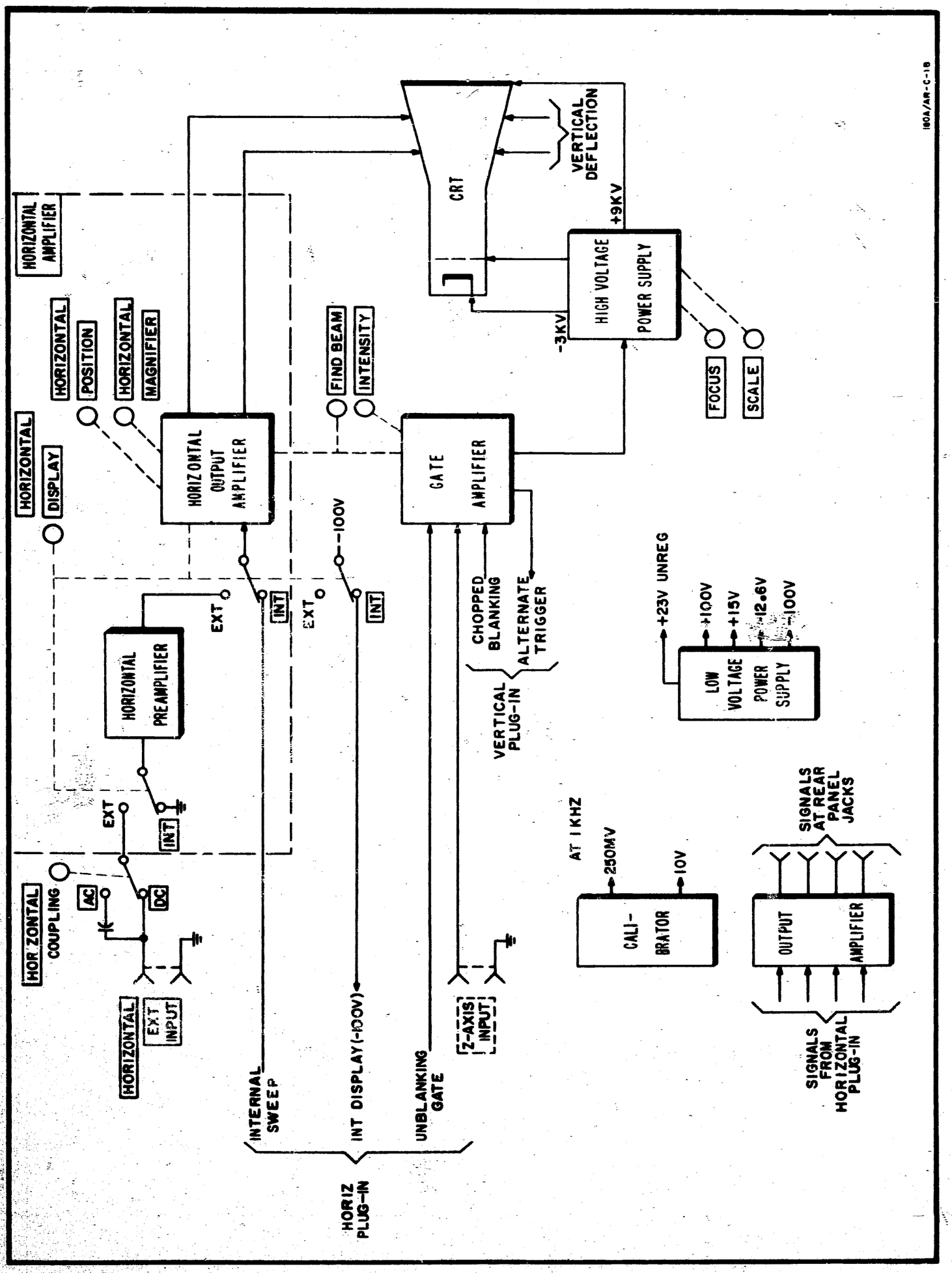


Figure 4-2. Model 180ER Overall Block Diagram

4-14. GATE AMPLIFIER.

4-15. The inputs to the gate amplifier (see Figure 4-1) are the unblanking gate, the chopped blanking signal, and the Z-axis input signal. These three signals may be present either singly or simultaneously, depending upon control settings. These inputs are combined with a current established by three front-panel controls: FIND BEAM, INTENSITY, and HORIZONTAL DISPLAY. Depressing FIND BEAM shunts the normally adjustable INTENSITY potentiometer and supplies maximum current from this source. Setting HORIZONTAL DISPLAY to EXT supplies additional current to brighten the beam.

4-16. The input current to amplifier Q101 through Q104 is converted to a voltage, amplified, and coupled to the control grid of the CRT. The output signal is also differentiated, clipped, and coupled to the Vertical Plug-in.

4-17. The input currents to the gate amplifier (see Figure 8-3, schematic) are summed in the low impedance emitter circuit of Q101. The resulting current is coupled to the complementary feedback amplifier (a current-fed operational amplifier) Q102/Q103/Q104, where it is converted to a voltage, and coupled to the control grid circuit of the CRT. The output voltage is approximately:

$$\Delta E_{Q104\ COLLECTOR} \cong (\Delta I_{CR101})\ (R_{R119\ \&\ R121})$$

The large negative feedback from the collectors of Q103 and Q104 to the base of Q102 provides the complementary feedback amplifier with a very stable gain. C110 and C113 adjust the high-frequency feedback. CR108 provides temperature compensation for Q103. CR109 and CR110 protect Q103 and Q104 from voltage breakdown. CR112 and CR113 isolate Q103 and Q104 from the high voltage in the control grid circuit of the CRT in the event of a grid or cathode short. The output from Q103 and Q104 is differentiated by C116, R128, and R130, and coupled through Q105 to the Vertical Plug-in. CR111 is a positive clipper.

4-18. HORIZONTAL AMPLIFIER.

4-19. The inputs to the horizontal amplifier (see Figure 4-3) are the internal sweep signal and an external signal applied to the HORIZONTAL EXT INPUT jack. Positioning HORIZONTAL DISPLAY to INT disconnects the external signal and grounds the input of the preamplifier. The internal sweep signal is connected through the HORIZONTAL DISPLAY switch to the output amplifier.

4-20. Selecting either EXT SENS or EXT CAL disconnects the internal sweep signal and connects the external signal through the preamplifier to the output amplifier. With EXT SENS selected, the amplitude of the signal from the preamplifier is adjustable by rotating HORIZONTAL DISPLAY between the extreme positions. In EXT CAL, R211 is shorted and the output amplitude is determined only by the input amplitude.

4-21. The selected signal is applied to the output amplifier and summed with a current established by the HORIZONTAL POSITION control. The resulting current is converted to a differential signal, amplified, and applied to the horizontal deflection plates of the CRT.

4-22. The external signal applied to the preamplifier (see Figure 8-4, schematic) is coupled through Q201 and Q202 to the HORIZONTAL DISPLAY switch, S101. The high input impedance of Q201 prevents loading the external circuit. Q202 provides the low impedance necessary to drive Q203. CR201 protects Q201 from voltage breakdown. C203 and C204, when switched in, decrease the bandwidth of the preamplifier. The decreased bandwidth compensates for the signal delay in the Vertical Plug-in and allows more accurate X-Y phase measurements to be made. R207 is adjusted for 0 Vdc across R211, eliminating horizontal dc shift as HORIZONTAL DISPLAY is rotated.

4-23. The input signal to Q203 is summed in the low impedance emitter circuit with a current established by the POSITION controls. The resulting signal is coupled from the emitter of Q206 through emitter follower Q204 to differential amplifier Q206/Q207. Q204 provides the low impedance necessary to drive Q206. The input signal to Q206 is coupled through the MAGNIFIER switch, S203, to Q207, S203 selects the amount of emitter degeneration between Q206 and Q207, and therefore controls the gain; as degeneration decreases, gain increases, R250, R248, and R246 adjust the gain in the X1, X5, and X10 positions, respectively, of S203. R253 adjusts the emitter potentials of Q206 and Q207 to be equal,

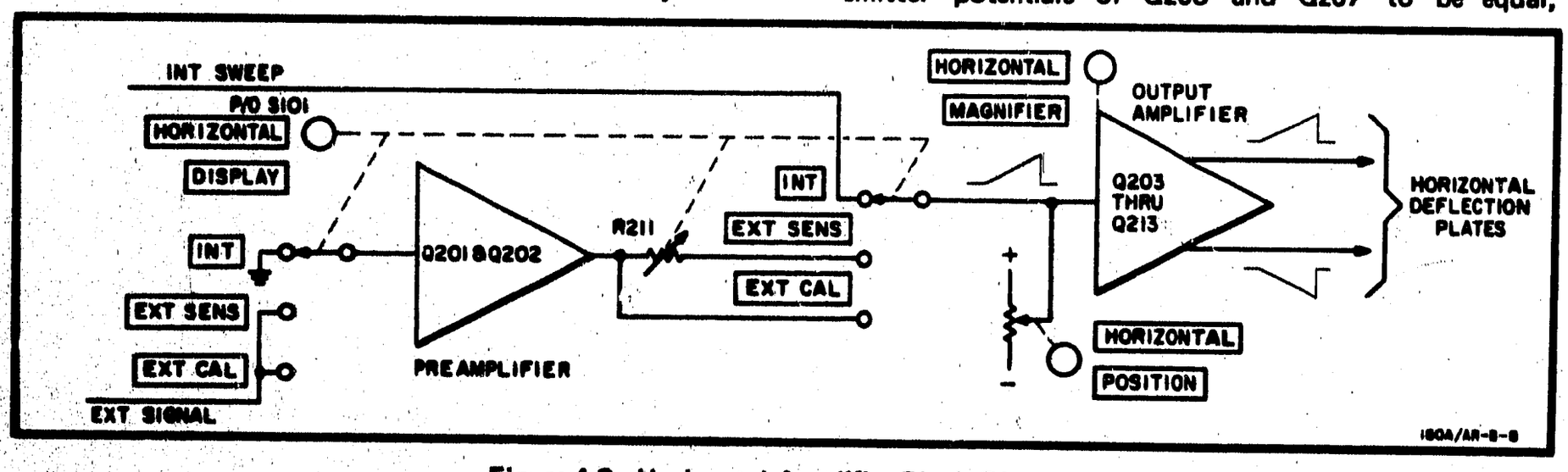


Figure 4-3. Horizontal Amplifier Block Diagram

preventing horizontal dc shift as the MAGNIFIER control is switched. Q205 provides a low impedance voltage source for the base of Q207. The differential signal at the collectors of Q206 and Q207 is applied to complementary feedback amplifiers (current-fed operational amplifiers) Q208/Q209/Q210 and Q211/Q212/Q213, converted to a voltage, and coupled to the horizontal deflection plates of the CRT. CR203 and CR206 prevent Q206 and Q207, respectively, from saturating. Diodes CR202/CR204 and CR207/CR208 limit the output to the deflection plates between +6 and +94 volts regardless of the input amplitude. Depressing the FIND BEAM control disables limiter CR207/CR208 and blocks the signal to Q211. The differential gain is effectively cut in half and the electron beam is confined to the horizontal limit of the CRT screen. The gain of the complementary feedback amplifier is very stable because of the large negative feedback from the collectors of Q209/Q210 and Q212/Q213 to the bases of Q208 and Q211, respectively. C210 and C229 adjust the high frequency feedback of each amplifier individually while C213 adjusts the feedback for both. CR205 and CR209 provide temperature compensation for Q210 and Q213.

4-24. HIGH-VOLTAGE POWER SUPPLY (HVPS).

4-25. The high voltage power supply (see Figure 4-4) produces three regulated voltages: −2950V, ≈+9 kV, and a control grid bias voltage. All three voltages are regulated by sampling the −2950 volt supply

4-26. The 50 kHz output from oscillator Q304/T301 (see Figure 8-5, schematic) is coupled to two half-wave rectifiers, CR302 and CR307, and to a voltage tripler circuit. The pulsating dc from CR302 is filtered and applied to the control grid of the CRT. R326 adjusts the dc potential on the grid. The pulsating dc from CR307 is filtered and applied to the cathode of the CRT. V301 and V302 limit the potential difference between the cathode and the control grid to 140 volts in the event of a grid or cathode short. The ac voltage applied to CR307 is also coupled to a voltage tripler, CR308–CR310 and C318–C321. The +9 kV output from the tripler is applied to the post-accelerator of the CRT.

4-27. Changes in the cathode voltage are coupled through the regulator Q301–Q303 to the oscillator Q304/T301. Assume the cathode voltage decreases (goes positive); a positive-going signal is applied through the regulator to the base of Q304; Q304 conducts for a greater portion of the input cycle and causes a greater voltage change across the primary of T301, thus increasing the voltage across the secondary. R302 adjusts the quiescent dc on the base of Q304 and controls the CRT cathode potential. L301 prevents the oscillator from running at 1 MHz. C308 provides an ac ground so that the oscillator's feedback is felt on the base of Q304.

4-28. LOW-VOLTAGE POWER SUPPLY (LVPS).

4-29. The low-voltage power supply produces five dc voltages. The −100, −12.6, +15, and +100-volt supplies are regulated and used throughout the Model 180ER and plug-ins. The unregulated +23V supply is used only by the HVPS and the pilot lamp. A regulated +105-volt supply is also produced, however, it is used only within the LVPS.

4-30. Figure 4-5 shows a basic regulated power supply. It is like a voltage divider in that the entire applied voltage must be dropped across the series regulator and the parallel combination of the load and the sensing device. If

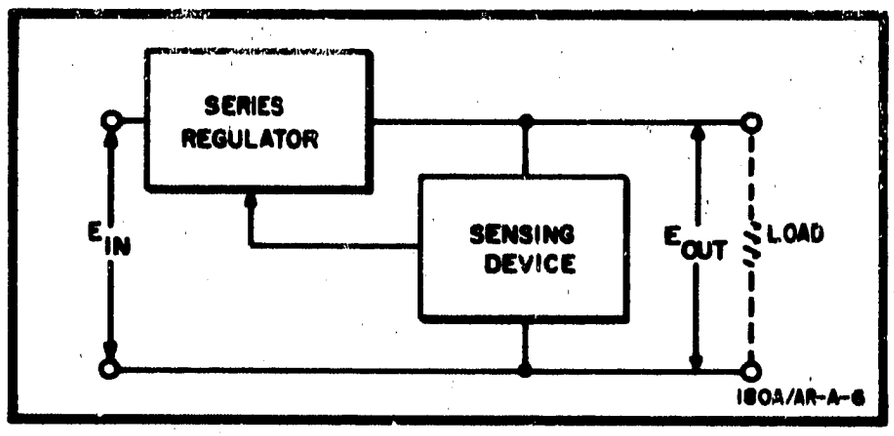


Figure 4-5. Basic Regulated Power Supply

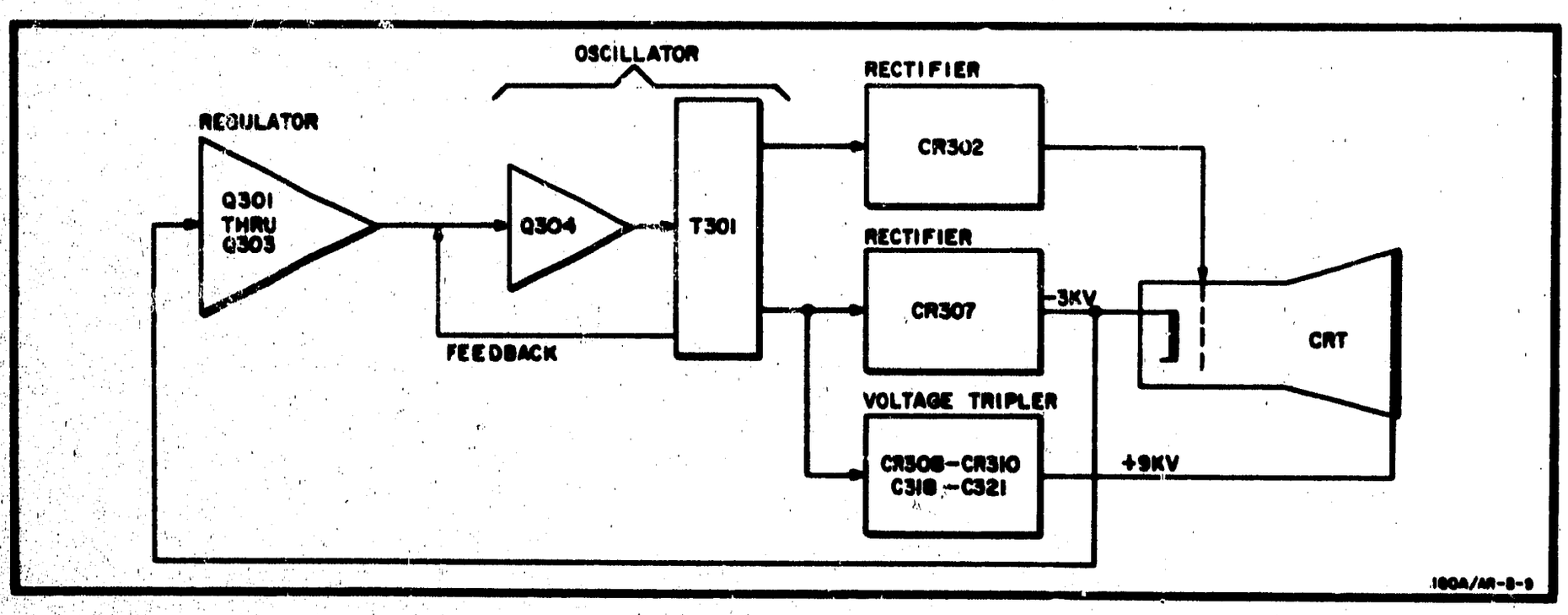


Figure 4-4. HVPS Block Diagram

the voltage across the load were to change, the sensing device would detect the change and cause the resistance of the series regulator to change and correct the output.

4-31. See the LVPS schematic diagram, Figure 8-6. Closing S401 supplies power through rear-panel switch S402 to the primary of T401. S402 connects the primary windings in either series or parallel for 230-volt or 115-volt operation, respectively.

4-32. AC voltages from the secondary windings of T401 are full-wave rectified by bridge circuits. The resulting dc voltages are filtered and applied to the regulating circuits described in the following paragraphs.

4-33. The −100V supply output is used as a reference for the other regulating circuits. It must be adjusted first since its amplitude will affect the other outputs.

4-34. −100-VOLT SUPPLY. The level of the −100V supply output voltage is controlled by a series regulator, Q414, in the supply ground path. Any change in output voltage is sensed by Q415 and Q416 which are connected in a differential amplifier configuration. The adjustable tap of R449 provides a sample of the supply output voltage which is used to control the conduction of Q416. Voltage regulator V402 maintains a constant voltage drop of 82 volts, and in conjunction with R444 divides the supply output voltage so that the total variation in output voltage will be sensed by Q415. If an increase in the load current requirement occurs, a decrease in output voltage will be observed, resulting in a positive-going (less negative) signal on the base of Q416, with a larger change being sensed by Q415. This causes Q415 to conduct more positive. Thus, the variation in output voltage is sensed and amplified. The positive-going change is coupled from the single-ended output of Q416 to the base of Q413. Driver Q413 controls the base bias level of Q414. The series regulator will therefore compensate for the change in output voltage by decreasing its series resistance to return the supply output voltage to the desired level. Temperature compensation for Q416 is provided by Q415. High-frequency variations in the driver input signal are filtered by C425 and R442 to prevent oscillation. Transistors Q415 and Q416 are protected by CR433 and CR434, while CR432 prevents voltage breakdown from the base of Q413 to the emitter of Q414. Overload current protection is furnished by F406, and CR430 protects against possible reverse charging of C427 in the event F406 opens.

4-35. +100-VOLT SUPPLY. The operation of the +100V supply is similar to the −100V supply. Q403 and Q404 operate as a differential amplifier, with Q404 sensing any variation in output or change in relation to the regulated −100V supply. Voltage regulator V401 and R407 divide the supply output voltage, and Q403 senses the total variation in output voltage. Protection against excessive current is provided by F403, and CR412 prevents the output filter capacitor, C408, from reverse charging if the fuse opens. Temperature compensation for Q404 is provided by Q403.

4-36. +105-VOLT SUPPLY. A dc voltage from rectifier CR401–CR404 is applied across R401 and breakdown diode VR401. Zener action keeps the top of VR401 five volts more positive than the bottom, which is at +100V. This +105-volt potential at the top of VR401 provides bias current for Q402 and Q404.

4-37. −12.6-VOLT SUPPLY. Part of the voltage from the −12.6V rectifier filter is dropped across the series regulator and R430, the rest is dropped across the load. Any variation in the output will be coupled through Q412 and Q409 to the base of the series regulator. Q412 provides a voltage gain, while Q409 provides a current gain. C419 and R428 shunt high frequencies to prevent oscillation. CR425 provides temperature compensation for Q412. CR420 protects Q412 from base to emitter voltage breakdown.

4-38. Current limiter, Q411, and R430 form a protective circuit for the series regulator. If the output is shorted, the voltage drop across R430 turns Q411 on. The resulting negative signal from the collector of Q411 is coupled through the driver to the series regulator, turning it off. The output current is limited to the current necessary to keep Q411 turned on.

4-39. +15-VOLT SUPPLY. The +15V supply is similar to the −12.6V supply. Changes in output voltage are applied to the base of Q409, amplified, and coupled through Q405 to series regulator Q406. Current limiting action is provided by R419 and Q407.

4-40. SUPPLY CURRENT AVAILABLE. Table 4-1 lists the current available from each power supply. There is no minimum current requirement for any supply.

Table 4-1. LVPS Current Capabilities

Power Supply	Maximum Safe Current Available
+100 VDC	160 mA
+15 VDC	420 mA
−12.6 VDC	725 mA
−100 VDC	80 mA

4-41. CALIBRATOR.

4-42. The schematic diagram of the calibrator is in Figure 8-3. Q106 and Q107 comprise a free-running multivibrator whose output is a 1 kHz square wave at two amplitudes, 250 mV and 10V. CR116 and CR117 protect Q106 and Q107 from voltage breakdown. CR115 disconnects the collector of Q107 from C122 as Q107 turns off, providing a faster risetime. The two outputs are supplied to front-panel connectors and may be used for probe compensation and sensitivity calibration.

4-43. OUTPUT AMPLIFIERS.

4-44. The output amplifiers (see Figure 8-3, schematic) are four emitter followers (Q108–Q111) that couple signals from the Horizontal Plug-in to rear-panel connectors. Check the specific plug-in manual to determine what signals are actually applied to the rear panel connectors.

PERFORMANCE CHECK

ADJUSTMENTS

Table 5-1. Required Test Equipment

Recommended Test Equipment		Required Characteristics	Reference Paragraph
Type	Model		
Voltmeter Calibrator	HP Model 738AR, 6920B, or E02-738BR	1, 2, and 10V pk-pk ±0.2%	5-11, step b; 5-12, steps b and d
Monitor Oscilloscope	HP Model 180A/AR w/1801A and 1820A plug-ins	Sensitivity 1 V/div sweep speed 1 usec/div risetime <3 usec sweep output	5-11, step g; 5-28, step b 5-28, step d, 1
10:1 Divider Probe	HP Model 10001A	±3%	5-28, step c
Constant Amplitude Signal Generator	Tektronix Type 190B/191	50 kHz – 50 MHz @ 10V pk-pk	5-13, step a; 5-29, step d,7
Digital Voltmeter	HP Model 3440A w/3441A or 3444A plug-in	± 100 Vdc ±.05%	5-22, step a; 5-23, step a
100:1 Divider Probe	HP Model 11044A	3000 Vdc	5-23, step a
Ammeter	HP Model 3440A w/3444A plug-in	0.20 mA – 2.5 mA ±0.2%	5-29, step c, 3
DC Power Supply	HP Model 6204B	2.5 mA ±0.3%	5-29, step c, 3
Square Wave Generator	HP Model 211A/B	200 kHz 1V pk-pk risetime <30 nsec	5-29, step d, 3
Oscillator	HP Model 20[illegible]9	100 kHz @ 10V pk-pk	5-29, step e, 2

SECTION V

PERFORMANCE CHECK AND ADJUSTMENTS

5-1. INTRODUCTION.

5-2. This section provides the performance check (Paragraph 5-5) and the adjustment procedure (Paragraph 5-17) for the Model 180ER. Troubleshooting information, schematic diagrams, and component identification are located in Section VIII.

5-3. TEST EQUIPMENT.

5-4. Test equipment required for maintaining and checking the performance of the Model 180ER is listed in Table 5-1. Test equipment having characteristics similar to those listed in the table may be used for the performance check and adjustments.

5-5. PERFORMANCE CHECK.

5-6. The performance check verifies whether or not the Model 180ER is operating within the specifications as stated in Table 1-1. This check may be used as part of an incoming quality control inspection, as a periodic operational check, or after repair and/or adjustments have been made. Recently calibrated test equipment should be used when performing the check.

5-7. A Performance Check Record form is included in this manual on Page 5-4a/b. As the initial performance check is accomplished, the actual readings should be entered on the form. The form should then be removed from the manual and filed in a safe place so that readings taken at a later date can be compared with the original readings.

5-8. The performance check must be done in the sequence given below. Do not attempt to start the procedure in mid-sequence, as succeeding steps are dependent upon control settings and results of previous steps.

5-9. PRELIMINARY SET-UP.

5-10. Apply power to the Model 180ER and allow a fifteen minute warm-up. Do not install plug-ins.

5-11. CALIBRATOR.

a. Set controls as follows:

MAGNIFIER X5
HORIZONTAL DISPLAY ..... EXT CAL
HORIZONTAL Coupling ..... AC

b. Connect a 10V pk-pk signal from Voltmeter Calibrator output to HORIZONTAL EXT INPUT.

c. Obtain a horizontal trace by adjusting INTENSITY and POSITION controls.

d. Adjust HORIZONTAL DISPLAY for 10 div of deflection.

e. Disconnect Voltmeter Calibrator and connect CALIBRATOR 10V output to HORIZONTAL EXT INPUT.

f. Trace is 10 div ± 1 minor div long.

g. Observe CALIBRATOR 10V output using the Monitor Oscilloscope.

h. Risetime of calibrator waveform should be less than 3 usec.

5-12. MAGNIFIER.

a. Set MAGNIFIER to X1 and HORIZONTAL DISPLAY to EXT CAL.

b. Connect a 10V pk-pk signal from Voltmeter Calibrator output to HORIZONTAL EXT INPUT.

c. Deflection is 10 div ±5 minor div.

d. Repeat above procedure setting MAGNIFIER to X5 with 2V pk-pk signal, and X10 with a 1V pk-pk signal. Deflection is 10 div ±5 minor div in each case.

5-13. BANDWIDTH.

a. Connect a 50 kHz signal from Constant Amplitude Signal Generator to HORIZONTAL EXT INPUT.

b. Set MAGNIFIER to X1. Adjust Signal Generator amplitude for 10 div of deflection.

c. Increase frequency to 5 MHz. Deflection is greater than 7.1 div. (If deflection is less than 2 div check that Phase/Bandwidth switch is in Bandwidth.)

5-14. BEAM FINDER.

a. Rotate INTENSITY and HORIZONTAL POSITION fully ccw.

b. Depress FIND BEAM.

c. Intensified beam appears on screen.

5-15. COVER REMOVAL.

5-16. The cover of the Model 180ER may be removed by removing the appropriate screws and lifting the cover free.

5-17. ADJUSTMENTS.

5-18. Procedure for adjusting the Model 180ER is given in Paragraphs 5-19 through 5-29. Required test equipment is listed in Table 5-1. Test equipment with similar characteristics may be substituted if necessary. Figure 5-1 shows the location of adjustments in the Model 180ER.

5-19. The adjustment procedure must be done in the sequence given below. Do not attempt to start the procedure in mid-sequence, as succeeding steps are dependent upon control settings of previous steps.

5-20. PRELIMINARY SET-UP.

5-21. Install plug-ins in Model 180ER. Turn power on and allow a fifteen minute warm-up. Make certain that Phase/Bandwidth switch is in Bandwidth position.

5-22. LOW-VOLTAGE POWER SUPPLY.

a. Connect the Digital Voltmeter to each test point in Table 5-2.

b. Make the proper adjustment to obtain the indicated voltage.

Table 5-2. Low Voltage Adjustments

Test Point	Measure	Adjust
TP404	−100V ± 0.1V	R449
TP401	+100V ± 0.1V	R412
TP403	−12.6V±0.01V	R434
TP402	+15V ± 0.01V	R423

5-23. HIGH-VOLTAGE POWER SUPPLY.

a. Monitor the −100 Vdc at TP404 with the Digital Voltmeter using a 100:1 Divider Probe.

b. Observe and note the voltage reading, which will be approximately −1.000 volt. Accuracy in noting the obtained voltage is essential for proper adjustment.

c. Multiply the reading obtained in step b by 29.50.

d. Monitor the High Voltage by TP301 with the Digital Voltmeter using a 100:1 Divider Probe.

WARNING

This voltage is dangerous to life.

e. Adjust R302 to obtain a voltage reading exactly equivalent to the result obtained in step c, (approximately −29.500V).

f. The required high-voltage output of the supply is −2950V ±0.5%.

5-24. ASTIGMATISM.

a. Set HORIZONTAL DISPLAY to EXT CAL and Vertical Display to A.

b. Center spot with Horizontal and Vertical POSITION controls.

c. Adjust FOCUS and ASTIGMATISM for the smallest round spot.

5-25. INTENSITY LIMIT.

a. Set Sweep Display switch on Horizontal Plug-in to MAIN (if applicable) and rotate INTENSITY to 10 o'clock position.

b. Adjust R326 until spot disappears.

5-26. FLOOD GUN.

a. Rotate INTENSITY fully ccw and SCALE fully cw.

b. Rotate R348 fully cw and then slowly ccw until entire screen is at a uniform intensity.

c. Rotate SCALE fully ccw.

5-27. TRACE ALIGNMENT.

a. Set HORIZONTAL MAGNIFIER to X1 and HORIZONTAL Coupling to AC.

b. Connect CALIBRATOR 10V output to HORIZONTAL EXT INPUT.

c. Rotate INTENSITY cw to view trace.

d. Adjust TRACE ALIGN to make trace parallel with center graticule line.

e. Connect CALIBRATOR 10V output to Channel A input.

f. Set Vertical Plug-in controls as follows:

Channel A Polarity. . . . . +UP
Channel A Volts/div. 1
Channel A Vernier . . . . . CAL
Channel A Coupling. . . . . AC

g. Adjust R336 to align trace parallel with center graticule line.

h. Disconnect CALIBRATOR from Vertical INPUT.

5-28. GATE AMPLIFIER RESPONSE.

a. Set following controls as applicable:

HORIZONTAL DISPLAY ..... INT
Main Time/div ..... 0.1 uSEC
Main Vernier ..... CAL
Sweep Mode ..... AUTO
Sweep Display ..... MAIN
Delayed Time/div ..... OFF

b. Set Monitor Oscilloscope controls as follows:

Volts/div 1
Time/div ..... 0.1 uSEC
Trigger Source ..... INT
Slope ..... +
Coupling ..... DC

c. Observe signal on collector of Q103 using a 10:1 Divider Probe. Adjust INTENSITY control to cause observed signal to increase by 2 minor div.

d. Adjust C110 and C113 for a fast risetime and a flat response.

5-29. HORIZONTAL AMPLIFIER.

a. DC BALANCE.

1. Set MAGNIFIER to X10 and HORIZONTAL DISPLAY to EXT CAL. Center spot with HORIZONTAL POSITION.

2. Set MAGNIFIER to X1 and re-center spot with R253.

3. Repeat steps 1 and 2 until spot does not shift position when MAGNIFIER is switched from X10 to X1.

b. VERNIER BALANCE.

1. Set MAGNIFIER to X10.

2. Rotate HORIZONTAL DISPLAY fully ccw (not into INT) and center spot with HORIZONTAL POSITION.

3. Rotate HORIZONTAL DISPLAY to EXT CAL and adjust R207 to re-center spot.

4. Repeat Steps 2 and 3 until spot does not shift when HORIZONTAL DISPLAY is rotated from fully ccw (not in INT) to EXT CAL.

c. GAIN.

1. Set HORIZONTAL MAGNIFIER to X1 and HORIZONTAL DISPLAY to EXT CAL.

2. Adjust Horizontal and Vertical POSITION to center spot on left edge of graticule.

Note

Table 5-3 lists the currents necessary to calibrate the horizontal gain. They should be accurate to 0.3% if plug-in interchangeability is desired.

3. Inject the current specified in Table 5-3 into the emitter of Q203. Spot should be at right edge of graticule.

Table 5-3. Gain Adjust

MAGNIFIER	INJECT	ADJUST
X1	2.5 mA	R250
X5	0.5 mA	R248
X10	0.25 mA	R246

4. Perform the adjustment specified in Table 5-3 to take up half of the difference between the spot and the right edge of the graticule.

Note

If 10 div of deflection can not be obtained by adjusting R250 and the CRT has been replaced, it may be necessary to select a new value for R251.

5. Repeat steps 2 through 4 until spot deflects 10 div.

6. Set HORIZONTAL MAGNIFIER to X5 and repeat steps 2 through 5 using applicable information in Table 5-3.

7. Set HORIZONTAL MAGNIFIER to X10 and repeat steps 2 through 5 using applicable information in Table 5-3.

d. TRANSIENT RESPONSE.

1. Connect a 1 usec/div sweep signal from the Monitor Oscilloscope to the Channel A Input of the Vertical Plug-in.

2. Adjust Channel A Volts/div and Vernier controls for an 8 div display.

3. Connect a 200 kHz 1V pk-pk, square wave from the Square Wave Generator to the Model 180ER HORIZONTAL EXT INPUT.

4. Synchronize the Monitor Oscilloscope with the 200 kHz signal.

5. Observe the waveform on the Model 180ER and adjust C210, C213, and C229 for best response on lower right-hand corner of the waveform.

Note

C210 and C229 should be adjusted so their slugs are almost equally extended.

6. Set controls as follows:

HORIZONTAL DISPLAY ..... INT
Channel A Volts/div 1
Channel A Vernier ..... CAL

7. Connect a 50 MHz sine wave at approximately 4V pk-pk from the Constant Amplitude Signal Generator to Channel A Input.

8. Select the fastest sweep speed and obtain a display.

9. Readjust C213 to display one cycle in 20 nanoseconds.

e. PHASE.

1. Set controls as follows:

Phase/Bandwidth ..... Phase
HORIZONTAL MAGNIFIER X1
HORIZONTAL DISPLAY ..... EXT CAL

2. Connect a 100 kHz sine wave from the Oscillator to HORIZONTAL EXT INPUT and to Channel A Input.

Note

Under normal conditions, only Channel A should be used (when using a multi-channel Vertical Plug-in). If another channel must be used, perform this procedure for that channel instead of A.

3. Adjust Oscillator amplitude for an 8 div display.

4. Adjust C203 for a single diagonal line of the CRT (no phase shift).

5. Return Phase/Bandwidth switch to Bandwidth position before replacing covers.

PERFORMANCE CHECK RECORD

Serial Number:_____

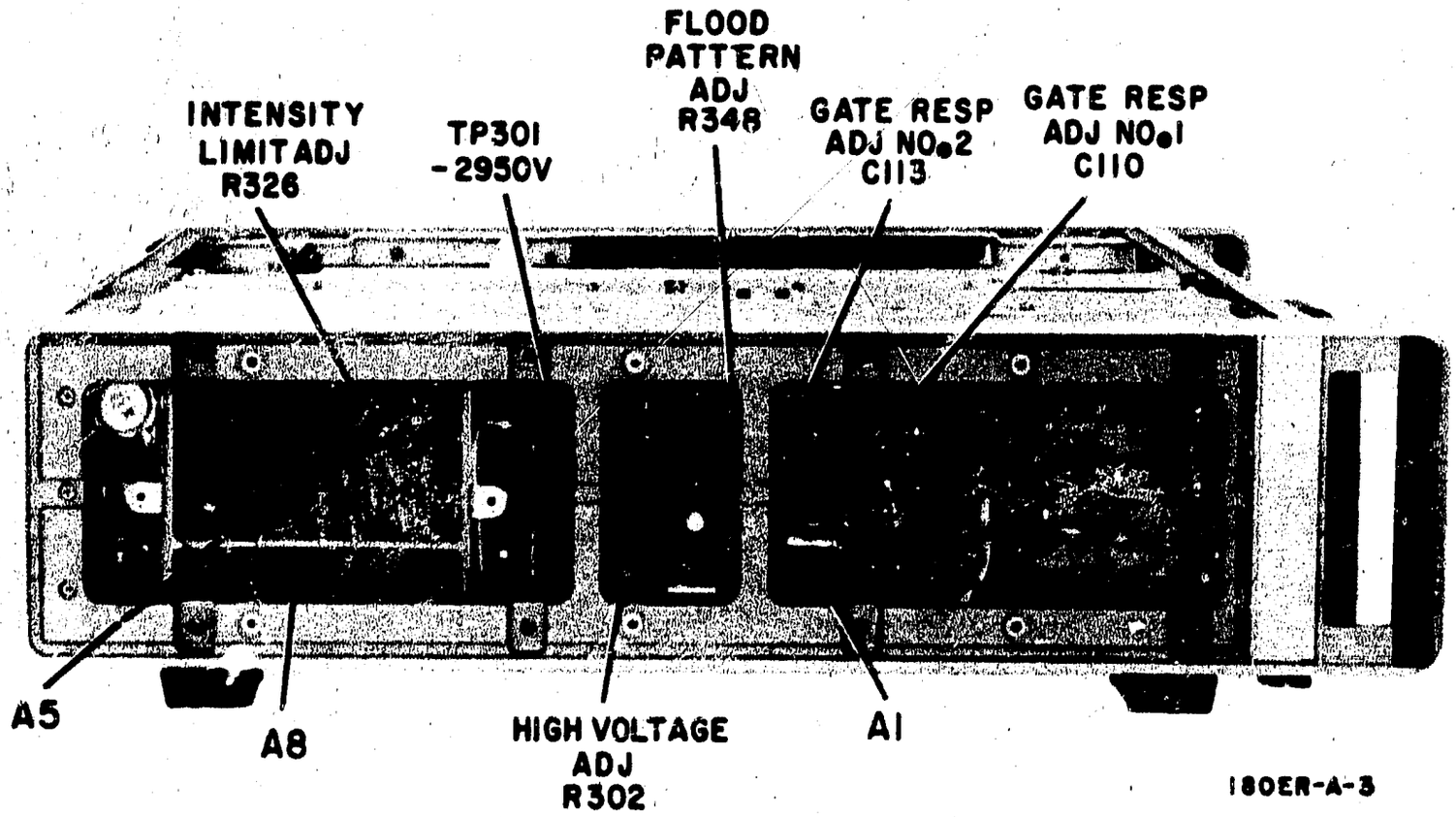
PARAGRAPH	CHECK	MINIMUM	READING	MAXIMUM
5-11	Calibrator			
step f	amplitude	9.9 div	_____	10.1 div
step h	risetime	none	_____	3 usec
5-12	Magnifier			
step c	X1	9.5 div	_____	10.5 div
step d	X5	9.5 div	_____	10.5 div
	X10	9.5 div	_____	10.5 div
5-13	Bandwidth			
step c	AC coupling	7.1 div	_____	none
5-14				
step c	Beam Finder	Intensified beam	_____	yes or no

CUT ALONG DOTTED LINE

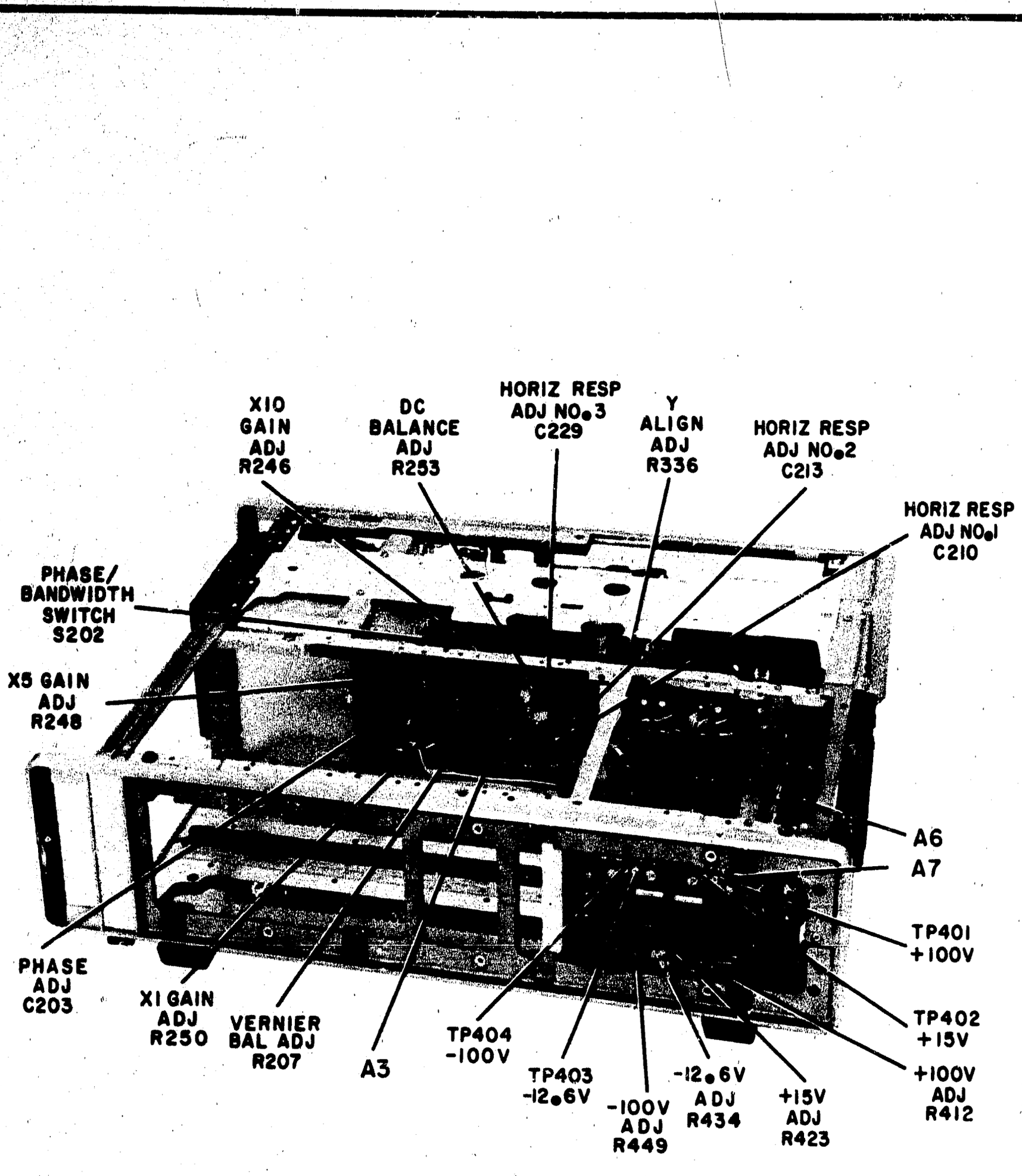
PERFORMANCE CHECK RECORD

Serial Number:_____

PARAGRAPH	CHECK	MINIMUM	READING	MAXIMUM
5-11	Calibrator			
step f	amplitude	9.9 div	_____	10.1 div
step h	risetime	none	_____	3 usec
5-12	Magnifier			
step c	X1	9.5 div	_____	10.5 div
step d	X5	9.5 div	_____	10.5 div
	X10	9.5 div	_____	10.5 div
5-13	Bandwidth			
step c	AC coupling	7.1 div	_____	none
5-14				
step c	Beam Finder	Intensified beam	_____	yes or no



p/o Figure 5-1. Adjustment Locations, Left Side View



p/o Figure 5-1. Adjustment Locations, Top and Side Views

PARTS LIST

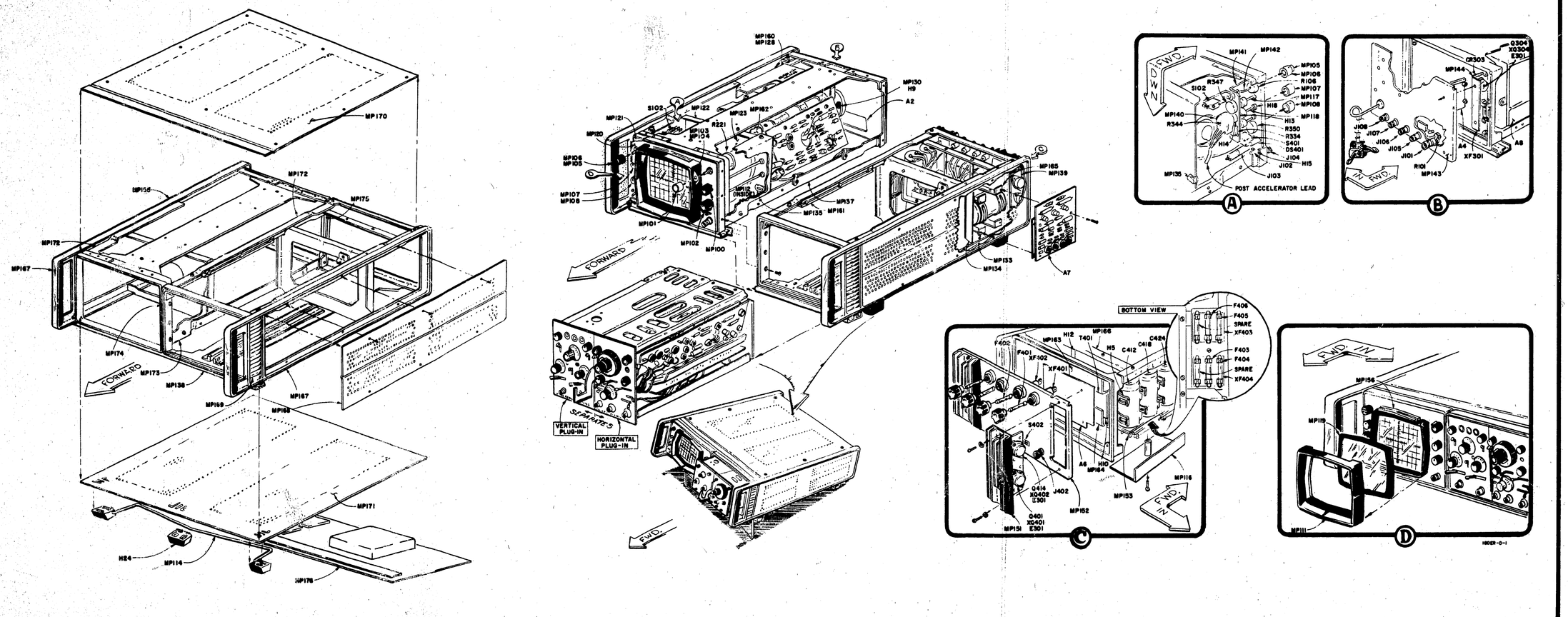


Figure 6-1. Model 180ER Mechanical Parts Identification

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replaceable parts for the instrument. Tables 6-2 and 6-3 list the parts in alpha-numerical order of their reference designations and provides the following information for each item:

a. Table 6-2 lists the HP Part Number.

b. Table 6-3 lists the equivalent military part number.

c. Description of part; see Table 6-1 for list of reference designators and abbreviations.

6-3. Mechanical parts are listed by reference designation in Table 6-2 and Table 6-3 and identified in Figure 6-1.

6-4. ORDERING INFORMATION.

6-5. To order a replacement part from the Hewlett-Packard Company, address the order or inquiry to the nearest Hewlett-Packard Sales/Service Office (list in rear of manual) and supply the following information:

a. HP Part Number of item(s).

b. Model number and eight-digit serial number of instrument.

c. Quantity of parts desired.

6-6. To order a part not listed in Table 6-2, provide the following information:

a. Model number and eight-digit serial number of the instrument

b. Description of part including function and location.

6-7. Component descriptions given in Tables 6-2 and 6-3 will assist in obtaining replacement parts from manufacturers other than HP. However, many parts are manufactured only by HP. Manufacturer and manufacturers part number for non-HP parts will be supplied upon request. Contact the nearest HP Sales/Service Office.

6-8. To order a replacement part from Table 6-3, refer to military procurement standards.

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		
CR	= diode	J	= jack	R	= resistor	VR	= voltage regulator (diode)
DL	= delay line	K	= relay	RT	= thermistor	W	= cable
DS	= device signaling (lamp)	L	= inductor	S	= switch	X	= socket
		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
d	= deci (10^{-1})	k	= kilo (10^3)	p	= pico (10^{-12})	trim.	= trimmer
depc	= deposited carbon			pc	= printed (etched) circuit(s)		
dp	= double pole	lb	= pound(s)	PGM	= program	u	= micro (10^{-6})
dt	= double throw	lev	= lever	piv	= peak inverse voltage(s)		
		lin	= linear taper	p/o	= part of	V	= volt(s)
elect.	= electrolytic	log.	= logarithmic taper	poly	= polystyrene	var	= variable
encap	= encapsulated	lpf	= low-pass filter(s)	porc	= porcelain		
ext	= external			pos	= position(s)	W	= watt(s)
		m	= milli (10^{-3})	pot.	= potentiometer(s)	w/	= with
F	= farad(s)	M	= mega (10^6)	pk-pk	= peak-to-peak	w/o	= without
fet	= field-effect transistor(s)	metfilm	= metal film	rect	= rectifier(s)	wVdc	= dc working volt(s)
fxd	= fixed	metox	= metal oxide	rf	= radio frequency	ww	= wirewound

Table 6-2. Replaceable Parts

Ref Desig	HP Part No.	TQ	Description (Refer to Table 6-1.)
A1	00180-66511	1	A: gate amplifier and high voltage regulator
A2	00180-66516	1	A: sweep gate output amplifier
A3	00180-66510	1	A: horizontal amplifier
A4	00180-66515	1	A: high voltage oscillator
A5	00180-66509	1	A: high voltage rectifier
A6	00180-66514	1	A: low voltage rectifier
A7	00180-66513	1	A: low voltage power supply
A8	00180-61102	1	A: high voltage power supply
A9	00180-61902	1	A: switch display
C101	0160-0168	5	C: fxd my. 0.1 uF 10% 200 wVdc
C102	0160-0207	1	C: fxd my. .01 uF 5% 200 wVdc
C103	0160-0162	12	C: fxd my. .022 uF 10% 200 wVdc
C104	0160-0162		C: fxd my. .022 uF 10% 200 wVdc
C105	0160-0162		C: fxd my. .022 uF 10% 200 wVdc
C106	0160-0162		C: fxd my. .022 uF 10% 200 wVdc
C110	0132-0004	1	C: var polystyrene 0.7 -3 pF 300 wVdc
C111	0150-0059	1	C: fxd cer 3.3 pF ±0.25 pF 500 wVdc
C112	0140-0180	1	C: fxd mica 2000 pF 2% 300 wVdc
C113	0121-0168	1	C: var teflon 0.2 -1.5 pF 600 wVdc
C114	0160-0162		C: fxd my. .022 uF 10% 200 wVdc
C115	0180-0039	1	C: fxd Al elect. 100 uF −10+75% 12 wVdc
C116	0150-0061	1	C: fxd cer 20 pF 10% 100 wVdc
C120	0180-0155	3	C: fxd Ta 2.2 uF 20% 20 wVdc
C121	0140-0189	2	C: fxd mica 5825 pF 2% 300 wVdc
C122	0140-0189		C: fxd mica 5825 pF 2% 300 wVdc
C123	0180-0089	1	C: fxd elect. 10 uF −10+100% 150 wVdc
C127	0180-0155		C: fxd Ta 2.2 uF 20% 20 wVdc
C128	0180-0155		C: fxd Ta 2.2 uF 20% 20 wVdc
C201	0170-0022	1	C: fxd my. 0.1 uF 20% 600 wVdc
C202	0150-0075	1	C: fxd cer 4700 pF −20+100% 500 wVdc
C203	0131-0004	1	C: var mica 16 - 150 pF 175 wVdc
C204	0140-0228	1	C: fxd mica 360 pF 1% 300 wVdc
C205	0160-0162		C: fxd my. .022 uF 10% 200 wVdc
C206	0160-0162		C: fxd my. .022 uF 10% 200 wVdc
C210	0132-0007	3	C: fxd var rexolite 0.7 - 3 pF 350 wVdc
C211	0160-0162		C: fxd my. .047 uF 10% 200 wVdc
C212	0170-0040	2	C: fxd my. .022 uF 10% 200 wVdc
C213	0132-0007		C: var rexolite 0.7 - 3 pF 350 wVdc
C214	0160-2235	1	C: fxd cer 0.75 pF ±0.25 pF 500 wVdc
C218	0160-0162		C: fxd my. .022 uF 10% 200 wVdc
C219	0160-0162		C: fxd my. .022 uF 10% 200 wVdc
C220	0180-0197	4	C: fxd Ta elect. 2.2 uF 10% 20 wVdc
C221	0180-0197		C: fxd Ta elect. 2.2 uF 10% 20 wVdc
C222	0160-0162		C: fxd my. .022 uF 10% 200 wVdc
C226	0180-0197		C: fxd Ta elect. 2.2 uF 10% 20 wVdc
C227	0180-0197		C: fxd Ta elect. 2.2 uF 10% 20 wVdc

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

Ref Desig	HP Part No.	TQ	Description (Refer to Table 6-1.)
C229	0132-0007		C: var rexolite 0.7 - 3 pF 350 wVdc
C230	0160-0162		C: fxd my. .022 uF 10% 200 wVdc
C231	0170-0040		C: fxd my. .047 uF 10% 200 wVdc
C301	0180-0076	1	C: fxd elect. 20 uF 25 wVdc
C302	0160-2486	1	C: fxd cer .0047 uF 20% 3500 wVdc
C303	0170-0019	1	C: fxd my. 0.1 uF 5% 200 wVdc
C307	0180-0097	3	C: fxd elect. 47 uF 10% 35 wVdc
C308	0160-0380	1	C: fxd my. 0.22 uF 10% 200 wVdc
C309	0160-0907	1	C: fxd cer .01 uF 5000 wVdc
C310	0160-0907	2	C: fxd cer .01 uF 20% 5000 wVdc
C311	0160-2320		C: fxd cer .01 uF 20% 5000 wVdc
C315	0160-2320		C: fxd cer .01 uF 5000 wVdc
C316	0160-0907		C: fxd cer .01 uF 20% 5000 wVdc
C317	0160-2320		C: fxd cer .01 uF 20% 5000 wVdc
C318	0160-0224		NSR: p/o A8 potted assy
C319	0160-0224		NSR: p/o A8 potted assy
C320	0160-0224		NSR: p/o A8 potted assy
C321	0160-0224		NSP: p/o A8 potted assy
C401	0180-1811	1	C: fxd elect. 100 uF 20 wVdc
C402	0160-0151	2	C: fxd cer 4700 pF +80 −20% 4000 wVdc
C404	0160-0151		C: fxd cer 4700 pF +80 −20% 4000 wVdc
C405	0180-1808	1	C: fxd elect. 430 uF −10 +50% 200 wVdc
C406	0160-0168	4	C: fxd my. 0.1 uF 10% 200 wVdc
C407	0180-0100	2	C: fxd Ta elect. 4.7 uF 20% 35 wVdc
C408	0180-1810	2	C: fxd Al elect. 18 uF −10 +50% 150 wVdc
C412	0180-1865	1	C: fxd elect. 2100 uF −10 +75% 40 wVdc
C413	0160-0168	1	C: fxd my. 0.1 uF 10% 200 wVdc
C414	0180-0097		C: fxd elect. 47 uF 10% 35 wVdc
C418	0180-1809	1	C: fxd elect. 3400 uF −10 +75% 25 wVdc
C419	0160-0168		C: fxd my. 0.1 uF 10% 200 wVdc
C420	0180-0097		C: fxd elect. 47 uF 10% 35 wVdc
C424	0180-1807	1	C: fxd elect. 290 uF −10 +50% 200 wVdc
C425	0160-0168		C: fxd my. 0.1 uF 10% 200 wVdc
C426	0180-0100		C: fxd Ta elect. 4.7 uF 10% 35 wVdc
C427	0180-1810		C: fxd Al elect. 18 uF −10 +50% 150 wVdc
CR101	1901-0179	1	CR: Si (special)
CR102	1901-0040	17	CR: Si (special)
CR103	1901-0040		CR: Si (special)
CR104	1901-0040		CR: Si (special)
CR106	1901-0040		CR: Si (special)
CR109	1901-0029	2	CR: Si (special)
CR110	1901-0029		CR: Si (special)
CR111	1901-0040		CR: Si (special)
CR112	1901-0436	2	CR: Si (special)
CR113	1901-0436		CR: Si (special)
CR115	1901-0096	4	CR: Si (special)
CR116	1901-0096		CR: Si (special)
CR117	1901-0096		CR: Si (special)

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

Ref Desig	HP Part No.	TQ	Description (Refer to Table 6-1.)
CR201	1901-0096		CR: Si (special)
CR202	5080-0464	4	CR: Si (special)
CR203	1901-0040		CR: Si (special)
CR204	5080-0464		CR: Si (special)
CR205	1901-0040		CR: Si (special)
CR206	1901-0040		CR: Si (special)
CR207	5080-0464		CR: Si (special)
CR208	5080-0464		CR: Si (special)
CR209	1901-0040		CR: Si (special)
CR301	1901-0049	5	CR: Si (special)
CR302	1901-0341	2	CR: Si (special)
CR307	1901-0341		CR: Si (special)
CR308	1880-0025		NSR: p/o A8 potted assy
CR309	1880-0025		NSR: p/o A8 potted assy
CR310	1880-0025		NSR: p/o A8 potted assy
CR401	1901-0049		CR: Si (special)
CR402	1901-0049		CR: Si (special)
CR403	1901-0049		CR: Si (special)
CR404	1901-0049		CR: Si (special)
CR405	1901-0040		CR: Si (special)
CR406	1901-0040		CR: Si (special)
CR407	1901-0040		CR: Si (special)
CR408	1901-0028	8	CR: Si (special)
CR409	1901-0028		CR: Si (special)
CR410	1901-0028		CR: Si (special)
CR411	1901-0028		CR: Si (special)
CR412	1901-0026	2	CR: Si (special)
CR413	1901-0049	6	CR: Si (special)
CR414	1901-0049		CR: Si (special)
CR415	1901-0049		CR: Si (special)
CR416	1901-0049		CR: Si (special)
CR417	1901-0040		CR: Si (special)
CR419	1901-0040		CR: Si (special)
CR420	1901-0040		CR: Si (special)
CR421	1901-0049		CR: Si (special)
CR422	1901-0049		CR: Si (special)
CR423	1901-0049		CR: Si (special)
CR424	1901-0049		CR: Si (special)
CR425	1901-0040		CR: Si (special)
CR426	1901-0028		CR: Si (special)
CR427	1901-0028		CR: Si (special)
CR428	1901-0028		CR: Si (special)
CR429	1901-0028		CR: Si (special)
CR430	1901-0026		CR: Si (special)
CR432	1901-0040		CR: Si (special)

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

Ref Desig	HP Part No.	TQ	Description (Refer to Table 6-1.)
CR433	1901-0040		CR: Si (special)
CR434	1901-0040		CR: Si (special)
DS401	1450-0359	1	DS: Indicator light, power 28V 40 mA
E301	1200-0043	5	Insulator: transistor
F301	2110-0012	1	F: 0.5A 250V cartridge
F401	2100-0021	1	F: 1.25V s-b 125V cartridge
F402	2110-0021	1	F: 1.25A s-b 125V cartridge
F403	2110-0067	1	F: .30A 250V cartridge
F404	2110-0002	2	F: 2A 250V cartridge
F405	2110-0002		F: 2A 250V cartridge
F406	2110-0067	1	F: 0.30A 250V cartridge
FL401	9100-2483	1	FL: Line Filter
H1	0362-0063	40	Clip: square pin
H2	5020-0495	109	Pin: interconnection square
H5	1400-0091	6	Clip: component 1-3/8 in. dia block
H6	0340-0114	2	Bushing: teflon
H7	5040-0402	1	Mount: T301 7/8 in.
H8	5040-0430	1	Mount: T301 21/32 in.
H9	1400-0026	1	Clamp: hose (CRT neck)
H10	00180-24701	4	Standoff: octagonal T401 mount
H11	00180-24702	1	Standoff: black insulating for A1
H12	0380-0724	2	Spacer: T401 support
H13	00180-45402	1	Bushing: insulator focus control
H14	00180-45404	1	Insulator: focus control
H15	00180-45403	3	Bushing: insulator calibrator jacks
H16	00180-09104	1	Clip: ground plug-in
H17	00180-09105	1	Clip: ground dag
H18	0510-0053	1	Retaining ring: focus shaft
H22	00180-41208	1	Clip: twin lead horiz
H23	5040-0464	2	Hanger: probe clip-on
H24	5060-0767	5	Foot: assy plastic
J1	1251-0137	1	J: female 32 pin
J101	1250-0083	6	J: BNC female
J102	00180-21702	2	J: banana female
J103	00180-21702		J: banana female
J105	1250-0083		J: BNC female
J106	1250-0083		J: BNC female
J107	1250-0083		J: BNC female
J108	1250-0083		J: BNC female
J201	1250-0083		J: BNC female
J402	1510-0038	1	J: binding post

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

Ref Desig	HP Part No.	TQ	Description (Refer to Table 6-1.)
L101	9140-0047	8	L: fxd 20 uH 10%
L102	9140-0047		L: fxd 20 uH 10%
L105	9140-0047		L: fxd 20 uH 10%
L107	9140-0047		L: fxd 20 uH 10%
L108	9140-0047		L: fxd 20 uH 10%
L200	9140-0047		L: fxd 20 uH 10%
L201	9140-0047		L: fxd 20 uH 10%
L202	9140-0047		L: fxd 20 uH 10%
L203	9170-0029	1	L: bead
L301	9140-0071	1	L: fxd 22 uH 10%
L302	5060-0435	1	L: trace align
L303	00180-65601	1	L: y align
MP100	00180-67404	2	Knob: assy bar w/black arrow
MP101	00180-67402	1	Knob: assy w/black arrow
MP102	00180-67404		Knob: assy bar w/black arrow
MP103	00180-05002	1	Lever: control fine horiz position
MP104	0370-0432	1	Knob: control lever
MP105	0370-0360	1	Button: push find beam
MP106	0370-0348	1	Knob: round hollow shaft intensity
MP107	00180-67401	1	Knob: assy w/black arrow
MP108	00180-67403	1	Knob: assy w/black arrow and off
MP111	5040-0444	1	Shield: light plastic bezel
MP112	0905-0331	1	Gasket: CRT mount
MP114	1490-0030	1	Stand: tilt
MP116	00180-44103	1	Cover: fuse block
MP117	00180-23202	2	Coupler: control screwdriver adjust
MP118	00180-23201	1	Coupler: control knob
MP119	10178-60501	1	Filter: mesh contrast filter
MP120	00180-00229	1	Panel: front (incl J104)
MP121	00180-00208	1	Panel: front sub
MP123	00180-00602	1	Shield: assy CRT
MP128	00180-64108	1	Cover: high voltage supply
MP130	00180-61201	2	Clamp: CRT neck plastic
MP133	00180-01210	1	Bracket: xfmr mount bottom front
MP134	00180-01209	1	Bracket: connector plug-in
MP135	0400-0010	2	Grommet: .250 I.D.
MP137	00180-43102	3	Guide: right plug-in
MP138	00180-60108	1	Chassis: assy power section
MP139	00180-61103	1	Heat Sink: right (incl XQ403, XQ404)
MP140	5040-0453	1	Insulator: high voltage
MP141	00180-01208	1	Bracket: CRT control
MP142	00180-23701	1	Shaft: find beam control
MP143	00180-00210	1	Panel: rear display section
MP144	00180-01206	1	Bracket: pwr transistor (incl XF301, XQ301)
MP151	00180-61104	1	Heat Sink: left (incl XQ401, XQ402)
MP152	00181-00209	1	Panel: rear power section
MP153	00180-01227	1	Bracket: capacitor (incl XF403, XF404, H5)

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

Ref Desig	HP Part No.	TQ	Description (Refer to Table 6-1.)
MP155	00130-60107	1	Chassis: assy display section
MP158	5020-0476	1	Bezel: front panel
MP160	00180-25401	1	Insulator: plexiglass high voltage cover
MP161	00180-43101	1	Guide: left plug-in
MP162	00180-01218	2	Bracket: mount L302
MP163	00180-01223	1	Bracket: T401 mount top rear
MP164	00180-01215	1	Bracket: T401 mount bottom rear
MP165	00180-01222	1	Bracket: T401 mount top front
MP166	00180-04703	1	Bracket: T401 support
MP167	5060-0447	2	Frame: assy side
MP168	5000-0444	2	Cover: side
MP169	5000-0051	2	Plate: fluted aluminum
MP170	5000-0446	1	Cover: top
MP171	5000-0445	1	Cover: bottom
MP172	00180-01217	2	Bracket: cover
MP173	00180-00601	1	Shield: post accelerator
MP174	5000-0449	1	Spacer: frame front
MP175	5000-0469	1	Spacer: frame rear
MP176	5060-0462	1	Kit: rack mount
MP201	4320-0231	1	Gasket: RFI
Q101	1854-0019	5	Q: Si npn (special)
Q102	1854-0019		Q: Si npn (special)
Q103	1853-0038	3	Q: Si pnp (special)
Q104	1854-0056	1	Q: Si npn 2N3119
Q105	1853-0009	3	Q: Si pnp (special)
Q106	1854-0234	2	Q: Si npn 2N3440
Q107	1845-0234		Q: Si npn 2N3440
Q108	1854-0071	12	Q: Si npn (special)
Q109	1854-0071		Q: Si npn (special)
Q110	1853-0016	2	Q: Si pnp 2N3638
Q111	1853-0016		Q: Si pnp 2N3638
Q201	1855-0020	1	Q: Si FET n-channel (special)
Q202	1854-0083	1	Q: Si npn (special)
Q203	1850-0158	1	Q: Ge pnp 2N2635
Q204	1854-0019		Q: Si npn (special)
Q205	1854-0071		Q: Si npn (special)
Q206	1854-0019		Q: Si npn (special)
Q207	1854-0019		Q: Si npn (special)
Q208	1853-0009		Q: Si pnp (special)
Q209	1854-0056	2	Q: Si npn 2N3119
Q210	1853-0038		Q: Si pnp (special)
Q211	1853-0009		Q: Si pnp (special)
Q212	1854-0056		Q: Si npn 2N3119
Q213	1853-0038		Q: Si pnp (special)
Q301	1854-0023	1	Q: Si npn (special)
Q302	1854-0071		Q: Si npn (special)

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

Ref Desig	HP Part No.	TQ	Description (Refer to Table 6-1.)
Q303	1854-0039	3	Q: Si npn 2N3053
Q304	1854-0291	1	Q: Si npn (special)
Q401	1854-0063	4	Q: Si npn 2N3055
Q402	1854-0090	2	Q: Si npn (special)
Q403	1854-0087		Q: Si npn (special)
Q404	1854-0071		Q: Si npn (special)
Q405	1854-0039		Q: Si npn 2N3053
Q406	1854-0063		Q: Si npn 2N3055
Q407	1854-0071		Q: Si npn (special)
Q408	1854-0071		Q: Si npn (special)
Q409	1854-0039		Q: Si npn 2N3053
Q410	1854-0063		Q: Si npn 2N3055
Q411	1854-0071		Q: Si npn (special)
Q412	1854-0071		Q: Si npn (special)
Q413	1854-0090		Q: Si npn (special)
Q414	1854-0063		Q: Si npn 2N3055
Q415	1854-0087		Q: Si npn (special)
Q416	1854-0071		Q: Si npn (special)
R101	0757-0438	8	R: fxd metflm 5.11 kilohms 1% 1/8W
R102	0757-0407	7	R: fxd metflm 200 ohms 1% 1/8W
R103	0757-0407		R: fxd metflm 200 ohms 1% 1/8W
R104	0757-0401	9	R: fxd metflm 100 ohms 1% 1/8W
R105	0757-0458	1	R: fxd metflm 51.1 kilohms 1% 1/8W
R106	2100-1904	1	R: var comp 10 kilohms 20% 1/4W
R107	0757-0281	1	R: fxd metflm 2.74 kilohms 1% 1/8W
R111	0757-0401		R: fxd metflm 100 ohms 1% 1/8W
R112	0757-0401		R: fxd metflm 100 ohms 1% 1/8W
R113	0757-0401		R: fxd metflm 100 ohms 1% 1/8W
R114	0757-0290	1	R: fxd metflm 6.19 kilohms 1% 1/8W
R115	0757-0724	1	R: fxd metflm 392 ohms 1% 1/4W
R116	0757-0461	1	R: fxd metflm 68.1 kilohms 1% 1/8W
R117	0757-0727	1	R: fxd metflm 562 ohms 1% 1/4W
R118	0757-0407		R: fxd metflm 200 ohms 1% 1/8W
R119	0757-0756	1	R: fxd metflm 13 kilohms 1% 1/4W
R120	0757-0469	1	R: fxd metflm 150 kilohms 1% 1/8W
R121	0757-0756		R: fxd metflm 13 kilohms 1% 1/4W
R125	0757-0280	10	R: fxd metflm 1 kilohm 1% 1/8W
R126	0757-0760	3	R: fxd metflm 20 kilohms 1% 1/4W
R127	0757-0416	1	R: fxd metflm 511 ohms 1% 1/8W
R128	0757-0441	2	R: fxd metflm 8.25 kilohms 1% 1/8W
R129	0757-0438		R: fxd metflm 5.11 kilohms 1% 1/8W
R130	0757-0434	5	R: fxd metflm 3.65 kilohms 1% 1/8W
R131	0757-0283	3	R: fxd metflm 2 kilohms 1% 1/8W
R132	0757-0421	1	R: fxd metflm 825 ohms 1% 1/8W
R133	0761-0083	1	R: fxd metox film 68 kilohms 5% 1W

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

Ref Desig	HP Part No.	TQ	Description (Refer to Table 6-1.)
R136	0757-0760		R: fxd metflm 20 kilohms 1% 1/4W
R137	0757-0468	2	R: fxd metflm 130 kilohms 1% 1/8W
R138	0757-0468		R: fxd metflm 130 kilohms 1% 1/8W
R139	0683-0275	5	R: fxd comp 2.7 ohms 5% 1/4W
R140	0757-0283		R: fxd metflm 2 kilohms 1% 1/8W
R141	0757-0407		R: fxd metflm 200 ohms 1% 1/8W
R142	0757-0760		R: fxd metflm 20 kilohms 1% 1/4W
R143	0698-5418	1	R: fxd metflm 50 ohms 0.1% 1/8W
R144	0698-5419	1	R: fxd metflm 1.95 kilohms 0.1% 1/2W
R145	0698-5421	1	R: fxd metflm 17.82 kilohms 0.1% 1/2W
R149	0757-0451	2	R: fxd metflm 24.3 kilohms 1% 1/8W
R150	0757-0438		R: fxd metflm 5.11 kilohms 1% 1/8W
R151	0757-0436	3	R: fxd metflm 4.32 kilohms 1% 1/8W
R152	0757-0451		R: fxd metflm 24.3 kilohms 1% 1/8W
R153	0757-0438		R: fxd metflm 5.11 kilohms 1% 1/8W
R154	0757-0436		R: fxd metflm 4.32 kilohms 1% 1/8W
R155	0757-0431	2	R: fxd metflm 2.43 kilohms 1% 1/8W
R156	0757-0283		R: fxd metflm 2 kilohms 1% 1/8W
R157	0757-0438		R: fxd metflm 5.11 kilohms 1% 1/8W
R158	0757-0431		R: fxd metflm 2.43 kilohms 1% 1/8W
R159	0757-0283		R: fxd metflm 2 kilohms 1% 1/8W
R160	0757-0438		R: fxd metflm 5.11 kilohms 1% 1/8W
R161	0683-0275		R: fxd comp 2.7 ohms 5% 1/4W
R162	0683-0275		R: fxd comp 2.7 ohms 5% 1/4W
R201	0757-0465	7	R: fxd metflm 100 kilohms 1% 1/8W
R202	0757-0344	1	R: fxd metflm 1 megohm 1% 1/4W
R203	0757-0401		R: fxd metflm 100 ohms 1% 1/8W
R204	0757-0845	1	R: fxd metflm 18.2 kilohms 5% 1/2W
R205	0757-0282	1	R: fxd metflm 221 ohms 1% 1/8W
R206	0757-0847	1	R: fxd metflm 27.4 kilohms 1% 1/2W
R207	2100-1418	1	R: var comp 50 kilohms 20% 1/5W
R208	0757-0440	2	R: fxd metflm 7.5 kilohms 1% 1/8W
R209	0698-5420	1	R: fxd metflm 3874 ohms 0.1% 1/8W
R210	0757-0463	2	R: fxd metflm 82.5 kilohms 1% 1/8W
R211	2100-2089	1	R: var comp 50 kilohms 30% 1/2W (special slot)
R215	0757-0441		R: fxd metflm 8.25 kilohms 1% 1/8W
R216	0757-0792	1	R: fxd metflm 681 kilohms 1% 1/4W
R217	0757-0401		R: fxd metflm 100 ohms 1% 1/8W
R218	2100-2076	1	R: var car comp dual 100 kilohms 20% (includes R221)
R219	0757-0460	4	R: fxd metflm 61.9 kilohms 1% 1/8W
R220	0757-0401		R: fxd metflm 100 ohms 1% 1/8W
R221			NSR: w/o R218
R222	0757-0283		R: fxd metflm 2 kilohms 1% 1/8W
R223	0757-0764	3	R: fxd metflm 33.2 kilohms 1% 1/4W
R225	0757-0741	2	R: fxd metflm 2.43 kilohms 1% 1/4W
R229	0757-0281		R: fxd metflm 2.74 kilohms 1% 1/8W

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

Ref Desig	HP Part No.	TQ	Description (Refer to Table 6-1.)
R230	0757-0443	2	R: fxd metflm 11 kilohms 1% 1/8W
R231	0757-0434		R: fxd metflm 3.65 kilohms 1% 1/8W
R232	0757-0736	2	R: fxd metflm 1.5 kilohms 1% 1/4W
R234	0757-0846	2	R: fxd metflm 22.1 kilohms 1% 1/2W
R235	0757-0413	2	R: fxd metflm 392 ohms 1% 1/8W
R237	0757-0407		R: fxd metflm 200 ohms 1% 1/8W
R238	0757-0841	2	R: fxd metflm 12.1 kilohms 1% 1/2W
R239	0757-0448		R: fxd metflm 18.2 kilohms 1% 1/8W
R244	0683-0275		R: fxd comp 2.7 ohms 5% 1/4W
R245	0757-0388	5	R: fxd metflm 30.1 ohms 1% 1/8W
R246	2100-1770	1	R: var ww 100 ohms 10% 1/2W
R247	0757-0284	1	R: fxd metflm 150 ohms 1% 1/8W
R248	2100-1771	1	R: var ww 200 ohms 10% 1/2W
R249	0757-0411	1	R: fxd metflm 332 ohms 1% 1/8W
R250	2100-1773	2	R: var ww 1 kilohm 10% 1/2W
R251	0757-0428	1	R: fxd metflm 1.62 kilohms 1% 1/8W
R252	0698-3416	2	R: fxd metflm 21.5 kilohms 1% 1/2W
R253	2100-0741	1	R: var ww 5 kilohms 5% 1W
R254	0698-3416		R: fxd metflm 21.5 kilohms 1% 1/2W
R257	0757-0468		R: fxd metflm 130 kilohms 1% 1/8W
R258	0757-0440		R: fxd metflm 7.5 kilohms 1% 1/8W
R259	0757-0427	1	R: fxd metflm 1.5 kilohms 1% 1/8W
R261	0757-0741		R: fxd metflm 2.43 kilohms 1% 1/4W
R262	0757-0281		R: fxd metflm 2.74 kilohms 1% 1/8W
R263	0757-0200	1	R: fxd metflm 5.62 kilohms 1% 1/8W
R264	0757-0443		R: fxd metflm 11 kilohms 1% 1/8W
R268	0757-0434		R: fxd metflm 3.65 kilohms 1% 1/8W
R269	0757-0736		R: fxd metflm 1.5 kilohms 1% 1/4W
R270	0757-0413		R: fxd metflm 392 ohms 1% 1/8W
R271	0757-0846		R: fxd metflm 22.1 kilohms 1% 1/2W
R273	0757-0407		R: fxd metflm 200 ohms 1% 1/8W
R275	0757-0841		R: fxd metflm 12.1 kilohms 1% 1/2W
R301	0683-0275		R: fxd comp 2.7 ohms 5% 1/4W
R302	2100-0943	1	R: var metflm 100 kilohms 20% 3/4W
R303	0727-0263	1	R: fxd metflm 950 kilohms 1% 1/2W
R304	0757-0442	2	R: fxd metflm 10 kilohms 1% 1/8W
R305	0698-6239	1	R: fxd metflm 30 megohms 2% 1/2W
R313	0757-0442		R: fxd metflm 10 kilohms 1% 1/8W
R314	0757-0438		R: fxd metflm 5.11 kilohms 1% 1/8W
R315	0698-3553	1	R: fxd car. flm 2.49 megohms 1% 1/2W
R316	0757-0283		R: fxd metflm 2 kilohms 1% 1/8W
R317	0757-0280		R: fxd metflm 1 kilohm 1% 1/8W
R318	0757-0465		R: fxd metflm 100 kilohms 1% 1/8W
R319	0757-0401		R: fxd metflm 100 ohms 1% 1/8W
R320	0757-0814	1	R: fxd metflm 511 ohms 1% 1/2W

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

Ref Desig	HP Part No.	TQ	Description (Refer to Table 6-1.)
R321	0757-0465		R: fxd metflm 100 kilohms 1% 1/8W
R325	0683-2235	1	R: fxd comp 22 kilohms 5% 1/4W
R326	2100-1618	1	R: var comp 1 megohm 20% lin 1/5W
R327	0836-0003	1	R: fxd depc 29 megohms 10% 1W
R328	0683-1055	1	R: fxd comp 1 megohm 5% 1/4W
R330	0757-0456	3	R: fxd metflm 43.2 kilohms 1% 1/8W
R331	0757-0460		R: fxd metflm 61.9 kilohms 1% 1/8W
R332	0757-0456		R: fxd metflm 43.2 kilohms 1% 1/8W
R333	0757-0460		R: fxd metflm 61.9 kilohms 1% 1/8W
R334	2100-1903	1	R: var ww 5 kilohms 10% 2W
R335	0757-0280		R: fxd metflm 1 kilohm 1% 1/8W
R336	2100-2030	1	R: var cer metflm 20 kilohms 30% 1/2W
R337	0757-0280		R: fxd metflm 1 kilohm 1% 1/8W
R341	0683-1535	1	R: fxd comp 15 kilohms 5% 1/4W
R342	0686-2245		NSR: p/o A8 potted assy
R343	0698-5677	1	R: fxd comp 8.25 megohms 5% 1W
R344	2100-1906	1	R: var comp 5 megohms 10% 1/2W
R345	0698-5678	1	R: fxd comp 16.25 megohms 5% 1W
R346	0683-1045	1	R: fxd comp 100 kilohms 5% 1/4W
R347	2100-1906	1	R: var comp 50 kilohms 20% 1/2W
R348	2100-2031	1	R: var cer metflm 50 kilohms 30% 1/2W
R349	0757-0454	1	R: fxd metflm 33.2 kilohms 1% 1/8W
R350	2100-1901	1	R: var ww 100 ohms 10% 2W
R351	0757-0280		R: fxd metflm 1 kilohm 1% 1/8W
R352	0757-0280		R: fxd metflm 1 kilohm 1% 1/8W
R353	0757-0460		R: fxd metflm 61.9 kilohms 1% 1/8W
R354	0757-0456		R: fxd metflm 43.2 kilohms 1% 1/8W
R401	0757-0280		R: fxd metflm 1 kilohm 1% 1/8W
R402	0811-1788	1	R: fxd ww 15 ohms 5% 2W
R403	0757-0465		R: fxd metflm 100 kilohms 1% 1/8W
R404	0757-0280		R: fxd metflm 1 kilohm 1% 1/8W
R406	0757-0399	2	R: fxd metflm 82.5 ohms 1% 1/8W
R408	0757-0843	3	R: fxd metflm 30.1 kilohms 1% 1/2W
R407	0757-0200	3	R: fxd metflm 5.62 kilohms 1% 1/8W
R408	0757-0438		R: fxd metflm 5.11 kilohms 1% 1/8W
R409	0757-0764		R: fxd metflm 33.2 kilohms 1% 1/4W
R410	0757-0386		R: fxd metflm 30.1 ohms 1% 1/8W
R411	0757-0200		R: fxd metflm 5.62 kilohms 1% 1/8W
R412	2100-1774	1	R: var ww 2 kilohms 10% 1/2W
R413	0757-0855	1	R: fxd metflm 68.1 kilohms 1% 1/2W
R417	0757-0386		R: fxd metflm 30.1 ohms 1% 1/8W
R418	0757-0044	1	R: fxd metflm 33.2 kilohms 1% 1/2W
R419	0811-1746	2	R: fxd ww 0.36 ohms 5% 2W
R420	0757-0463		R: fxd metflm 82.5 kilohms 1% 1/8W
R421	0757-0480	1	R: fxd metflm 432 kilohms 1% 1/8W
R422	0757-0434		R: fxd metflm 3.65 kilohms 1% 1/8W

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

Ref Desig	HP Part No.	TQ	Description (Refer to Table 6-1.)
R423	2100-1772	2	R: var ww 500 ohms 10% 1/2W
R424	0757-0060	2	R: fxd metfilm 24.3 kilohms 1% 1/2W
R428	0757-0388		R: fxd metfilm 30.1 ohms 1% 1/8W
R429	0757-0848		R: fxd metfilm 30.1 kilohms 1% 1/2W
R430	0811-1748		R: fxd ww 0.36 ohms 5% 2W
R431	0757-0465		R: fxd metfilm 100 kilohms 1% 1/8W
R432	0757-0477	1	R: fxd metfilm 332 kilohms 1% 1/8W
R433	0757-0434		R: fxd metfilm 3.65 kilohms 1% 1/8W
R434	2100-1772		R: var ww 500 ohms 10% 1/2W
R435	0757-0060		R: fxd metfilm 24.3 kilohms 1% 1/2W
R439	0811-1678	1	R: fxd ww 10 ohms 5% 2W
R440	0757-0465		R: fxd metfilm 100 kilohms 1% 1/8W
R441	0757-0280		R: fxd metfilm 1 kilohm 1% 1/8W
R442	0757-0399		R: fxd metfilm 82.5 ohms 1% 1/8W
R443	0757-0348		R: fxd metfilm 30.1 kilohms 1% 1/2W
R444	0757-0200		R: fxd metfilm 5.62 kilohms 1% 1/8W
R445	0757-0465		R: fxd metfilm 100 kilohms 1% 1/8W
R446	0757-0764		R: fxd metfilm 33.2 kilohms 1% 1/4W
R447	0757-0388		R: fxd metfilm 30.1 ohms 1% 1/8W
R448	0757-0436		R: fxd metfilm 4.32 kilohms 1% 1/8W
R449	2100-1773		R: var ww 1 kilohm 10% 1/2W
R450	0698-3416	1	R: fxd metfilm 21.5 kilohms 1% 1/2W
S101	3100-1344	1	S: rotary two-position (includes R211)
S102	3101-0977	1	S: pushbutton dpdt mom. 30 Vac 250 mA
S201	3101-0070	1	S: slide dpdt minat 125 Vac-Vdc 0.5A
S202	3101-0982	1	S: slide spdt minat 125 Vac-Vdc 0.5A pc mount
S203	3100-1345	1	S: rotary three-position one-section
S401	3101-0995	1	S: toggle switch dpdt 125 Vac 5A
S402	3101-0109	1	S: slide dpdt slotted 125 Vac-Vdc 0.5A
T301	00180-60601	1	T: high voltage
T401	9100-1109	1	T: power (for Options 003 and 004)
TP301	1251-0206	5	TP: female
TP401	1251-0206		TP: female
TP402	1251-0206		TP: female
TP403	1251-0206		TP: female
TP404	1251-0206		TP: female
V301	2140-0018	1	V: neon glow ABA-C (NE-2E1)
V302	2140-0018		V: neon glow ABA-C (NE-2E1)
V303	5083-9063	1	V: CRT internal graticule P31 phosphor
V401	1940-0013	2	V: voltage reference 62.0V ±1.0V
V402	1940-0013		V: voltage reference 62.0V ±1.0V
VR301	1902-0045	1	VR: avalanche 7.2V 2%

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

Ref Desig	HP Part No.	TQ	Description (Refer to Table 6-1.)
VR302	1902-0025	1	VR: avalanche 10.0V 5%
VR401	1902-3086	1	VR: avalanche 5.32V 5%
VR402	1902-3354	2	VR: avalanche 54.6V 5%
VR403	1902-3354		VR: avalanche 54.6V 5%
W1	00180-61617	1	W: assy coax J1 to S101
W2	00180-61626	1	W: assy vert deflection
W4	00180-61650	1	W: assy sweep gate output
W5	00180-61656	1	W: assy horiz deflection
W6	00180-61653	1	W: assy low voltage supply
W7	00180-61665	1	W: assy main harness
W8	00180-61657	1	W: assy horiz magnifier
W9	00180-61658	1	W: assy T401
W101	00180-61652	1	W: assy coax display switch
W401	00180-61674	1	W: power input
XF301	1400-0008	1	XF: block single
XF401	1400-0084	2	XF: cartridge single extractor-post type
XF402	1400-0084		XF: cartridge single extractor-post type
XF403	1400-0123	2	XF: block three-fuse
XF404	1400-0123		XF: block three-fuse
XQ304	1200-0041	5	XQ: insulated two-pin
XQ401	1200-0041		XQ: insulated two-pin
XQ402	1200-0041		XQ: insulated two-pin
XQ403	1200-0041		XQ: insulated two-pin
XQ404	1200-0041		XQ: insulated two-pin
XV303	– –		Consists of:
	1200-0192	1	Socket: CRT
	1200-0050	7	Pin: CRT socket
	1200-0408	1	Cover: CRT socket

Ref Desig	Description
A1	CIRCUIT BOARD, CALIBRATOR; GATE AND HIGH VOLTAGE CONTROL: Printed circuit board w/all components assembled for operation; mfr 28480, P/N 00180-66511.
A2	CIRCUIT BOARD, MAIN AND DELAYED SWEEP AND GATE OUTPUT AMPLIFIER: Printed circuit board w/all components assembled for operation; mfr 28480, P/N 00180-66516.
A3	CIRCUIT BOARD, HORIZONTAL AMPLIFIER: Printed circuit board w/all components assembled for operation; mfr, 28480, P/N 00180-66510.
A4	CIRCUIT BOARD, HIGH VOLTAGE OSCILLATORS: Printed circuit board w/all components assembled for operation, P/N 00180-66515.
A5	CIRCUIT BOARD, HIGH VOLTAGE RECTIFIER: Printed circuit board w/all components assembled for operation; mfr 28480, P/N 00180-66509.
A6	CIRCUIT BOARD, LOW VOLTAGE RECTIFIER: Printed circuit board w/all components assembled for operation; mfr 28480, P/N 00180-66514.
A7	CIRCUIT BOARD, LOW VOLTAGE POWER SUPPLY: Printed circuit board w/all components assembled for operation, mfr 28480, P/N 00180-66513.
A8	TRIPLER ASSEMBLY, HIGH VOLTAGE: Box w/all components assembled for operation; mfr 28480, P/N 00180-61102.
A9	SWITCH DISPLAY: Printed circuit board w/all components assembled for operation; mfr 28480, P/N 00180-61902.
C100	Not Used.
C101	CAPACITOR, FIXED, MYLAR: 0.1 uF 10% 200 vdcw
C102	CAPACITOR, FIXED, MYLAR: 0.01 uF ±5%, 200 vdcw; mfr 56289, P/N 192P10352 PTS.
C103	CAPACITOR, FIXED, MYLAR: 0.022 uF ±10%; mfr 56289, P/N 192P22392 PTS.
C104	CAPACITOR: Same as C103.
C105	CAPACITOR: Same as C103.
C106	CAPACITOR: Same as C103.
C107	Not Used.
C108	Not Used.
C109	Not Used.
C110	CAPACITOR, VARIABLE, POLYSTYRENE: 0.7 to 3 pf, 300 vdcw, mfr 72932, P/N 535-009-4R.
C111	CAPACITOR: MIL type CC20CJ3R3C.
C112	CAPACITOR: MIL type CM06FC202G03.
C113	CAPACITOR, VARIABLE, TEFLON: 0.2 to 1.5 pf, 600 vdcw; mfr 72982, P/N 530-000.
C114	CAPACITOR: Same as C103.
C115	CAPACITOR, FIXED, ELECTROLYTIC: 100 uf, 12 vdcw; mfr 56289, P/N 30D107G012CC2DSM.
C116	CAPACITOR, FIXED, CERAMIC: 20 pf, 100 vdcw; mfr 56289, P/N 53C47.
C117	Not Used.

Ref Desig	Description
C118	Not Used.
C119	Not Used.
C120	CAPACITOR, FIXED, TANTALUM: 2.2 uf ±20%, 20 vdcw; MIL type CS13BE225M.
C121	CAPACITOR, FIXED, MICA: 5825 pf ±2%, 300 vdcw; mfr 00853, P/N RDM20F5825QG3S.
C122	CAPACITOR: Same as C121.
C123	CAPACITOR, FIXED, ELECTROLYTIC: 10 uf -10% +100%, 150 vdcw; mfr 56289, P/N 30D106F150DD2DSM.
C124	Not Used.
C125	Not Used.
C126	Not Used.
C127	CAPACITOR, FIXED, TANTALUM: 2.2 uf 20% 20 vdcw.
C128	CAPACITOR, FIXED, TANTALUM: 2.2 uf 20% 20 wvdc.
C200	Not Used.
C201	CAPACITOR, FIXED, MYLAR: 0.1 uf 20% 600 vdcw
C202	CAPACITOR, FIXED, CERAMIC: 4700 pf -20% +100%, 500 vdcw; mfr 72982, P/N 851-000X5U0-472Z.
C203	CAPACITOR, VARIABLE, MICA: 16 to 150 pf, 175 vdcw; mfr 28480, P/N 0131-0004.
C204	CAPACITOR: MIL type CM05F361F03.
C205	CAPACITOR: Same as C103.
C206	CAPACITOR: Same as C103.
C207	Not Used.
C208	Not Used.
C209	Not Used.
C210	CAPACITOR, VARIABLE, GLASS: 0.7 to 3 pf, 350 vdcw; mfr 72982, P/N 535-033-4R.
C211	CAPACITOR: Same as C103.
C212	CAPACITOR, FIXED, MYLAR: 0.047 uf ±10%, 200 vdcw; mfr 56289, P/N 192P47392PTS.
C213	CAPACITOR: Same as C210.
C214	CAPACITOR: MIL type CC20CKR75C.
C215	Not Used.
C216	Not Used.
C217	Not Used.
C218	CAPACITOR: Same as C103.
C219	CAPACITOR: Same as C103.
C220	CAPACITOR: MIL type CS13BE225K.
C221	CAPACITOR: Same as C220.
C222	CAPACITOR: Same as C103.
C223	Not Used.
C224	Not Used.
C225	Not Used.
C226	CAPACITOR: Same as C220.
C227	CAPACITOR: Same as C220.
C228	CAPACITOR: MIL type CSR13G154KM.
C229	CAPACITOR: Same as C210.

Ref Desig	Description
C230	CAPACITOR: Same as C103.
C231	CAPACITOR: Same as C212.
C300	Not Used.
C301	CAPACITOR, FIXED, ELECTROLYTIC: 20 uf, 25 vdcw; mfr 56289, P/N 40D206G025DC6DST.
C302	CAPACITOR, FIXED, CERAMIC: 4500 pf, 3500 vdcw; mfr 28480, P/N 0160-2486.
C303	CAPACITOR, FIXED, MYLAR: 0.1 uf ±5%, 200 vdcw; mfr 56289, P/N 192P10452PTS.
C304	Not Used.
C305	Not Used.
C306	Not Used.
C307	CAPACITOR, FIXED ELECTROLYTIC: 47 uf 10% 35 vdcw; mfr 28480, P/N 0180-0097
C308	CAPACITOR, FIXED, MYLAR: 0.22 uf 10% 200 vdcw; mfr 28480, P/N 0160-0380.
C309	CAPACITOR, FIXED, CERAMIC: 0.1 uf 5000 vdcw; mfr 28480, P/N 0160-0907.
C310	CAPACITOR, FIXED, CERAMIC: 0.01 uf, 5000 vdcw; mfr 71590, P/N DA938-000J.
C311	CAPACITOR, FIXED, CERAMIC: 0.01 uf, 5000 vdcw; mfr 28480, P/N 0160-2320.
C312	Not Used.
C313	Not Used.
C314	Not Used.
C315	CAPACITOR: Same as C309.
C316	CAPACITOR: Same as C310.
C317	CAPACITOR: Same as C311.
C318	CAPACITOR: Potted assy, not replaceable.
C319	CAPACITOR: Same as C318.
C320	CAPACITOR: Same as C318.
C321	CAPACITOR: Same as C318.
C400	Not Used.
C401	CAPACITOR, FIXED, ELECTROLYTIC: 100 uf –10+75%, 20 vdcw; Mfr 56289, P/N 600D107G020DD4.
C402	CAPACITOR, FIXED, CERAMIC: 4700 pf –20+80% 4000 vdcw; Mfr 71590, P/N 2DDH67S472ZAA.
C403	Not Used.
C404	CAPACITOR: Same as C402.
C405	CAPACITOR, FIXED, ELECTROLYTIC: 430 uf 200 vdcw; mfr 56289, P/N 32D212G040AB6A.
C406	CAPACITOR, FIXED, MYLAR: 0.1 uf 10% 200 vdcw; mfr 28480, P/N 0160-0168.
C407	CAPACITOR, FIXED, TANTALUM, ELECTROLYTIC: 4.7 uf 10% 35 vdcw; mfr 28480, P/N 0180-0100.
C408	CAPACITOR, FIXED, ALUMINUM, ELECTROLYTIC: 18 uf -10% +50%, 150 vdcw; mfr 28480, P/N 0180-1810.
C409	Not Used.
C410	Not Used.
C411	Not Used.
C412	CAPACITOR, FIXED, ELECTROLYTIC: 2100 uf, 40 vdcw; mfr 56289, P/N 32D212G040AB6A.

Ref Desig	Description
C413	CAPACITOR, FIXED, MYLAR: 0.1 uf 10% 200 vdcw; mfr 28480 P/N 0160-0168.
C414	CAPACITOR, FIXED, ELECTROLYTIC: 47 uf 10% 35 vdcw; mfr 28480, P/N 0180-0097.
C415	Not Used.
C416	Not Used.
C417	Not Used.
C418	CAPACITOR, FIXED, ELECTROLYTIC: 3400 uf, 25 vdcw, mfr 56289, P/N 32D342G025AB2A.
C419	CAPACITOR, FIXED, MYLAR: 0.1 uf 10% 200 vdcw; mfr 28480, P/N 0160-0168.
C420	CAPACITOR, FIXED, ELECTROLYTIC: 47 uf 10% 35 vdcw; mfr 28480, P/N 0180-0097.
C421	Not Used.
C422	Not Used.
C423	Not Used.
C424	CAPACITOR, FIXED, ELECTROLYTIC: 290 uf 200 vdcw; mfr 56289, P/N 32D291F200AB2A.
C425	CAPACITOR, FIXED, MYLAR: 0.1 uf 10% 200 vdcw; mfr 28480, P/N 0160-0168.
C426	CAPACITOR, FIXED, TANTALUM, ELECTROLYTIC: 4.7 uf 10% 35 vdcw; mfr 28480, P/N 0180-0100.
C427	CAPACITOR, ALUMINUM, ELECTROLYTIC: 18 uf -10% +50% 150 vdcw; mfr 28480, P/N 0180-1810.
CR100	Not Used.
CR101	DIODE, SILICON: Mfr 07263, P/N FD7018.
CR102	DIODE, SILICON: JAN 1N914.
CR103	DIODE: Same as CR102.
CR104	DIODE: Same as CR102.
CR105	Not Used.
CR106	Not Used.
CR107	Not Used.
CR108	DIODE: Same as CR102.
CR109	DIODE, SILICON: Mfr 04713, P/N SR1358-10.
CR110	DIODE: Same as CR109.
CR111	DIODE: Same as CR102.
CR112	DIODE, SILICON: Mfr 04713, P/N SR1356.
CR113	DIODE: Same as CR112.
CR114	Not Used.
CR115	DIODE, SILICON: Mfr 07263, P/N FD2225.
CR116	DIODE: Same as CR115.
CR117	DIODE: Same as CR115.
CR201	DIODE: Same as CR115.
CR202	DIODE, SILICON: Mfr 28480, P/N 5080-0464.
CR203	DIODE: Same as CR102.
CR204	DIODE: Same as CR202.
CR205	DIODE: Same as CR102.

Table 6-3. Military Part No. (Cont'd.)

Ref Desig	Description
CR206	DIODE: Same as CR102.
CR207	DIODE: Same as CR202.
CR208	DIODE: Same as CR202.
CR209	DIODE: Same as CR102.
CR300	Not Used.
CR301	DIODE, SILICON: Mfr 28480, P/N 19010049.
CR302	DIODE, SILICON: Mfr 28480, P/N 1901-0341.
CR303	Not Used.
CR304	Not Used.
CR305	Not Used.
CR306	Not Used.
CR307	DIODE: Same as CR302.
CR400	Not Used.
CR401	DIODE: Same as CR301.
CR402	DIODE: Same as CR301.
CR403	DIODE: Same as CR301.
CR404	DIODE: Same as CR301.
CR405	DIODE: Same as CR102
CR406	DIODE: Same as CR102.
CR407	DIODE: Same as CR102.
CR408	DIODE, SILICON: Mfr 28480, P/N 1901-0028.
CR409	DIODE: Same as CR408.
CR410	DIODE: Same as CR408.
CR411	DIODE: Same as CR408.
CR412	DIODE, SILICON: Mfr 04713 P/N 1358-8.
CR413	DIODE: Same as CR301.
CR414	DIODE: Same as CR301.
CR415	DIODE: Same as CR301.
CR416	DIODE: Same as CR301.
CR417	DIODE: Same as CR102.
CR418	Not Used.
CR419	DIODE: Same as CR102.
CR420	DIODE: Same as CR102.
CR421	DIODE: Same as CR301.
CR422	DIODE: Same as CR301.
CR423	DIODE: Same as CR301.
CR424	DIODE: Same as CR301.
CR425	DIODE: Same as CR102.
CR426	DIODE: Same as CR408.
CR427	DIODE: Same as CR408.
CR428	DIODE: Same as CR408.
CR429	DIODE: Same as CR408.
CR430	DIODE: Same as CR412.
CR432	DIODE: Same as CR102.
CR433	DIODE: Same as CR102.
CR434	DIODE: Same as CR102.

Table 6-3. Military Part No. (Cont'd.)

Ref Desig	Description
DS400	Not Used.
DS401	LIGHT, INDICATOR: Mfr 08717, P/N 102SR-G-FB13.
F300	Not Used.
F301	FUSE: MIL type MS 90078-7.
F400	Not Used.
F401	FUSE, SLOW BLOW: 3 AG, 125v, 1¼ amp; mfr 71400, P/N MDL1¼.
F402	FUSE: Same as F401.
F403	FUSE: 3 AG, 250v, 3/10 amp; mfr 71400, P/N AGC3/10.
F404	FUSE: MIL type MS90078-9
F405	FUSE: Same as F404.
F406	FUSE: Same as F403.
FL400	Not Used.
FL401	FILTER, LINE: Mfr 28480, P/N 9100-2483.
H1	CLIP: SQUARE PIN, mfr 28480, P/N 0362-0063.
H2	PIN: SQUARE INTERCONNECTION, mfr 28480, P/N 5020-0495.
H5	CLIP: COMPONENT, 1-3/8 dia. block, mfr 28480, P/N 1400-0091.
H6	BUSHING: TEFLON, mfr 28480, P/N 0340-0114.
H7	MOUNT: Transformer T301 7/8 in., mfr 28480, P/N 5040-0402.
H8	MOUNT: Transformer T301 21/32 in., mfr 28480, P/N 5040-0430.
H9	CLAMP, HOSE: CRT neck, mfr 28480, P/N 1400-0026.
H10	STANDOFF, TRANSFORMER: Mfr 28480, P/N 00180-24701.
H11	STANDOFF, GATE BOARD: Mfr 28480, P/N 00180-24702.
H12	SPACER, POST TYPE: Mfr 28480, P/N 0380-0724.
H13	INSULATOR, BUSHING: Mfr 28480, P/N 00180-45402.
H14	INSULATOR, FOCUS: Mfr 28480, P/N 00180-45404.
H15	INSULATOR: 1/4-inch bushing, mfr 28480, P/N 00180-45403.
H16	CLIP, GROUND: Mfr 28480, P/N 00180-09104.
H17	CLIP, DAG GROUND: Mfr 28480, P/N 00180-09105.
H18	RETAINING RING: focus shaft, mfr 28480, P/N 0510-0053.
H22	CLIP, LEAD HORIZONTAL: Mfr 28480, P/N 00180-41208.
H23	HANGER, PROBE, CLIP-ON: Mfr 28480, P/N 5040-0464.
H24	FOOT: Assy plastic, Mfr 28480, P/N 5060-0767.
J1	CONNECTOR, RECEPTACLE: 32-contact, female; mfr 02660, P/N 264200-32S.
J100	Not Used.
J101	CONNECTOR, BNC, FEMALE: Mfr 95712, P/N 30624-1.
J102	JACK, BANANA: Mfr 833330, P/N 219-0.
J103	JACK: Same as J102.
J104	Not Used.
J105	CONNECTOR: Same as J101.
J106	CONNECTOR: Same as J101.
J107	CONNECTOR: Same as J101.

Ref Desig	Description
J108	CONNECTOR: Same as J101.
J200	Not Used.
J201	CONNECTOR: Same as J101.
J400	Not Used.
J401	Not Used.
J402	POST BINDING: Mfr 28480, P/N 1510-0038.
L100	Not Used.
L101	INDUCTOR, FIXED: 20 uh ±10%; mfr 99848, P/N H51074020.
L102	INDUCTOR: Same as L101.
L103	Not Used.
L104	Not Used.
L105	INDUCTOR: Same as L101.
L106	Not Used.
L107	INDUCTOR: Same as L101.
L108	INDUCTOR: Same as L101.
L200	INDUCTOR: Same as L101.
L201	INDUCTOR: Same as L101.
L202	INDUCTOR: Same as L101.
L203	INDUCTOR, BEAD, FERRITE: Mfr 02114, P/N 56-590-65/4A.
L300	Not Used.
L301	INDUCTOR: Same as L101.
L302	COIL, ALIGNMENT: Trace align; mfr 28480, P/N 5060-0435.
L303	COIL, ALIGNMENT: Y align; mfr 28480, P/N 00180-65601.
MP100	KNOB ASSEMBLY: Horizontal magnifier; mfr 28480, P/N 00180-67404.
MP101	KNOB ASSEMBLY: Horizontal position, coarse; mfr 28480, P/N 00180-67402.
MP102	KNOB ASSEMBLY: Horizontal display; Same as MP100.
MP103	LEVER: Horizontal position, Fine; mfr 28480, P/N 00180-05002.
MP104	KNOB, LEVER: Mfr 28480, P/N 0370-0432.
MP105	PUSH-BUTTON: Find beam; mfr 28480, P/N 0370-0350.
MP106	KNOB ASSEMBLY: Intensity; mfr 28480, P/N 0370-0348.
MP107	KNOB ASSEMBLY: Focus; mfr 28480, P/N 00180-67401.
MP108	KNOB ASSEMBLY: Scale; mfr 28480, P/N 00180-67403.
MP109	Not Used.
MP110	Not Used.
MP111	SHIELD, LIGHT: Mfr 28480, P/N 5040-0444.
MP112	GASKET, SHOCK MOUNTING: Mfr 28480, P/N 0905-0331.
MP113	Not Used.
MP114	STAND, TILT: Mfr 28480, P/N 1490-0030.
MP115	Not Used.
MP116	COVER, FUSE: Mfr 28480, P/N 00180-44103.
MP117	COUPLER, SHORT: 2 required; mfr 28480, P/N 00180-23203.
MP118	COUPLER, FOCUS: Mfr 28480, P/N 00180-23201.
MP119	FILTER, MESH CONTRAST: Mfr 28480, P/N 10178-60501.

Ref Desig	Description
MP120	PANEL, FRONT: Mfr 28480, P/N 00180-00229.
MP121	PANEL, SUB: Mfr 28480, P/N 00180-00208.
MP123	SHIELD, CRT: Mfr 28480, P/N 00180-00602.
MP128	COVER PLATE, HIGH VOLTAGE SUPPLY: Mfr 28480, P/N 00180-64128.
MP130	CLAMP, SHOCK MOUNT ASSEMBLY: Mfr 28480, P/N 00180-61201.
MP133	BRACKET, TRA RMER, FRONT, BOTTOM: Mfr 28480, P/N 00180-01210.
MP134	BRACKET, CONNECTOR: Mfr 28480, P/N 00180-01209.
MP135	GROMMET: .250 Inside diameter; mfr 28480, P/N 0400-0010.
MP137	GUIDE, RIGHT PLUG-IN: Mfr 28480, P/N 00180-43102.
MP138	CHASSIS ASSEMBLY, POWER CABINET: Mfr 28480, P/N 00180-60108.
MP139	HEAT SINK ASSEMBLY, RIGHT TRANSISTOR: Mfr 28480, P/N 00180-61103.
MP140	INSULATOR, CONTROL: Mfr 28480, P/N 5040-0453.
MP141	BRACKET, CONTROL MOUNTING: Mfr 28480, P/N 00180-01208.
MP142	COUPLER, SHORT: 2 Required; mfr 28480, P/N 00180-23701.
MP143	PANEL, REAR: Mfr 28480, P/N 00180-00210.
MP144	BRACKET, TRANSISTOR: Mfr 28480, P/N 00180-01206.
MP151	HEAT SINK ASSEMBLY, LEFT TRANSISTOR: Mfr 28480, P/N 00180-61104.
MP152	PANEL, REAR POWER SECTION: Mfr 28480, P/N 00180-00209
MP153	BRACKET, CAPACITOR: Mfr 28480, P/N 00180-01227.
MP155	CHASSIS ASSEMBLY, DISPLAY CABINET: Mfr 28480, P/N 00180-60107.
MP156	BEZEL: Mfr 28480, P/N 5020-0476.
MP160	INSULATOR, COVER PLATE: Mfr 28480, P/N 00180-25401.
MP161	GUIDE, LEFT PLUG-IN: Mfr 28480, P/N 00180-43101.
MP162	BRACKET, TRACE ALIGN COIL: Mfr 28480, P/N 00180-01218.
MP163	BRACKET, TRANSISTOR, REAR, TOP: Mfr 28480, P/N 00180-01223.
MP164	BRACKET, TRANSFORMER, REAR, BOTTOM: Mfr 28480, P/N 00180-01215.
MP165	BRACKET, TRANSFORMER, FRONT, TOP: Mfr 28480, P/N 00180-01222.
MP166	SUPPORT, TRANSFORMER: Mfr 28480, P/N 00180-04703.
MP167	FRAME, SIDE: 2 Required; mfr 28480, P/N 5060-0447.
MP168	COVER ASSEMBLY: Mfr 28480, P/N 5000-0444.
MP169	PLATE, FLUTED ALUMINUM: Mfr 28480, P/N 5000-0051.
MP170	COVER, TOP: Mfr 28480, P/N 5000-0446.
MP171	COVER, BOTTOM: Mfr 28480, P/N 5000-0445.
MP172	BRACKET, COVER: Mfr 28480, P/N 00180-01217.
MP173	SHIELD, POST ACCELERATOR: Mfr 28480, P/N 00180-01217.
MP174	SPACER, FRONT: Mfr 28480, P/N 5000-0449.
MP175	SPACER, REAR: Mfr 28480, P/N 5000-0469.
MP176	KIT, RACK MOUNT: Mfr 28480, P/N 5060-0462.
MP501	GASKET: RFI; Mfr 07700, P/N 85-90053.
Q100	Not Used.
Q101	TRANSISTOR, SILICON, NPN: Mfr 04713, P/N SS2188.

Ref Desig	Description
Q102	TRANSISTOR: Same as Q101.
Q103	TRANSISTOR, SILICON, PNP: Mfr 04713, P/N SS2123.
Q104	TRANSISTOR, SILICON, NPN: MIL type 2N3119.
Q105	TRANSISTOR, SILICON, PNP: Mfr 04713, P/N SS2111.
Q106	TRANSISTOR, SILICON, NPN: MIL type 2N3440.
Q107	TRANSISTOR: Same as Q106.
Q108	TRANSISTOR, SILICON, NPN: Mfr 01295, P/N SK1124.
Q109	TRANSISTOR: Same as Q108.
Q110	TRANSISTOR, SILICON, PNP: MIL type 2N3638.
Q111	TRANSISTOR: Same as Q110.
Q200	Not Used.
Q201	TRANSISTOR, SILICON, FIELD-EFFECT, N CHANNEL: Mfr 05397, P/N F1151.
Q202	TRANSISTOR, SILICON, NPN: Mfr 01295, P/N SM6924.
Q203	TRANSISTOR, GERMANIUM, PNP: MIL type 2N2635.
Q204	TRANSISTOR: Same as Q101.
Q205	TRANSISTOR: Same as Q108.
Q206	TRANSISTOR: Same as Q101.
Q207	TRANSISTOR: Same as Q101.
Q208	TRANSISTOR: Same as Q105.
Q209	TRANSISTOR: Same as Q104.
Q210	TRANSISTOR: Same as Q103.
Q211	TRANSISTOR: Same as Q105.
Q212	TRANSISTOR: Same as Q104.
Q213	TRANSISTOR: Same as Q103.
Q300	Not Used.
Q301	TRANSISTOR, SILICON, NPN: Mfr 07263, P/N S3620.
Q302	TRANSISTOR: Same as Q108.
Q303	TRANSISTOR, SILICON, NPN: MIL type 2N3053.
Q304	TRANSISTOR, SILICON, NPN: Mfr 04713 P/N SJ1266.
Q400	Not Used.
Q401	TRANSISTOR, SILICON, NPN: MIL type 2N3055.
Q402	TRANSISTOR, SILICON, NPN: Mfr 04713, P/N SM8158.
Q403	TRANSISTOR, SILICON, NPN: Mfr 04713, P/N MPS3417.
Q404	TRANSISTOR: Same as Q108.
Q405	TRANSISTOR: Same as Q303.
Q406	TRANSISTOR: Same as Q401.
Q407	TRANSISTOR: Same as Q108.
Q408	TRANSISTOR: Same as Q108.
Q409	TRANSISTOR: Same as Q303.
Q410	TRANSISTOR: Same as Q401.
Q411	TRANSISTOR: Same as Q108.
Q412	TRANSISTOR: Same as Q402.
Q413	TRANSISTOR: Same as Q402.
Q414	TRANSISTOR: Same as Q401.
Q415	TRANSISTOR: Same as Q403.
Q416	TRANSISTOR: Same as Q108.

Table 6-3. Military Part No. (Cont'd.)

Ref Desig	Description
R100	Not Used.
R101	RESISTOR: MIL type RN60C5111F.
R102	RESISTOR: MIL type RN50C2000F.
R103	RESISTOR: Same as R102.
R104	RESISTOR: MIL type RN50C1000F.
R105	RESISTOR: MIL type RN60C5112F.
R106	RESISTOR, VARIABLE, COMPOSITION: 10k ohms ±20% 1/4; mfr 28480, P/N 2100-1904.
R107	RESISTOR: MIL type RN60C2471F.
R108	Not Used.
R109	Not Used.
R110	Not Used.
R111	RESISTOR: Same as R104.
R112	RESISTOR: Same as R104.
R113	RESISTOR: Same as R104.
R114	RESISTOR: MIL type RN60C6191F.
R115	RESISTOR: MIL type RN60C3920F.
R116	RESISTOR: MIL type RN60C6812F.
R117	RESISTOR: MIL type RN65C5620F.
R118	RESISTOR: Same as R102.
R119	RESISTOR: MIL type RN65C1302F.
R120	RESISTOR: MIL type RN60C1503F.
R121	RESISTOR: Same as R119.
R122	Not Used.
R123	Not Used.
R124	Not Used.
R125	RESISTOR: MIL type RN60C1001F.
R126	RESISTOR: MIL type RN65C2002F.
R127	RESISTOR: MIL type RN60C5110F.
R128	RESISTOR: MIL type RN60C8251F.
R129	RESISTOR: Same as R101.
R130	RESISTOR: MIL type RN60C3651F.
R131	RESISTOR: MIL type RN60C2001F.
R132	RESISTOR: MIL type RN60C8250F.
R133	RESISTOR, FIXED, METAL OXIDE: 68k ohms ±5%, 1w; mfr 14674, P/N C32-6802J.
R134	Not Used.
R135	Not Used.
R136	RESISTOR: Same as R126.
R137	RESISTOR: MIL type RN60C1303F.
R138	RESISTOR: Same as R137.
R139	RESISTOR: MIL type RC07GF2R7J.
R140	RESISTOR: Same as R131.
R141	RESISTOR: Same as R102.
R142	RESISTOR: Same as R126.
R143	RESISTOR, FIXED, METAL FILM: 50 ohms ±0.1%, 1/8w; mfr 19701, P/N MF5C-C1951B.
R144	RESISTOR, FIXED, METAL FILM: 1.95k ohms ±0.1%, 1/8w; mfr 19701, P/N MF5C-C1951B.
R145	RESISTOR, FIXED, METAL FILM: 17.82k ohms ±0.1%, 1/2w; mfr 28480, P/N 0698-5421.
R146	Not Used.

Ref Desig	Description
R147	Not Used.
R148	Not Used.
R149	RESISTOR: MIL type RN60C2432F.
R150	RESISTOR: Same as R129.
R151	RESISTOR: MIL type RN60C4321F.
R152	RESISTOR: Same as R149.
R153	RESISTOR: Same as R129.
R154	RESISTOR: Same as R151.
R155	RESISTOR: MIL type RN60C2431F.
R156	RESISTOR: Same as R131.
R157	RESISTOR: Same as R129.
R158	RESISTOR: Same as R155.
R159	RESISTOR: Same as R131.
R160	RESISTOR: Same as R129.
R161	RESISTOR: Same as R139.
R162	RESISTOR: Same as R139.
R200	Not Used.
R201	RESISTOR: MIL type RN60C1003F.
R202	RESISTOR: MIL type RN65C1004F.
R203	RESISTOR: Same as R104.
R204	RESISTOR: MIL type RN70C1822F.
R205	RESISTOR: MIL type RN60C2210F.
R206	RESISTOR: MIL type RN70C2472F.
R207	RESISTOR, VARIABLE, COMPOSITION: 50k ohms ±20%, 1/5w; mfr 28480, P/N 2100-1418.
R208	RESISTOR: MIL type RN60C7501F.
R209	RESISTOR, FIXED, METAL FILM: 3874 ohms ±0.1%, 1/8w; mfr 28480, P/N 2100-1418.
R210	RESISTOR: MIL type RN60C8252F.
R211	RESISTOR, VARIABLE COMPOSITION: 50k ohms 30% 1/2w; mfr 28480 P/N 2100-2089.
R212	Not Used.
R213	Not Used.
R214	Not Used.
R215	RESISTOR: Same as R128.
R216	RESISTOR: MIL type RN65C6813F.
R217	RESISTOR: Same as R104.
R218	RESISTOR, VARIABLE, COMPOSITION, OVAL: 100k ohms 20%, mfr 28480, P/N 2100-2076.
R219	RESISTOR: MIL type RN60C6192F.
R220	RESISTOR: Same as R104.
R221	Part of R218.
R222	RESISTOR: Same as R131.
R223	RESISTOR: MIL type RN65C3322F.
R224	Not Used.
R225	RESISTOR: Same as R155.
R226	Not Used.
R227	Not Used.
R228	Not Used.
R229	RESISTOR: Same as R107.

Ref Desig	Description
R230	RESISTOR: MIL type RN60C1102F.
R231	RESISTOR: Same as R130.
R232	RESISTOR: MIL type RN60C1501F.
R233	Not Used.
R234	RESISTOR: MIL type RN70C2212F.
R235	RESISTOR: MIL type RN60C3920F.
R236	Not Used.
R237	RESISTOR: Same as R102.
R238	RESISTOR: MIL type RN70C1212F.
R239	RESISTOR: MIL type RN60C1822F.
R240	Not Used.
R241	Not Used.
R242	Not Used.
R243	Not Used.
R244	RESISTOR: Same as R139.
R246	RESISTOR: MIL type RN60C30R1F.
R248	RESISTOR, VARIABLE, WIRE WOUND: 100 ohms ±5% 1w; mfr 28480, P/N 2100-1773.
R247	RESISTOR: MIL type RN60C1500F.
R248	RESISTOR, VARIABLE, WIRE WOUND: 200 ohms ±5%, 1w; mfr 28480, P/N 2100-1773.
R249	RESISTOR: MIL type RN60C3320F.
R250	RESISTOR, VARIABLE, WIRE WOUND: 1k ohms ±10%, 1/2w; mfr 19701, P/N MF7C-D2152F.
R251	RESISTOR: MIL type RN60C1621F.
R252	RESISTOR, FIXED, METAL FILM: 21.5k ohms ±1%, 1/2w; mfr 19701, P/N MF7C-D2152F.
R253	RESISTOR, VARIABLE, WIRE WOUND: 5k ohms ±5%, 1w; mfr 28480, P/N 2100-0741.
R254	RESISTOR: Same as R252.
R255	Not Used.
R256	Not Used.
R257	RESISTOR: Same as R137.
R258	RESISTOR: Same as R208.
R259	RESISTOR: MIL type RN60C1501F.
R260	Not Used.
R261	RESISTOR: Same as R225.
R262	RESISTOR: Same as R107.
R263	RESISTOR: MIL type RN60C5621F.
R264	RESISTOR: Same as R230.
R265	Not Used.
R266	Not Used.
R267	Not Used.
R268	RESISTOR: Same as R130.
R269	RESISTOR: Same as R232.
R270	RESISTOR: Same as R235.
R271	RESISTOR: Same as R234.
R272	Not Used.
R273	RESISTOR: Same as R102.
R274	Not Used.
R275	RESISTOR: Same as R238.

Ref Desig	Description
R300	Not Used.
R301	RESISTOR: Same as R139.
R302	RESISTOR, VARIABLE, METAL FILM: 100k ohms ±20%; mfr 28480, P/N 2100-0943.
R303	RESISTOR: MIL type RN65D9503F.
R304	RESISTOR: MIL type RN60C1002F.
R305	RESISTOR, FIXED, METAL FILM: 30 megohms ±2%, 1/2w; mfr 03888, P/N HV2000N5.
R306	Not Used.
R307	Not Used.
R308	Not Used.
R309	Not Used.
R310	Not Used.
R311	Not Used.
R312	Not Used.
R313	RESISTOR: Same as R304.
R314	RESISTOR: Same as R129.
R315	RESISTOR, FIXED, CARBON FILM: 2.49 megohms ±1%, 1/2w; mfr 28480, P/N 0698-3553.
R316	RESISTOR: Same as R131.
R317	RESISTOR: Same as R125.
R318	RESISTOR: Same as R201.
R319	RESISTOR: Same as R104.
R320	RESISTOR: MIL type RN70C5110F.
R321	RESISTOR: Same as R201.
R322	Not Used.
R323	Not Used.
R324	Not Used.
R325	RESISTOR, FIXED, COMPOSITION: MIL type RN70C2202F.
R326	RESISTOR, VARIABLE, COMPOSITION: 1 megohm ±20% lin 2/5w; mfr 28480, P/N 2100-1618.
R327	RESISTOR, FIXED, DEPC: 29 megohms ±10% 1w; mfr 28480, P/N 0698-0003.
R328	RESISTOR: MIL type RC07GF105J.
R329	Not Used.
R330	RESISTOR: MIL type RN60C4322F.
R331	RESISTOR: Same as R219.
R332	RESISTOR: Same as R330.
R333	RESISTOR: Same as R219.
R334	RESISTOR, VARIABLE, WIRE WOUND: 5k ohms, ±10% 2w; mfr 28480, P/N 2100-1903.
R335	RESISTOR: Same as R125.
R336	RESISTOR, VARIABLE, METAL FILM: 20k ohms ±30%; mfr 73138, P/N 62P-R20K.
R337	RESISTOR: Same as R125.
R338	Not Used.
R339	Not Used.
R340	Not Used.
R341	RESISTOR: MIL type RC07GF153J.
R342	Part of A8.
R343	RESISTOR, FIXED, COMPOSITION: 8.25 megohms ±5%, 1w; mfr 28480, P/N 0685-5677.

Ref Desig	Description
R344	RESISTOR, VARIABLE, COMPOSITION: 5 megohms ±10%, 1/2w; mfr 28480, P/N 2100-1906.
R345	RESISTOR, FIXED, COMPOSITION: 16.25 megohms ±5%, 1w; mfr 28480, P/N 0698-5678.
R346	RESISTOR, FIXED, COMPOSITION: 100k ohms ±5%, 1/4w; mfr 01121, P/N CB1045.
R347	RESISTOR, VARIABLE, COMPOSITION: 50k ohms ±20%, 1/2w; mfr 28480, P/N 2100-1905.
R348	RESISTOR, VARIABLE, METAL FILM: 50k ohms ±30%; mfr 73138, P/N 62P-R50K.
R349	RESISTOR: MIL type RN60C3322F.
R350	RESISTOR, VARIABLE, WIRE WOUND: 100 ohms ±10%, 2w; mfr 28480, P/N 2100-1901.
R351	RESISTOR: Same as R125.
R352	RESISTOR: Same as R125.
R353	RESISTOR: Same as R219.
R354	RESISTOR: Same as R330.
R400	Not Used.
R401	RESISTOR: Same as R125.
R402	RESISTOR, FIXED, WIRE WOUND: 15 ohms ±5%, 2w; mfr 28480, P/N 0811-1788.
R403	RESISTOR, FIXED, METAL FILM: 100k ohms ±1%, 1/8w; mfr 28480, P/N 0757-0465.
R404	RESISTOR: Same as R125.
R405	RESISTOR: MIL type RN60C82R5F.
R406	RESISTOR: MIL type RN70C3012F.
R407	RESISTOR: Same as R263.
R408	RESISTOR: Same as R129.
R409	RESISTOR: Same as R223.
R410	RESISTOR: Same as R245.
R411	RESISTOR: Same as R263.
R412	RESISTOR, VARIABLE, WIRE WOUND: 2k ohms ±10%, 1/2w; mfr 28480, P/N 2100-1774.
R413	RESISTOR: MIL type RN70C6812F.
R414	Not Used.
R415	Not Used.
R416	Not Used.
R417	RESISTOR: MIL type RN70C30R1F.
R418	RESISTOR: MIL type RN70C3322F.
R419	RESISTOR, FIXED, WIRE WOUND: 0.36 ohms ±5%, 2w; mfr 28480, P/N 0811-1746.
R420	RESISTOR: Same as R210.
R421	RESISTOR: MIL type RN60C4323F.
R422	RESISTOR: Same as R130.
R423	RESISTOR, VARIABLE, WIRE WOUND: 500 ohms ±10%, 1/2w; mfr 28480, P/N 2100-1772.
R424	RESISTOR: MIL type RN70C2432F.
R425	Not Used.
R426	Not Used.
R427	Not Used.
R428	RESISTOR: Same as R245.
R429	RESISTOR: Same as R406.

Ref Desig	Description
R430	RESISTOR: Same as R419.
R431	RESISTOR: Same as R201.
R432	RESISTOR: MIL type RN60C3323F.
R433	RESISTOR: Same as R130.
R434	RESISTOR: Same as R423.
R435	RESISTOR: Same as R424.
R436	Not Used.
R437	Not Used.
R438	Not Used.
R439	RESISTOR, FIXED, WIRE WOUND: 10 ohms ±5%, 2w; mfr 28480, P/N 0811-1078.
R440	RESISTOR: Same as R201.
R441	RESISTOR: Same as R125.
R442	RESISTOR: Same as R405.
R443	RESISTOR: Same as R406.
R444	RESISTOR: Same as R263.
R445	RESISTOR: Same as R201.
R446	RESISTOR: Same as R223.
R447	RESISTOR: Same as R245.
R448	RESISTOR: Same as R151.
R449	RESISTOR: Same as R250.
R450	RESISTOR: Same as R252.
S100	Not Used.
S101	SWITCH, ROTARY: Includes R211; mfr 28480, P/N 3100-1344.
S102	SWITCH, PUSHBUTTON: DPDT; mfr 82389, P/N 12S1–032.
S200	Not Used.
S201	SWITCH, SLIDE: DPDT, 1/2 amp, 125 vac; mfr 79727, P/N G126.
S202	SWITCH, SLIDE: DPDT, 1/2 amp, 125 vac; mfr 28480, P/N 3101-0982.
S203	SWITCH, ROTARY: 3-position; mfr 28480, P/N 3100-1345.
S400	Not Used.
S401	SWITCH, TOGGLE: DPDT, 5 amp 115 vac; mfr 90353, P/N 7201-WHT-GW.
S402	SWITCH, SLIDE: DPDT, VOLTS AC, mfr 82389, P/N 11A-1037.
T301	TRANSFORMER, HIGH VOLTAGE: Mfr 28480, P/N 00180-60801.
T400	Not Used.
T401	TRANSFORMER, POWER: 50/1000 cps at 115/230 vac input, 4.9/6.9/9.4/16.4/ 21.3/106 vac output, solder type terminals; mfr 28480, P/N 9100-1109.
TP300	Not Used.
TP301	JACK, TEST, FEMALE: Mfr 98291, P/N SKT400.
TP400	Not Used.
TP401	JACK, TEST: Same as TP301.
TP402	JACK, TEST: Same as TP301.
TP403	JACK, TEST: Same as TP301.
TP404	JACK, TEST: Same as TP301.
V300	Not Used.
V301	LAMP, NEON: Mfr 2445E, P/N NE2E1.
V302	LAMP: Same as V301.
V303	TUBE, CATHODE RAY: Mfr 28480, P/N 5083-9023.
V400	Not Used.
V401	TUBE, VOLTAGE REFERENCE: 82 volts; mfr 74276, P/N Z82R7.
V402	TUBE: Same as V401.

Ref Desig	Description
VR300	Not Used.
VR301	DIODE, ZENER: 7.2v, 400 mw; mfr 01281, P/N PS18247B.
VR302	DIODE, ZENER: 10v, 400 mw; mfr 01281, P/N PS18260A.
VR400	Not Used
VR401	DIODE, ZENER: 5.23v, 400 mw; mfr 01281, P/N PS18233A.
VR402	DIODE, ZENER: 54.6v, 400 mw; mfr 04713, P/N SZ10939-395.
VR403	DIODE: Same as VR402.
W1	CABLE, COAX, ASSY: Mfr 28480, P/N 00180-61617.
W2	CABLE, VERTICAL DEFLECTION ASSY: Mfr 28480, P/N 00180-61626.
W4	CABLE, SWEEP GATE OUTPUT: Mfr 28480, P/N 00180-61650.
W5	CABLE, HORIZONTAL DEFLECTION: Mfr 28480, P/N 00180-61656.
W6	CABLE, LOW VOLTAGE SUPPLY: Mfr 28480, P/N 00180-61653.
W7	CABLE, MAIN HARNESS: Mfr 23480, P/N 00180-61665.
W8	CABLE, HORIZONTAL MAGNIFIER: Mfr 28480, P/N 00180-61657.
W9	CABLE, TRANSFORMER ASSY: Mfr 28480, P/N 00180-61658.
W101	CABLE DISPLAY SWITCH: Mfr 28480, P/N 00180-61652.
W401	CABLE POWER INPUT: Mfr 28480, P/N 00180-61674.
XF301	BLOCK, SINGLE-FUSE: Mfr 28480, P/N 1400-0008.
XF400	Not Used.
XF401	POST, FUSE: Mfr 75915, P/N 342014.
XF402	POST, FUSE: Same as XF401.
XF403	BLOCK, THREE-FUSE: mfr 28480, P/N 1400-0123.
XF404	BLOCK, THREE-FUSE: Same as XF403.
XQ304	CONNECTOR, INSULATED: Two pin; mfr 28480, P/N 1200-0041.
XQ401	CONNECTOR: Same as XQ304.
XQ402	CONNECTOR: Same as XQ304.
XQ403	CONNECTOR: Same as XQ304.
XQ404	CONNECTOR: Same as XQ304.
XV303	SOCKET, CRT: Mfr 72825, P/N 9709-4.

Table 6-4. Code List of Manufacturers

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Microfron Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc.	Cherry Hill, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00809	Crowen Ltd.	Whitby, Ontario Canada
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
00929	Microlab Inc.	Livingston, N.J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
01009	Aiden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01253	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01538	Small Parts Inc.	Los Angeles, Calif.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02116	Wheelock Signals, Inc.	Long Branch, N.J.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
02875	Hudson Tool & Die Co.	Newark, N.J.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Calif.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div. Finderne Plant	Sumerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04062	Arco Electronic Inc.	Great Neck, N.Y.
04217	Essex Wire	Los Angeles, Calif.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.
04673	Dakota Engr. Inc.	Culver City, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	Ohio Motor Company	Westchester, Ill.
04913	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05245	Components Corp.	Chicago, Ill.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05397	Union Carbide Corp., Elect. Div.	New York, N.Y.
05574	Viking Ind. Inc.	Canoga Park, Calif.
05593	Loore Electro-Plastics Inc.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metro Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Calif.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Ariz.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
06980	Varian Assoc. Eimac Div.	San Carlos, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07256	Silicon Transistor Corp.	Carle Place, N.Y.
07261	Avnet Corp.	Culver City, Calif.
07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Bitcher Corp., The	Monterey Park, Calif.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Calif.
07700	Technical Wire Products Inc.	Cranford, N.J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Calif.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N.J.
08792	CBS Electronics Semiconductor Operations, Div of C.B.S. Inc.	Lowell, Mass.
08806	General Electric Co. Miniat. Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09922	Burndy Corp.	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
11314	National Seal	Downey, Calif.
11453	Precision Connector Corp.	Jamaica, N.Y.
11534	Duncan Electronics Inc.	Costa Mesa, Calif.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12040	National Semiconductor	Danbury, Conn.
12136	Philadelphia Handle Co.	Camden, N.J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc. Data System Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12728	Elmar Filter Corp.	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13019	Airco Supply Co., Inc.	Witchita, Kansas
13103	Thermolloy	Dallas, Texas
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dubilier Electric Corp.	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	San Gabriel, Calif.
14960	Williams Mfg. Co.	San Jose, Calif.
15106	The Sphere Co., Inc.	Little Falls, N.J.
15203	Webster Electronics Co.	New York, N.Y.
15287	Scionics Corp.	Northridge, Calif.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15558	Micron Electronics	Garden City, Long Island, N.Y.
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15631	Cabletronics	Costa Mesa, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Ameico Inc.	Mt. View, Calif.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Farmington, Mich.
16352	Computer Diode Corp.	Lodi, N.J.
16585	Boots Aircraft Nut Corp.	Pasadena, Calif.
16688	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokoma, Ind.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
17554	Components Inc.	Biddeford, Ma.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Calif.
17856	Siliconix Inc.	Sunnyvale, Calif.

ORIGINAL

Code No.	Manufacturer	Address
17870	McGraw-Edison Co.	Manchester, N.H.
18042	Power Design Pacific Inc.	Palo Alto, Calif.
18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.
18324	Signetics Corp.	Sunnyvale, Calif.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19589	Concoa	Baldwin Park, Calif.
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
24796	Paralco Inc.	San Juan Capistrano, Calif.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac/Hollister Co.	Hollister, Calif.
26992	Hamilton Watch Co.	Lancaster, Pa.
27251	Specialities Mfg. Co., Inc.	Stratford, Conn.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto Ontario, Canada
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	Sanborn Company	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Ampenite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap. Div.	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Technological Products Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Elect Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.
73734	Federal Screw Products Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Calif.
73957	Groov-Pin Corp.	Ridgefield N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights Inc.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phanostran Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78424	Specialty Leather Prod. Co.	Newark, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80033	Prestole Corp	Toledo, Ohio
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Any brand Tube meeting EIA Standards-Washington, DC.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio

Table 6-4. Code List of Manufacturers (Cont'd.)

Code No.	Manufacturer	Address
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Calif.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Instruments Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	. . . . .
81483	International Rectifier Corp.	El Segundo, Calif.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp. Space & Defense System Div.	Paramus, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc. Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83014	Hartwell Corp.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Calif.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Calif.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisade's Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co. Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp. Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp. Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	TRW Capacitor Div.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85650	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Div.	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Calif.
87034	Marco Industries	Anaheim, Calif.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	San Francisco, Calif.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	US Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90763	United Carr Fastener Corp.	Chicago, Ill.
90970	Bearing Engineering Co.	San Francisco, Calif.
91146	ITT Cannon Elect, Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91886	Malco Mfg. Co., Inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Div.	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co. Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Westbury Long Island, N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Palisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Calif.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94142	Phelps Dodge	Yonkers, N.Y.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp. Electronics Div.	East Paterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Cr.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.,	Dania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West Inc.	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96306	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
96508	Xcelite Inc.	Orchard Park, N.Y.
96733	San Fernando Elect. Mfg. Co.	San Fernando, Calif.
96881	Thomson Ind. Inc.	Long Is., N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Troncis, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Hewlett-Packard Co., Moseley Div.	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Calif.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Div. of Hewlett-Packard Co.	Palo Alto, Calif.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp. Semiconductor Div.	El Monte, Calif.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

THE FOLLOWING HP VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CS	Hewlett-Packard Co., Colorado Springs	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Mfg. Co.	San Jose, Calif.
000QQ	Cooltron	Oakland, Calif.
000WW	California Eastern Lab.	Burlington, Calif.
000YY	S.K. Smith Co.	Los Angeles, Calif.

BACK DATING

MANUAL

CHANGES

SECTION VII

MANUAL CHANGES AND OPTIONS

7-1. MANUAL CHANGES.

7-2. This manual applies directly to the Model 180ER Oscilloscope (as manufactured) with serials prefixed 915-. The following paragraphs explain how to adapt this manual to apply to later instruments (higher serial prefix), or earlier instruments (lower serial prefix). Technical corrections to this manual (if any) are called Errata and are listed on the separate MANUAL CHANGES sheet supplied with this manual.

7-3. LATER INSTRUMENTS. If the serial prefix of your Model 180ER is above 915–, refer to the separate MANUAL CHANGES sheet supplied with this manual. Locate the serial prefix of your instrument and make the indicated changes.

Table 7-1. Manual Changes

Instrument Serial Prefix	Make Change
756–	1

7-5. OPTIONS.

7-6. Options are standard modifications performed on HP instruments at the factory. Two options for the Model 180ER are offered at the present time. Option 003 provides for operation with 100/200V input power, and Option 004 provides for a 110/220V input.

7-7. SPECIAL INSTRUMENTS.

7-8. Special instruments are standard HP instruments that are modified at the factory according to customer specifications. A separate insert sheet is included with the manual for special instruments having electrical changes. Make the changes specified in addition to any other changes that are necessary per the MANUAL CHANGES sheet.

CHANGE 1

Table 6-2 and 6-3,

Delete: C402, C404, MP501.

W401: Change to HP Part No. 5060-0444; W: Cable, power; mfr 28480, P/N 5060-0444.

SERVICE INFORMATION

SECTION VIII

SCHEMATICS AND TROUBLESHOOTING

8-1. INTRODUCTION.

8-2. This section provides schematic diagrams, component identification, and troubleshooting and repair information for the Model 180ER.

8-3. SCHEMATIC DIAGRAMS.

8-4. Schematic diagrams appear on right-hand pages that unfold outside the right edge of the manual. These "throw-clear" pages allow viewing the schematics while referring to other sections.

8-5. Schematics are drawn primarily to show electronic function. A given schematic may include all or part of several assemblies. Information about symbols and conventions used in the schematics is provided by Table 8-1. Schematics also provide dc voltages and waveform test points. DC voltage measurement conditions, waveform measurement conditions, and waveforms applicable to each schematic are shown next to that schematic.

8-6. COMPONENT IDENTIFICATION.

8-7. Whenever possible, components appearing on a schematic are identified on the page opposite that schematic. When components on a given assembly appear on more than one schematic, all components on that assembly are identified opposite the first schematic showing the assembly. Adjustments, assemblies, and chassis-mounted electrical components are identified in Figure 6-1. Mechanical components are identified in Figure 6-1.

8-8. TROUBLESHOOTING.

8-9. The first and most important prerequisite for successful troubleshooting is a thorough understanding of instrument operation and function. Often, suspected malfunctions are caused by improper control settings such as: intensity set too low, display selector or mode switch in wrong position, trigger level maladjusted, etc. Read Section III, Operation, and Section IV, Principles of Operation, for this information.

8-10. DC voltages for most active components (transistors, FET's, etc.) are indicated on the schematics. Waveform test points (▽ with an enclosed number) are also placed on the schematic at various points along the main signal path. The numbers inside the test point symbols are keyed to the proper waveform adjacent to the schematic. These voltages and waveforms are invaluable for troubleshooting the instrument. Applications include: checking stage gain, locating unbalance in differential amplifiers, locating faulty transistors, etc. Always refer to the specific measurement conditions before using dc voltages or waveforms. Allow the level to stabilize before noting dc voltages. Small dots are etched on the circuit board assemblies next to the emitter lead of transistors, the source leads of FET's, the cathode end of diodes, and the positive end of electrolytic capacitors as an aid to locating test points.

CAUTION

When taking waveform or dc voltage measurements, use extreme care to avoid shorting supply voltages or components.

8-11. If a malfunction occurs, Figure 8-2 may help isolate the trouble to a particular circuit in the Model 180ER or to a particular plug-in. Always begin troubleshooting with a visual inspection. Check for burned or loose components, loose wire connections, faulty switch contacts or any similar conditions suggesting a source of trouble.

8-12. REPAIR AND REPLACEMENT.

8-13. Almost all electrical components are accessible for replacement from the component side of the etched circuit boards. Section VI provides a detailed parts list to allow ordering replacement parts from either Hewlett-Packard or a typical manufacturer. If satisfactory operation or repair cannot be accomplished, contact the nearest Hewlett-Packard Sales/Service Office (addresses at rear of this manual). If shipment for repairs is required, see Section II for recommended packaging information.

8-14. HIGH-VOLTAGE SUPPLY REPAIR.

8-15. The following procedure should be used in replacing the high-voltage supply assembly (A8), the high voltage rectifier assembly (A5), or the high voltage transformer (T301).

a. Remove two screws and remove cover.

b. Remove rear instrument cover and unsolder five wires from small etched circuit board mounted to T301.

c. Remove four screws from corners of rectifier assembly, A5. Remove two screws from ends of T301.

d. Unsolder leads at cathode end of CR302 and CR307.

e. Unsolder lead at junction of C309 and R325.

f. Raise the rectifier assembly (including T301) from compartment in the HV supply assembly. T301 should be completely disconnected (small pc board is part of transformer.

WARNING

The post accelerator lead may hold a high-voltage charge. Use a screwdriver and carefully lift the insulator cap. Ground the screwdriver and the post accelerator lead as the lead is loosened and disconnected from the CRT.

8-16. CRT REMOVAL AND REPLACEMENT.

8-17. To remove the CRT, proceed as follows:

WARNING

To prevent possible injury, always wear a face mask or goggles, and gloves. Handle the CRT with extreme care.

a. Remove the top and bottom covers.

b. Remove the plug-ins and the shield (two screws) next to the CRT post accelerator lead (shield is between CRT and plug-in compartment).

WARNING

The post accelerator lead may hold a high-voltage charge. Use a screwdriver and carefully lift the insulator cap. Ground the screwdriver and the post accelerator lead as the lead is loosened and disconnected from the CRT.

c. Remove post accelerator lead from CRT.

d. Remove the connections from the nine neck pins on the CRT (use long-nose pliers through access holes in CRT shield).

e. Squeeze plastic light shield at mid-point at top and bottom, and remove it.

f. Remove screws holding metal bezel on front panel.

g. Carefully pry the socket from the CRT base.

h. Loosen clamp at rear of CRT.

i. Place one hand on the CRT face and, with the other hand, slide the CRT forward and out of the instrument.

j. To replace the CRT, reverse the procedure.

k. After replacing the CRT, check the following adjustments: Intensity Limit, Paragraph 5-25; Flood Gun, Paragraph 5-26; Trace Alignment, Paragraph 5-27; and Horizontal Amplifier Gain, Paragraph 5-29, step c.

8-18. SERVICING ETCHED CIRCUIT BOARDS.

8-19. Etched circuit boards in this instrument have components mounted on one side of the board, conductive surfaces on both sides, and plated-through component mounting holes. Hewlett-Packard Service Note M-20E contains useful information on servicing etched circuit boards. Some important considerations are as follows:

a. Use a 37 to 47.5 watt chisel tip soldering iron with a tip diameter of 1/16 to 1/8 inch, and a small diameter rosin core solder.

b. Components may be removed by placing the soldering iron on the component leads on either side of the board and pulling the component straight away from the board. If heat is applied to the component side of the board, greater care is required to avoid damage to the components, especially semi-conductors. Heat damage may be minimized by gripping the lead with long nose pliers between the soldering iron and the components, thereby forming a heat sink.

c. If a component is obviously damaged or faulty, clip the leads close to the component and then unsolder the leads from the board.

d. Large components, such as potentiometers, may be removed by rotating the soldering iron from lead to lead and applying steady pressure to lift the part free. The alternative is to clip the leads of the damaged part and remove them individually.

e. Excessive heat or force will destroy the laminate bond between the metal plated surface (conductor) and the board. If this problem should occur, the lifted conductor may be cemented down with a small amount of quick-drying acetate-base cement having good insulating properties. Another method of repair is to solder a section of good conducting wire along the damaged area.

f. Before replacing a component, heat the remaining solder in the component hole and clean it out with a toothpick or "solder sucker". Sharp pointed metalic tools are not recommended since they may loosen eyelets in boards or remove plating from the inside of holes on plated-through etched circuit boards.

g. Tin and shape replacement component leads to fit existing holes.

h. Install the replacement component in the same position as the original.

Table 8-1. Schematic 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

NC = No connection

3 = Waveform test point (with number)

A = Common electrical point (with letter) not necessarily ground

= Single-pin connector on board

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

= Coaxial cable connected to snap-on jack

= Coaxial cable connected directly to board

= Wire connected to pressure-fit socket on board

= Main signal path

= Primary feedback path

= Secondary feedback path

G D S = Field-effect transistor (P-type base)

G D S = Field-effect transistor (N-type base)

= Breakdown diode (voltage regulator)

= Tunnel diode

= Step-recovery diode

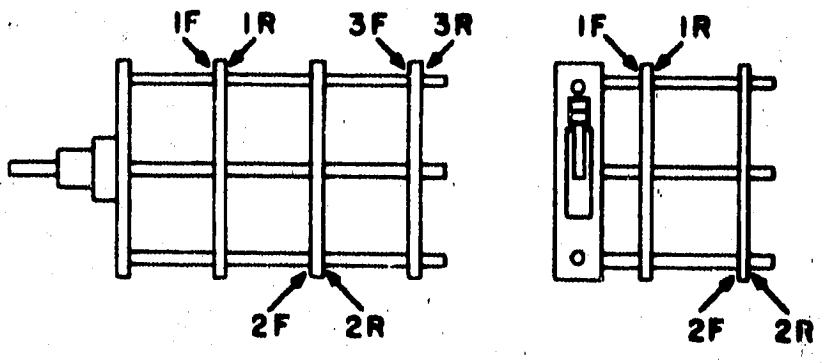
= Circuits or components drawn with dashed lines (phantom) show function only and are not intended to be complete. The circuit or component is shown in detail on another schematic.

(925) = Wire colors are given by numbers in parentheses using the resistor color code

[(925) is wht-red-grn]

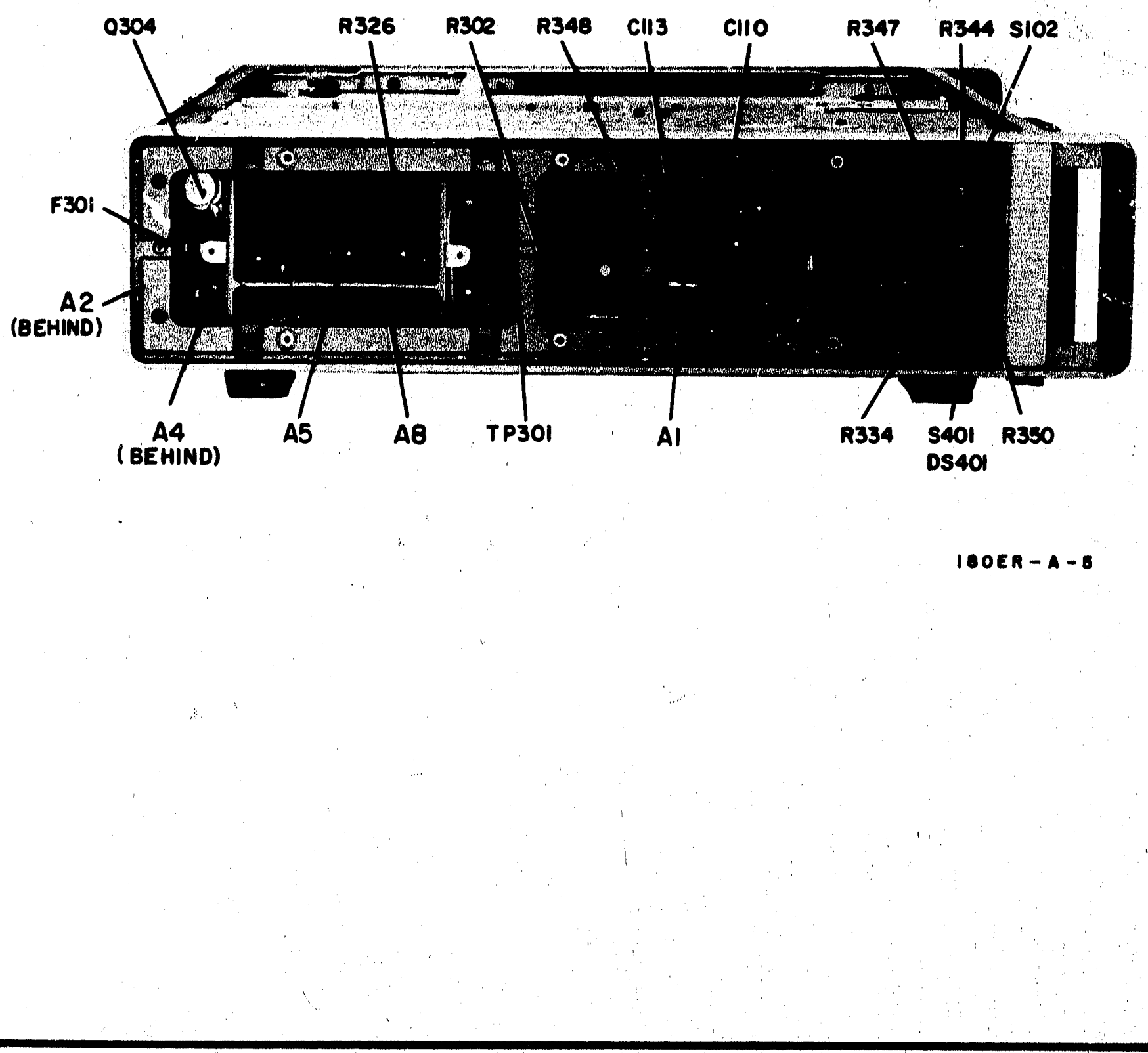
0 - Black	5 - Green
1 - Brown	6 - Blue
2 - Red	7 - Violet
3 - Orange	8 - Gray
4 - Yellow	9 - White

Switch wafers are identified as follows:

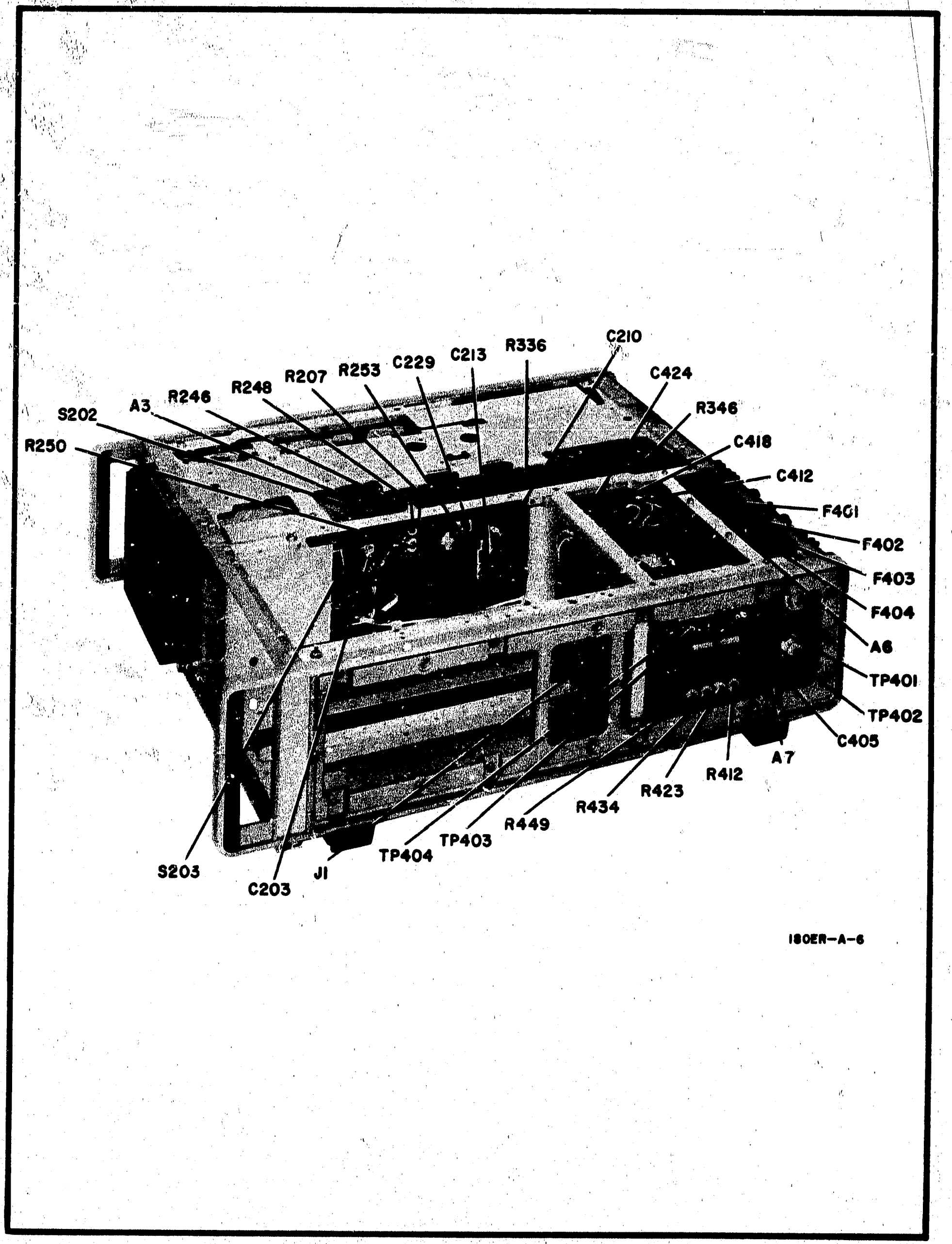


* = Optimum value selected at factory, typical value shown; part may have been omitted.

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



p/o Figure 8-1. Component Identification, Left Side View



p/o Figure 8-1. Component Identification, Top and Side Views

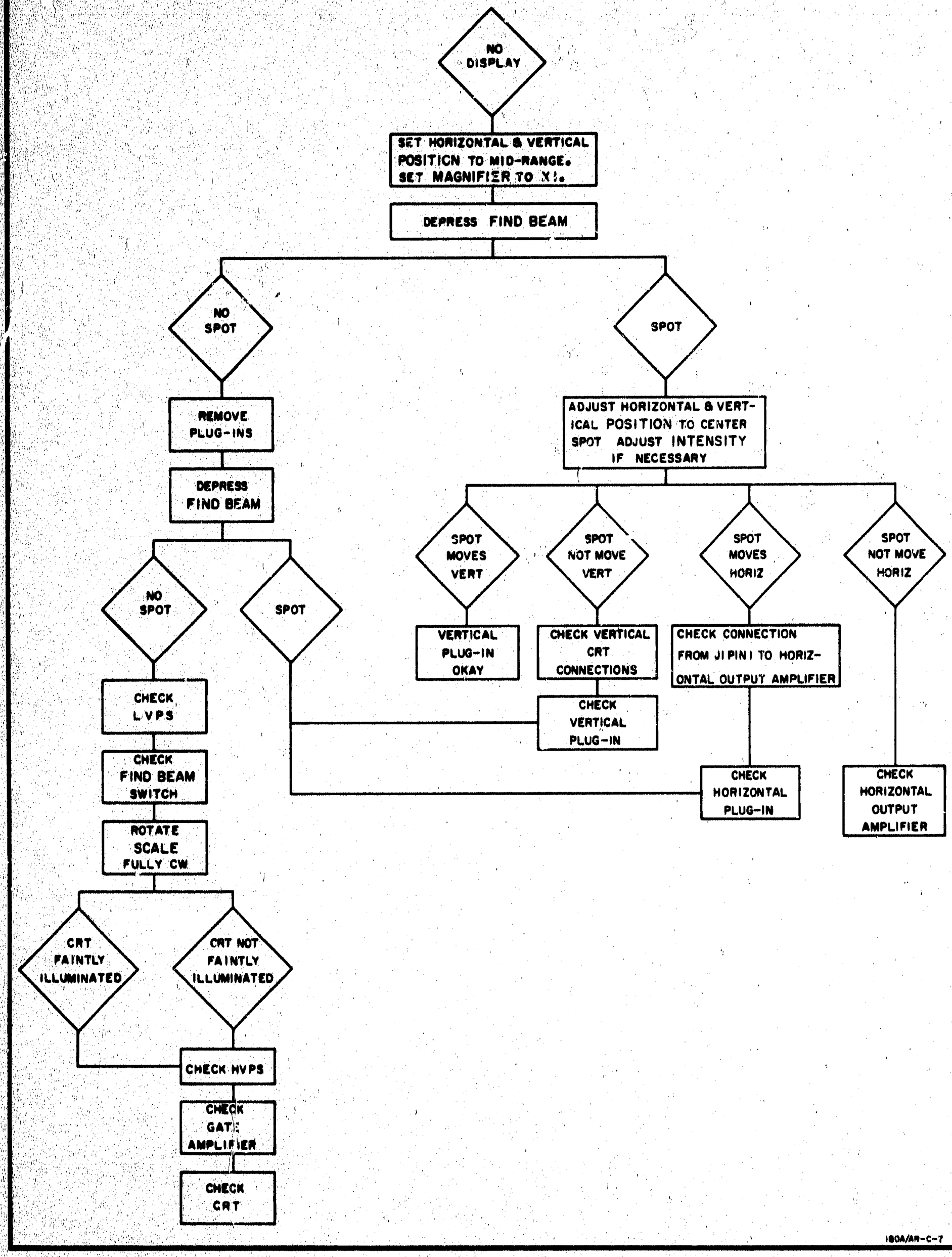
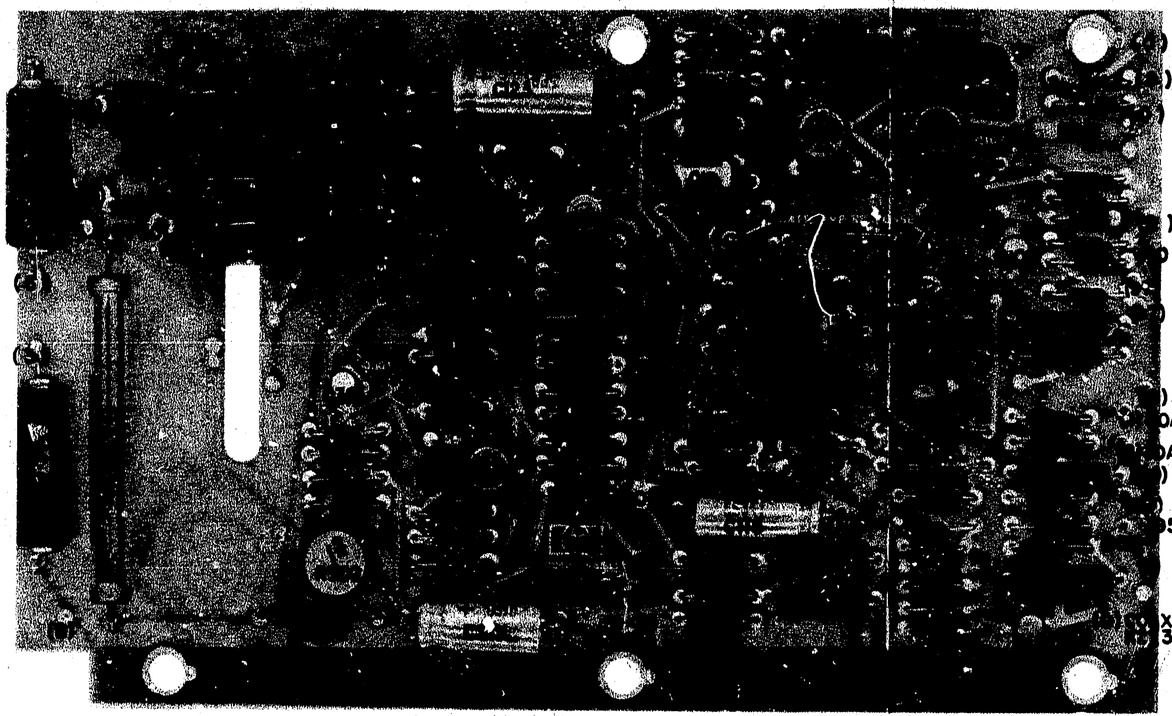
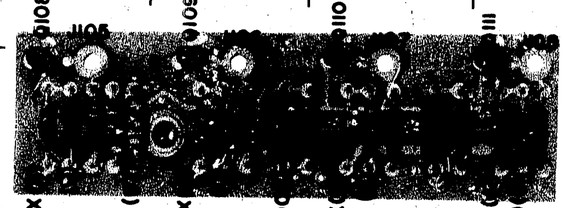


Figure 8-2. Over-all Troubleshooting Tree





REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C102	H-4	C123	D-1	CR111	H-2	Q107	G-2	R117	H-3	R137	F-1	R313	C-4	R341	B-2
C103	H-4	C301	D-5	CR112	D-2	Q301	C-3	R118	G-3	R138	G-1	R314	C-4	R343	A-2
C104	F-4	C302	C-2	CR113	D-2	Q302	D-4	R119	G-2	R139	F-2	R315	D-3	R345	A-4
C105	H-3	C303	D-2	CR115	G-1	Q303	D-4	R120	F-2	R140	F-1	R316	C-4	R348	E-2
C106	F-5	C310	C-1	CR116	F-2	R102	H-4	R121	F-2	R141	F-1	R317	D-4	R349	E-2
C110	G-5	C311	C-2	CR117	F-2	R103	H-3	R125	F-4	R142	F-1	R318	D-4	R351	E-3
C111	F-2	C316	C-2	H4	F-3	R104	H-4	R126	G-4	R143	H-1	R319	D-4	R352	E-3
C112	G-3	C317	C-2	L102	F-5	R105	H-4	R127	F-3	R144	H-2	R320	D-3	R353	E-4
C113	F-2	CR101	G-4	L105	E-2	R107	H-4	R128	G-2	R145	H-2	R321	D-3	R354	E-4
C114	F-4	CR102	G-4	Q101	H-5	R111	F-4	R129	H-3	R301	E-4	R328	B-1	TP301	B-2
C115	F-4	CR103	G-5	Q102	G-3	R112	H-3	R130	H-2	R302	C-4	R330	E-3	V301	B-1
C116	G-2	CR104	G-5	Q103	F-3	R113	F-5	R131	H-2	R303	C-5	R331	E-3	V302	B-2
C120	F-1	CR108	F-4	Q104	F-3	R114	G-4	R132	H-2	R304	C-4	R332	E-3	VR301	D-3
C121	G-1	CR109	F-4	Q105	H-2	R115	G-4	R133	D-2	R305	B-4	R333	E-3	VR302	D-3
C122	F-1	CR110	F-3	Q106	F-2	R116	G-4	R136	G-2						

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C127	L-3	L108	J-3	R151	J-3	R157	L-3
C128	J-3	Q108	J-2	R152	K-3	R158	M-3
J105	J-2	Q109	K-2	R153	K-3	R159	M-3
J106	K-2	Q110	L-2	R154	K-3	R160	M-3
J107	L-2	Q111	M-2	R155	L-3	R161	K-3
J108	M-2	R149	J-3	R156	L-3	R162	J-3
L107	K-3	R150	J-3				

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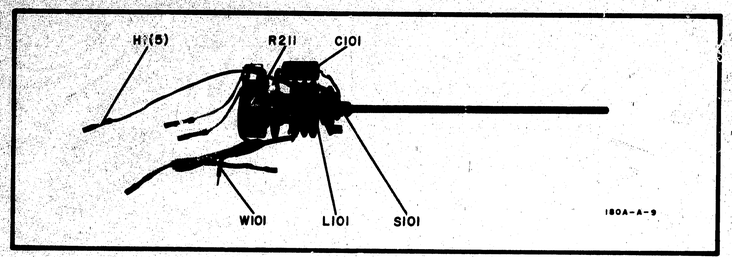
p/o Figure 8-3. Component Identification, A1 and A2



p/o Figure 8-3. Component Identification, A9

DC VOLTAGE MEASUREMENT CONDITIONS

a. Set HORIZONTAL DISPLAY to EXT CAL.

b. Set Vertical Display to A.

c. Adjust INTENSITY for +57 Vdc on collectors of Q103 and Q104.

WAVEFORM MEASUREMENT CONDITIONS

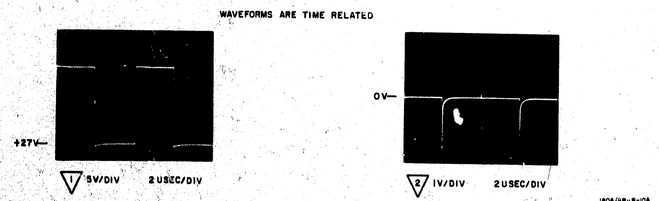
a. Set HORIZONTAL DISPLAY to EXT CAL.

b. Set Vertical Display to A.

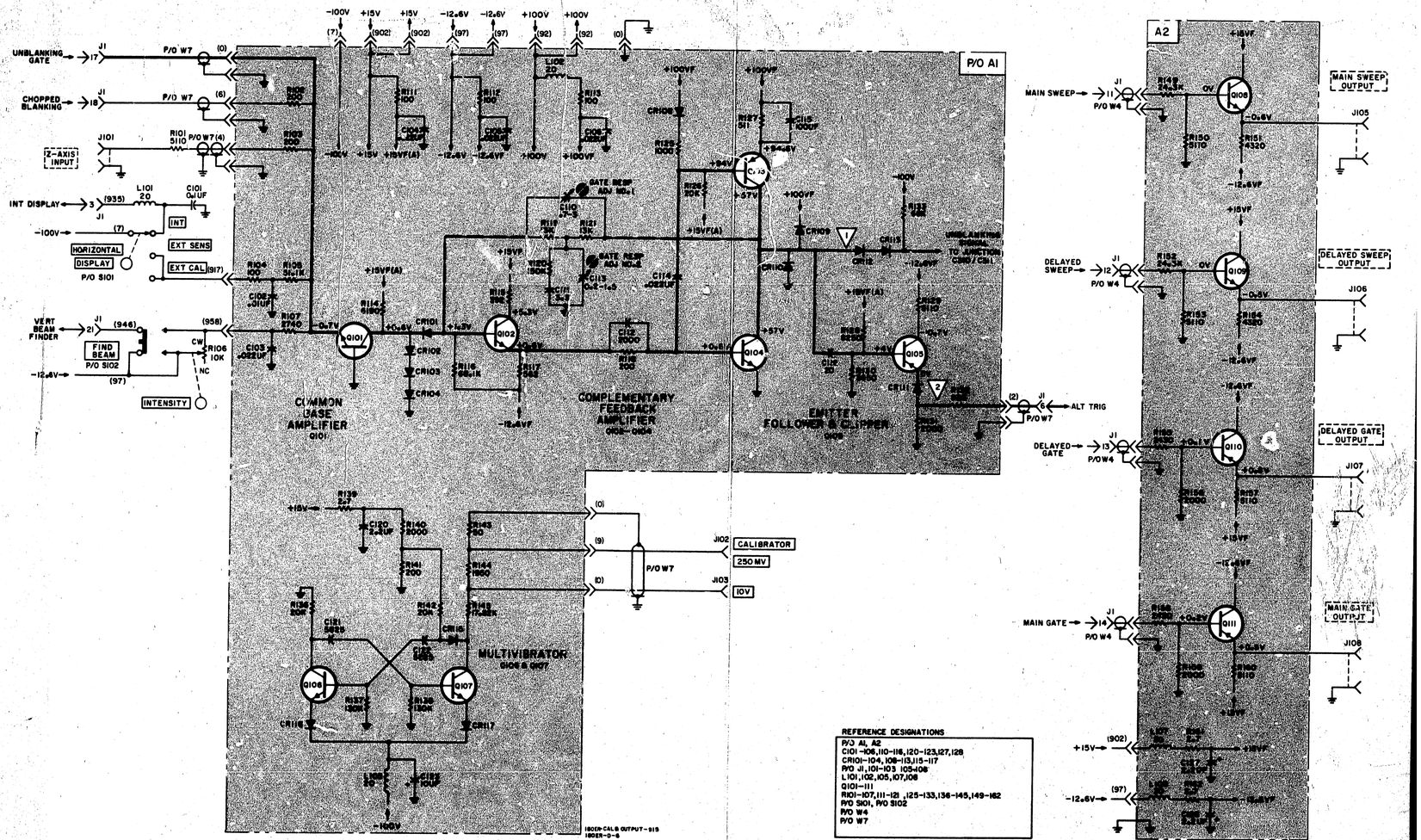
c. Rotate HORIZONTAL POSITION fully cw to move spot off screen.

d. Adjust INTENSITY for +30 Vdc on collector of Q103.

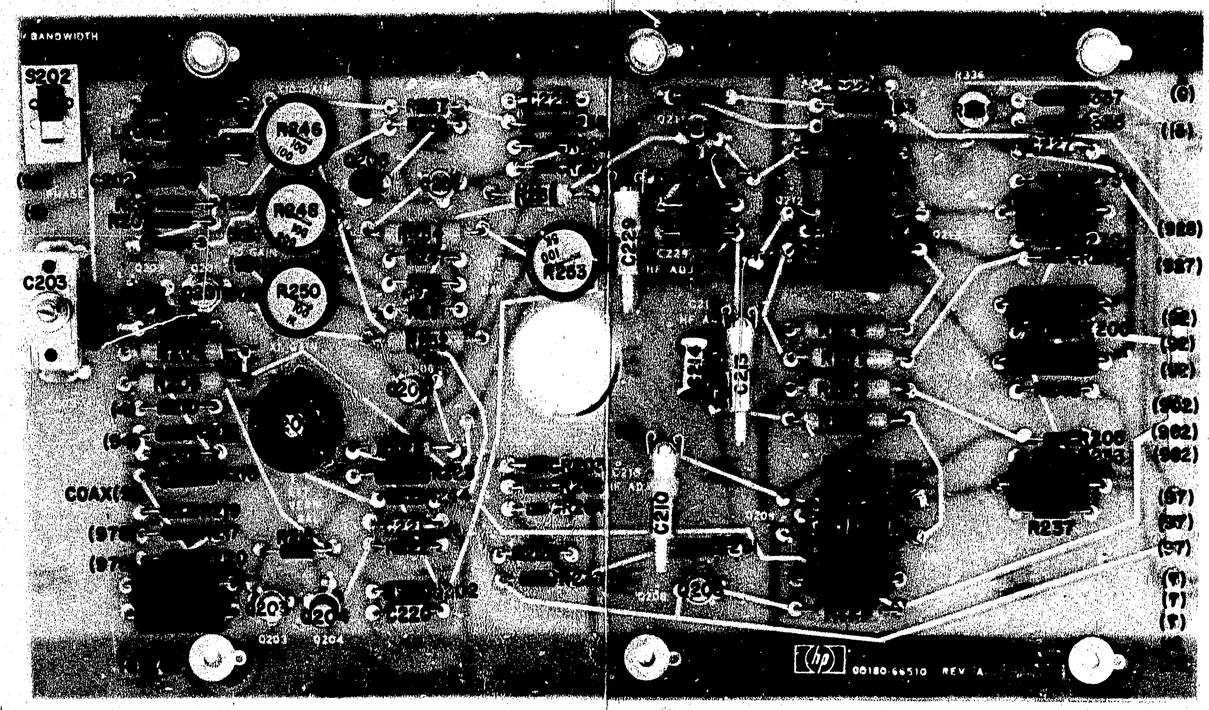
e. Connect a 100 kHz, 5V pk-pk, negative, square wave with a risetime of less than 30 nsec to Z-axis Input.



p/o Figure 8-3. Waveforms and Measurement Conditions



p/o Figure 8-3. Gate Amplifier



A3

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C202	D-2	C221	E-5	CR206	F-2	Q207	F-2	R207	E-4	R230	F-5	R248	E-3	R263	H-2
C203	C-3	C222	J-3	CR207	F-2	Q208	G-5	R208	D-4	R231	G-5	R249	E-3	R264	G-2
C204	C-3	C226	F-2	CR208	G-2	Q209	H-5	R209	D-4	R232	H-5	R250	E-3	R268	G-3
C205	D-5	C227	J-2	CR209	J-3	Q210	I-5	R210	D-4	R234	H-4	R251	E-3	R269	G-2
C206	D-5	C228	H-2	L200	J-3	Q211	G-2	R215	E-5	R235	J-4	R252	E-3	R270	J-3
C210	G-5	C229	G-3	L201	D-2	Q212	H-3	R216	D-4	R237	J-4	R253	F-3	R271	H-3
C211	H-5	C230	H-2	L202	E-5	Q213	I-3	R217	D-5	R238	H-4	R254	E-3	R273	J-2
C212	J-4	C231	J-3	Q201	D-3	R201	D-2	R219	D-4	R239	H-4	R257	E-2	R275	H-3
C213	H-4	CR201	D-3	Q202	D-3	R202	D-2	R220	D-5	R244	E-4	R258	F-2	R335	J-2
C214	G-4	CR202	F-4	Q203	D-5	R203	D-2	R222	E-5	R245	J-4	R259	E-2	R336	I-2
C218	J-3	CR203	F-4	Q204	E-5	R204	D-4	R223	E-4	R246	E-2	R261	F-2	R337	J-2
C219	D-2	CR204	F-4	Q205	E-2	R205	D-3	R225	E-4	R247	E-3	R262	H-2	S202	C-2
C220	E-5	CR205	J-4	Q206	E-4	R206	D-3	R229	F-5						

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p/o Figure 8-4. Component Identification, A3

DC VOLTAGE MEASUREMENT CONDITIONS

a. Set HORIZONTAL DISPLAY to EXT CAL and HORIZONTAL MAGNIFIER to X1.

b. Adjust HORIZONTAL POSITION to center spot.

c. All voltages are referenced to ground.

WAVEFORM MEASUREMENT CONDITIONS

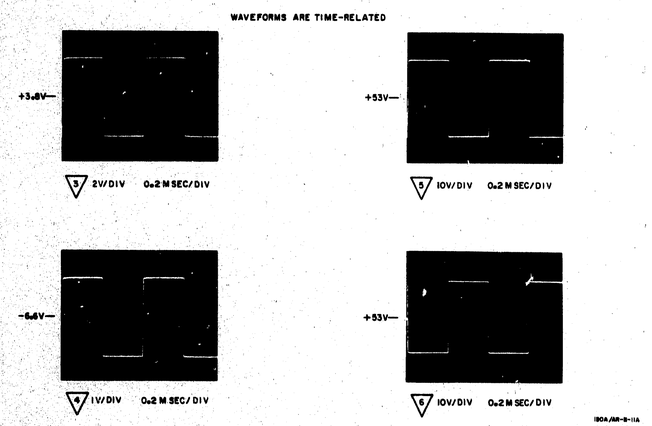
a. Set Model 180ER controls as follows:

HORIZONTAL MAGNIFIER X1
HORIZONTAL DISPLAY . . . . . EXT CAL
HORIZONTAL EXT INPUT . . . . . AC

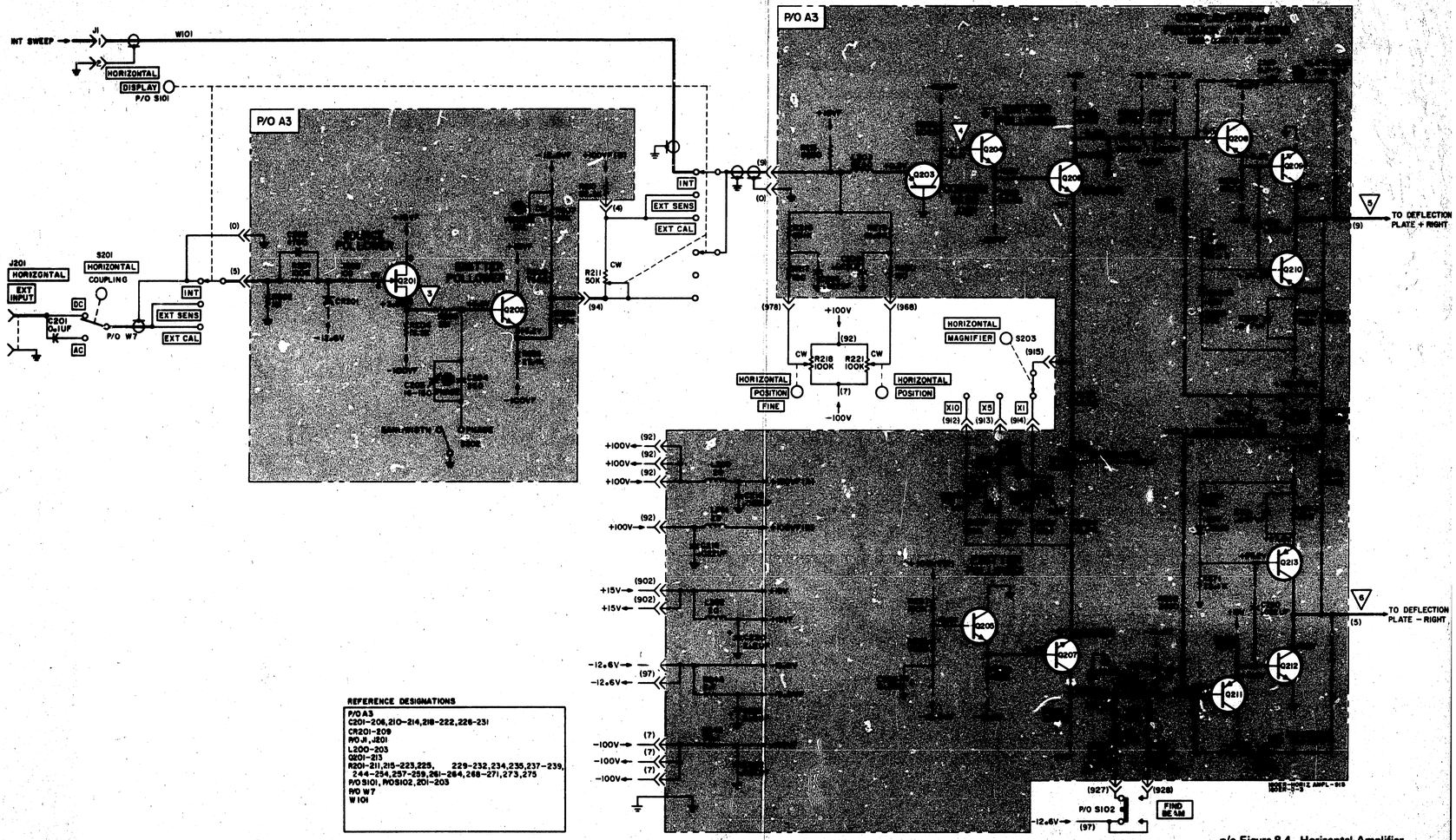
b. Set Vertical Display to A.

c. Connect CALIBRATOR 10V output to HORIZONTAL EXT INPUT.

d. Adjust vertical and horizontal POSITION to center trace (increase INTENSITY if necessary).



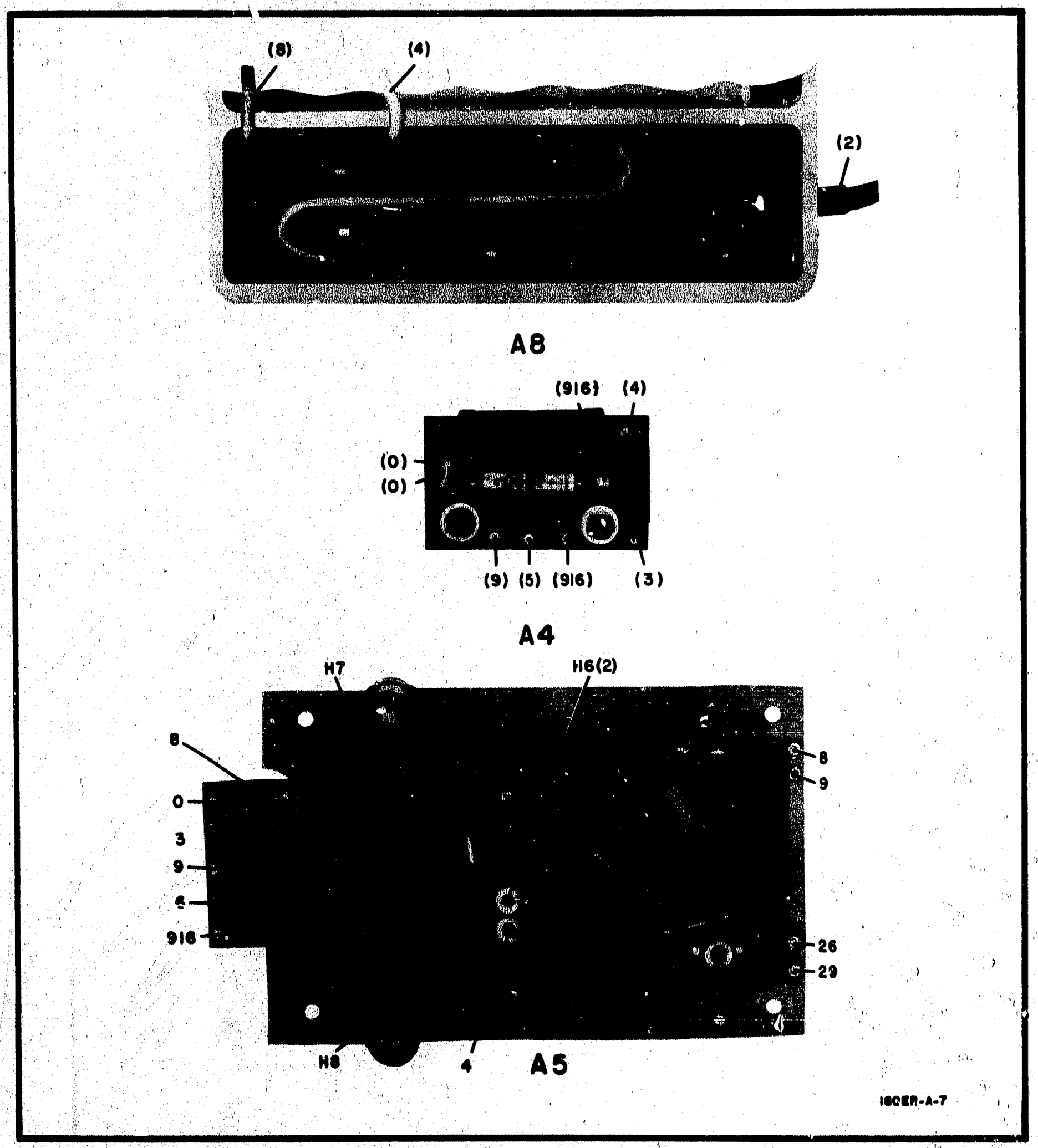
p/o Figure 8-4. Waveforms and Measurement Conditions



p/o Figure 8-4. Horizontal Amplifier

Component Identification for A1 on Figure 8-3.

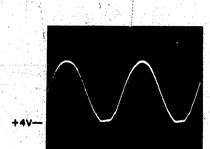
Component Identification for A3 on Figure 8-4.



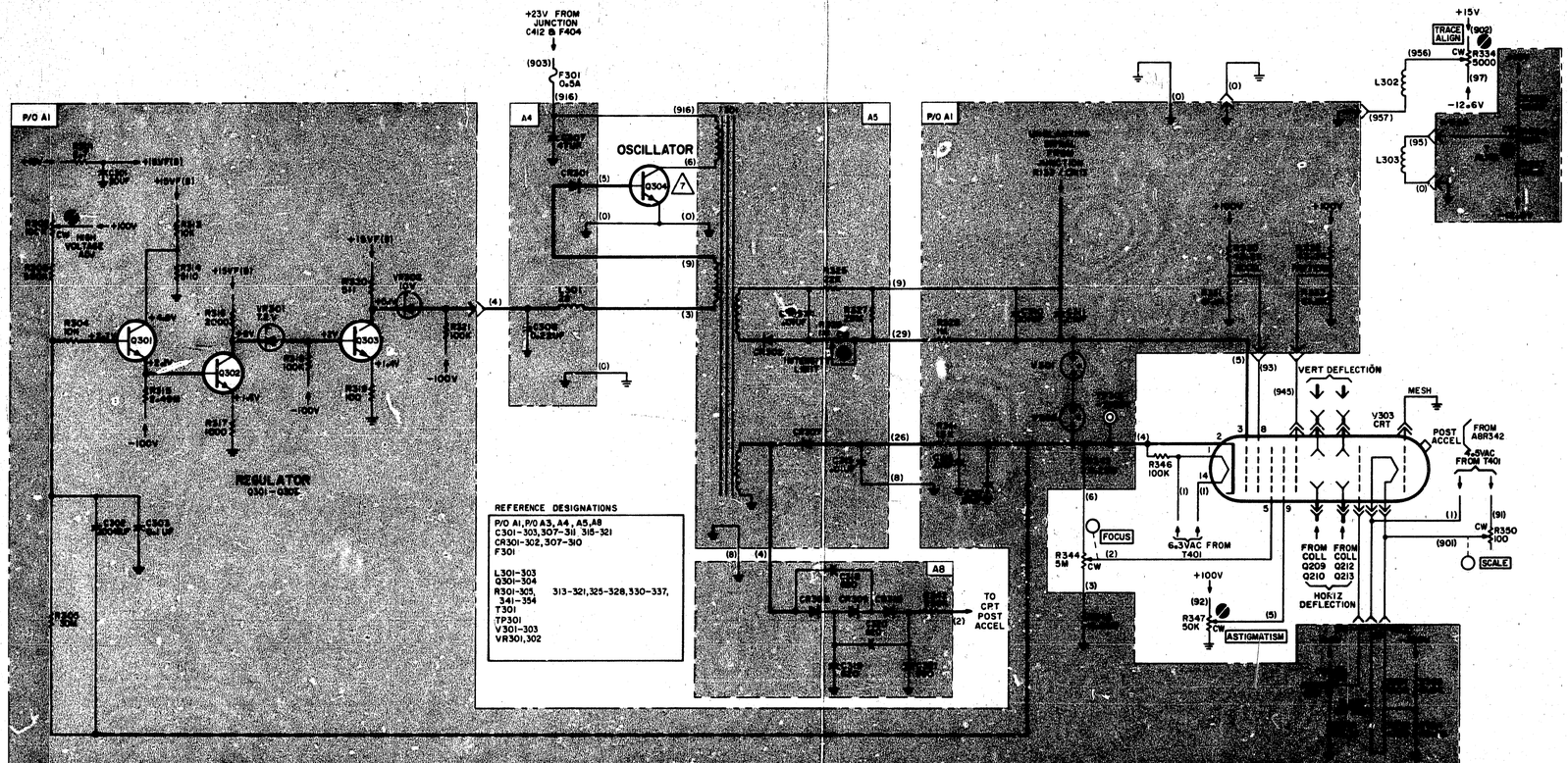
p/o Figure 8-5. Component Identification, A4, A5 and A8

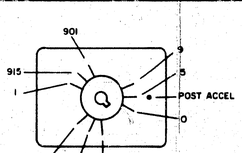
WAVEFORM AND DC VOLTAGE MEASUREMENT CONDITIONS

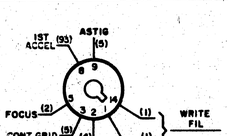
Turn POWER on



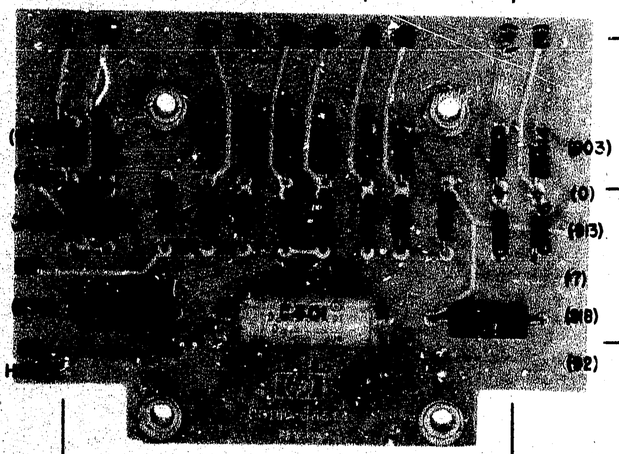
p/o Figure 8-5. Waveform and Measurement Conditions

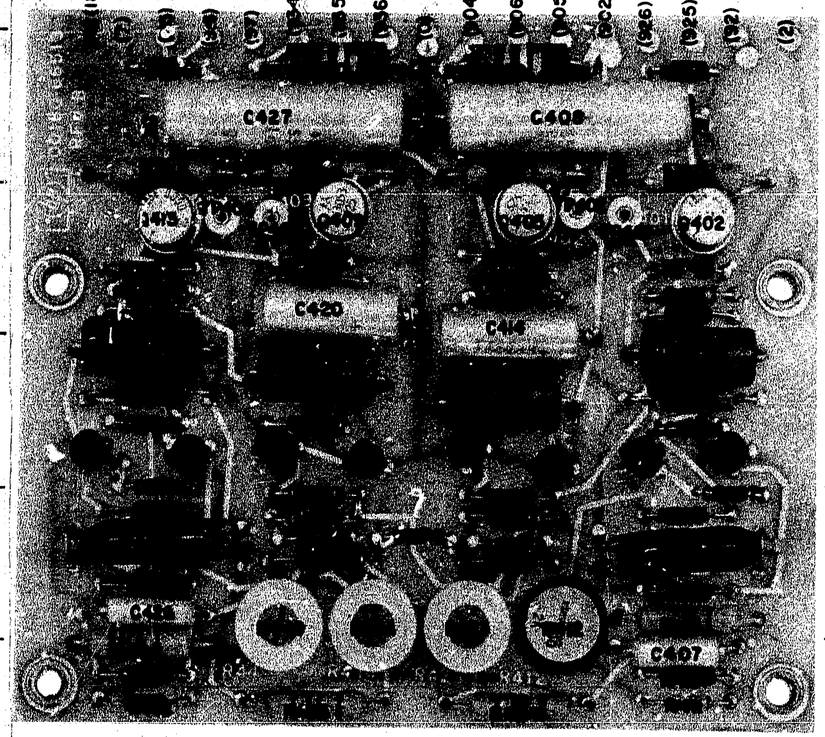






p/o Figure 8-5. High Voltage Power Supply





REF DESIG	GRID LOC	REF DESIG	GRID LOC
C401	C-4	CR421	B-3
CR401	C-3	CR422	B-3
CR402	C-3	CR423	B-4
CR-	C-4	CR424	B-4
CR404	C-4	CR426	D-3
CR406	B-3	CR427	D-3
CR408	C-3	CR428	D-4
CR410	C-4	CR429	D-4
CR411	C-4	R402	B-4
CR413	D-3	R403	B-3
CR414	E-3	R439	D-4
CR415	D-4	R440	D-4
CR416	E-4		

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C406	K-4	CR405	J-3	CR433	H-4	Q412	I-4	R409	K-4	R422	J-5	R435	I-6	R450	H-6
C407	K-6	CR406	K-4	CR434	H-5	Q413	H-3	R410	K-6	R423	J-5	R441	H-3	TP401	K-3
C408	J-2	CR407	K-5	Q402	K-3	Q415	H-4	R411	K-6	R424	J-6	R442	H-3	TP402	K-3
C413	J-4	CR413	K-2	Q403	L-4	Q416	G-4	R412	K-5	R428	I-3	R443	H-2	TP403	I-3
C414	J-4	CR417	J-5	Q404	K-4	R401	K-4	R413	K-5	R429	I-2	R444	H-5	TP404	H-3
C419	I-4	CR419	I-5	Q405	J-3	R404	J-3	R417	J-4	R430	I-2	R445	H-5	V401	K-5
C420	I-3	CR420	I-4	Q407	J-4	R405	K-3	R418	J-3	R431	I-5	R446	H-4	V402	H-5
C425	H-4	CR425	I-5	Q408	J-4	R406	K-2	R419	J-2	R432	I-5	R447	H-5	VR401	K-3
C426	H-5	CR430	H-2	Q409	I-3	R407	K-5	R420	J-5	R433	I-5	R448	H-6	VR402	J-3
C427	I-2	CR432	I-3	Q411	I-4	R408	K-5	R421	J-5	R434	I-5	R449	I-5	VR403	H-3

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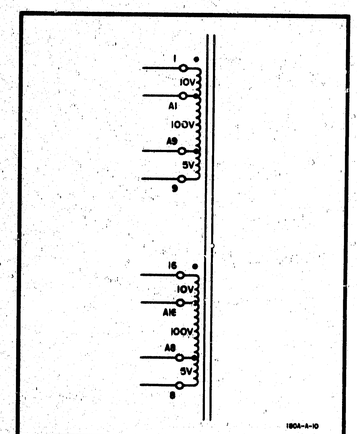
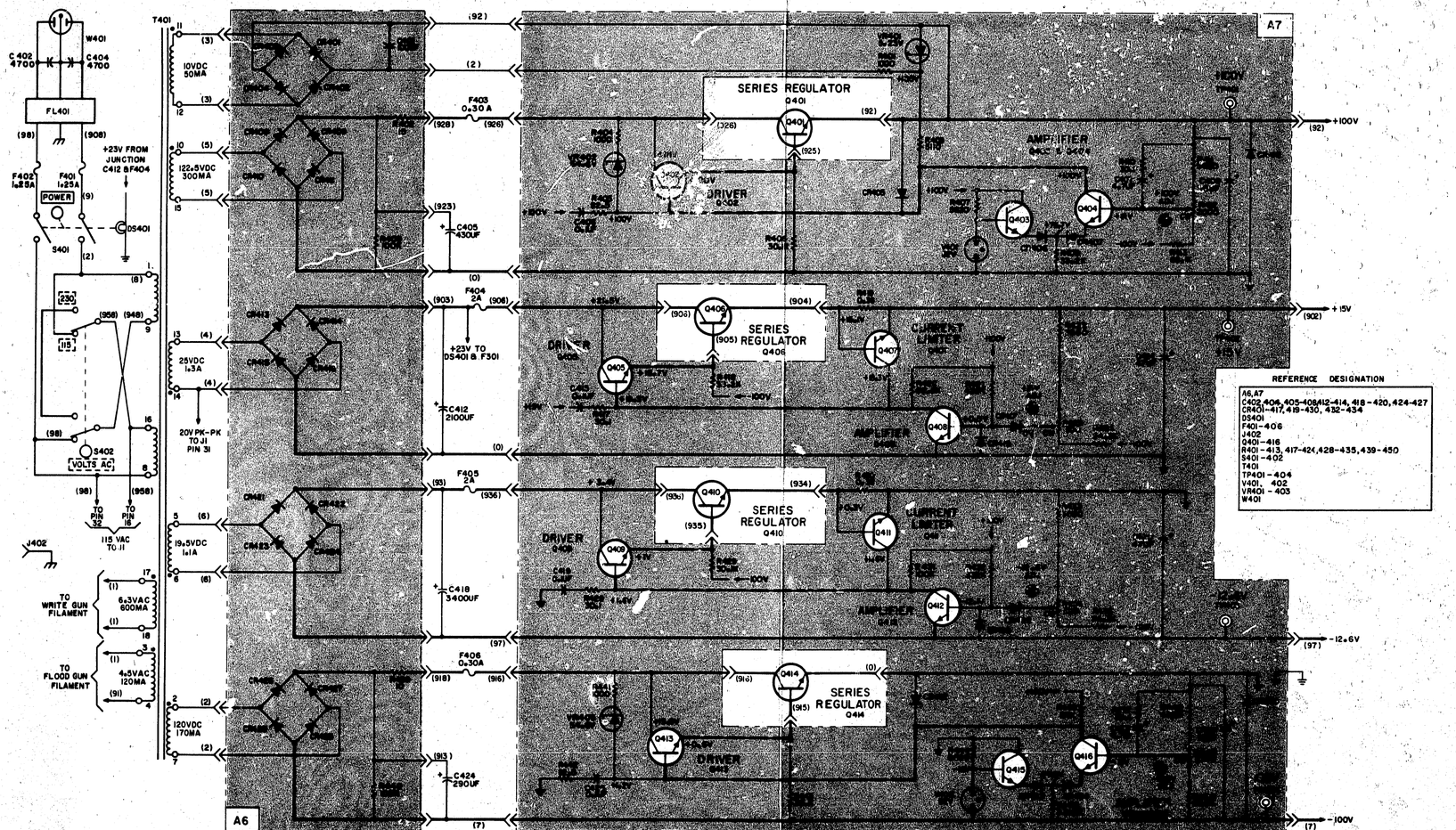
p/o Figure 8-6. Component Identification, A6 and A7

DC VOLTAGE MEASUREMENT CONDITIONS

Turn POWER on



T401 primary winding for Options 003 and 004.



p/o Figure 8-6. Low Voltage Power Supply

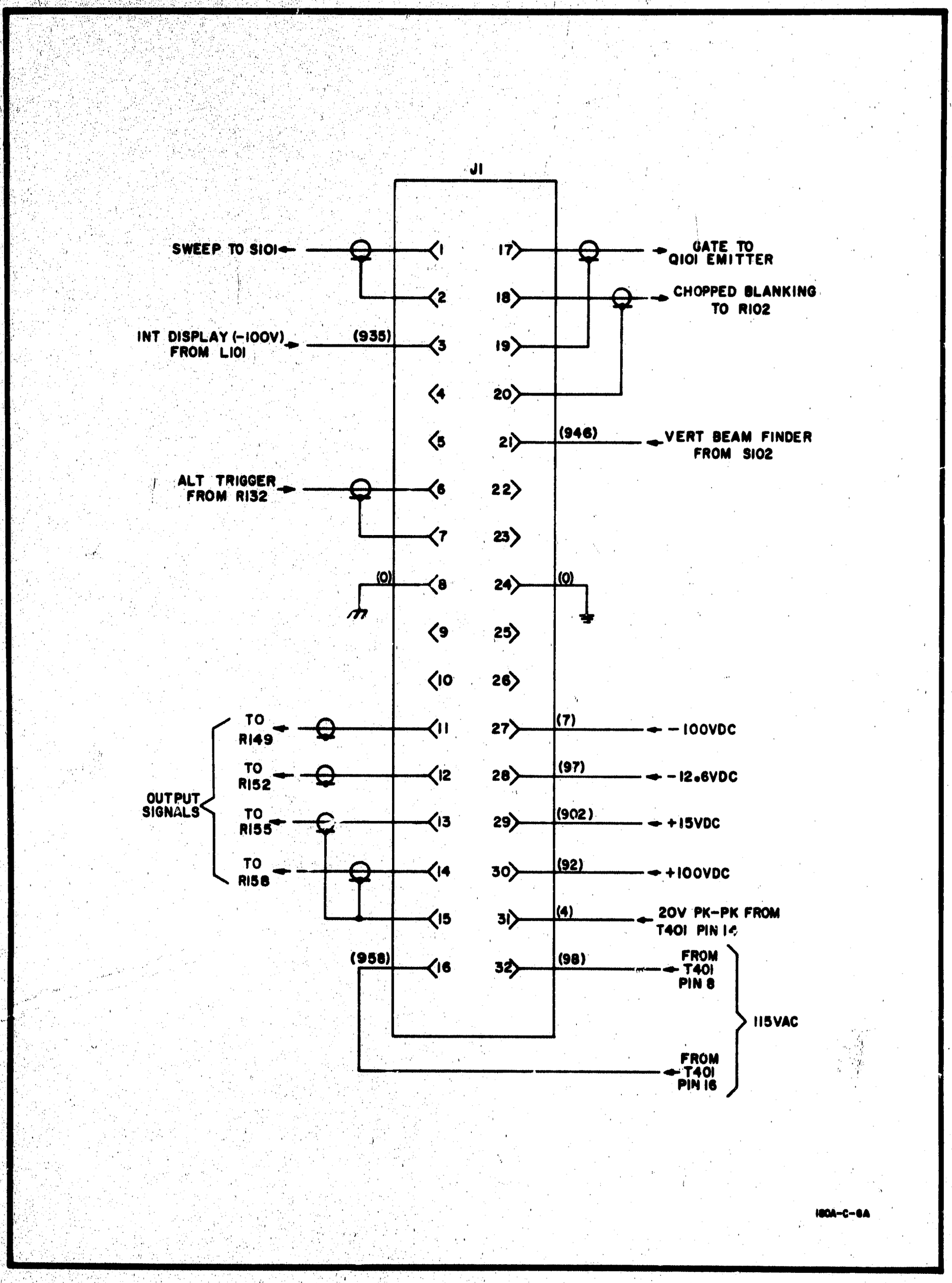


Figure 8-7. Jack Connections

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.

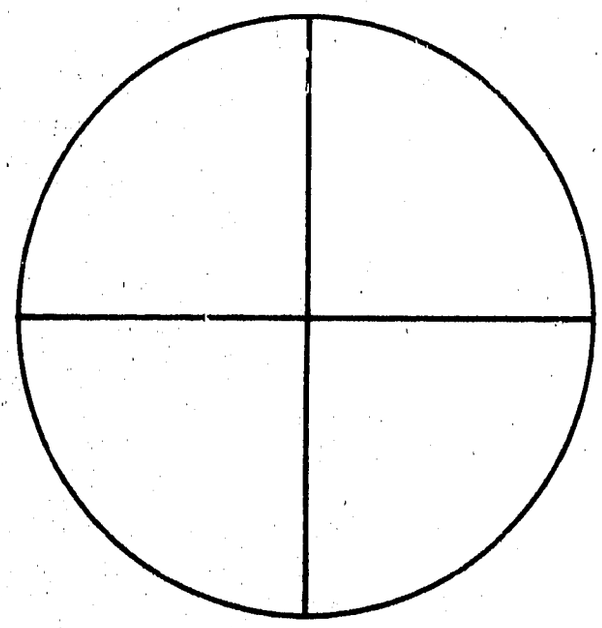
_____

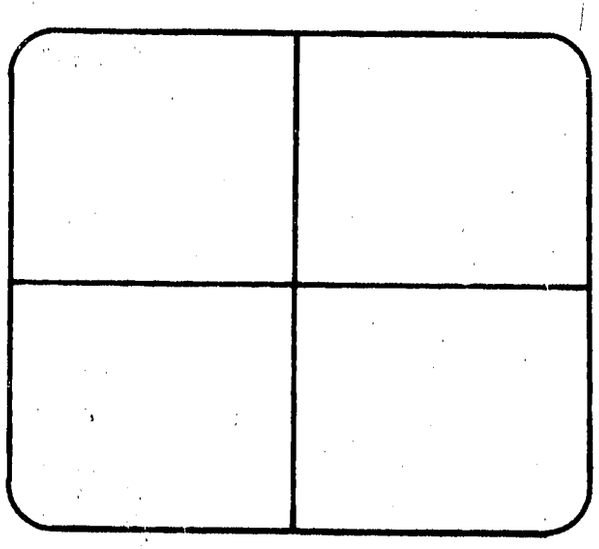
_____

_____

_____

_____





5. Is the CRT within warranty? Yes_____ No_____

6. hp Sales/Service Office _____ Repair Order No. _____

CUT ALONG DOTTED LINE

02537-4

MANUAL CHANGES

MANUAL CHANGES

MANUAL IDENTIFICATION

Model Number:	180ER
Date Printed:	MARCH 1970
Part Number:	00180-90913

This supplement contains important information for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

To use this supplement:

Make all ERRATA corrections.

Make all appropriate serial number related changes indicated in the tables below.

Serial Prefix or Number	Make Manual Changes
1210A	1
1220A	1 and 2
1944A	1, 2 and 3
2135A	1, 2, 3 and 4

Serial Prefix or Number	Make Manual Changes

▲ NEW ITEM

Paragraph 2-12,

Delete paragraph 2-12a and b; replace with the following:

a. 115V OPERATION. This instrument, as shipped, is ready for operation on 115 Vac. Four 1.6-ampere fuses (HP Part No. 2110-0005) are installed in the rear-panel fuseholders. Two fuses are in use and two are spares.

CAUTION

Before applying power, check the rear-panel slide switch for proper position (115 or 230).

b. 230V OPERATION. If the instrument is to be operated on 230 Vac, set the rear-panel switch to 230 and replace the four rear-panel fuses with 0.8-ampere fuses (HP Part No. 2110-0020). Two fuses are in use and two are spares.

c. The 115/230 rear-panel switch selects the proper transformer connections for the desired operating voltage. This switch and the fuses should always be checked before connecting the instrument to a power source to avoid damage to the instrument.

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.

Table 5-1,

Change the 100:1 Divider Probe, HP Model 11044A to: 1000:1 Divider Probe, HP Model K05-3440A.

Paragraph 5-23a,

Change the 100:1 Divider Probe to a 1000:1 Divider Probe.

NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.

HEWLETT PACKARD

Printed in U.S.A.

Table 6-2,
C115: Change HP Part No. to 0160-0303, C:fxd my 0.015 uF 200 wVdc.
C204: Change HP Part No. to 0140-0231, C:fxd mica 440 pF 1% 300 wVdc.
C301: Change to HP Part No. 0180-0049, C:fxd elect. 20 μF +75 −10% 50 wVdc.
F401, F402: Change HP Part No. to 2110-0020; F:0.8A SB (230V operation).
Add: F401, F402; HP Part No. 2110-0005; F:1.6A SB (115V operation).
J1: Change to HP Part No. 00180-27601, J:female 32-pin modified.
Add: J104, HP Part No. 00180-61001; TQ1; J: ground post.
MP137: Change to HP Part No. 0403-0129.
MP161: Change to HP Part No. 0403-0128.
R104: Change TQ to 8.
R151: Change TQ to 2.
R203: Change HP Part No. to 0757-0407, TQ1, R:fxd metflm 200 ohms 1% 1/8W.
R253: Change to HP Part No. 2100-1775, R: var ww 5 kilohms 5% 1W.
R305: Change HP Part No. to 0698-7182; R:fxd metflm 30 megohms 1% 2W, (Preferred replacement).
R448: Change HP Part No. to 0757-0435, TQ1, R:fxd metflm 3.92 kilohms 1% 1/8W.
S402: Change to HP Part No. 3101-1234, S: slide dpdt 250 Vac 6A.
V401, V402: Change HP Part No. to 1940-0025, V:voltage reference 83.0V ±1.0V.

Table 6-3,
C115: Change description to: CAPACITOR, FIXED, MYLAR: 0.15 uF 200 vdcw, mfr 28480, P/N 0160-0303.
C204: Change description to: CAPACITOR, FIXED, MICA: 440 pF, 300 vdcw, mfr 04062, P/N ROM15F-441F3C.
C301: Change description to: CAPACITOR, FIXED, ELECTROLYTIC: 20 uf, 50 vdcw; mfr 56289, P/N 30D206G050CC2-DSM.
C309: Change value to 0.01 uF.
F401, F402: Change description to FUSE, SLOW-BLOW: 0.8 amp 250v (230v operation), mfr 75915, P/N 313.800S.
Add: F401, F402, FUSE, SLOW-BLOW 1.6 amp 125v (115v operation), mfr 71400, P/N MDL 1.6.

Table 6-3 (Cont'd),
J1: Change description to: CONNECTOR:RECEPTACLE: 32-contact, female; Mfr 28480, P/N 00180-27601.
Add: J104, GROUND POST: mfr 28480, P/N 00180-61001.
MP128: Change P/N to 00180-64108.
MP137: Change description to: GUIDE, RIGHT PLUG-IN: mfr 28480, P/N 0403-0129.
MP161: Change description to: GUIDE, LEFT PLUG-IN: mfr 28480, P/N 0403-0128.
R203: Change description to: RESISTOR, FIXED, METAL FILM: 200 ohms ±1% 1/8W, mfr 28480, P/N 0757-0407.
R253: Change description to RESISTOR, VARIABLE, WIRE WOUND: 5k ohms ±5%, 1w; mfr 28480, P/N 2100-1775.
R305: Change description to: RESISTOR, FIXED, METAL FILM: 30 megohms ±1%, 2W; mfr 28480, P/N 0698-7182.
R448: Change description to: MIL type RN60C3921F.
S402: Change description to SWITCH, SLIDE: DPDT, VOLTS AC, mfr 82389, P/N 11A-1242A.
V401: Change description to: TUBE, VOLTAGE REFERENCE: 83 volts; mfr 74276, P/N Z83R4A.

Page 7-1/7-2, paragraph 7-6,
Add following statement to paragraph 7-6 :Option 021 exchanges the standard front panel (MP120) for HP Part No. 00180-00229.

Page 8-5, Schematic,
Add: Ground jack to calibrator schematic under J03. Connect jack to chassis ground. Label jack GND and designate as J104.
CR109: Delete cathode connection to +100 VF. Connect CR109 to emitter of Q103.
C115: Change value to 0.15 uF.

Page 8-7, Schematic,
C204: Change value to 440 pF.
R203: Change value to 200 ohms.

Page 8-11, Schematic,
F401, F402: Change value to 1.6A (115V operation), 0.8A (230V operation).
R448: Change value to 3920 ohms.
V401, V402: Change value to 83V.

CHANGE 1

Table 6-2,
R305: Change to HP Part No. 0698-7182, R:fxd metflm 30 megohms 1% 2W.

Table 6-3,
R305: Change description to: RESISTOR, FIXED, METAL FILM: 30 megohms ±1%, 2W; mfr 28480, P/N 0698-7182.

CHANGE 2

Table 6-2,
R218: Change HP Part No. to 00180-61501; R:var comp dual 100 kilohms 20%. (Includes R221 and all mounting parts.)

Table 6-3,
R128: Change description to: RESISTOR, VARIABLE, COMPOSITION, DUAL: 100k ohms 20%; mfr 28480, P/N 00180-61501. (Includes R221 and all mounting parts.)

CHANGE 3

Table 6-2,
S401: Change HP Part No. to 3101-2269,
Change described ratings to "250 Vac 3A".
MP121: Change HP Part No. to 00180-00267.
MP143: Change HP Part No. to 00180-00265.
MP152: Change HP Part No. to 00180-00266.
W401: Change HP Part No. to 8120-1521,
Change description to W: Power Assy 7.5 Ft.
DS401: Delete.
Add: J2, HP Part No. 1251-2357, TQ 1, J: AC PWR MALE.

Table 6-3,
S401: Change rating to "3 amp 250 Vac",
Change Mfr to "28480" and P/N to "3101-2269".
MP121: Change P/N to 00180-00267.
MP143: Change P/N to 00180-00265.
MP152: Change P/N to 00180-00266.
W401: Change to "CABLE POWER ASSY 7.5 FT: Mfr 28480, P/N 8120-1521".
DS401: Delete.
Add: J2, CONNECTOR, RECEPTACLE, AC POWER, male.

▲ CHANGE 4

Page 4-5, Paragraph 4-33,
Change the paragraph to read as follows:
The +100V supply is used as a reference for the −100V supply and the −100V supply is a reference for the +15V and −12.6V supplies. The +100V must be adjusted first, then the −100V, then the +15V and −12.6V supplies.

Page 5-2, Table 5-2. Low Voltage Adjustments,
Change the order of supply adjustment as follows:

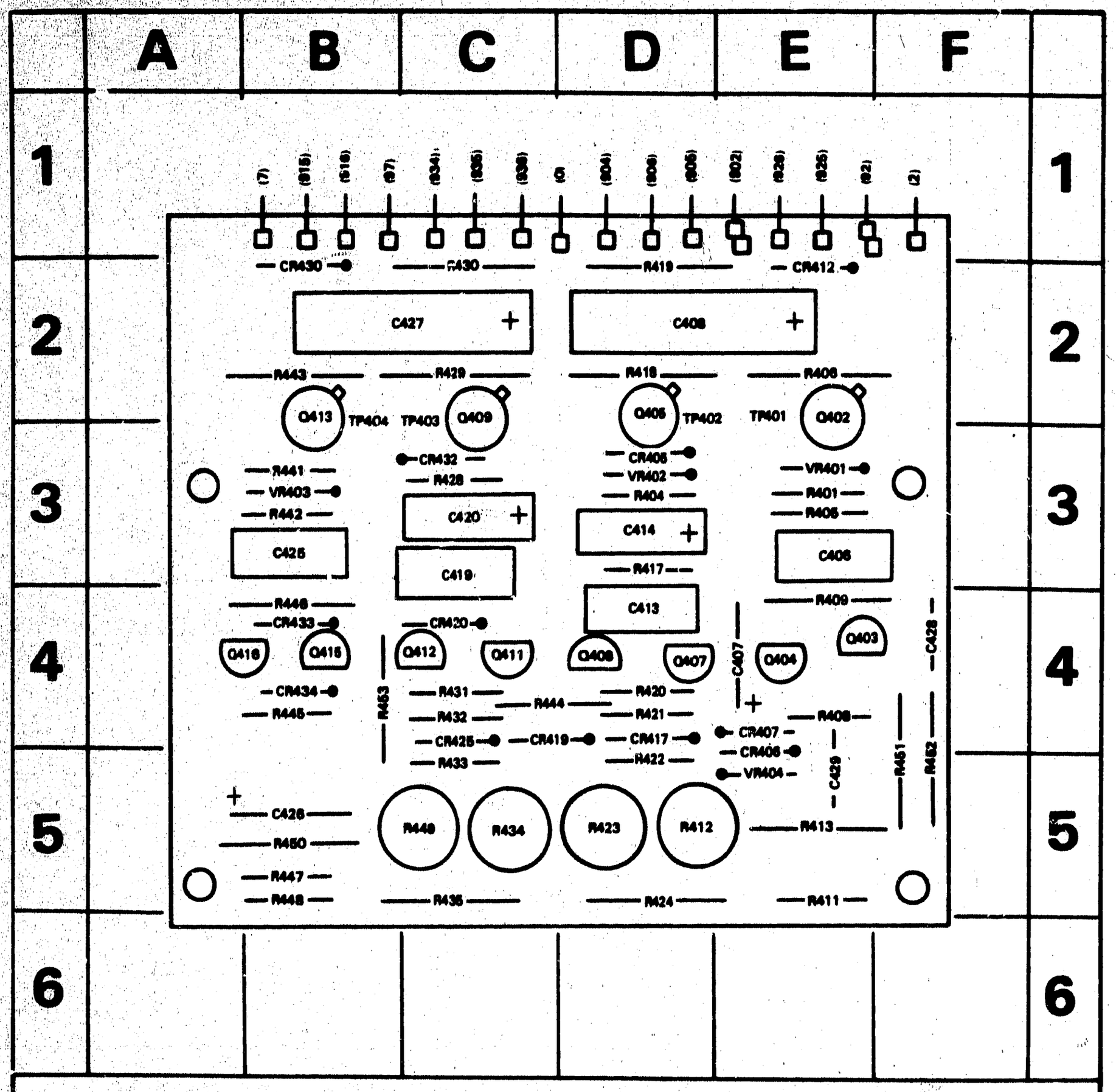
Test Point	Measure	Adjust
TP401	+100V ± .1V	R412
TP404	−100V ± .1V	R449
No Change		
No Change		

Table 6-2. Replaceable Parts,
C407: Change to HP Part No. 0180-0269, C:FXD ELEC 1μF 150 wVdc.
Add: C428, C429, HP Part No. 0140-0176, C:FXD MICA 100 pf 300 wVdc
Q403: Change to HP Part No. 1854-0471.
Delete: R407.
R411: Change to HP Part No. 0757-0436, R:FXD METFLM 4320 OHMS 1% 1/8W.
R412: Change to HP Part No. 2100-1773, R:VAR WW 1000 OHMS 1W.
R413: Change to HP Part No. 0757-0767, R:FXD METFLM 43.2K 1% 1/4W.
R444: Change to HP Part No. 0757-0770, R:FXD METFLM 56.2K 1% 1/4W.
R448: Change to HP Part No. 0757-0436, R:FXD METFLM 4320 OHMS 1% 1/8W.
Add: R451, R452 HP Part No. 0757-0435, R:FXD METFLM 24.3K 1% 1/4W.
Add: R453 HP Part No. 0757-0766, R FXD METFLM 39.2K 1% 1/4W.
Delete: V401, V402.

Table 6-3. Military Part No.,
C407: Change description to CAPACITOR, FIXED, ELECTROLYTIC: 1 μF 150wVdc Mfr 28480 P/N 0180-0269.
Add: C428 C429 CAPACITOR, FIXED, MICA: 100pf 300V Mfr 28480 P/N 0140-0176.
Q403: Change description to TRANSISTOR: SAME AS Q108.
Delete: R407.
R411: Change description to RESISTOR: MIL TYPE RN60C4321F.
R412: Change description to RESISTOR, VARIABLE, WIREWOUND 1K OHMS 1W Mfr 28480 P/N 2100-1773.
R413: Change description to RESISTOR: MIL TYPE RN65C4322F.
R444: Change description to RESISTOR: MIL TYPE RN65C5622F.
R448: Change description to RESISTOR: MIL TYPE RN60C4321F.
Add: R451 RESISTOR:MIL TYPE RN65C2432F.
Add: R452 RESISTOR: SAME AS R451.
Add: R453 RESISTOR: MIL TYPE RN65C3922F.
Delete: V401, V402.

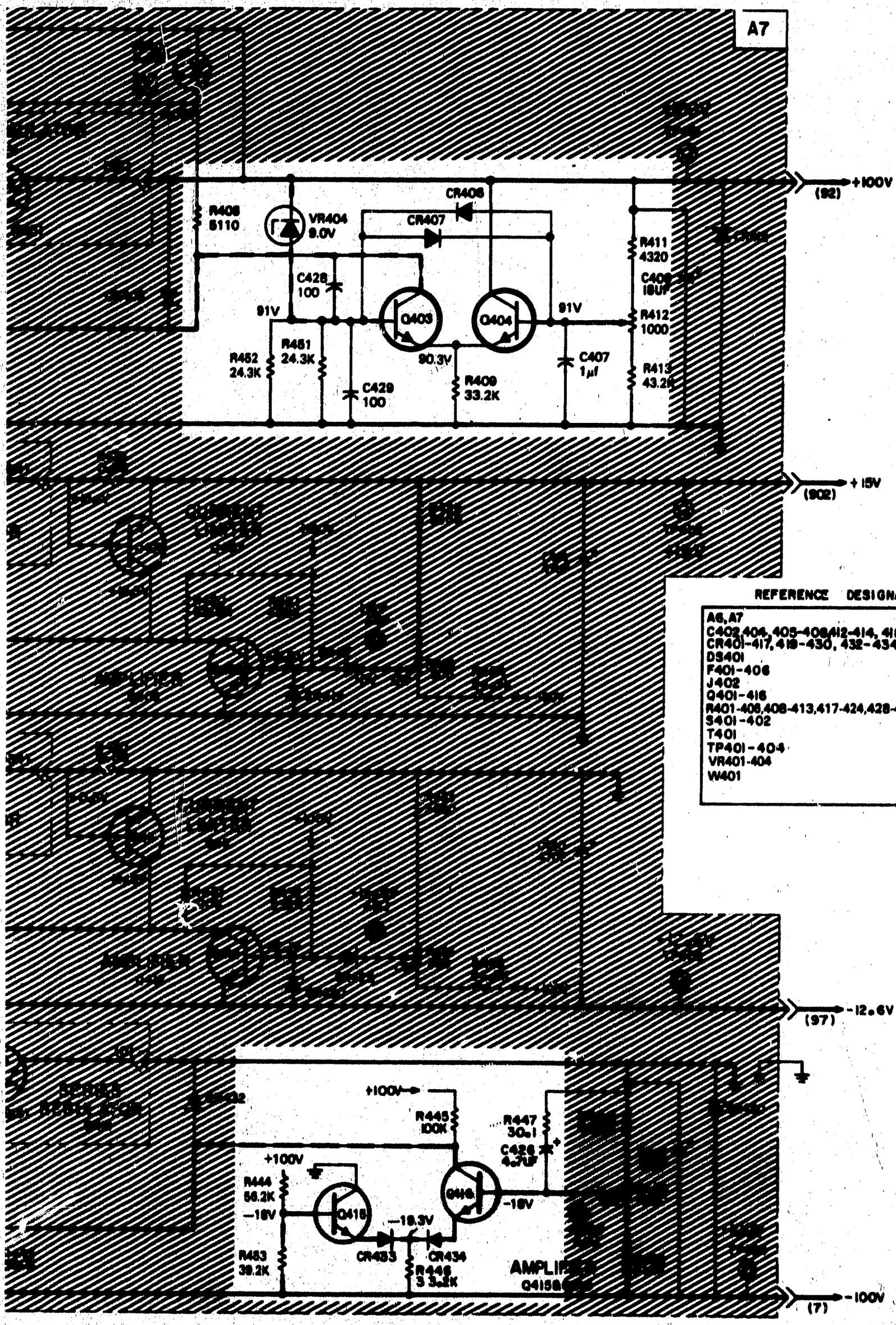
Page 8-10, P/O Figure 8-6,
Replace A7 Component Locator and table with Figure 1 this change sheet.

Page 8-11, P/O Figure 8-6,
Make changes shown in Figure 2 of this change sheet.



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C406	E-3	CR405	D-3	Q402	E-2	R401	E-3	R420	D-4	R435	C-6	R452	F-5
C407	E-4	CR406	E-5	Q403	E-4	R404	D-3	R421	D-4	R441	B-3	R453	B-4
C408	D-2	CR407	E-4	Q404	E-4	R405	E-3	R422	D-5	R442	B-3	TP401	E-2
C413	D-4	CR412	E-2	Q405	D-2	R406	E-2	R423	D-5	R443	B-2	TP402	D-2
C414	D-3	CR417	D-4	Q407	D-4	R408	E-4	R424	D-5	R444	C-4	TP403	C-2
C419	C-3	CR419	C-4	Q408	D-4	R409	E-4	R428	C-3	R445	B-4	TP404	B-2
C420	C-3	CR420	C-4	Q409	C-2	R411	E-5	R429	C-2	R446	B-4	VR401	E-3
C425	B-3	CR425	C-4	Q411	C-4	R412	D-5	R430	C-2	R447	B-5	VR402	D-3
C426	B-5	CR430	B-2	Q412	C-4	R413	E-5	R431	C-4	R448	B-5	VR403	B-3
C427	C-2	CR432	C-3	Q413	B-2	R417	D-3	R432	C-4	R449	C-5	VR404	E-5
C428	F-4	CR433	B-4	Q415	B-4	R418	D-2	R433	C-5	R450	B-5		
C429	E-5	CR434	B-4	Q416	B-4	R419	D-2	R434	C-5	R451	F-5		

Figure 1. Replacement for A7 Component Identification



REFERENCE DESIGNATION

A6, A7
C402,404, 405-408,412-414, 418-420, 424-429
CR401-417, 419-430, 432-434
DS401
F401-406
J402
Q401-416
R401-408,408-413,417-424,428-435,439-453
S401-402
T401
TP401-404
VR401-404
W401

Figure 2. Modifications to Low Voltage Power Supply