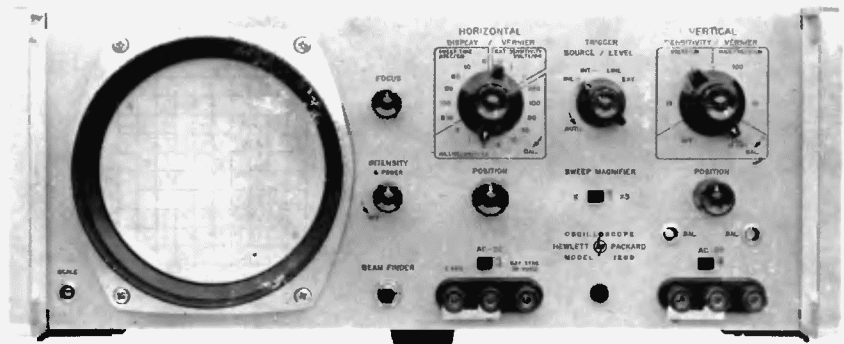


# OSCILLOSCOPE

## 120B



HEWLETT  PACKARD

# **K4XL's** **BAMA**

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*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.*

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OPERATING AND SERVICE MANUAL

MODEL 120B  
OSCILLOSCOPE

SERIALS PREFIXED: 601-

(For Instruments With Other Serial Prefixes,  
See Section I and Appendix I)

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1900 GARDEN OF THE GODS ROAD, COLORADO SPRINGS, COLORADO, U. S. A.



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Table 1-1. Specifications

## **SWEEP**

### **Sweep Range:**

One  $\mu\text{sec/cm}$  to at least 0.5  $\text{sec/cm}$ . Fifteen calibrated sweeps accurate to within  $\pm 5\%$ , in a 1, 2, 5, 10... sequence, from 5  $\mu\text{sec/cm}$  to 200  $\text{millisec/cm}$ . Vernier control permits continuous adjustment of sweep time between calibrated steps, and extends the 200  $\text{millisec/cm}$  to at least 0.5  $\text{sec/cm}$ .

### **Sweep Expand:**

X5 sweep expansion may be used on all ranges and expands fastest sweep to 1  $\mu\text{sec/cm}$ . Expanded sweep accuracy is  $\pm 10\%$ .

### **Automatic Synchronization:**

Internal: from signals 50 cps to 450 kc with approximately 0.5-cm or more vertical deflection; and from line voltage.

External: from signal 50 cps to 450 kc, 1.5 v peak-to-peak.

### **Trigger Point:**

Zero-crossing negative slope of external sync signals; or zero-crossing positive or negative slope of vertical deflection signals. Front-panel control overrides automatic and permits the trigger point to be set between -7 to +7 volts. Turning control fully counterclockwise restores automatic operation.

## **VERTICAL AMPLIFIER**

### **Bandwidth:**

DC coupled: dc to 450 kc. AC coupled: 2 cps to 450 kc. Bandwidth is at least 450 kc regardless of sensitivity setting.

### **Sensitivity:**

10 millivolts/cm to 100 volts/cm. Four calibrated steps with attenuator accuracy of  $\pm 3\%$ , 10 mv/cm, 100 mv/cm, 1 v/cm, and 10 v/cm. Vernier permits continuous adjustment of sensitivity between steps, and extends 10 v/cm step to at least 100 v/cm.

### **Internal Calibrator:**

Calibrating signal automatically connected to vertical amplifier for standardizing of gain, accuracy  $\pm 2\%$ .

### **Input Impedance:**

1 megohm, shunted by approximately 50 pf.

### **Balanced Input:**

On 10 mv/cm range only; input impedance is 2 megohms shunted by approximately 25 pf.

### **Common-Mode Rejection:**

Rejection at least 40 db. Common mode signal must not exceed  $\pm 3$  volts peak.

### **Phase Shift:**

Vertical and horizontal amplifiers have same phase characteristics within  $\pm 2^\circ$  to 100 kc when verniers are in CAL.

## **HORIZONTAL AMPLIFIER**

### **Bandwidth:**

DC coupled: dc to 300 kc. AC coupled: 2 cps to 300 kc. Bandwidth is at least 300 kc regardless of attenuator setting.

### **Sensitivity:**

0.1 volt/cm to 100 volts/cm. Three calibrated steps, accurate within  $\pm 5\%$ , 0.1 v/cm, 1 v/cm, and 10 v/cm. Vernier permits continuous adjustment of sensitivity between steps and extends 10 v/cm step to at least 100 v/cm.

### **Input Impedance:**

1 megohm nominal, shunted by approximately 100 pf.

### **Phase Shift:**

Horizontal and vertical amplifiers have same phase characteristics within  $\pm 2^\circ$  to 100 kc when verniers are in CAL.

## **GENERAL**

### **Cathode Ray Tube:**

P31 phosphor, mono-accelerator with internal graticule normally supplied; 2700-volt accelerating potential. Face plate eliminates glare and reduces hazard of implosion. P2, P7, and P11 phosphors also available.

### **Internal Graticule:**

10 cm x 10 cm marked in cm squares. Major horizontal and vertical axes have 2-mm subdivisions. Eliminates parallax error.

### **Intensity Modulation:**

Terminals on front panel. Plus 20 volt pulse required to blank trace of normal intensity.

### **Dimensions:**

16-3/4 in. wide, 7-1/2 in. high, 18-3/8 in. deep, overall; hardware furnished for quick conversion to 7 in. x 19 in. rack mount.

### **Weight:**

Net: 32 lbs; shipping 45 lbs.

### **Power:**

115 or 230 volts  $\pm 10\%$ , 50 to 1000 cps, approximately 95 watts.

### **Options:**

05. External graticule crt with P31 phosphor.
06. Rear terminals in parallel with front.
10. Provision for single sweep operation.
13. Special front panel for rack mounting only.

## SECTION I GENERAL INFORMATION

### 1-1. INTRODUCTION.

1-2. This manual provides complete instructions on the installation, operation, theory of operation, and maintenance of the Hewlett-Packard Model 120B Oscilloscope.

1-3. The Hewlett-Packard Company uses a two-section, eight-digit serial number (e. g. 000-00000). If the serial prefix (first three digits) on your instrument does not agree with the prefix shown on the title page of this manual, refer to either the separate change sheet included or Appendix I, which contain changes required to adapt this manual to the listed prefixes. The separate change sheet also contains corrections required for all known errata (errors). Contact your Hewlett-Packard Sales/Service Office if additional information or clarification is required.

### 1-4. DESCRIPTION.

1-5. The Model 120B is a general-purpose oscilloscope whose bandwidth extends from dc to 450 kc. It combines the precision characteristics of calibrated

horizontal sweeps, calibrated vertical sensitivity, and a crt that eliminates parallax error; in addition, its construction provides easy circuit accessibility and quick convertibility from a rack-mounting to a bench-model configuration. Specifications are listed in table 1-1.

1-6. The internal graticule of the Model 120B is in the same plane as the phosphor and crt trace; consequently, crt parallax error is avoided, allowing easier, quicker, and more accurate measurements.

1-7. The Model 120B can be used with either internal or external sweeps, which can be either internally or externally synchronized. Because of its high sensitivity and balanced input, the Model 120B can be used to view complex waveforms and monitor transducer outputs.

1-8. Computations are avoided and possibilities of error are reduced by direct-reading calibrated sweeps. A single control selects 1 of 15 calibrated sweeps between the ranges of 5 microseconds/cm and 200

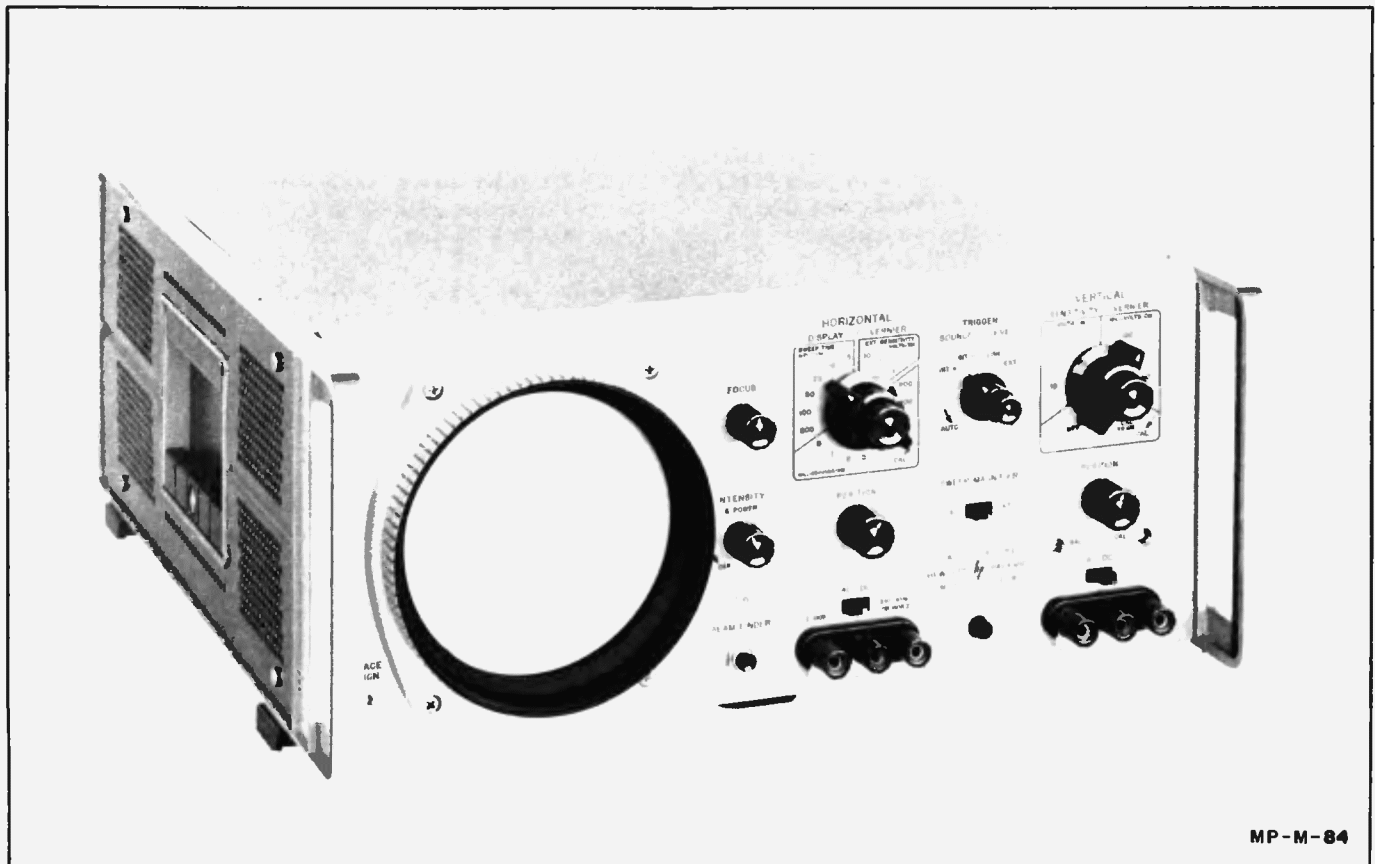


Figure 1-1. Model 120B Oscilloscope

milliseconds/cm or determines the calibrated sensitivity of the horizontal amplifier. Continuous control of sweep time and horizontal sensitivity between calibrated steps is provided by a vernier control; the vernier control extends the 200 milliseconds/cm sweep time to at least 0.5 seconds/cm, and reduces the horizontal amplifier sensitivity to at least 100 volts/cm.

1-9. Accurate direct-reading sweeps are obtained from a feedback type (Miller) integrator, which ensures high linearity and stability of the horizontal sweep. This type of sweep generator is reliable and relatively independent of vacuum-tube characteristics.

1-10. Observation and analysis of transients are simplified by the expanded-sweep control. This X5 sweep expander may be used on all sweep time settings, and expands the fastest sweep time to 1 microsecond/cm.

1-11. An automatic trigger capability facilitates establishing a base line on the crt when a synchronizing signal is not present. The automatic baseline provision can be easily locked-out and an adjustable trigger level established.

1-12. Accurate voltage measurements of waveforms are quickly made with the Model 120B. A built-in calibrator that is accurate to within  $\pm 2$  percent permits rapid verification and standardization of vertical amplifier sensitivity.

1-13. Phase-shift measurements can be made accurately over a wide range of input frequencies. Relative phase shift between the vertical and horizontal amplifiers is less than 2 degrees up to 100 kc.

#### **1-14. CATHODE RAY TUBE WARRANTY.**

1-15. The cathode ray tube supplied with the Model 120B and replacement crt's purchased from Hewlett-Packard Company are guaranteed against electrical failure for one year from the date of sale by Hewlett-Packard. The Cathode Ray Tube Warranty and Claim sheet is included at the rear of this manual.

#### **1-16. OPTIONS.**

1-17. The Model 120B is available with four options, as listed in table 1-1. Replaceable parts for all options are listed under MISCELLANEOUS at the end of table 6-1.

1-18. OPTION 05. This option provides a crt without internal graticule. An external graticule with adjustable illumination is installed over the face of the crt. Refer to figure 5-9 for a schematic of the added circuit. CRT's without internal graticule are available with types P7, P11, and P31 phosphor. A filter is also supplied with each crt; amber for P7 type, blue for P11 type, and green for P31 type.

1-19. OPTION 06. This option provides rear panel connectors in parallel with the front panel input connectors. One connector is wired in parallel with the VERTICAL input terminals on the front panel, and one connector is wired in parallel with the HORIZONTAL input terminals as shown in figures 5-6 and 5-7. Mating connectors and cable clamps are also supplied. The additional circuitry changes the vertical input capacitance to approximately 75 pf, and the horizontal input capacitance to approximately 135 pf.

1-20. OPTION 10. This option provides circuitry for single sweep operation. Operation procedures are contained in figure 3-2 and a schematic for the added circuit is shown in figure 5-8.

1-21. OPTION 13. This option provides a plain 7 x 9 x 3/16 inch front panel for rack mounting only. The panel is suitable for installing special handles to match existing equipment in system or console configuration.

1-22. AMBER FILTER. A special amber filter is supplied with oscilloscopes having an internal graticule crt with P7 phosphor. This filter may be installed for improved visual observation of displays such as single-shot phenomena or very low frequency applications. The filter will improve the long persistency characteristics desired for visual observations of this type display. To install the filter proceed as follows:

- a. Remove front panel crt bezel.
- b. Set filter into bezel, aligning larger rectangular slots in the edge of filter with metal guide posts of the bezel casting.
- c. Remove oscilloscope top cover for access to rear of crt.
- d. Carefully move crt toward rear of instrument enough to provide clearance for thickness of installed filter (about 1/8 inch).
- e. Loosen clamp at socket of crt.
- f. Replace bezel with filter and tighten bezel screws.
- g. Slide crt forward until light mask on front of crt just lightly touches filter.
- h. Tighten clamp just enough to keep crt from turning. Do not over-tighten the clamp or tube damage may result.
- i. Check alignment of trace with graticule according to the procedure given in Section V of this manual.

## SECTION II INSTALLATION

### 2-1. INCOMING INSPECTION.

2-2. **MECHANICAL INSPECTION.** Unpack and inspect the Model 120B in the presence of the carrier. Be careful when unpacking the instrument, for all electron tubes including the cathode ray tube remain installed during shipment. Save all packing materials until inspection is complete. These materials may be required for reshipping in the event shipping damage is discovered.

2-3. Inspect the instrument for signs of possible damage in shipment such as scratched panel, broken knobs, etc. If possible, energize the equipment and check it operationally (see paragraph 2-5).

2-4. If there are any indications of damage, file a claim with the carrier. Refer to the Hewlett-Packard Warranty sheet at the front of this manual.

2-5. **PERFORMANCE CHECK.** Paragraph 5-52 contains performance check procedures for verifying operation within listed specifications. The performance check is recommended for inclusion in receiving quality-control inspection. The following procedure is offered, however, as a means to check basic operation.

2-6. **INITIAL TURN ON.** Energize the 120B as follows:

- a. Turn INTENSITY control to OFF and plug in power cable.
- b. Set SWEEP MAGNIFIER switch to X1 position.
- c. Set HORIZONTAL DISPLAY switch to 0.5 MILLISECONDS/CM position.
- d. Center HORIZONTAL POSITION and VERTICAL POSITION controls.
- e. Turn 120B on and allow two minutes warmup.
- f. Set TRIGGER LEVEL to AUTO.
- g. Rotate INTENSITY clockwise until trace appears. If crt remains blank, press BEAM FINDER and re-adjust position controls as necessary.
- h. Adjust FOCUS for thin, well-defined trace, and adjust HORIZONTAL POSITION to place left end of sweep on left-end graticule line.

### 2-7. POWER REQUIREMENTS.

2-8. The Model 120B requires a power source of 115 or 230 volts  $\pm 10\%$ , single phase, 50 to 1000 cps, which can deliver approximately 95 watts. The oscilloscope is normally shipped from the factory wired for use with a 115-volts power source. To convert the instrument for use with a 230-volt source, change the dual primary windings of transformer T302 from a parallel combination to a series combination. Figure 2-1 illustrates the connection for 115- and 230-volt operation. At the time of the change, replace the 1.6-ampere slow-blow line fuse with 0.8-ampere slow-blow fuse.

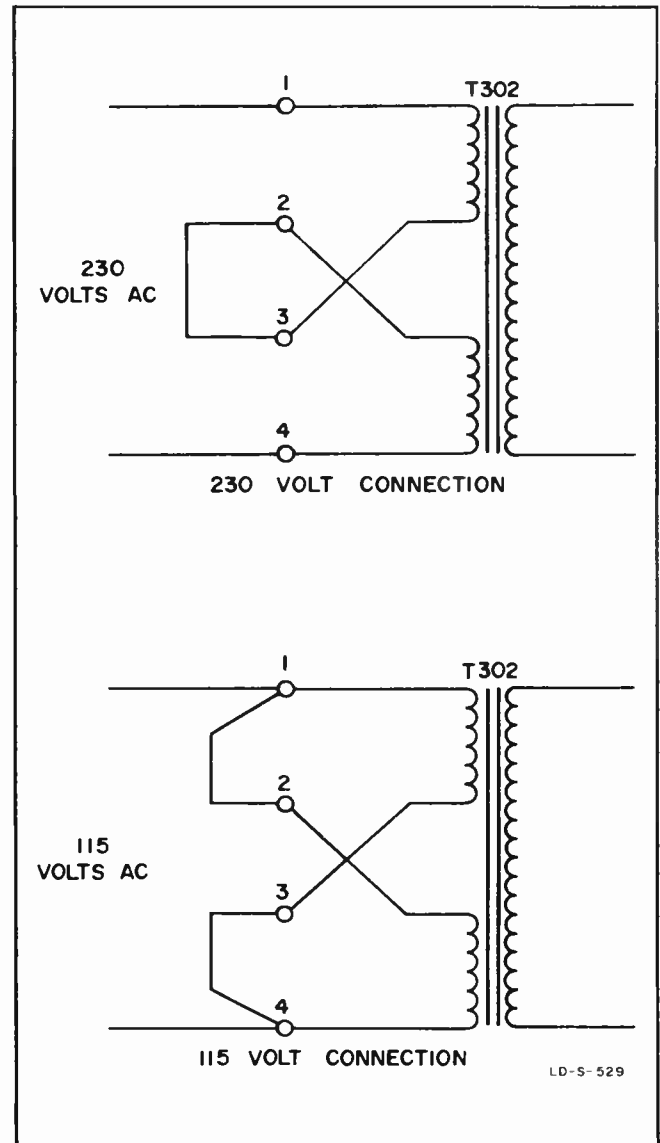


Figure 2-1. Primary-Power Connections

2-9. For the protection of operating personnel, the National Electrical Manufacturers' Assn (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground pin. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

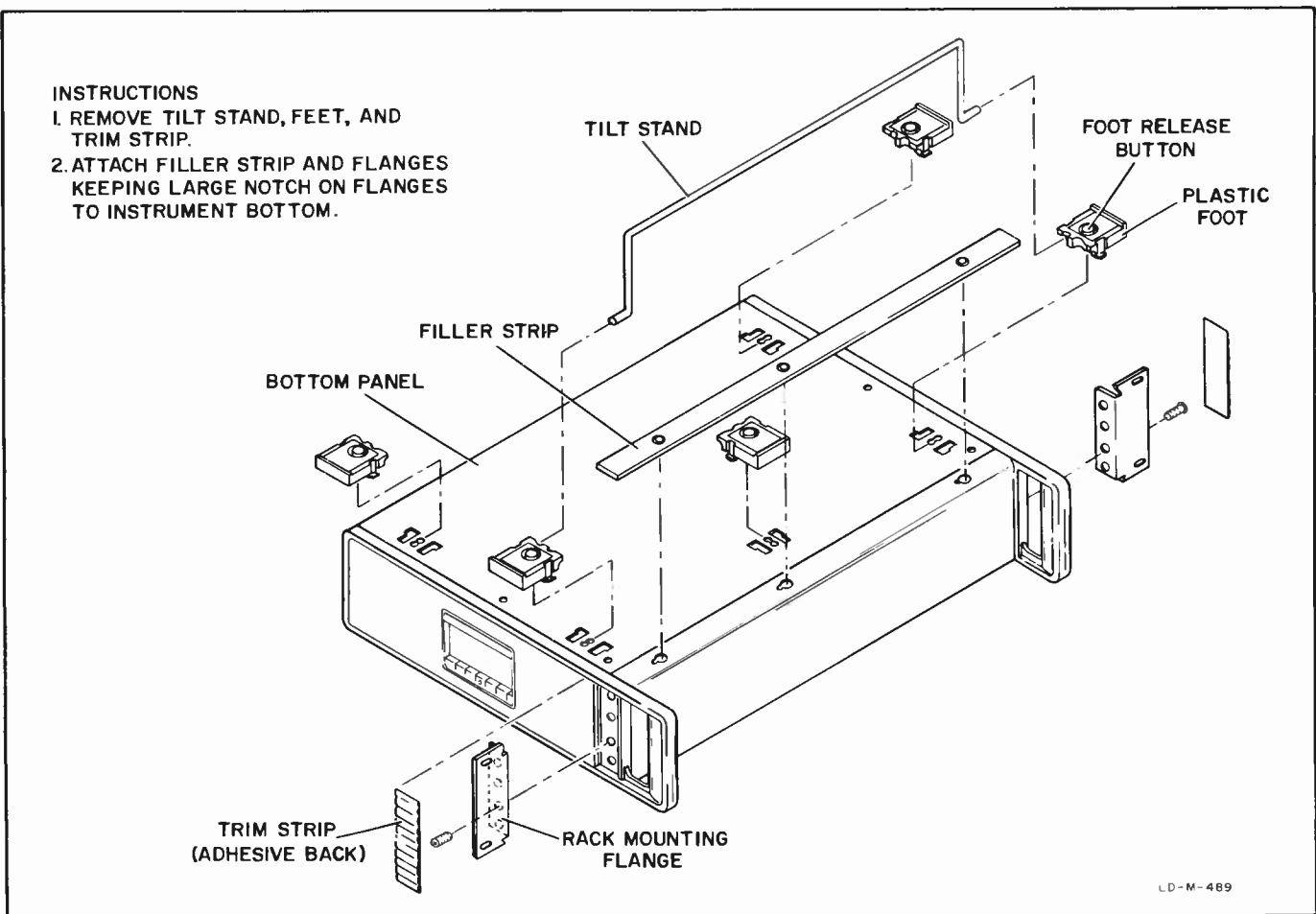


Figure 2-2. Rack Mounting

## 2-10. INSTALLATION.

2-11. MODULAR CABINET. The Model 120B Oscilloscope is shipped from the factory as a bench instrument with the tilt stand, feet and plastic trim in place. The top and bottom cabinet covers may be removed, giving complete accessibility to all components and adjustments. When used on the bench, other instruments may be stacked on the louver-free top surface; however, sufficient space should be allowed around the cabinet for adequate circulation of air.

2-12. RACK MOUNTING. Prepare the cabinet for rack mounting as illustrated in figure 2-2. The trim strip and rack-mounting flanges are in the shipping container with the instrument. After preparation, lift instrument into place and secure mounting flanges to rack with appropriate screws. Allow adequate ventilation for the instrument in the rack.

## 2-13. REPACKAGING FOR SHIPMENT.

2-14. The following list is a general guide for repackaging an instrument for shipment; however, if you have any questions, contact your authorized Hewlett-Packard sales representative.

- a. If possible, use original container designed for the instrument.
- b. Wrap instrument in heavy paper or plastic before placing it in shipping container.
- c. Use sufficient quantities of packing material around all sides of the instrument and protect panel with cardboard strips.
- d. Use heavy cardboard carton or wooden box to house the instrument and use heavy tape or metal bands to seal the container.
- e. Mark packing box with "Fragile", "Delicate Instrument", etc.

### Note

If the instrument is to be shipped to Hewlett-Packard Company for service or repair, attach to the instrument a tag identifying the owner, the instrument's complete serial number, and the service or repair to be accomplished; in addition, notify Hewlett-Packard Company or a representative before shipping the instrument. In any correspondence, reference the instrument by model number and complete serial number.

## SECTION III OPERATION

### 3-1. INTRODUCTION.

3-2. This section contains operating instructions for the Model 120B Oscilloscope. Included are descriptions of the Model 120B controls and indicators, and operation of the Model 120B as a general-purpose oscilloscope.

### 3-3. CONTROLS AND INDICATORS.

3-4. Figure 3-1 illustrates the controls and indicators along with a short description of the particular function of each.

### 3-5. GENERAL OPERATING SUGGESTIONS.

3-6. The following paragraphs, 3-7 through 3-16, provide suggestions for expediting and simplifying operation of the Model 120B.

3-7. **SYNCHRONIZING THE SWEEP.** The horizontal sweep can be synchronized with the vertical input signal (INT positions of TRIGGER SOURCE switch), the ac line frequency (LINE position), or an external sync signal (EXT position).

3-8. When the TRIGGER LEVEL control is in AUTO position, a sweep appears on the crt without application of any type of synchronizing signal; however, when a synchronizing signal above approximately 50 cps is applied, the sweep automatically synchronizes with this signal and the sweep is triggered at the point where the signal crosses the zero axis (average dc level of synchronization signal). If a synchronizing signal below approximately 50 cps is being used, the TRIGGER LEVEL control should be out of AUTO position.

3-9. Rotating the TRIGGER LEVEL control in a clockwise direction permits the trigger point to be set between  $\pm 2$  cm along the positive or negative-going portion of a vertical input signal, depending on whether the TRIGGER SOURCE switch is in INT+ or INT- position, respectively. When the TRIGGER SOURCE switch is in EXT position, rotating the TRIGGER LEVEL control in a clockwise direction permits the trigger point to be set between  $\pm 7$  volts along the negative-going portion of the synchronizing signal.

3-10. The particular type of synchronization best suited depends on the type of measurement being made and the type of crt display desired.

3-11. **AC/DC COUPLING.** Ac coupling (AC-DC switch in AC position) removes any dc level present in the vertical or horizontal input signals. This prevents excessive dc levels from deflecting the crt trace off the face of the crt, often to the point where the POSITION controls cannot bring the crt trace within view.

### CAUTION

When using ac coupling, do not exceed a dc level input of 600 volts.

3-12. When pulse or square waves having a frequency less than 200 cps are being measured, dc coupling is recommended (AC-DC switch in DC position).

3-13. **BEAM FINDER OPERATION.** The crt trace may frequently be deflected off the crt face by excessive dc input levels or by misadjustment of the vertical POSITION and horizontal POSITION controls. The BEAM FINDER pushbutton is extremely useful under these conditions. When the BEAM FINDER is depressed, the beam is confined to the face of the crt, brightened, and defocused to prevent burning of the crt phosphor. If the crt trace is centered with the POSITION controls when the BEAM FINDER is depressed, the trace will remain on the crt face when the BEAM FINDER is released.

3-14. **VERTICAL SENSITIVITY SELECTION.** When the vertical VERNIER control is in CAL position, the VERTICAL SENSITIVITY switch provides attenuation of the vertical input signal in four calibrated steps, 10 mv/cm, 100 mv/cm, 1 v/cm, and 10 v/cm. Rotating the vertical VERNIER control in a counterclockwise direction permits continuous adjustment of sensitivity between steps, and extends 10 v/cm step to at least 100 v/cm. When the VERTICAL SENSITIVITY switch is in CAL position, a calibrating signal is automatically connected to the vertical amplifier.

3-15. **COMMON-MODE REJECTION.** Balanced input to the vertical amplifier is obtained by removing the ground jumper across two of the vertical input terminals and applying a balanced signal input. Balanced input is useful in applications where it is desired to simultaneously amplify the out-of-phase (differential) signal and attenuate the in-phase (common mode) signals, such as hum, noise, etc.

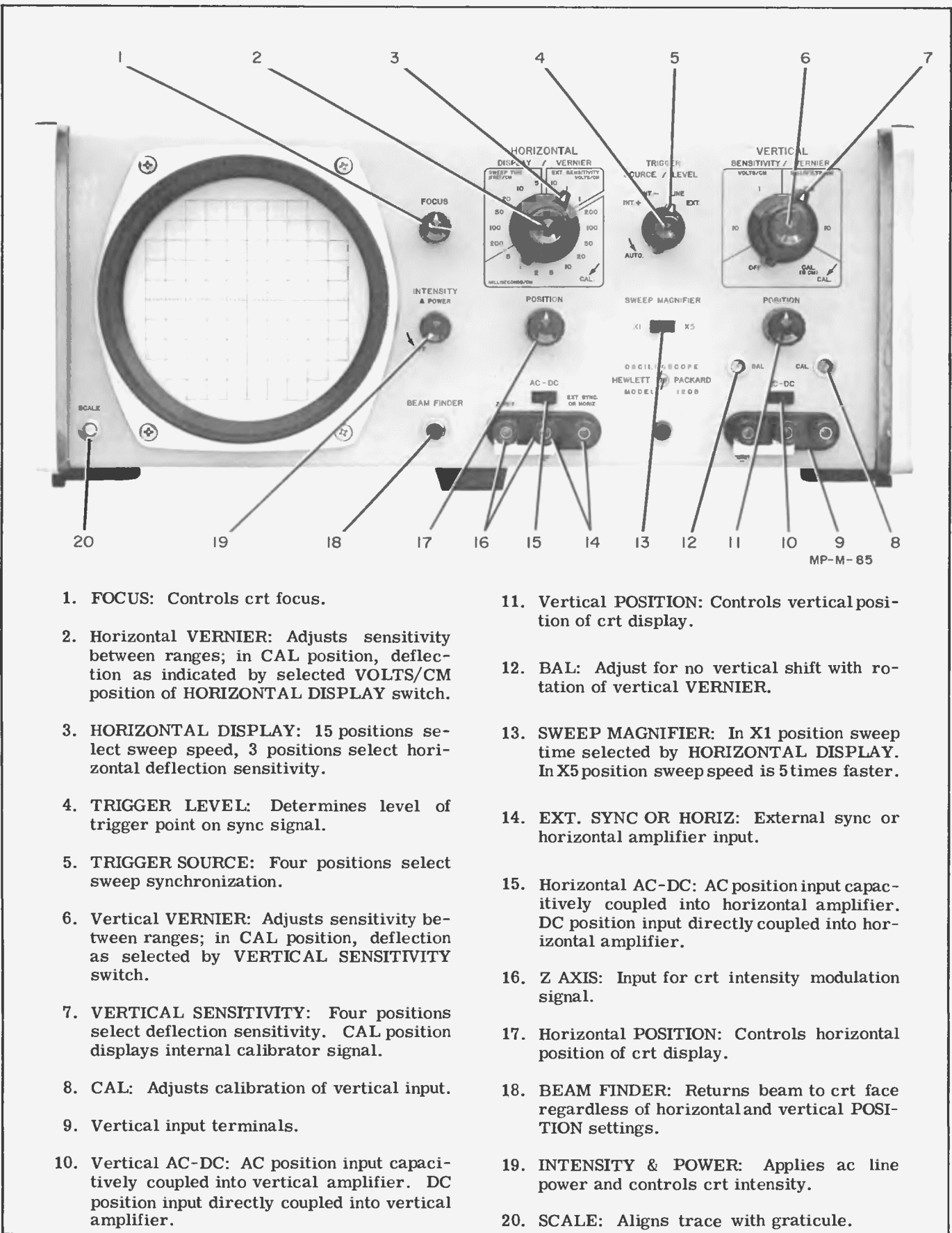
3-16. A change in the relative position of the Model 120B Oscilloscope with respect to the earth's magnetic field could result in the trace becoming misaligned. To re-align the trace with the graticule, adjust SCALE, screwdriver adjustment, on the front panel (Figure 3-1).

### Notes

Figures 3-2 through 3-5 assume that the FOCUS, POSITION, and INTENSITY controls are preset by the operator for the desired display.

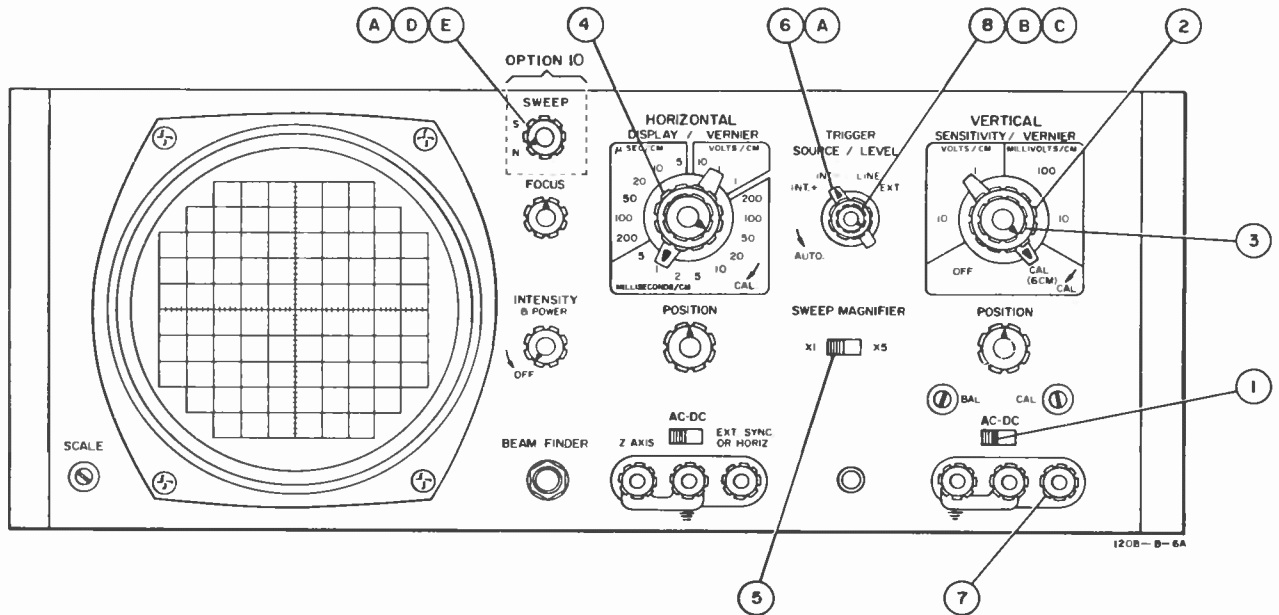
If in doubt as to the exact function of a switch listed in figures 3-2 through 3-5, refer to figure 3-1 for a functional description.





1. FOCUS: Controls crt focus.
2. Horizontal VERNIER: Adjusts sensitivity between ranges; in CAL position, deflection as indicated by selected VOLTS/CM position of HORIZONTAL DISPLAY switch.
3. HORIZONTAL DISPLAY: 15 positions select sweep speed, 3 positions select horizontal deflection sensitivity.
4. TRIGGER LEVEL: Determines level of trigger point on sync signal.
5. TRIGGER SOURCE: Four positions select sweep synchronization.
6. Vertical VERNIER: Adjusts sensitivity between ranges; in CAL position, deflection as selected by VERTICAL SENSITIVITY switch.
7. VERTICAL SENSITIVITY: Four positions select deflection sensitivity. CAL position displays internal calibrator signal.
8. CAL: Adjusts calibration of vertical input.
9. Vertical input terminals.
10. Vertical AC-DC: AC position input capacitively coupled into vertical amplifier. DC position input directly coupled into vertical amplifier.
11. Vertical POSITION: Controls vertical position of crt display.
12. BAL: Adjust for no vertical shift with rotation of vertical VERNIER.
13. SWEEP MAGNIFIER: In X1 position sweep time selected by HORIZONTAL DISPLAY. In X5 position sweep speed is 5 times faster.
14. EXT. SYNC OR HORIZ: External sync or horizontal amplifier input.
15. Horizontal AC-DC: AC position input capacitively coupled into horizontal amplifier. DC position input directly coupled into horizontal amplifier.
16. Z AXIS: Input for crt intensity modulation signal.
17. Horizontal POSITION: Controls horizontal position of crt display.
18. BEAM FINDER: Returns beam to crt face regardless of horizontal and vertical POSITION settings.
19. INTENSITY & POWER: Applies ac line power and controls crt intensity.
20. SCALE: Aligns trace with graticule.

Figure 3-1. Model 120B Oscilloscope, Front View



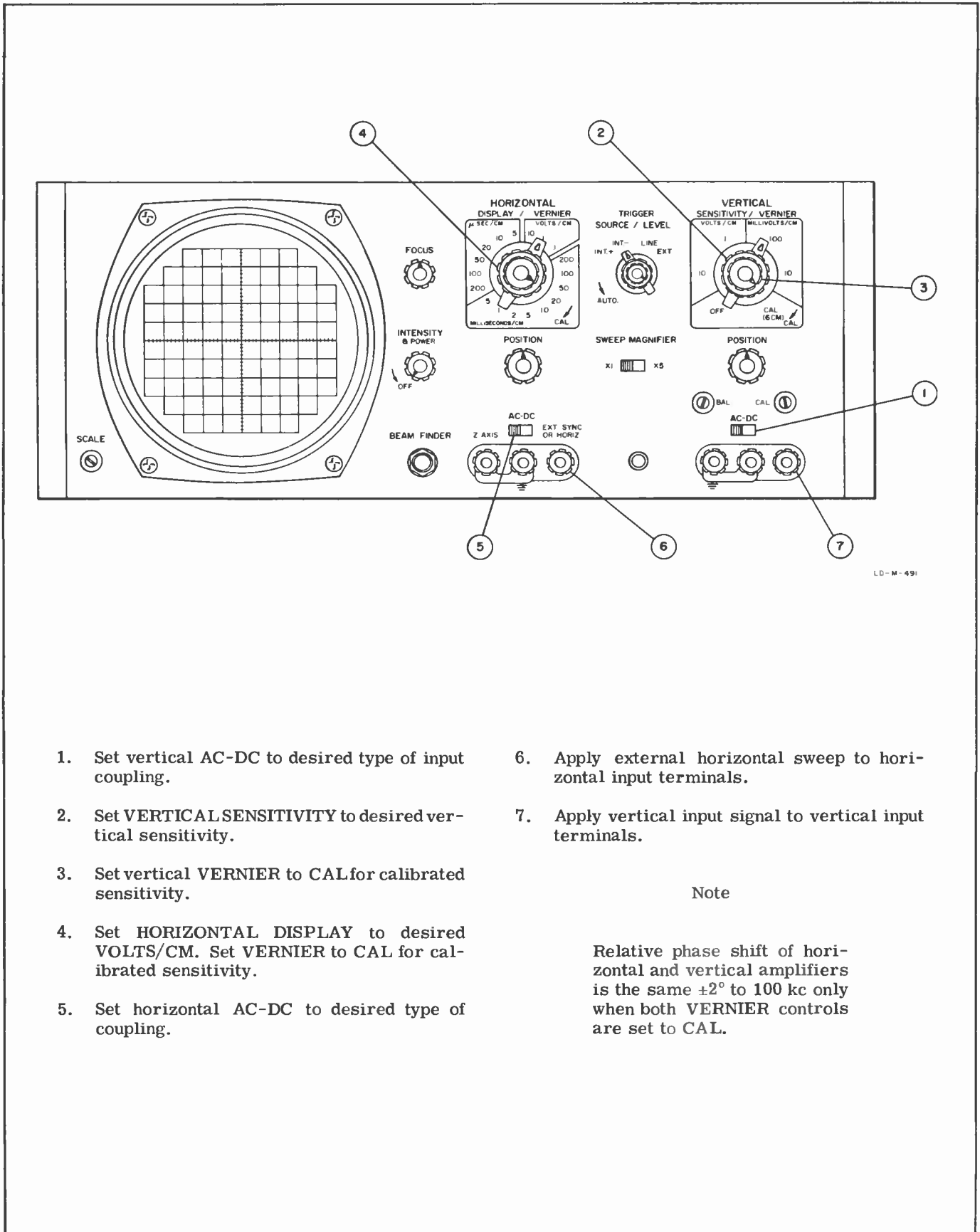
**INTERNAL HORIZONTAL SWEEP:**

1. Set vertical AC-DC to desired type of input coupling.
2. Set VERTICAL SENSITIVITY to desired vertical sensitivity.
3. Set vertical VERNIER to CAL for calibrated sensitivity.
4. Set HORIZONTAL DISPLAY to desired horizontal sweep time. Set VERNIER to CAL for calibrated sweep time.
5. Set SWEEP MAGNIFIER to X1 or X5, as desired.
6. Set TRIGGER SOURCE to desired type of horizontal sweep synchronization. If external sync is selected, connect sync signal to EXT. SYNC.
7. Apply vertical input signal to vertical input terminals.
8. Adjust TRIGGER LEVEL for desired synchronization.

**SINGLE SWEEP (OPTION 10):**

- A. Set SWEEP switch to normal (N), TRIGGER SOURCE switch to EXT, and remove any external trigger source.
- B. Adjust TRIGGER LEVEL control fully clockwise. Minimum trigger sensitivity is obtained with the control in this position.
- C. To increase trigger sensitivity, rotate TRIGGER LEVEL control counterclockwise. Maximum sensitivity will be obtained just prior to the point where the oscilloscope sweeps intermittently.
- D. Set SWEEP switch to single (S). The instrument is now in the "armed" state and will sweep once when triggered.
- E. To rearm the sweep circuit, set SWEEP switch from S to N and then back to S. External triggering should not be applied during this operation to prevent the single sweep from occurring immediately when the switch is returned to the S position.

Figure 3-2. Operation Using Internal Horizontal Sweep or Single Sweep

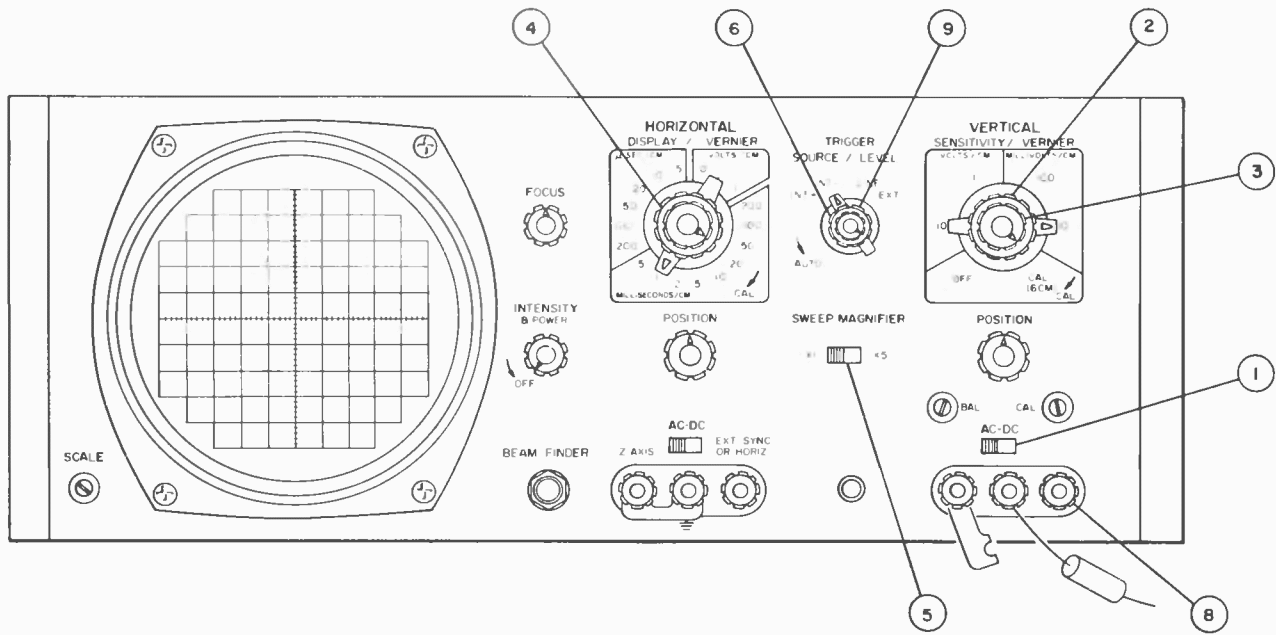


1. Set vertical AC-DC to desired type of input coupling.
2. Set VERTICAL SENSITIVITY to desired vertical sensitivity.
3. Set vertical VERNIER to CAL for calibrated sensitivity.
4. Set HORIZONTAL DISPLAY to desired VOLTS/CM. Set VERNIER to CAL for calibrated sensitivity.
5. Set horizontal AC-DC to desired type of coupling.
6. Apply external horizontal sweep to horizontal input terminals.
7. Apply vertical input signal to vertical input terminals.

Note

Relative phase shift of horizontal and vertical amplifiers is the same  $\pm 2^\circ$  to 100 kc only when both VERNIER controls are set to CAL.

Figure 3-3. Operation Using External Horizontal Input



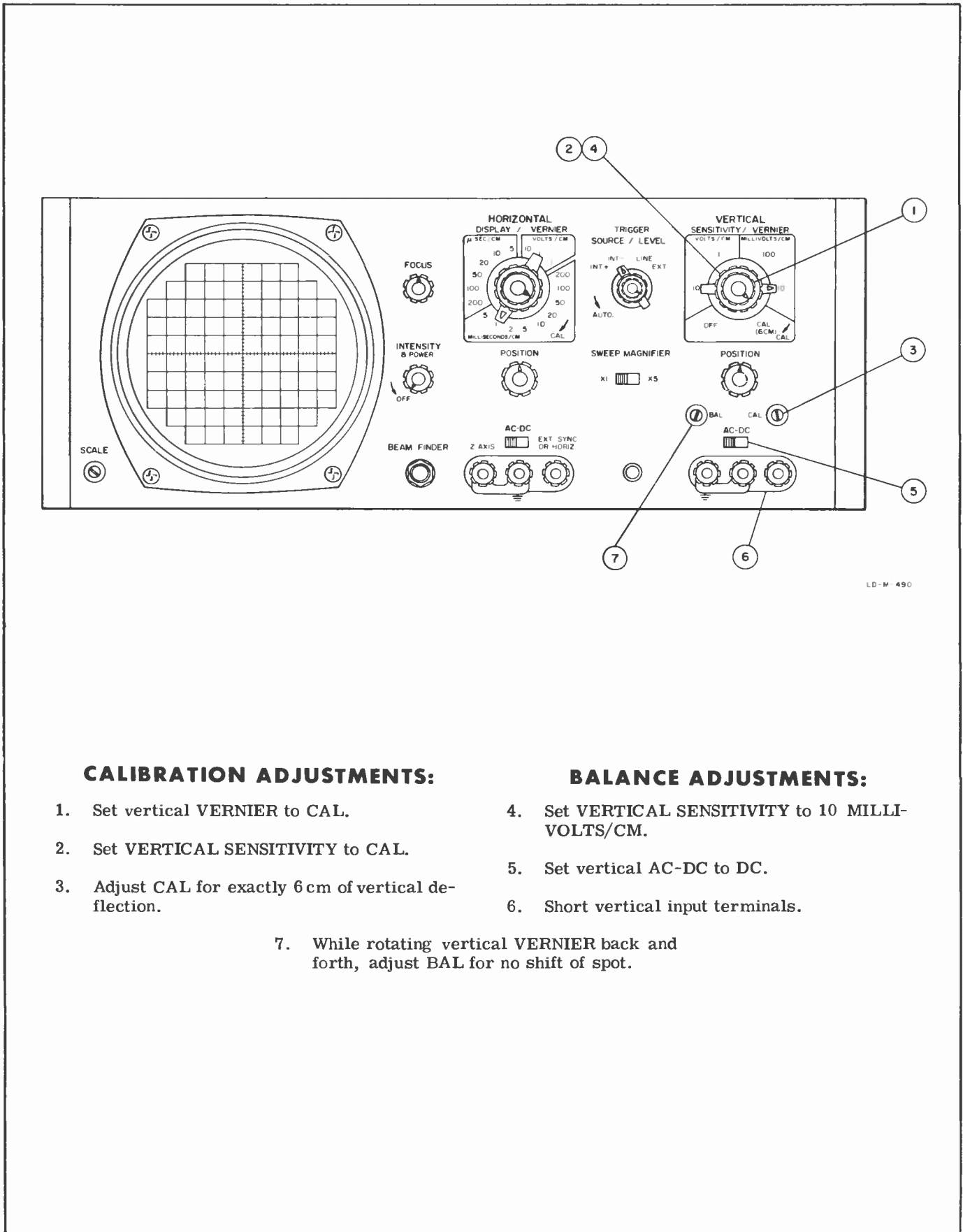
1.5 M-492

- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1. Set vertical AC-DC to desired type of input coupling.</li> <li>2. Set VERTICAL SENSITIVITY to 10 MILLI-VOLTS/CM. (Input not balanced in any other position of VERTICAL SENSITIVITY switch.)</li> <li>3. Set vertical VERNIER to CAL for calibrated sensitivity.</li> <li>4. Set HORIZONTAL DISPLAY to desired horizontal sweep speed.</li> <li>5. Set SWEEP MAGNIFIER to X1 or X5, as desired.</li> <li>6. Set TRIGGER SOURCE to desired type of horizontal sweep synchronization.</li> </ol> | <ol style="list-style-type: none"> <li>7. Remove grounding strap from vertical input terminals.</li> <li>8. Connect vertical signal to vertical input terminals; if ac coupling is desired, connect 0.1-uf 600-volt capacitor in series with center vertical input terminal.</li> <li>9. Adjust TRIGGER LEVEL for desired synchronization.</li> </ol> |
|---|---|

**Note**

The common-mode input signal voltage, either positive or negative, must not exceed 3 volts minus the peak amplitude of the differential input signal.

Figure 3-4. Operation Using Balanced Vertical Input



LD-M 490

**CALIBRATION ADJUSTMENTS:**

1. Set vertical VERNIER to CAL.
2. Set VERTICAL SENSITIVITY to CAL.
3. Adjust CAL for exactly 6 cm of vertical deflection.

**BALANCE ADJUSTMENTS:**

4. Set VERTICAL SENSITIVITY to 10 MILLI-VOLTS/CM.
5. Set vertical AC-DC to DC.
6. Short vertical input terminals.
7. While rotating vertical VERNIER back and forth, adjust BAL for no shift of spot.

Figure 3-5. Vertical Deflection Calibration and Balance Adjustment

## SECTION IV PRINCIPLES OF OPERATION

### 4-1. OVERALL BLOCK-DIAGRAM DESCRIPTION.

4-2. The oscilloscope is comprised of five major functional circuit groups: the vertical amplifier, the sweep generator, the horizontal amplifier, the low-voltage power supply, and the high-voltage power supply (see figure 4-1).

4-3. The vertical input signal is applied to the vertical amplifier through a frequency-compensated attenuator. The vertical amplifier converts the vertical input to two 180-degree-out-of-phase signals and applies the amplified signals to the crt as the vertical deflection; in addition, the vertical amplifier applies the signals to the TRIGGER SOURCE switch, when they are used as the INT+ and INT- sync signals.

4-4. The horizontal or sync input signal is applied to the HORIZONTAL DISPLAY switch. Depending on the setting of this switch, the signal is applied to either the TRIGGER SOURCE switch (to be used as the external sync signal) or to the horizontal amplifier (to be used as the external horizontal input signal).

4-5. In addition to the internal and external sync signals, the TRIGGER SOURCE switch receives 6.3 volts ac from the low-voltage power supply; this provides for a sync-signal repetition rate equal to the line-voltage frequency.

4-6. The sync signal selected by the TRIGGER SOURCE switch is applied to the sweep generator, wherein the sync signal initiates the horizontal sweep signal and the unblanking gate. The sweep generator applies the sweep signal to the horizontal amplifier, and the resultant amplified sweep is applied to the crt as the horizontal deflection signal. The unblanking gate is applied to the high-voltage power supply. If an external horizontal sweep is being applied in place of the sweep from the sweep generator, the external sweep is amplified by the horizontal amplifier and applied to the crt.

4-7. The low-voltage power supply receives 115/230-volts, single-phase power from the line and generates the following output voltages: 6.3 volts ac, a regulated +19 volts dc, +99 volts dc, +100 volts dc, -150 volts dc, +300 volts dc, and an unregulated +420 volts dc. These voltages are distributed, as required, to the high-voltage power supply, the vertical amplifier, the horizontal amplifier, and the sweep generator.

4-8. The high-voltage power supply generates the high voltages for the crt. The unblanking gate and Z-axis signals applied to the high-voltage power supply effectively alter the value of the power-supply voltages to allow unblanking and modulation of the crt intensity.

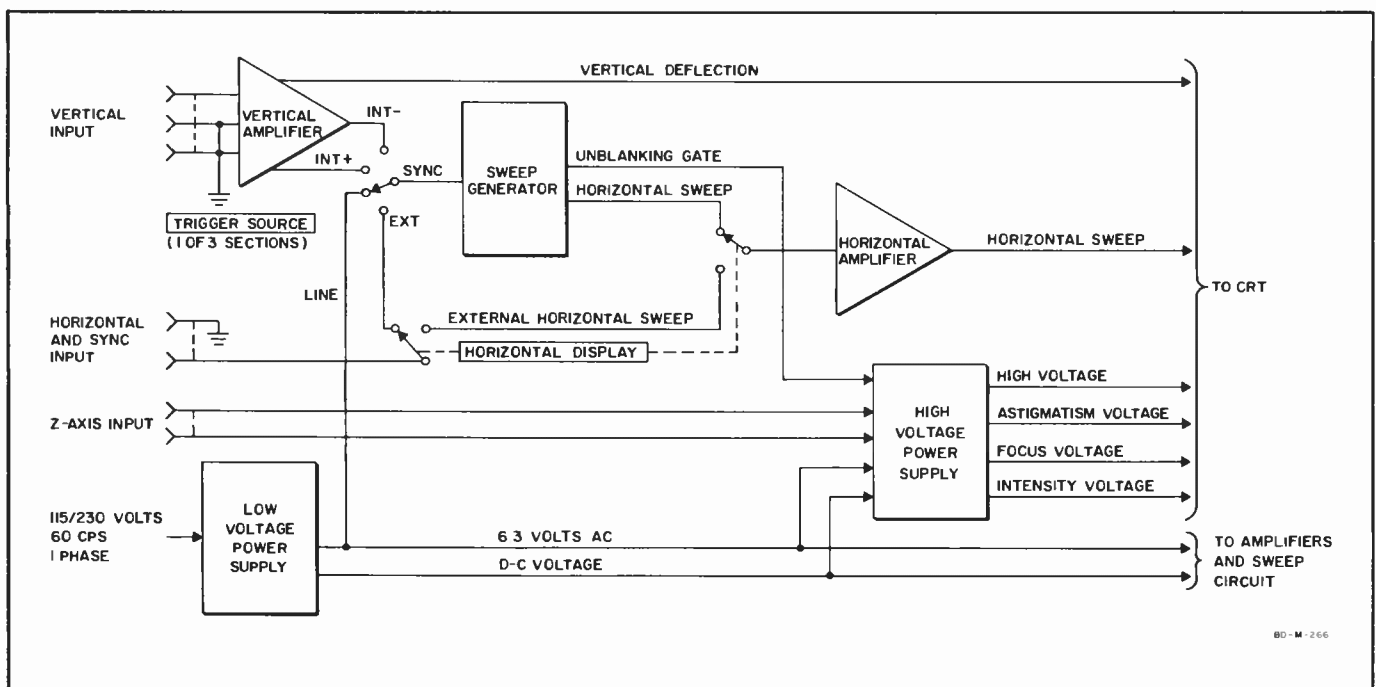


Figure 4-1. Overall Block Diagram

## 4-9. CIRCUIT ANALYSIS.

### 4-10. VERTICAL AMPLIFIER.

4-11. For ac coupling, capacitor C1 is placed in series with the signal path by means of the AC-DC switch. (See figure 5-6.) The input signal is then applied to VERTICAL SENSITIVITY switch S2. When the switch is in the CAL position, the input of the amplifier is directly connected to the output of the calibrator (V4, V5, and associated circuit parts). When the VERTICAL SENSITIVITY switch is in other positions, precision frequency-adjusted attenuators are inserted. These attenuators give a ten-to-one attenuation between adjacent positions. The input signal is then applied to the control grid of amplifier V1A.

4-12. Balanced input to differential amplifier V1B is obtained by removing the ground jumper across resistor R1 (ground strap on front panel) and applying a balanced signal input. Balanced input is useful in applications where it is desired to simultaneously amplify the out-of-phase (differential) signal and attenuate the in-phase (common mode) signals, such as hum, noise, etc. This rejection is an inherent property of differential amplifiers. The common-mode signals are attenuated by 40 db (100:1), whereas any differential input is amplified.

4-13. The vertical amplifier consists of three sets of balanced differential amplifiers (V1, V2, and V3) in cascade. The three stages are neutralized by plate-to-grid cross neutralization. The first stage, V1, has balance and gain adjustments. The balance adjustment (BAL) is potentiometer R16 in the cathode circuit, which adjusts the current distribution be-

tween the two triodes. Potentiometers R21 (VERNIER control) and R20 (CAL) adjust the resistance between the plates and therefore determine the gain of the amplifier. The VERTICAL VERNIER control provides a ten-to-one variation in gain between ranges of the VERTICAL SENSITIVITY switch. The second differential amplifier, V2, has potentiometer R32 (vertical POSITION control) between its cathodes. This potentiometer controls the current distribution between the two triodes and thus determines the vertical position of the crt display. The third differential amplifier, V3, is the output stage. Synchronization signals are taken from the plates of V3 for application to the TRIGGER SOURCE switch. Since the horizontal sweep circuits trigger only on the negative slope of the signal, provision is made to take the proper synchronizing signal from either plate of V3.

4-14. One section of the BEAM FINDER switch is in the cathode circuit of V3. When pressed, the switch increases the common cathode resistance and so reduces the gain of the stage that no amount of unbalance ahead of V3 can deflect the sweep off the crt.

4-15. The calibrator circuit consists of neon lamps V4, V5, and associated circuit parts. When VERTICAL SENSITIVITY switch S2 is placed in the CAL position, V4 ionizes and capacitor C14 begins charging. As the voltage across capacitor C14 rises, the voltage at the junction of V4 and R52 rises proportionally. When the voltage at this junction reaches the firing potential of V5, V5 ionizes. Since the conducting potential of V5 is less the firing potential, the voltage at the junction of V4 and V5 drops, and V4 de-ionizes. C14 discharges through R53, and the potential across V4 increases. When the potential across

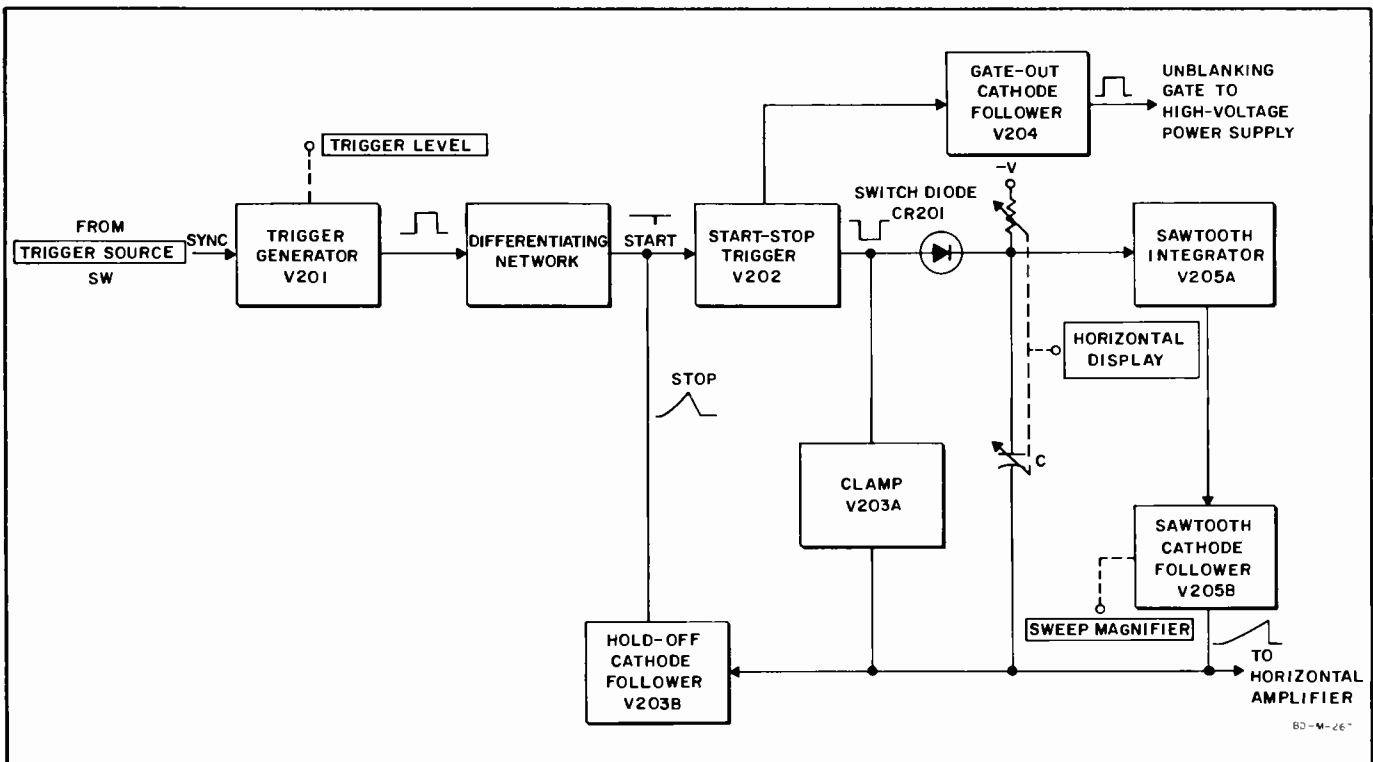


Figure 4-2. Sweep Generator, Block Diagram

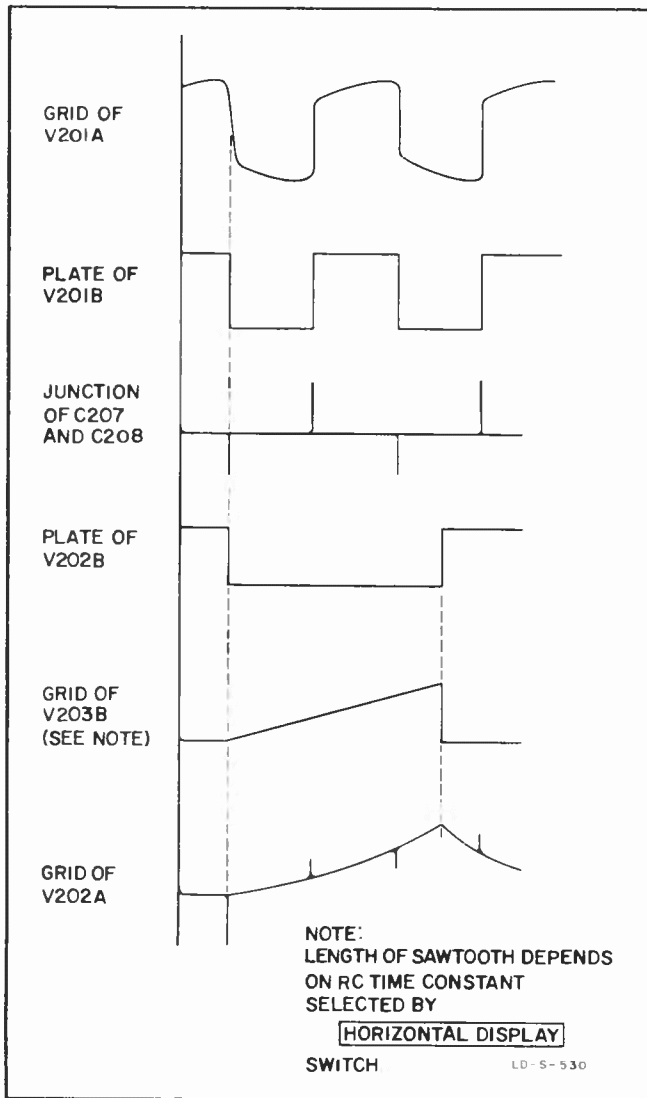


Figure 4-3. Sweep Generator Waveforms

V4 reaches the firing potential, V4 fires and the voltage at the junction of V4 and V5 drops, deionizing V5. C14 starts charging again, and the cycle repeats. A 60-mv square wave is developed across R54, and this signal is applied through the SENSITIVITY switch to the vertical amplifier.

4-16. SWEEP GENERATOR.

4-17. BLOCK-DIAGRAM DESCRIPTION. (See figure 4-2.) The sync signal from the TRIGGER SOURCE switch is applied to trigger generator V201. The trigger generator produces a rectangular wave with a repetition frequency equal to that of the input sync signal. This rectangular wave is applied to a differentiating network which converts it to positive and negative spikes that are coincident with the leading and trailing edges of the rectangular wave. These spikes are then applied to the input of start-stop trigger V202.

4-18. The negative spike switches the start-stop trigger, which produces two step outputs. The positive-going output is applied through V204 to the high-voltage power supply as the crt unblanking gate, and

the negative-going output is applied to switch diode CR201.

4-19. Switch diode CR201 normally clamps the input to sawtooth integrator V205A to a low negative voltage, preventing sawtooth integrator V205A from generating a sawtooth waveform. When the negative-going step signal from the start-stop trigger is applied to the switch diode, however, the diode is reverse biased and allows the sawtooth integrator to generate a sawtooth waveform.

4-20. The sawtooth output of V205B is simultaneously applied to the horizontal amplifier to serve as the horizontal sweep signal and the hold-off cathode follower V203B. The output of the hold-off cathode follower is applied to the input of the start-stop trigger to terminate the sweep. The values of R and C selected by the HORIZONTAL DISPLAY switch determines the slope of the sweep and therefore the time of the sweep. Clamp V204 ensures that the sawtooth always starts at the same level. Figure 4-3 shows the relative timing of the sweep generator waveforms.

4-21. TRIGGER GENERATOR V201. (See figure 5-8.) The sync signal selected by the TRIGGER SOURCE switch is applied through capacitor C202 and resistor R201 to the input control grid of V201, which is a Schmitt trigger circuit when the TRIGGER LEVEL control is not in AUTO. The Schmitt trigger is a form of bi-stable multivibrator, and is used to obtain pulses with rapid rise and fall times.

4-22. Figure 4-4 illustrates a simplified Schmitt trigger and typical input and output waveforms. If initially the input voltage (figure 4-4) is such that V1 is

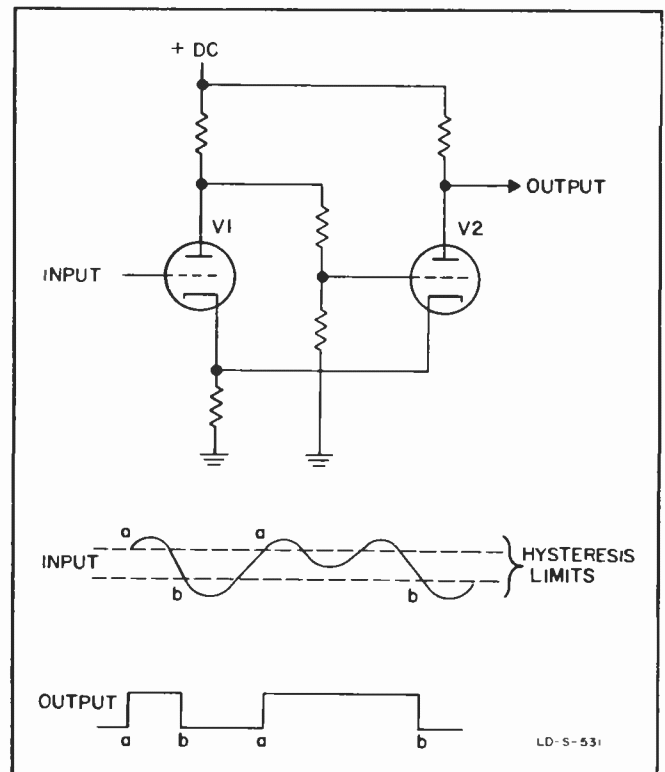


Figure 4-4. Typical Schmitt Trigger



cutoff, V2 conducts. As the input voltage becomes more positive, it eventually reaches a predetermined level (a) at which the circuit changes state; that is, V1 conducts and V2 is cutoff. If the input voltage then goes negative, the common cathode potential decreases and the grid of V2 becomes positive. When the input reaches a second predetermined level (b), V2 conducts and the circuit switches back to its initial state. The output of the circuit is a voltage step, either positive or negative depending upon the slope of the input signal.

4-23. The input voltage levels at which a Schmitt trigger circuit switches are called the hysteresis limits. Note that the circuit (figure 4-4) does not switch unless the input crosses both limits.

4-24. Trigger generator V201 has some additional features: the TRIGGER LEVEL control adjusts the bias on V201A and thus determines the level which the input trigger must reach to change state; in addition, when the TRIGGER LEVEL control is at its extreme limit, switch S202 is placed in AUTO. This opens the shunt across resistor R207 and capacitors C205 and C206, and the trigger generator becomes an astable multivibrator. This provides triggers to the stop-start trigger even though no sync is applied to the trigger generator. When a sync signal above approximately 50 cps is applied, however, the trigger generator then synchronizes with the sync signal. The step output of the trigger generator is taken from the plate of V201B and applied to a differentiating network.

4-25. DIFFERENTIATING NETWORK. (See figure 5-8.) The differentiating network is composed of the series combination of capacitor C207, inductor L201, and resistor R210. The r-c time constant of this network is extremely small compared with the width of the trigger generator output pulses; consequently, the signal developed across inductor L201 and resistor R210 consists of short negative and positive spikes that are coincident with the leading and trailing edges of the trigger generator output pulses. These spikes are coupled through capacitor C208 to the control grid of V202A, one half of the start-stop trigger.

4-26. START-STOP TRIGGER V202, CLAMP V203A, AND SWITCH DIODE CR201. (See figure 5-8.) The start-stop trigger is a Schmitt trigger circuit. A typical Schmitt trigger is described in paragraph 4-22. V202 is triggered by a negative spike pulse from the differentiating network. One output step waveform is taken from the plate of V202B and simultaneously applies to switch diode CR201 and the grid of clamp V203A. The waveform applied to V203A cuts off V203A, and thus disables the clamping action of this tube. The waveform applied to switch diode CR201 reverse-biases the diode, and thus it ceases conduction. Another step output is taken from the plate of V202A and applied through cathode follower V204 to the high-voltage power supply; this serves as the crt unblanking gate.

4-27. SAWTOOTH GENERATOR V205A AND SAWTOOTH CATHODE FOLLOWER V205B. (See figure

5-8.) Sawtooth generator V205A is a Miller integrator which produces a linear sawtooth waveform. When switch diode CR201 ceases conduction, the integrating capacitor charges through the integrating resistance, producing a negative-going potential at the control-grid of V205A. The amplified signal at the plate of V205A is coupled back through sawtooth cathode follower V205B to the integrating capacitor, completing the negative feedback required by this Miller type integrator.

4-28. The sawtooth signal at the cathode of V205B is also applied to SWEEP MAGNIFIER switch S102. When S102 is in the X5 position, the sawtooth applied to the horizontal amplifier has a peak amplitude five times greater than that applied when S102 is in the X1 position; hence, the angle of slope is increased five times and the sweep time is one-fifth of that selected by the HORIZONTAL DISPLAY switch.

4-29. The sawtooth signal at the cathode of V203B is applied to the control grid of V202A. When the slope of the signal reaches the upper hysteresis limit of the start-stop trigger, the trigger changes state; hence, the unblanking gate output of V203A is terminated. The switch diode CR201 and clamp V204 again conduct, respectively, halting the charging of the integrating capacitor and terminating the sawtooth waveform. The hold-off capacitor in the cathode of V203B charges during the rising slope of the signal output of the hold-off cathode follower but does not immediately discharge when the sawtooth input to the hold-off cathode follower terminates. This prevents the start-stop trigger from again being triggered by a negative spike until the sweep circuits have fully recovered. A different value of hold-off capacity is selected for each setting of the HORIZONTAL DISPLAY switch.

#### 4-30. HORIZONTAL AMPLIFIER.

4-31. The grid of V101A (figure 5-7) receives either the sweep output from the horizontal sweep circuits or from an external sweep source, depending on the setting of the HORIZONTAL DISPLAY switch. When external sweep is being used (EXT SENSITIVITY positions), any one of three horizontal sweep sensitivities can be selected: .1 VOLTS/CM, 1 VOLTS/CM, or 10 VOLTS/CM. The AC-DC switch allows selection of direct coupling, or ac coupling through capacitor C101.

4-32. The horizontal amplifier consists of two differential amplifiers (V101 and V102) in cascade. When the HORIZONTAL DISPLAY switch is set to one of the EXT SENSITIVITY positions, the resistance between the cathodes of amplifier V101 consists of the horizontal VERNIER control (R275B) in series with the horizontal gain control (R104); otherwise, resistor R107 is between the cathodes. The horizontal POSITION control (potentiometer R109) between the plates of V101 controls the horizontal position of the crt trace. The second stage (V102) is neutralized by plate-to-grid cross neutralization. The output of the horizontal amplifier is taken from the plates of V102 and applied directly to the horizontal deflection plates of the crt.

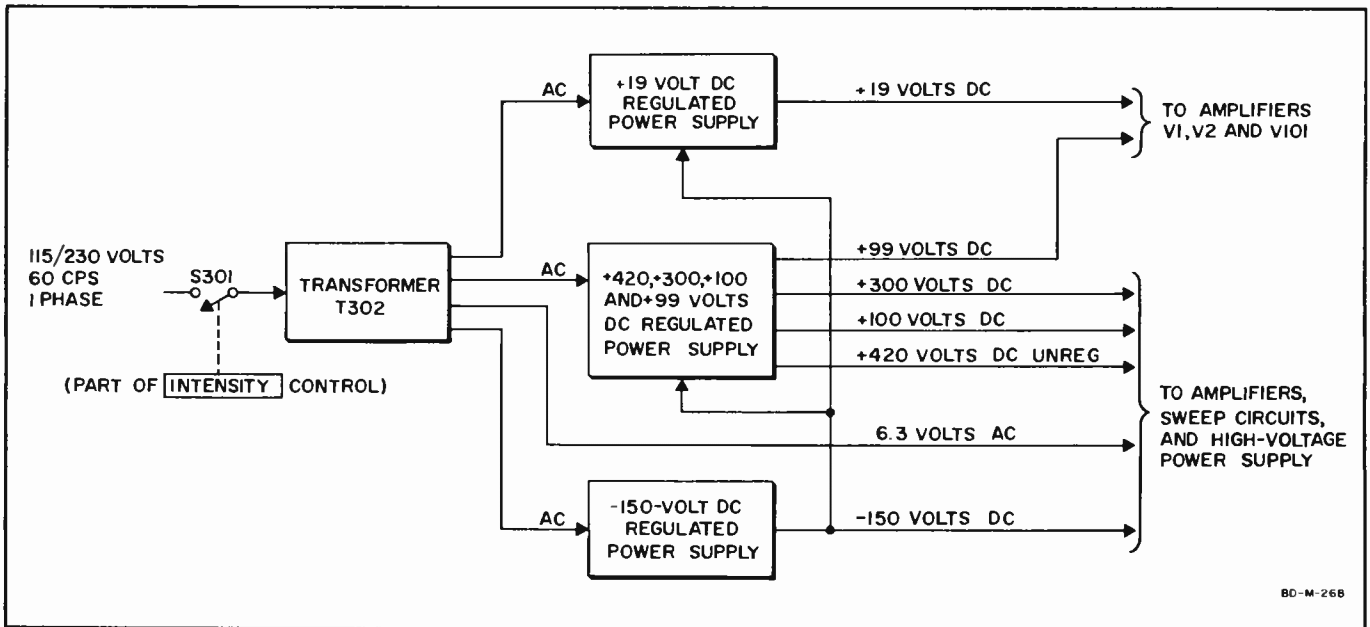


Figure 4-5. Low-Voltage Power Supply, Block Diagram

4-33. One section of the BEAM FINDER switch is in the cathode circuit of V102. When pressed, the switch increases the common cathode resistance and so reduces the gain of the stage that no amount of unbalance ahead of V102 can deflect the sweep off the crt.

#### 4-34. LOW-VOLTAGE POWER SUPPLY.

4-35. BLOCK-DIAGRAM DESCRIPTION. (See figure 4-5.) The 115/230-volt, single-phase power is applied through switch S301 to transformer T302. The transformer applies 6.3 volts ac to the vertical amplifier, horizontal amplifier, sweep generator, and high-voltage power supply for use as filament voltage; the transformer also applies appropriate ac voltages to the following: the +19-volt d-c regulated power supply; the +300-, +100-, and +99-volt dc regulated power supply; and the -150-volt dc regulated power supply.

4-36. The regulated power supplies deliver their dc outputs to the following circuits: +19 volts dc is applied to the horizontal and vertical amplifiers; and +19, +100, +300, and -150 volts dc are applied to the vertical amplifier, the horizontal amplifier, the horizontal sweep circuits, and the high-voltage power supply; in addition, the -150-volt supply applies a negative voltage to the +19-, +99-, +100-, and +300-volt supplies for use as a control voltage.

4-37. -150-VOLT DC REGULATED POWER SUPPLY. The -150-volt supply (figure 5-9) in the 120B is used as a reference supply for the +300-, +100-, and +99-volt supplies; therefore, any change in the -150 volt supply is reflected as a change in these supply voltages. The ac voltage from T302 is rectified and partially filtered by rectifier CR303 and capaci-

tor C325A. The resulting dc voltage is regulated further by tubes V309, V310, and V311.

4-38. The circuit functions as follows: when power is applied (assuming the -150-volt supply has been adjusted properly) the cathode of V310 becomes fixed at -65 volts and the grid assumes a slightly more negative value. If a line voltage surge or load current change were to occur, tending to lower the supply voltage, V310 grid potential would tend to change by half the amount, since the grid is tied to a voltage divider between -150 volts and ground. The result is increased bias for V310, lowering its current, raising its plate voltage, which, in turn, lowers the bias on V309. This bias change in V309 lowers its resistance, decreasing the voltage drop across this element which tends to return the supply voltage to its original value.

4-39. +300-, +100- AND +99-VOLT DC REGULATED POWER SUPPLY. The +300-volt supply (figure 5-9) operates in almost exactly the same manner as the -150-volt supply except that it uses the -150-volt supply as its voltage reference. In this supply, CR301, CR302, V307, and V308 are the rectifier, series regulator, and amplifier, respectively. The +100- and +99-volt supply is further regulated by V308B, referenced to the +300-volt supply.

4-40. +19-VOLT DC REGULATED POWER SUPPLY. (See figure 5-9.) The +19-volt supply (for the filaments of vertical amplifiers V1 and V2) uses rectifier CR304 and capacitor C328 for rectifier and filter. Transistor Q301 is a series regulator using the potential across Zener diode CR302 for its voltage reference. The current in transistor Q301 determines the value of the dc voltage across the filaments.

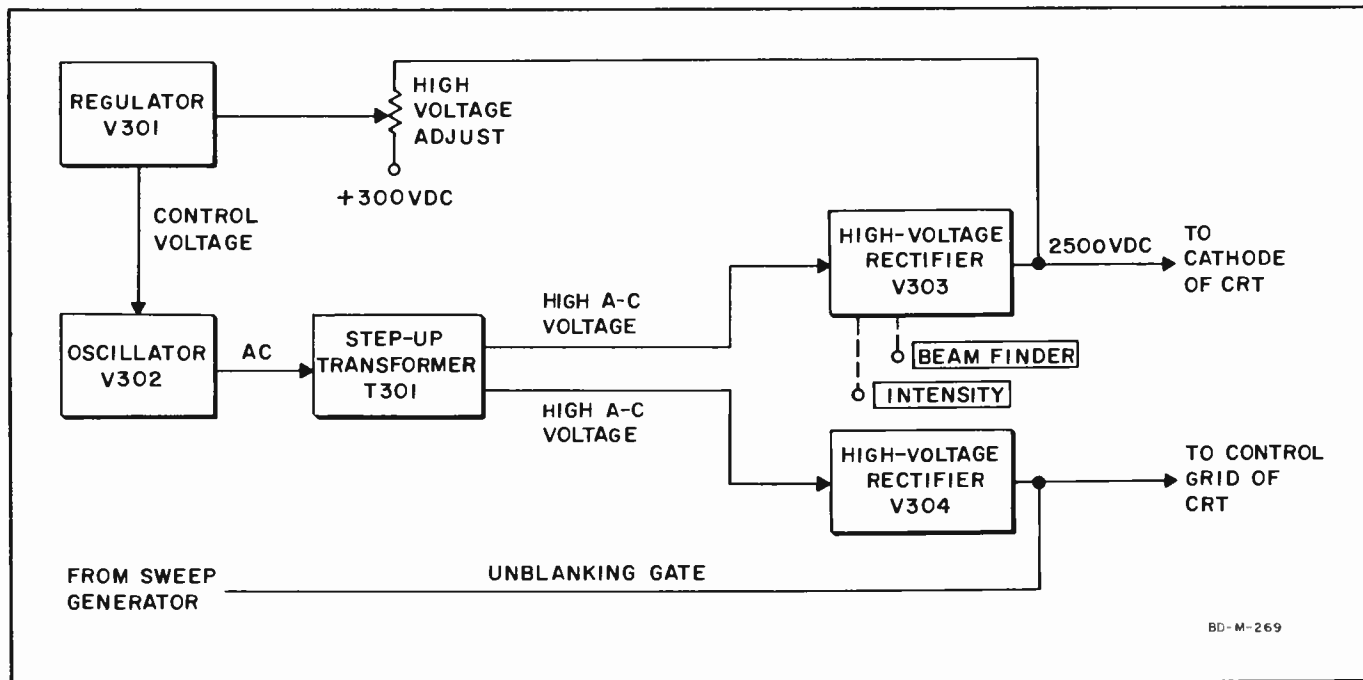


Figure 4-6. High-Voltage Power Supply, Block Diagram

4-41. HIGH-VOLTAGE POWER SUPPLY.

4-42. BLOCK-DIAGRAM DESCRIPTION. (See figure 4-6.) Oscillator V302 generates an ac voltage and applies it to step-up transformer T301. The stepped-up ac voltage is applied to rectifiers V303 and V304. The negative high-voltage output of V303 is applied to the cathode of the crt, and the negative high-voltage output of V304 is applied to the control grid of the crt. The difference between the two voltages is the crt bias and thus controls the crt intensity.

4-43. When the INTENSITY control setting is changed, a change occurs in the cathode high voltage, causing a change in the voltage level at the wiper of the -2500-volt adjust potentiometer. This results in regulator V301 altering the control voltage in a direction necessary to return the cathode high voltage to its original value; however, this now results in the control-grid high voltage being higher or lower than previously and thus the crt intensity is altered.

4-44. HIGH-VOLTAGE RECTIFIER V303. (See figure 5-10.) The ac high voltage present in one secondary winding of T301 is rectified by V303 and filtered by capacitor C308. A portion of the +100 volts dc taken from the wiper of INTENSITY potentiometer R321 is effectively in series with and opposing the high-voltage output of V303. When the BEAM FINDER pushbutton is depressed, the opposing voltage from the wiper of potentiometer R321 is effectively removed and the intensity of the crt trace is increased.

4-45. When a signal is applied to the Z AXIS input, the signal is applied through capacitor C307 to the cathode of the crt and thus modulates the crt intensity.

4-46. A voltage-divider network, consisting of resistors R313, R311, R310, R309, R307, potentiometers R312 (FOCUS control) and R308 (-2500 adjust), is tied between +300 volts dc and the cathode of the crt. The voltage present at the wiper of R312 is applied to the crt focusing grid as focusing voltage, and the voltage present at the wiper of R308 is applied to amplifier V301B as the high-voltage control voltage.

4-47. AMPLIFIER V301. (See figure 5-10.) When a change in the value of the high voltage occurs, a corresponding change occurs at the wiper of potentiometer R308. This alters the bias at the grid of V301B, and the resultant change in the plate voltage is dc coupled through R305 to the control grid of V301A. This, in turn, results in a change in the plate voltage of V301A, which is connected to the screen grid of oscillator V302. The overall effect is that when the high voltage decreases, the screen grid voltage of V302 increases to a point where the increased ac output of V302 restores the high voltage to its original value.

4-48. HIGH-VOLTAGE RECTIFIER V304. (See figure 5-10.) The ac high voltage across the other secondary of transformer T301 is rectified by V304 and filtered by capacitor C310. The negative side of the high voltage is applied through resistor R327 to the control grid of the crt. The positive side of the high voltage is applied through resistor R326 to the horizontal sweep circuits, wherein the unblanking gate is generated. When the positive-going unblanking gate is generated, the crt control grid bias becomes less negative and the crt is unblanked.

## SECTION V MAINTENANCE

### 5-1. INTRODUCTION.

5-2. This section provides maintenance and service instructions for the Model 120B Oscilloscope. Included are troubleshooting, repair, adjustment, performance checks, and diagrams.

### 5-3. TEST EQUIPMENT.

5-4. Table 5-1 lists the test equipment required to maintain the Model 120B. Equipment with similar characteristics can be substituted.

### 5-5. TROUBLESHOOTING.

5-6. The troubleshooting procedures are divided into two categories: system troubleshooting, which is used

to isolate a malfunction to a particular functional section of the Model 120B; and sectional troubleshooting, which is used to locate the faulty detail part. Figures 5-1 through 5-4 show the location of parts whose designations are not directly imprinted on a circuit board or chassis.

### 5-7. SYSTEM TROUBLESHOOTING.

5-8. Most troubles occurring in the Model 120B will directly affect the display on the crt; consequently, the system-troubleshooting procedures are based on the most common types of faults detectable by crt observations. Table 5-2 lists the common types of defects that occur in oscilloscope displays, together with the circuits most likely to be at fault. After finding the faulty section, refer to the sectional troubleshooting procedures.

Table 5-1. Recommended Test Equipment

Item No.	Type	Characteristics	Use	Model No.
1	Test Oscilloscope	Bandwidth: dc to at least 600 kc. Sensitivity: 10 mv/cm to 100 v/cm.	Observation of waveforms.	Hewlett-Packard 140A.
2	Precision DC Voltmeter	Voltage range: 10-300 volts. Accuracy: $\pm 1\%$ . Input impedance: 1 megohm.	Voltage measurements.	Hewlett-Packard Model 412A.
3	High-Voltage DC Voltmeter	Voltage range: 3000 volts. Accuracy: 8%. Input impedance: 100 megohms.	Voltage measurements.	Hewlett-Packard Model 410C with Model 11045A Voltage Divider Probe
4	Audio Oscillator	Frequency range: 50 cps to 450 kc.	Source of sine-wave signal.	Hewlett-Packard Model 200CD.
5	AC Voltmeter	Voltage range: 1 mv to 300 v. Accuracy: 3%, depending on scale used. Frequency Range: 50 cps to 450 kc.	Voltage measurements.	Hewlett-Packard Models 400D/H/L.

Table 5-1. Recommended Test Equipment (Cont'd)

Item No.	Type	Characteristics	Use	Model No.
6	Square Wave Generator	Frequency range: 1 kc to 100 kc. Rise time: Less than 0.2 $\mu$ sec. Amplitude: To 50 volts peak-to-peak.	Source of square wave.	Hewlett-Packard Model 211A.
7	Voltmeter Calibrator	Accuracy: 0.5%.	Accurate source of ac and dc voltages.	Hewlett-Packard Models 738A/B.
8	Time Mark Generator	Marker intervals: decade steps from 10 $\mu$ sec to 100 msec. Accuracy: 1%.	Set sweep times.	Tektronix 180.
9	Power Auto-Transformer	Output voltage: 103-127 volts ac (for 115-volt input to 120B); 206-254 volts ac (for 230-volt input to 120B).	Vary line voltage.	General Radio Type W10HM.
10	Attenuator	Attenuation: 110 db in 1-db steps. Power capacity: 5 watts.	Attenuation	Hewlett-Packard Model 350D.

5-9. SECTIONAL TROUBLESHOOTING.

5-10. GENERAL. Prior to troubleshooting any functional section, a visual inspection should be performed. Check for open fuse, broken wires, discolored parts, leaky capacitors, etc. The best method for checking tubes is by substitution.

5-11. HORIZONTAL AND VERTICAL AMPLIFIERS. In the event of vertical or horizontal troubles such as unbalance or no deflection, check plate voltages, starting at the input stage and working toward the crt. Be sure the position controls are centered, no signals are applied, and the HORIZONTAL DISPLAY switch is set to an external horizontal input position. Make detailed voltage checks (see paragraph 5-67) in the first stage with incorrect plate voltages. In the event of frequency response troubles, check tubes first (by substitution) then frequency-compensating devices such as trimmer capacitors, neutralizing and bypass capacitors.

5-12. SWEEP GENERATOR. With the exception of trigger generator V201, the sweep generator circuits form a feedback loop; consequently, a failure in any functional stage in the loop results in abnormal waveforms appearing in all stages of the loop. For this reason, voltage readings are the best means for locating troubles in the sweep generator circuit. Voltage measurements for both the start-of-sweep and end-of-sweep circuit conditions are listed on figure 5-8. In

the event of sweep failure, it is recommended that both voltage measurements be employed to isolate the trouble. A 10 to 15% deviation from the values given can be expected, a larger deviation indicates a source of trouble.

5-13. LOW - VOLTAGE POWER SUPPLY. When checking the power supplies, check the -150-volt supply first, for it affects all supplies. Check the other supplies in any order. Check all vacuum tubes and transistor Q301; if normal, make voltage checks (see paragraph 5-67). Voltage and ripple tolerances are given in table 5-4.

CAUTION

Do not operate the Model 120B with incorrect power supply voltages for prolonged periods of time. Where the procedure calls for a measurement, turn the instrument on just long enough to make the measurement; then turn the instrument off again.

5-14. HIGH-VOLTAGE POWER SUPPLY.

WARNING

Use caution when measuring high voltages. Use equipment suited for high-voltage measurements.

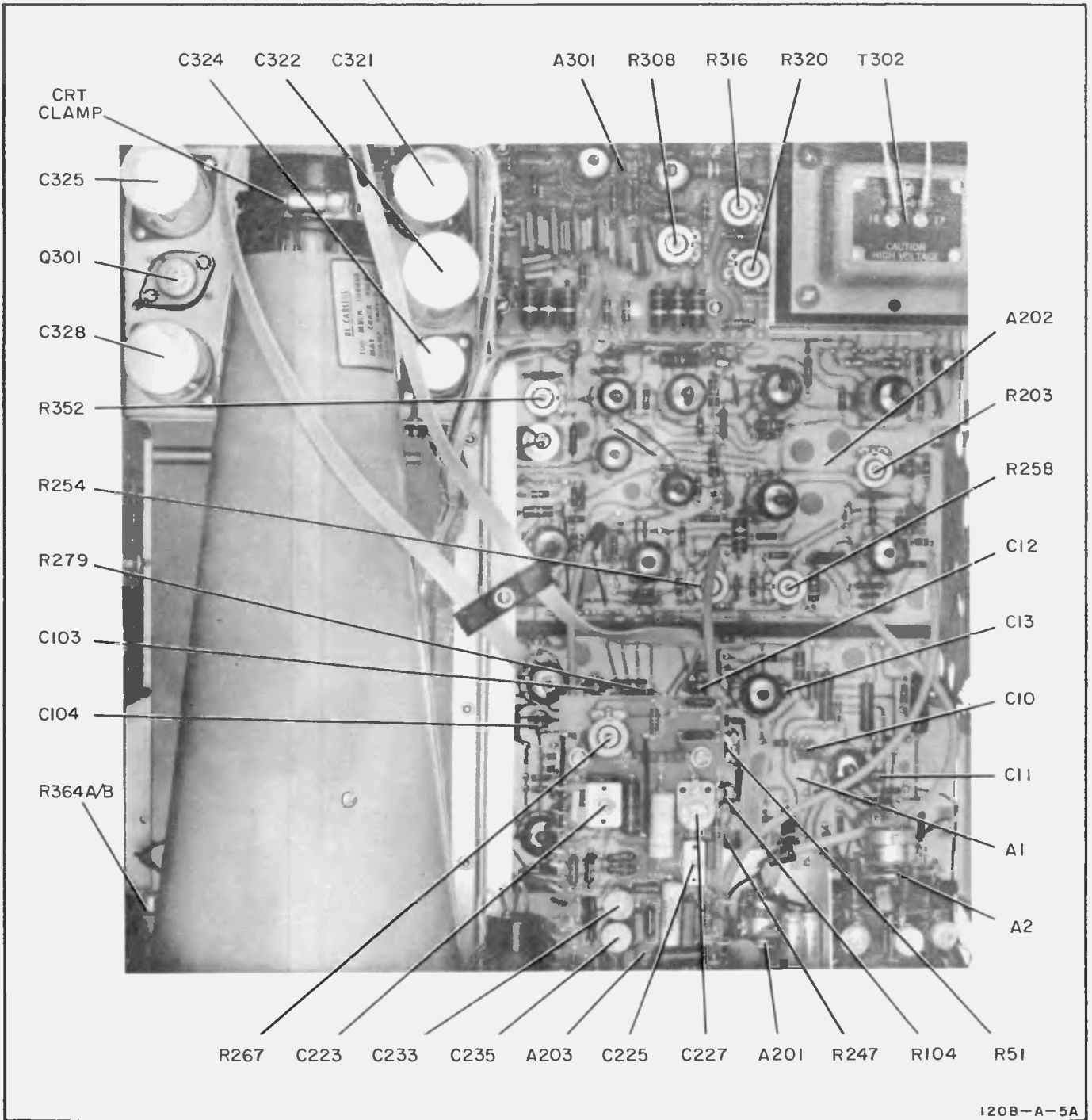


Figure 5-1. Top View, Location of Parts and Adjustments

5-15. Measure the voltages supplied to the crt. If they are normal, replace the crt. If the high voltages are not present, check that oscillator V302 is oscillating. Note that a fault in the crt cathode supply affects the crt grid supply, whereas a fault in the crt grid supply has no effect on the cathode supply. If both crt supplies are excessively high, or both excessively low, make voltage checks on V301 (see paragraph 5-67).

Note

Do not reset high voltage adjustment R308 unless the need for such adjustment is clearly indicated. The adjustment of high voltages affects the sensitivity of the crt and makes necessary the readjustment of vertical and horizontal gain and time scales.

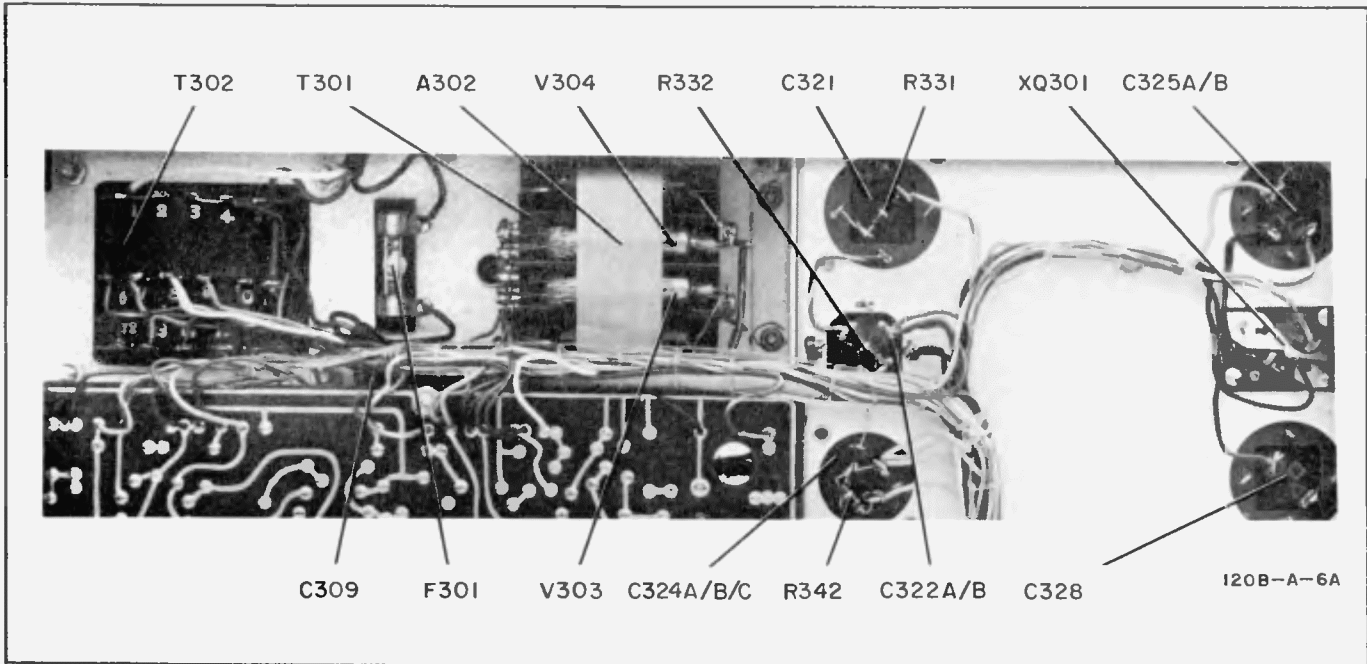


Figure 5-2. High-Voltage Power Supply, Location of Parts

Table 5-2. System Troubleshooting

Symptom	Probable Trouble	Paragraph Reference
Nothing visible on crt with BEAM FINDER pressed.	<ol style="list-style-type: none"> <li>1. Low-voltage power supply.</li> <li>2. Vertical amplifier.</li> <li>3. Horizontal amplifier.</li> <li>4. High-voltage power supply.</li> <li>5. Crt.</li> </ol>	<ol style="list-style-type: none"> <li>1. Paragraphs 4-34 and 5-13</li> <li>2. Paragraphs 4-10 and 5-11</li> <li>3. Paragraphs 4-30 and 5-11</li> <li>4. Paragraphs 4-41 and 5-14</li> <li>5. Paragraph 5-21</li> </ol>
Vertical sensitivity out of specifications on all sensitivity ranges; horizontal sweep normal.	<ol style="list-style-type: none"> <li>1. Vertical amplifier.</li> </ol>	<ol style="list-style-type: none"> <li>1. Paragraphs 4-10 and 5-11</li> </ol>
Vertical sensitivity out of specifications on one range.	<ol style="list-style-type: none"> <li>2. VERTICAL SENSITIVITY switch S2.</li> </ol>	
External horizontal sensitivity out of specifications; vertical sensitivity normal.	<ol style="list-style-type: none"> <li>1. Horizontal amplifier.</li> </ol>	<ol style="list-style-type: none"> <li>1. Paragraphs 4-30 and 5-11</li> </ol>
Faulty sweep; external horizontal deflection normal.	<ol style="list-style-type: none"> <li>1. Sweep generator circuits.</li> </ol>	<ol style="list-style-type: none"> <li>1. Paragraphs 4-16 and 5-12</li> </ol>
Poor focusing; intensity normal.	<ol style="list-style-type: none"> <li>1. High-voltage power supply.</li> <li>2. Crt</li> </ol>	<ol style="list-style-type: none"> <li>1. Paragraphs 4-41 and 5-14</li> <li>2. Paragraph 5-21</li> </ol>
Poor intensity.	<ol style="list-style-type: none"> <li>1. Low-voltage power supply.</li> <li>2. High-voltage power supply.</li> <li>3. Crt</li> </ol>	<ol style="list-style-type: none"> <li>1. Paragraphs 4-34 and 5-13</li> <li>2. Paragraphs 4-41 and 5-14</li> <li>3. Paragraph 5-21</li> </ol>



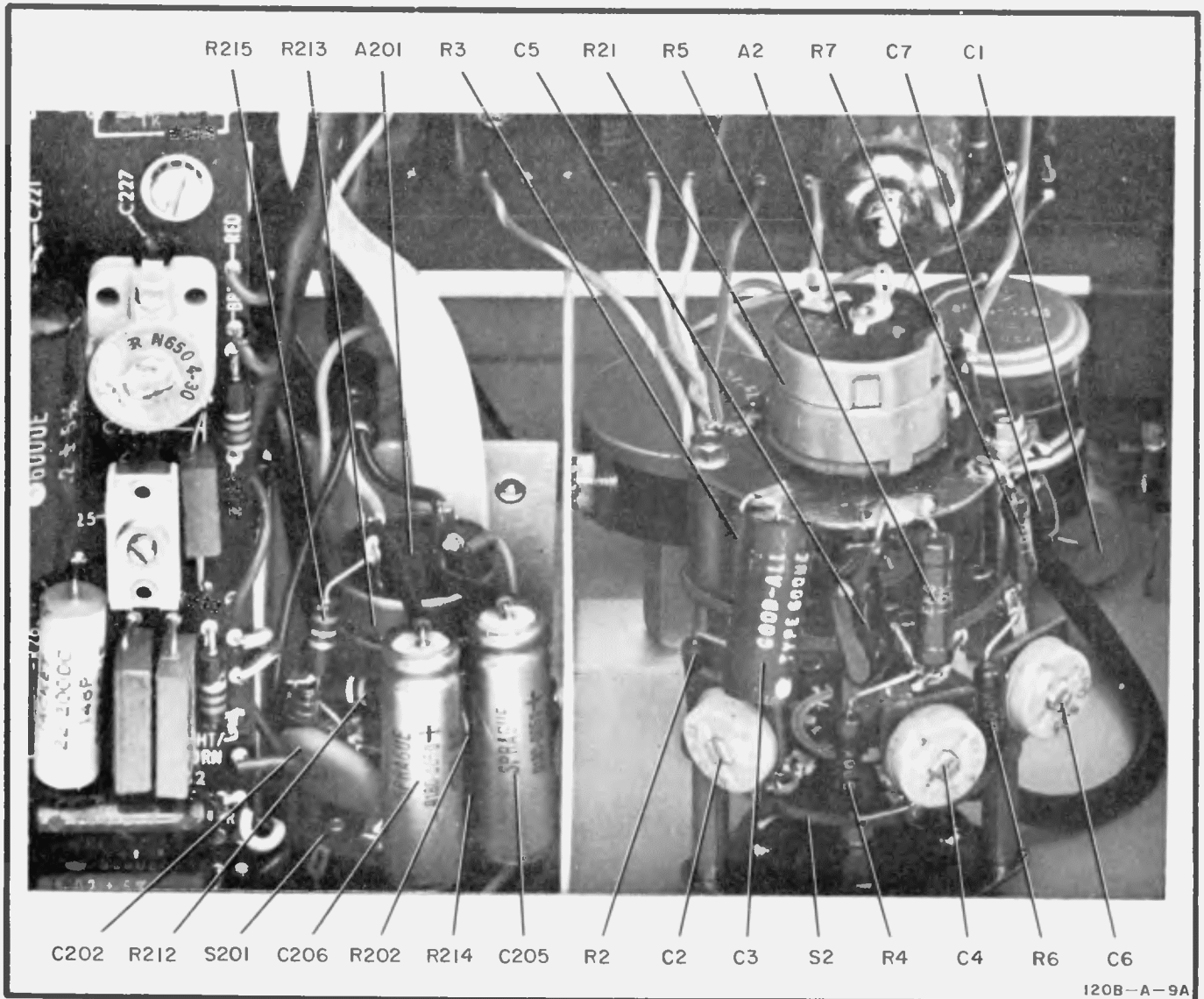


Figure 5-3. Vertical Sensitivity (A2) and Trigger Source (A201) Switches, Location of Parts and Adjustments

**5-16. REPAIR.**

**5-17. REPLACEMENT OF SEMICONDUCTORS.**

5-18. Excessive heat can destroy semiconductors. When soldering or unsoldering transistors or diodes, place a heat-sink (such as long-nose pliers) on the lead of the part; in addition, isolate the Model 120B from ground, or ground the body of the soldering iron to prevent leakage current from damaging the part.

**Note**

When replacing Q301, use a thin coat of silicone grease (hp Stock No. 8500-0059) on each side of the insulator to improve heat transfer from transistor to deck.

**5-19. SERVICING ETCHED CIRCUIT BOARDS.**

5-20. Figure 5-5 illustrates the recommended method of servicing etched circuit boards. Removal of 01260-2

components, such as tube sockets, that are attached to the board at more than two points is difficult when trying to remove the part intact. Simplify the removal by first cutting the pins or other connections between the body of the part and the circuit board, and then remove the pins individually.

**5-21. CRT REPLACEMENT.**

**WARNING**

When replacing the crt, handle crt with care; wear gloves and plastic face mask or goggles.

5-22. Replace the crt as follows:

- a. Remove four mounting screws from bezel, and remove bezel.
- b. Loosen clamp screw (figure 5-1) on crt base; do not remove screw or clamp.





Figure 5-4. Right-Side View, Side Panel Removed, Location of Parts and Adjustments

- c. Remove socket from crt base.
- d. Slide crt forward and out.
- e. Replace in reverse order.
- f. Energize the Model 120B and obtain a free-running trace.
- g. If necessary, align graticule and trace by adjusting SCALE control.

### 5-23. ADJUSTMENTS.

#### 5-24. ADJUSTMENTS FOLLOWING REPAIR.

5-25. Table 5-3 lists the adjustments required following the replacement of a tube, transistor, or diode. If a part associated with an item listed in the table is replaced, check the adjustment of the listed item.

5-26. The following paragraphs, 5-27 through 5-51, describe the adjustments necessary to align the Model 120B.

#### 5-27. LOW-VOLTAGE POWER SUPPLY.

5-28. Table 5-4 lists the tolerances of the dc voltage outputs of the low-voltage power supply. If any voltage is not within tolerance it is probable that the line voltage is abnormal, a malfunction has occurred, or the replacement of a tube or part has caused the misadjustment. If it is confirmed that the power supply and line voltage are normal and the voltages are not within tolerance, adjustment is then required.

5-29. **-150-VOLT ADJUSTMENT.** Using a dc VTVM, adjust potentiometer R352 (figure 5-1) for -150 volts dc.

5-30. **+19-VOLT ADJUSTMENT.** There is no adjustment for the +19-volt output; if out of tolerance a faulty transistor or part is indicated, or a fault exists in the -150-volt power supply.

5-31. **+300-VOLT ADJUSTMENT.** There is no adjustment for the +300-volt output; if out of tolerance a faulty tube or part is indicated, or a fault exists in the -150-volt power supply.

5-32. **+100- AND +99-VOLT ADJUSTMENT.** There is no adjustment for these outputs; if out of tolerance a faulty tube or part is indicated, or a fault exists in the -150-volt power supply.

#### Note

If the +300 volts dc is within tolerance and the +100 and/or +99 volts dc are not within tolerance, a fault exists in V308 or associated parts.

#### 5-33. HIGH-VOLTAGE POWER SUPPLY.

5-34. Adjust the high-voltage power supply as follows:

#### Note

Adjustment of the high voltage affects crt deflection sensitivity, intensity, focus, and astigmatism. Check horizontal and vertical gain adjustments following any adjustment of the high voltage. Intensity, focus, and astigmatism adjustments are included in the following adjustment of the high-voltage power supply.

#### WARNING

Voltages in excess of 2,500 volts are present in the high-voltage power supply. Take all possible precautions when performing high-voltage measurements.

- a. Connect high-voltage voltmeter between terminal 17 or 18 of transformer T302 and ground.
- b. Adjust potentiometer R308 (figure 5-1) for a voltmeter reading of -2500 volts.

### SERVICING ETCHED CIRCUIT BOARDS

Excessive heat or pressure can lift the copper strip from the board. Avoid damage by using a low power soldering iron (50 watts maximum) and following these instructions. Copper that lifts off the board should be cemented in place with a quick drying acetate base cement having good electrical insulating properties.

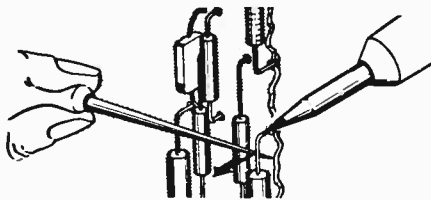
A break in the copper should be repaired by soldering a short length of tinned copper wire across the break.

Use only high quality rosin core solder when repairing etched circuit boards. NEVER USE PASTE FLUX. After soldering, clean off any excess flux and coat the repaired area with a high quality electrical varnish or lacquer.

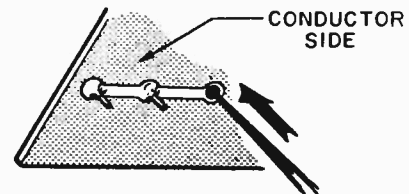
When replacing components with multiple mounting pins such as tube sockets, electrolytic capacitors, and potentiometers, it will be necessary to lift each pin slightly, working around the components several times until it is free.

**WARNING:** If the specific instructions outlined in the steps below regarding etched circuit boards without eyelets are not followed, extensive damage to the etched circuit board will result.

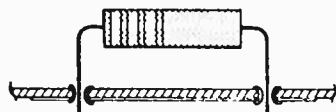
1. Apply heat sparingly to lead of component to be replaced. If lead of component passes through an eyelet in the circuit board, apply heat on component side of board. If lead of component does not pass through an eyelet, apply heat to conductor side of board.



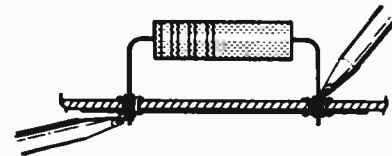
2. Reheat solder in vacant eyelet and quickly insert a small awl to clean inside of hole. If hole does not have an eyelet, insert awl or a #57 drill from conductor side of board.



3. Bend clean tinned leads on new part and carefully insert through eyelets or holes in board.

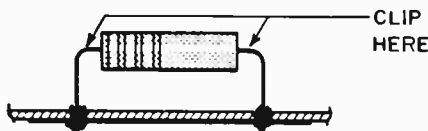


4. Hold part against board (avoid overheating) and solder leads. Apply heat to component leads on correct side of board as explained in step 1.

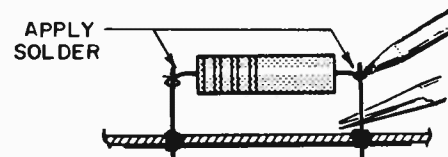


In the event that either the circuit board has been damaged or the conventional method is impractical, use method shown below. This is especially applicable for circuit boards without eyelets.

1. Clip lead as shown below.



2. Bend protruding leads upward. Bend lead of new component around protruding lead. Apply solder using a pair of long nose pliers as a heat sink.



This procedure is used in the field only as an alternate means of repair. It is not used within the factory.

Figure 5-5. Servicing Etched Circuit Boards

Table 5-3. Adjustments Following Tube, Transistor, and Diode Replacement

Reference Designation	Function	Adjustment and Paragraph
<b>Vertical Amplifier</b>		
V1	Amplifier	<ol style="list-style-type: none"> <li>1. Balance adjustment (figure 3-5)</li> <li>2. Gain adjustment (paragraph 5-37)</li> <li>3. Neutralization adjustment (paragraphs 5-38 and 5-40)</li> </ol>
V2	Amplifier	<ol style="list-style-type: none"> <li>1. Balance adjustment (figure 3-5)</li> <li>2. Gain adjustment (paragraph 5-37)</li> <li>3. Neutralization adjustment (paragraphs 5-39 and 5-40)</li> </ol>
V3	Amplifier	<ol style="list-style-type: none"> <li>1. Balance adjustment (figure 3-5)</li> <li>2. Gain adjustment (paragraph 5-37)</li> <li>3. Neutralization adjustment (paragraph 5-39)</li> </ol>
V4	Calibrator	None
V5	Calibrator	<ol style="list-style-type: none"> <li>1. Calibrator adjustment (paragraph 5-41)</li> </ol>
<b>Horizontal Amplifier</b>		
V101	Amplifier	<ol style="list-style-type: none"> <li>1. Gain adjustment (paragraph 5-43)</li> <li>2. X1 Sweep adjustment (paragraph 5-49)</li> <li>3. Neutralization adjustment (paragraph 5-44)</li> </ol>
V102	Amplifier	<ol style="list-style-type: none"> <li>1. Gain adjustment (paragraph 5-43)</li> <li>2. X1 Sweep adjustment (paragraph 5-49)</li> <li>3. Neutralization adjustment (paragraph 5-44)</li> </ol>
<b>Sweep Generator</b>		
V201	Trigger generator	Trigger sensitivity adjustment (paragraph 5-47)
V202	Start-stop trigger	Preset adjustment (paragraph 5-46)
V203	Clamp and hold-off cathode follower	None
V204	Gate-out cathode follower	None
V205	Sawtooth integrator and cathode follower	Sweep time adjustment (paragraph 5-50)
V206		Preset adjustment (paragraph 5-46)
V207		Sweep length adjustment (paragraph 5-51)
V208		None
V209		None
CR201	Switch diode	None

Table 5-3. Adjustments Following Tube, Transistor, and Diode Replacement (Cont'd)

Reference Designation	Function	Adjustment and Paragraph
High-Voltage Power Supply		
V301	Amplifier	Adjust horizontal gain (paragraph 5-43) Adjust vertical gain (paragraph 5-37) Adjust sweep times (paragraph 5-48)
V302	Oscillator	
V303	Rectifier	
V304	Rectifier	
V305	CRT	
Low-Voltage Power Supply		
V307	Regulator	None
V308	Amplifier-output cathode follower	None
V309	Regulator	None
V310	Amplifier	Adjust -150 volts (paragraph 5-29)
V311	Reference tube	Adjust -150 volts (paragraph 5-29)
Q301	Heater regulator	None
CR301-CR304	Rectifiers	None
CR305	Reference diode	None

Table 5-4. Low-Voltage Power Supply Voltages

Voltage**	Tolerance*	Typical** Ripple	Typical** Resistance
-150 volts dc	VTVM Accuracy ( $\pm 3\%$ )	5 mv	10K
+ 19 volts dc	-1.5 volts; +1 volt	45 mv	4K (with V101 removed)
+300 volts dc	$\pm 9$ volts	45 mv	75K
+100 volts dc	$\pm 3$ volts	15 mv	50K
+ 99 volts dc	$\pm 3$ volts	15 mv	

\*Line voltage 115 or 230 volts ac, as required.

\*\*With respect to chassis ground.

c. Switch HORIZONTAL DISPLAY to 1 VOLTS/CM and center the spot.

d. Set INTENSITY control to 9 o'clock and adjust R320 (figure 5-1) to the point where the spot just extinguishes.

e. Increase INTENSITY control and adjust FOCUS control for best spot.

f. Adjust Astigmatism control R316 (figure 5-1) for small round spot readjusting FOCUS control as required.

5-35. VERTICAL AMPLIFIER.

5-36. BALANCE ADJUSTMENT. Adjust the vertical amplifier balance as described in figure 3-5.

5-37. GAIN ADJUSTMENT. Adjust the vertical amplifier gain as follows:

a. Set VERTICAL SENSITIVITY to 10 MILLI-VOLTS/CM.

- b. Set vertical VERNIER to CAL.
- c. Using voltmeter calibrator, apply a 400-cps 0.1-volt peak-to-peak signal to the vertical input terminals.
- d. Adjust CAL screwdriver adjustment for a crt deflection of 10 cm.

5-38. ATTENUATOR - FREQUENCY - COMPENSATION AND FIRST-STAGE-NEUTRALIZATION ADJUSTMENTS. Adjust the vertical amplifier attenuator-frequency compensation and first-stage neutralization as follows:

- a. Connect square-wave generator to the vertical input terminals.
- b. Rotate vertical VERNIER fully counterclockwise.
- c. Set VERTICAL SENSITIVITY to 100 MILLIVOLTS/CM.
- d. Set vertical AC-DC to AC.
- e. Set HORIZONTAL DISPLAY to 0.5 MSEC/CM.
- f. Adjust output of generator to 1 kc and set amplitude for 10 cm of deflection on crt.
- g. Adjust capacitor C6 (figure 5-3) for best square-wave pattern on crt.
- h. Rotate vertical VERNIER to CAL.
- i. Readjust square-wave generator for 10 cm of deflection on crt.
- j. Adjust C9 (figure 5-4) for best square-wave pattern on crt.
- k. Repeat adjustment of C6 and C9 until best square-wave pattern is obtained at the extreme vernier settings.

Note

There may be a capacitor in parallel with C9 which serves to optimize the adjustment range of C9. When changing V1 it may be necessary to alter the value of the capacitor, or add it if not present.

- l. Set VERTICAL SENSITIVITY to 1 VOLTS/CM.
- m. Readjust square-wave generator for 10 cm of deflection on crt.
- n. Adjust capacitor C4 (figure 5-3) for best square-wave pattern on crt.
- o. Set VERTICAL SENSITIVITY to 10 VOLTS/CM.
- p. Readjust square-wave generator for 10 cm of deflection on crt.
- q. Adjust capacitor C2 (figure 5-3) for best square-wave pattern on crt.

5-39. THIRD-STAGE VERTICAL-NEUTRALIZATION ADJUSTMENT. Adjust the third-stage vertical neutralizers as follows:

- a. Rotate vertical VERNIER fully counterclockwise.
- b. Set VERTICAL SENSITIVITY to 10 MILLIVOLTS/CM.
- c. Set vertical AC-DC to AC.
- d. Set HORIZONTAL DISPLAY to 5  $\mu$ SEC/CM.
- e. Set TRIGGER SOURCE to INT+.
- f. Turn TRIGGER LEVEL to AUTO.
- g. Using square-wave generator, apply a 100-kc square wave to vertical input terminals.
- h. Adjust generator output to give 10-cm deflection, and center the pattern vertically.
- i. Using test oscilloscope, monitor the cathode of V3.

- j. Adjust C12 and C13 (figure 5-1) simultaneously, for the best square wave on both test oscilloscope and scope under test.

Notes

Ignore the very fast overshoot at the leading edge as viewed on monitor scope.

There may be a capacitor in parallel with C13 which serves to optimize the adjustment range of C13. When changing V2 or V3 it may be necessary to alter the value of the capacitor, or add it if not present.

5-40. SECOND-STAGE VERTICAL NEUTRALIZATION ADJUSTMENT. Adjust the second-stage vertical neutralizers as follows:

- a. Rotate vertical VERNIER to CAL.
- b. Repeat steps b through h of paragraph 5-39.
- c. Adjust C10 and C11 (figure 5-1) simultaneously for best square wave on scope.

Note

There may be a capacitor in parallel with C10 which serves to optimize the adjustment range of C10. When changing V1 or V2 it may be necessary to alter the value of the capacitor, or to add it if not present.

5-41. CALIBRATOR ADJUSTMENT. Adjust the output of the calibrator as follows:

- a. Adjust vertical gain as described in paragraph 5-37.
- b. Set VERTICAL SENSITIVITY to CAL.
- c. Turn vertical VERNIER to CAL.
- d. Set HORIZONTAL DISPLAY to 1 MILLISECOND/CM.
- e. Set TRIGGER SOURCE to INT-.
- f. Turn TRIGGER LEVEL to AUTO.
- g. Adjust potentiometer R51 (figure 5-1) for a crt deflection of 6 cm.

5-42. HORIZONTAL AMPLIFIER.

5-43. GAIN ADJUSTMENT. Adjust horizontal gain as follows:

- a. Set HORIZONTAL DISPLAY to .1 VOLTS/CM.
- b. Turn horizontal VERNIER to CAL.
- c. Using voltmeter calibrator, apply a 400-cps 1-volt peak-to-peak signal to the horizontal input terminals.
- d. Adjust horizontal gain potentiometer R104 (figure 5-1) for a peak-to-peak crt deflection of 10 cm.

5-44. HORIZONTAL NEUTRALIZER ADJUSTMENT. Adjust horizontal neutralization as follows:

- a. Set VERTICAL SENSITIVITY to 1 VOLTS/CM.
- b. Turn vertical VERNIER to CAL.
- c. Set HORIZONTAL DISPLAY to .1 VOLTS/CM.
- d. Turn horizontal VERNIER to CAL.

e. Using oscillator, apply an 8-kc sine wave to vertical input terminals and the sync input of square-wave generator.

f. Using square-wave generator, apply a 100-kc 1-volt peak-to-peak square wave to horizontal input terminals.

g. Adjust oscillator frequency to synchronize sine wave and square wave on crt (stabilize presentation).

h. Adjust C103 and C104 (figure 5-1) for best square-wave response.

**5-45. ATTENUATOR FREQUENCY-COMPENSATION ADJUSTMENT.** Adjust the horizontal attenuator frequency compensation as follows:

a. Set VERTICAL SENSITIVITY to 1 VOLTS/CM.

b. Turn vertical VERNIER to CAL.

c. Turn horizontal VERNIER to CAL.

d. Set HORIZONTAL DISPLAY to 1 VOLTS/CM.

e. Using square-wave generator, apply a 1-kc 10-volt peak-to-peak square wave to the horizontal input terminals.

f. Using oscillator, apply an 800-cps 10-volt peak-to-peak signal to the vertical input and sync input of square-wave generator.

g. Adjust oscillator to synchronize sine wave and square wave on crt (stabilize presentation).

h. Adjust capacitor C235 (figure 5-1) for optimum square wave on crt.

i. Set HORIZONTAL DISPLAY to 10 VOLTS/CM.

j. Increase square-wave generator output to 50 volts peak-to-peak.

k. Adjust capacitor C233 (figure 5-1) for optimum square-wave on crt.

**5-46. PRESET ADJUSTMENT.** Adjust preset as follows:

a. Set VERTICAL SENSITIVITY to CAL.

b. Set HORIZONTAL DISPLAY to .5 MILLISECONDS/CM.

c. Set TRIGGER SOURCE to INT+.

d. Turn TRIGGER LEVEL just out of AUTO.

e. Connect dc voltmeter (-100-volt range) between pin 2 of V202 and ground.

f. Adjust potentiometer R258 (figure 5-1) clockwise until crt sweep free-runs, then counterclockwise until the sweep just stops; note the readings on the voltmeter.

g. Adjust voltage to 3 volts less negative than the last reading.

**5-47. TRIGGER-SENSITIVITY ADJUSTMENT.** Adjust the trigger sensitivity as follows:

a. Set VERTICAL SENSITIVITY to 100 MILLIVOLTS/CM.

b. Set HORIZONTAL DISPLAY to 5 MILLISECONDS/CM.

c. Turn both VERNIER controls to CAL.

d. Set TRIGGER SOURCE to EXT.

e. Turn TRIGGER LEVEL to AUTO.

f. Set SWEEP MAGNIFIER to X5.

g. Set vertical and horizontal AC-DC switches to AC.

h. Connect oscillator to both the VERTICAL and HORIZONTAL inputs and set the frequency to 450 kc and amplitude to 0.16 volts rms (using hp Model 400D/H/L AC VTVM).

i. Adjust R203 (trigger sensitivity) fully counterclockwise.

j. Observing crt presentation, adjust R203 clockwise until the presentation becomes stable.

k. Adjust oscillator output amplitude down to 0.1 v rms, presentation should become slightly unstable between 0.15 and 0.10 v rms.

l. Set oscillator output amplitude to 0.5 v rms, and adjust frequency from 50 cps to 450 kc. Presentation should remain stable across complete frequency range.

#### 5-48. SWEEP GENERATOR.

**5-49. X1 SWEEP ADJUSTMENT.** Adjust the X1 sweep as follows:

a. Set VERTICAL SENSITIVITY to 1 VOLTS/CM.

b. Turn vertical VERNIER to CAL.

c. Turn horizontal VERNIER to CAL.

d. Set HORIZONTAL DISPLAY to 5 MILLISECONDS/CM.

e. Set SWEEP MAGNIFIER to X1.

f. Set TRIGGER SOURCE to INT-.

g. Turn TRIGGER LEVEL to AUTO.

h. Using time mark generator, apply 100-cps time markers to the vertical input terminals.

i. Adjust X1 sweep gain R267 (figure 5-1) to obtain 5 cycles per 10 cm on the crt.

**5-50. SWEEP-TIME ADJUSTMENT.** Adjust the horizontal sweep time as follows:

a. Set VERTICAL SENSITIVITY to 1 VOLTS/CM.

b. Turn vertical VERNIER to CAL.

c. Turn horizontal VERNIER to CAL.

d. Set TRIGGER SOURCE to INT-.

e. Set SWEEP MAGNIFIER to X1.

f. Connect time mark generator to the vertical input terminals.

g. Referring to table 5-5, adjust the time mark generator output and the HORIZONTAL DISPLAY switch to the indicated marker interval and sweep time, respectively, for each step; adjust or check for the indicated markers per 10 cm listed in the table.

**5-51. SWEEP LENGTH ADJUSTMENT.** Adjust the sweep length as follows:

a. Set VERTICAL SENSITIVITY to 100 MILLIVOLTS/CM.

b. Turn vertical VERNIER to CAL.

c. Set vertical AC-DC to AC.

d. Set HORIZONTAL DISPLAY to .5 MILLISECONDS/CM.

e. Turn horizontal VERNIER to CAL.

f. Set SWEEP MAGNIFIER to X1.

g. Set TRIGGER SOURCE to INT-.

h. Turn TRIGGER LEVEL to AUTO.

i. Adjust potentiometer R254 (figure 5-1) for a sweep length of 10.75 cm (minimum length on any range should be 10.5 cm).

#### 5-52. PERFORMANCE CHECK.

**5-53.** The following paragraphs, 5-54 through 5-66, list the various performance checks to determine that the Model 120B is performing properly.

**5-54. VERTICAL ATTENUATOR-ERROR CHECK.** Check the vertical attenuator error as follows:

a. Set vertical AC-DC to DC.

b. Set VERTICAL SENSITIVITY to 10 MILLIVOLTS/CM.

c. Turn vertical VERNIER to CAL.

Table 5-5. Horizontal Sweep-Time Adjustment

Step	Marker Interval	Sweep Time	Adjust	Markers per 10 cm
1	10 $\mu$ sec	5 $\mu$ SEC/CM	C227	5
2	10 $\mu$ sec	10 $\mu$ SEC/CM	C227 *	10
3	10 $\mu$ sec	20 $\mu$ SEC/CM	C227 *	20
4	100 $\mu$ sec	50 $\mu$ SEC/CM	C225	5
5	100 $\mu$ sec	100 $\mu$ SEC/CM	C225 *	10
6	100 $\mu$ sec	200 $\mu$ SEC/CM	C225 *	20
7	1 ms	.5 MILLISECONDS/CM	C223	5
8	1 ms	1 MILLISECONDS/CM	C223 *	10
9	1 ms	2 MILLISECONDS/CM	C233 *	20
10	10 ms	5 MILLISECONDS/CM	R267	5
11	10 ms	10 MILLISECONDS/CM	R267 *	10
12	10 ms	20 MILLISECONDS/CM	R267 *	20
13	100 ms	50 MILLISECONDS/CM	R247	5
14	100 ms	100 MILLISECONDS/CM	R247 *	10
15	100 ms	200 MILLISECONDS/CM	R247 *	20

\* Do not adjust if indication is within  $\pm 0.5$  cm of that listed in the "markers per 10 cm" column.

d. Using voltmeter calibrator, apply a 400-cps 0.1-volt peak-to-peak signal to the vertical input terminals.

e. Adjust CAL for a crt deflection of exactly 10 cm.

f. Set VERTICAL SENSITIVITY to 100 MILLI-VOLTS/CM.

g. Adjust voltmeter calibrator output to 1 volt peak-to-peak.

h. Vertical deflection should be  $10 \pm 0.3$  cm. Repeat step for 1 and 10 volts/cm positions of VERTICAL SENSITIVITY switch, adjusting voltmeter calibrator output to 10 and 100 volts peak-to-peak, respectively; vertical deflection should be  $10 \pm 0.3$  cm in both cases.

5-55. VERTICAL DC SHIFT CHECK. Check the dc shift as follows:

a. Set VERTICAL SENSITIVITY to 10 MILLI-VOLTS/CM.

b. Set vertical AC-DC to AC.

c. Turn vertical VERNIER to CAL.

d. Short vertical input terminals to ground.

e. Switch HORIZONTAL DISPLAY to 10 VOLTS/CM, and observe the spot.

f. Switch vertical AC-DC switch to DC, and observe the spot.

g. Vertical shift should be approximately 0.2 cm or less.

5-56. VERTICAL FREQUENCY-RESPONSE CHECK. Check vertical frequency response as follows:

a. Set VERTICAL SENSITIVITY to 10 MILLI-VOLTS/CM.

b. Turn vertical VERNIER to CAL.

c. Set vertical AC-DC to AC.

d. Set TRIGGER SOURCE to INT+.

e. Turn TRIGGER LEVEL to AUTO.

f. Set HORIZONTAL DISPLAY to 1 MILLI-SECONDS/CM.

g. Using oscillator, apply a 4.5-kc signal to the input of attenuator; adjust for 10-db of attenuation.

h. Connect the output of attenuator to the vertical input terminals.

i. Set oscillator output to provide 10 cm of vertical deflection.

j. Monitor output with ac voltmeter and note voltage reading.

k. Maintaining voltage reading in step j, change oscillator frequency to 450 kc.

l. Display amplitude should be at least 7 cm peak-to-peak.

5-57. HORIZONTAL DC SHIFT CHECK. Check dc shift as follows:

- a. Set HORIZONTAL SENSITIVITY to .1 VOLTS/CM.
- b. Turn horizontal VERNIER to CAL.
- c. Short horizontal input terminals.
- d. Center spot and alternately switch horizontal AC-DC to AC and DC positions.
- e. Spot should shift less than 0.2 cm.

5-58. HORIZONTAL ATTENUATOR-ERROR CHECK. Check attenuator error as follows:

- a. Set HORIZONTAL DISPLAY to .1 VOLTS/CM.
- b. Turn horizontal VERNIER to CAL.
- c. Using voltmeter calibrator, apply a 400-cps 1-volt peak-to-peak sine wave to the horizontal input terminals.
- d. Adjust horizontal gain potentiometer R104 (figure 5-1) to give 10-cm deflection.
- e. Change HORIZONTAL DISPLAY to 1 VOLTS/CM and voltmeter calibrator output to 10 volts peak-to-peak.
- f. Horizontal deflection should be  $10 \pm 0.5$  cm.
- g. Change HORIZONTAL SENSITIVITY to 10 VOLTS/CM and voltmeter calibrator output to 100 volts peak-to-peak.
- h. Horizontal deflection should be  $10 \pm 0.5$  cm.

5-59. HORIZONTAL PHASE-SHIFT CHECK. Check phase shift as follows:

- a. Set VERTICAL SENSITIVITY to 100 MILLI-VOLTS/CM.
- b. Turn vertical VERNIER to CAL.
- c. Set HORIZONTAL DISPLAY to .1 VOLTS/CM.
- d. Turn horizontal VERNIER to CAL.
- e. Set vertical and horizontal AC-DC to AC.
- f. Using oscillator, apply a 100-kc 0.5-volt peak-to-peak sine wave to both vertical and horizontal input terminals.
- g. Pattern opening on crt should be less than 0.2 cm ( $\pm 2$  degrees).
- h. Change VERTICAL SENSITIVITY to 1 VOLTS/CM, HORIZONTAL DISPLAY to 1 VOLTS/CM, and voltmeter calibrator output to 5 volts peak-to-peak.
- i. Indication should be same as step g.
- j. Change VERTICAL SENSITIVITY to 10 VOLTS/CM, HORIZONTAL DISPLAY to 10 VOLTS/CM, and voltmeter calibrator output to 50 volts peak-to-peak.
- k. Indication should be same as step g.

5-60. HORIZONTAL RESPONSE CHECK. Check frequency response as follows:

- a. Set HORIZONTAL DISPLAY to 1 VOLTS/CM.
- b. Turn horizontal VERNIER to CAL.
- c. Using oscillator, apply a 4.5-kc signal to the horizontal input terminals.
- d. Set oscillator output to provide a 10-cm trace.
- e. Monitor output with ac voltmeter and note voltage reading.
- f. Maintaining voltage reading in step e, change oscillator frequency to 300 kc.
- g. Trace length should be greater than 7 cm (3-db point).

5-61. EXTERNAL TRIGGER-SENSITIVITY CHECK. Check external trigger sensitivity as follows:

- a. Set VERTICAL SENSITIVITY to 1 VOLTS/CM.

- b. Set vertical AC-DC to AC.
- c. Turn vertical VERNIER to CAL.
- d. Set HORIZONTAL DISPLAY to 5  $\mu$ SEC/CM.
- e. Set TRIGGER SOURCE to EXT.
- f. Set TRIGGER LEVEL to AUTO.
- g. Using oscillator, apply a sine wave to both the vertical and horizontal input terminals.
- h. Vary oscillator frequency from 50 cps to 450 kc, maintaining a 0.53-volt input (1.5 volts peak-to-peak).
- i. Presentation should be stable over frequency range in step h.

5-62. SYNC - POLARITY AND TRIGGER - LEVEL-RANGE CHECK. Check sync polarity and trigger-level range as follows:

- a. Set VERTICAL SENSITIVITY to 10 VOLTS/CM.
- b. Turn vertical VERNIER to CAL.
- c. Set TRIGGER SOURCE to EXT.
- d. Apply a 7.0-volt r-m-s 400-cps signal to vertical and external sync inputs.
- e. Center pattern on crt.
- f. Rotate TRIGGER LEVEL; triggering should be possible at any point along the negative slope of the input signal.

5-63. SWEEP-TIME CHECK. Check the sweep times as follows:

- a. Set VERTICAL SENSITIVITY to 1 VOLT/CM.
- b. Turn vertical VERNIER to CAL.
- c. Set horizontal VERNIER to CAL.
- d. Set SWEEP MAGNIFIER to X1.
- e. Set TRIGGER SOURCE to INT-.
- f. Adjust TRIGGER LEVEL for best synchronization.
- g. Connect time mark generator to vertical input terminals.
- h. Referring to table 5-6, adjust the time mark generator output and the HORIZONTAL DISPLAY switch to the indicated markers and setting, respectively, for each step; check for the indicated markers per 10 cm listed in the table.

5-64. CALIBRATOR AMPLITUDE CHECK. Check the amplitude of the calibrator as follows:

- a. Set VERTICAL SENSITIVITY to CAL.
- b. Turn vertical VERNIER to CAL.
- c. Set HORIZONTAL DISPLAY to 1 MILLISEC-OND/CM.
- d. Set TRIGGER SOURCE to INT-.
- e. Turn TRIGGER LEVEL to AUTO.
- f. Calibrator amplitude should be  $6 \pm 0.12$  cm.

5-65. INTENSITY MODULATION CHECK. Check intensity modulation as follows:

- a. Set VERTICAL SENSITIVITY to 10 VOLTS/CM.
- b. Turn vertical VERNIER to CAL.
- c. Set HORIZONTAL DISPLAY to 50  $\mu$ SECONDS/CM.
- d. Using square-wave generator, apply a 50-kc 20-volt peak-to-peak square wave to the vertical input terminals.
- e. Remove shorting bar from Z axis terminal and connect clip lead from vertical input to Z axis terminal.
- f. With normal intensity, the top edge of square wave should be extinguished when 20-volt peak-to-peak square wave is applied at the Z axis terminal.



Table 5-6. Horizontal Sweep Time

Step	Marker Interval	Sweep Time	Markers per 10 cm*
1	10 $\mu$ sec	5 $\mu$ SEC/CM	5
2	10 $\mu$ sec	10 $\mu$ SEC/CM	10
3	10 $\mu$ sec	20 $\mu$ SEC/CM	20
4	100 $\mu$ sec	50 $\mu$ SEC/CM	5
5	100 $\mu$ sec	100 $\mu$ SEC/CM	10
6	100 $\mu$ sec	200 $\mu$ SEC/CM	20
7	1 ms	.5 MILLISECONDS/CM	5
8	1 ms	1 MILLISECONDS/CM	10
9	1 ms	2 MILLISECONDS/CM	20
10	10 ms	5 MILLISECONDS/CM	5
11	10 ms	10 MILLISECONDS/CM	10
12	10 ms	20 MILLISECONDS/CM	20
13	100 ms	50 MILLISECONDS/CM	5
14	100 ms	100 MILLISECONDS/CM	10
15	100 ms	200 MILLISECONDS/CM	20

\*  $\pm 0.5$  cm

5-66. LINE-VOLTAGE VARIATION CHECK. Check line-voltage variation as follows:

a. Connect power cable to power autotransformer and adjust output to 115 volts ac.

b. Set VERTICAL SENSITIVITY to CAL.

c. Set HORIZONTAL DISPLAY to 2 MILLISECONDS/CM.

d. Set TRIGGER LEVEL to AUTO.

e. Adjust horizontal VERNIER to obtain exactly 5 cycles of calibrator signal per 10 cm; note exact amplitude of each calibrator signal.

f. Set line voltage to 103 volts ac, then to 127 volts ac. (Allow periods of at least 2 minutes for each voltage.) Calibrator signal amplitude should be  $\pm 0.3$  cm; the five cycles of the signal should change less than 0.5 cm in length.

### 5-67. DIAGRAMS.

5-68. Figures 5-6 through 5-11 are schematic diagrams of the Model 120B. DC voltages are provided on the schematics as an aid in troubleshooting.

5-69. The following notations are applicable to figures 5-6 through 5-11.

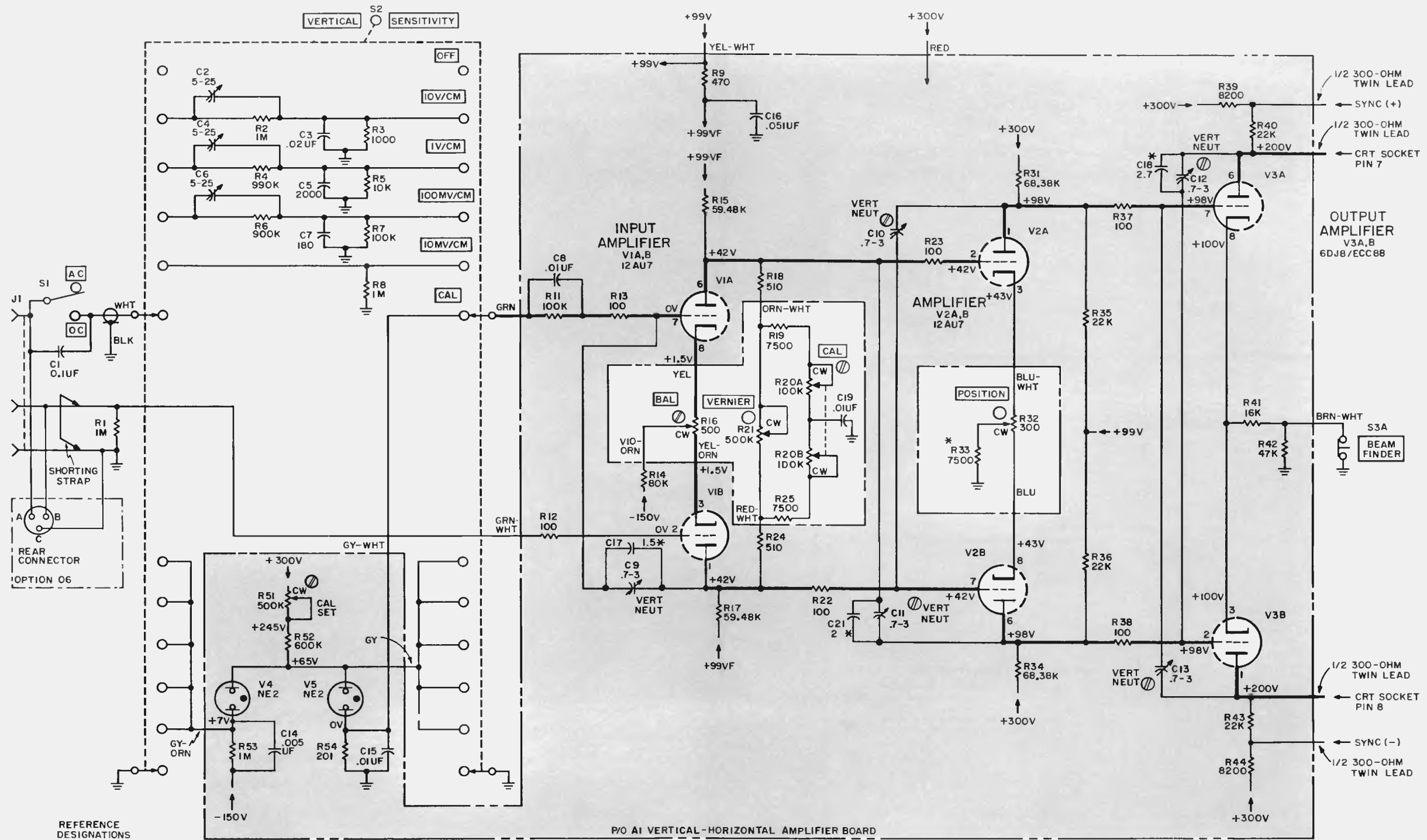
a. All values are in ohms, picofarads, and microhenries unless otherwise indicated.

b. Lettering enclosed in heavy boxes indicates front-panel engraving.

c. Voltage measurements are with respect to ground and made with Hewlett-Packard Model 412A VTVM.

d. Voltage measurements are made with Model 120B front-panel controls set as follows:

<u>Control</u>	<u>Setting</u>
VERTICAL SENSITIVITY switch	CAL
VERTICAL VERNIER control	CAL
Vertical AC-DC switch	AC
FOCUS control	Centered
VERTICAL POSITION control	Centered
INTENSITY control	Centered
HORIZONTAL POSITION control	Centered
HORIZONTAL DISPLAY switch	5 $\mu$ SEC/CM
HORIZONTAL VERNIER control	CAL
TRIGGER SOURCE switch	INT-
TRIGGER LEVEL control	AUTO
Horizontal AC-DC switch	AC
SWEEP MAGNIFIER switch	X1



REFERENCE DESIGNATIONS

A1
C1 - 21
J1
R1 - 54
S1 - 3A
V1 - 5

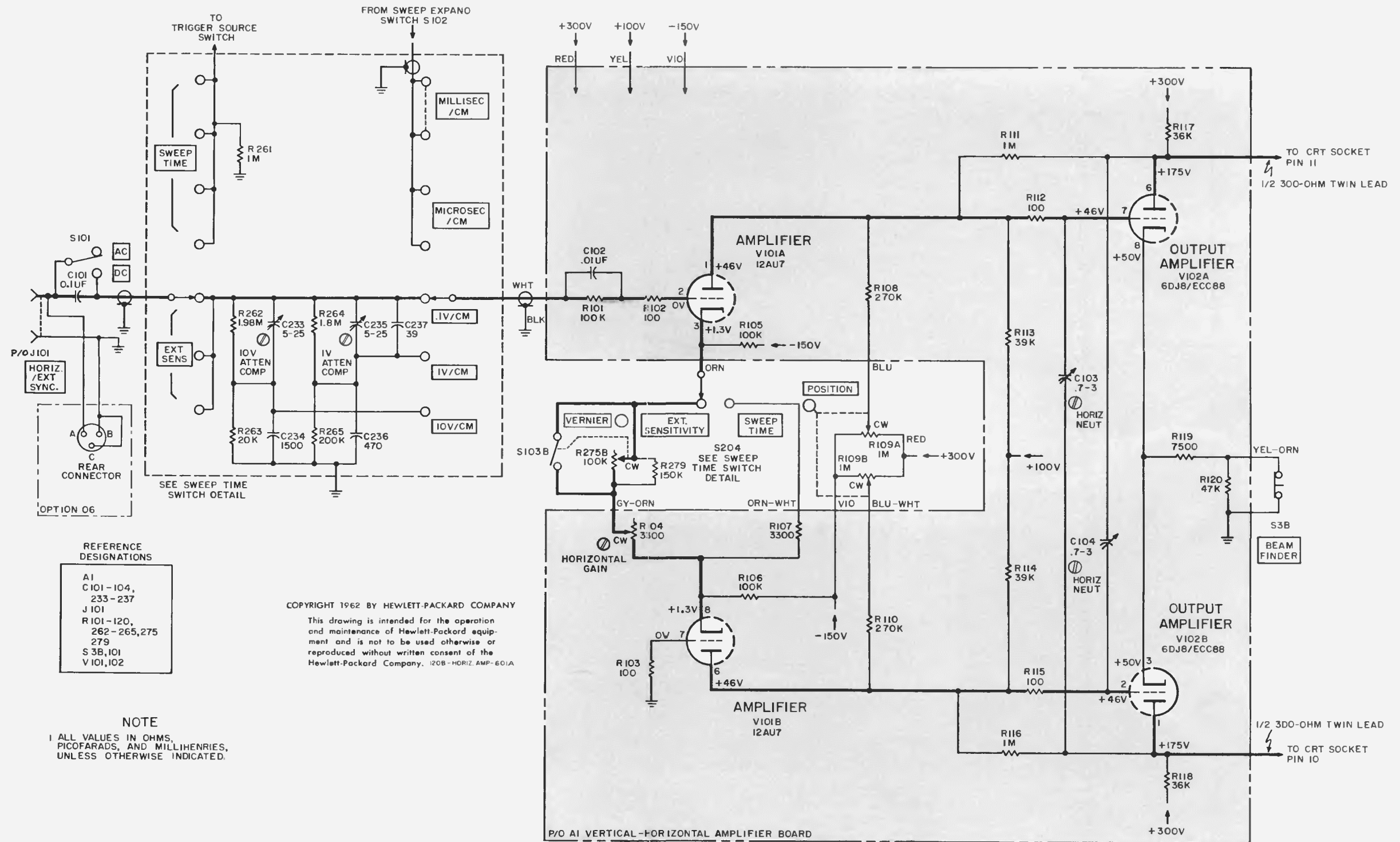
UNASSIGNED:  
C20  
R10, 26 - 30, 45 - 50

NOTES

1. ALL VALUES ARE IN OHMS, PICOFARADS AND MILLIHENRIES, UNLESS OTHERWISE INDICATED.
2. \* - AVERAGE VALUE SHOWN OPTIMUM VALUE SELECTED AT FACTORY, PART MAY BE OMITTED.

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Figure 5-6. Vertical Amplifier



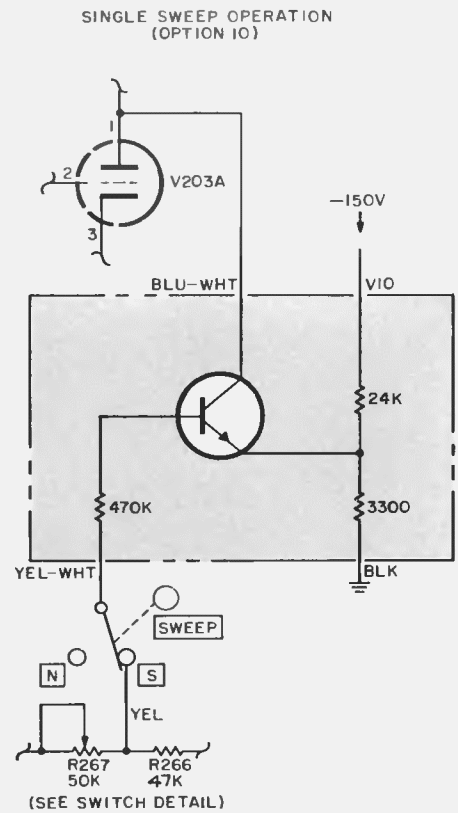
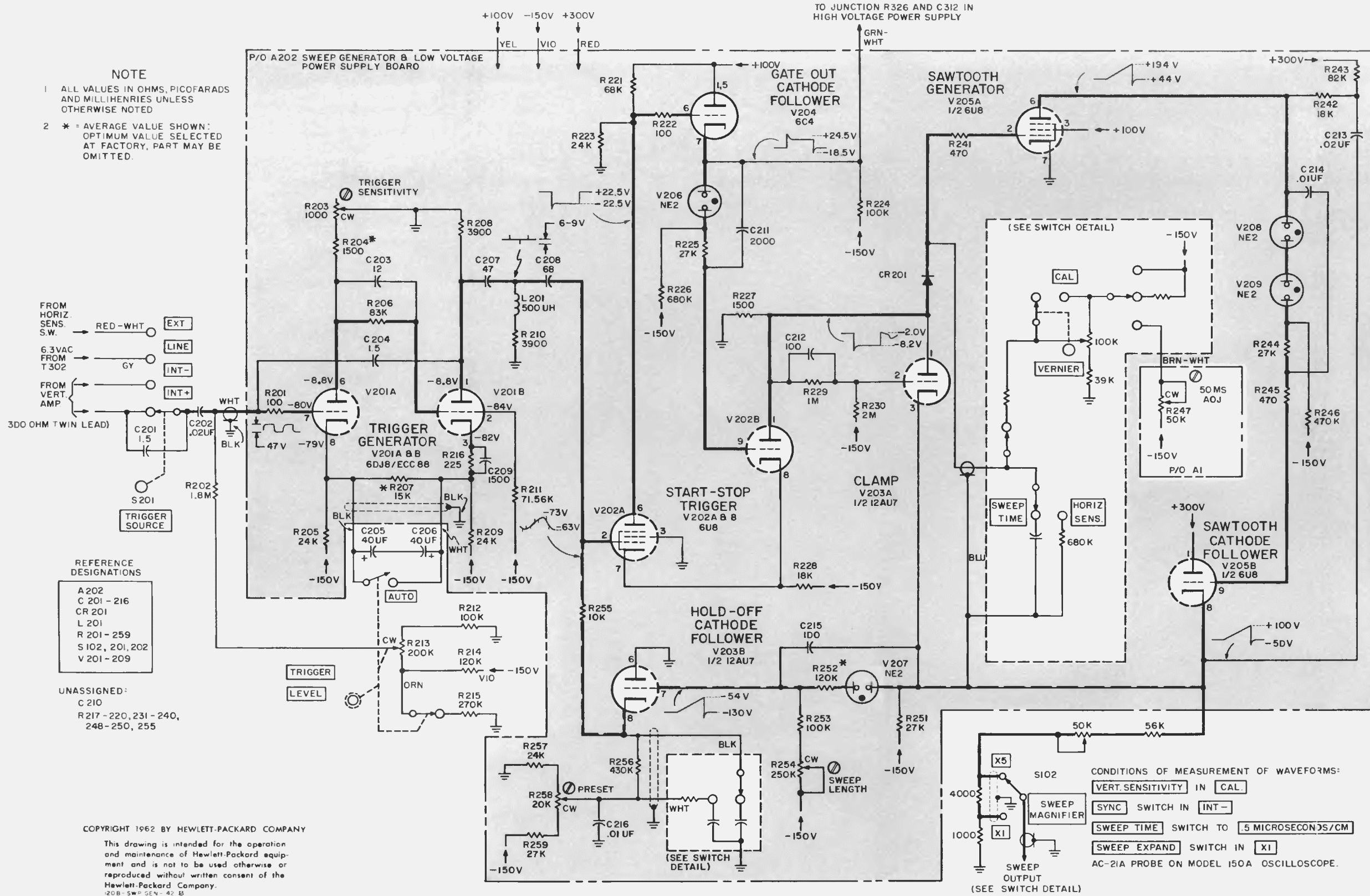
REFERENCE DESIGNATIONS

A1	C101-104,
	233-237
J101	R101-120,
	262-265,275
	279
S3B,101	V101,102

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NOTE  
ALL VALUES IN OHMS, PICOFARADS, AND MILLIHENRIES, UNLESS OTHERWISE INDICATED.

Figure 5-7. Horizontal Amplifier



Test Point	Sweep Completed*	Reset**
V202 pin 1	-8.15 volts	-1.47 volts
pin 9	-41 volts	-28 volts
pin 8	-41 volts	-1.1 volts
pin 6	+26.5 volts	+19.5 volts
pin 2	-150 volts	0 volts
V203 pin 2	-55 volts	-50 volts
pin 3	+130 volts	-49 volts
pin 7	-52 volts	-118 volts
pin 8	-55 volts	-3.5 volts
V204 pin 6	+26.5 volts	+19.5 volts
pin 7	+29 volts	+22 volts
V205 pin 2	-8.5 volts	-1.83 volts
pin 6	+240 volts	+48 volts
pin 9	+130 volts	-58 volts
pin 8	+130 volts	-49 volts
V206 (R225 side)	-25 volts	-28 volts
V207 (R252 side)	+73 volts	-100 volts
V208 (V209 side)	+185 volts	-5.1 volts
V209 (R244 side)	+130 volts	-58 volts
R242/R243 jct	+252 volts	+95 volts
R244/R245 jct	-	-58 volts

\*Sweep Completed: Connect V202 pin 2 to -150 volts.  
\*\*Reset: Connect V202 pin 2 to ground.

**NOTE**  
1 ALL VALUES IN OHMS, PICO FARADS AND MILLI HENRIES UNLESS OTHERWISE NOTED  
2 \* = AVERAGE VALUE SHOWN; OPTIMUM VALUE SELECTED AT FACTORY, PART MAY BE OMITTED.

FROM HORIZ. SENS. S.W. → RED-WHT EXT  
6.3VAC FROM T302 → GY LINE  
FROM VERT. AMP → INT-  
300 OHM TWIN LEAD → INT+  
WHT → TRIGGER SOURCE  
S201 → TRIGGER SOURCE

**REFERENCE DESIGNATIONS**  
A 202  
C 201 - 216  
CR 201  
L 201  
R 201 - 259  
S 102, 201, 202  
V 201 - 209

**UNASSIGNED:**  
C 210  
R 217 - 220, 231 - 240, 248 - 250, 255

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120B-SWP GEN-42 15

**CONDITIONS OF MEASUREMENT OF WAVEFORMS:**  
VERT. SENSITIVITY IN CAL  
SYNC SWITCH IN INT-  
SWEEP TIME SWITCH TO .5 MICROSECONDS/CM  
SWEEP EXPAND SWITCH IN X1  
AC-21A PROBE ON MODEL 150A OSCILLOSCOPE.

Figure 5-8. Sweep Generator



Section V  
Figure 5-9

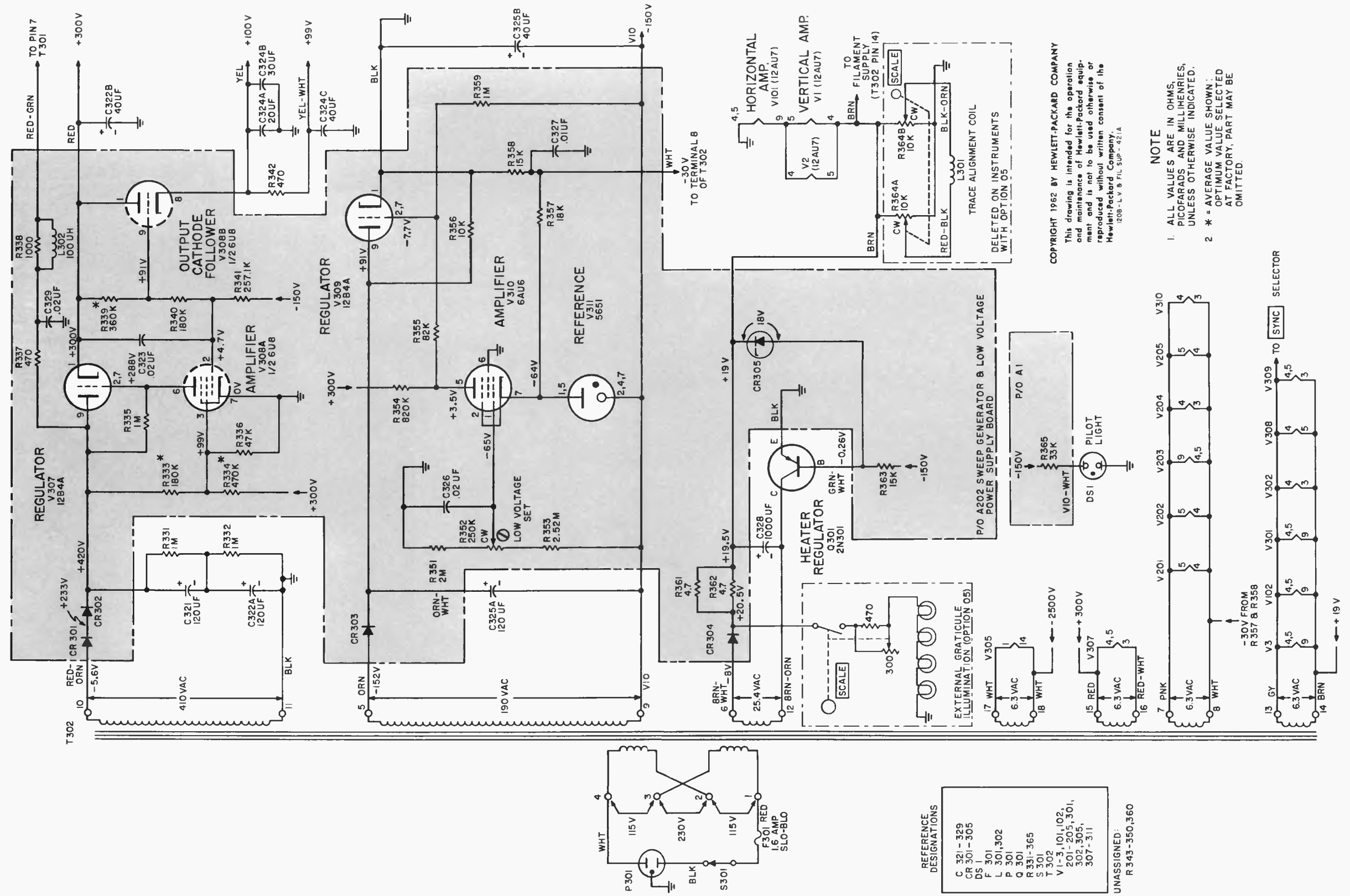


Figure 5-9. Low-Voltage Power Supply

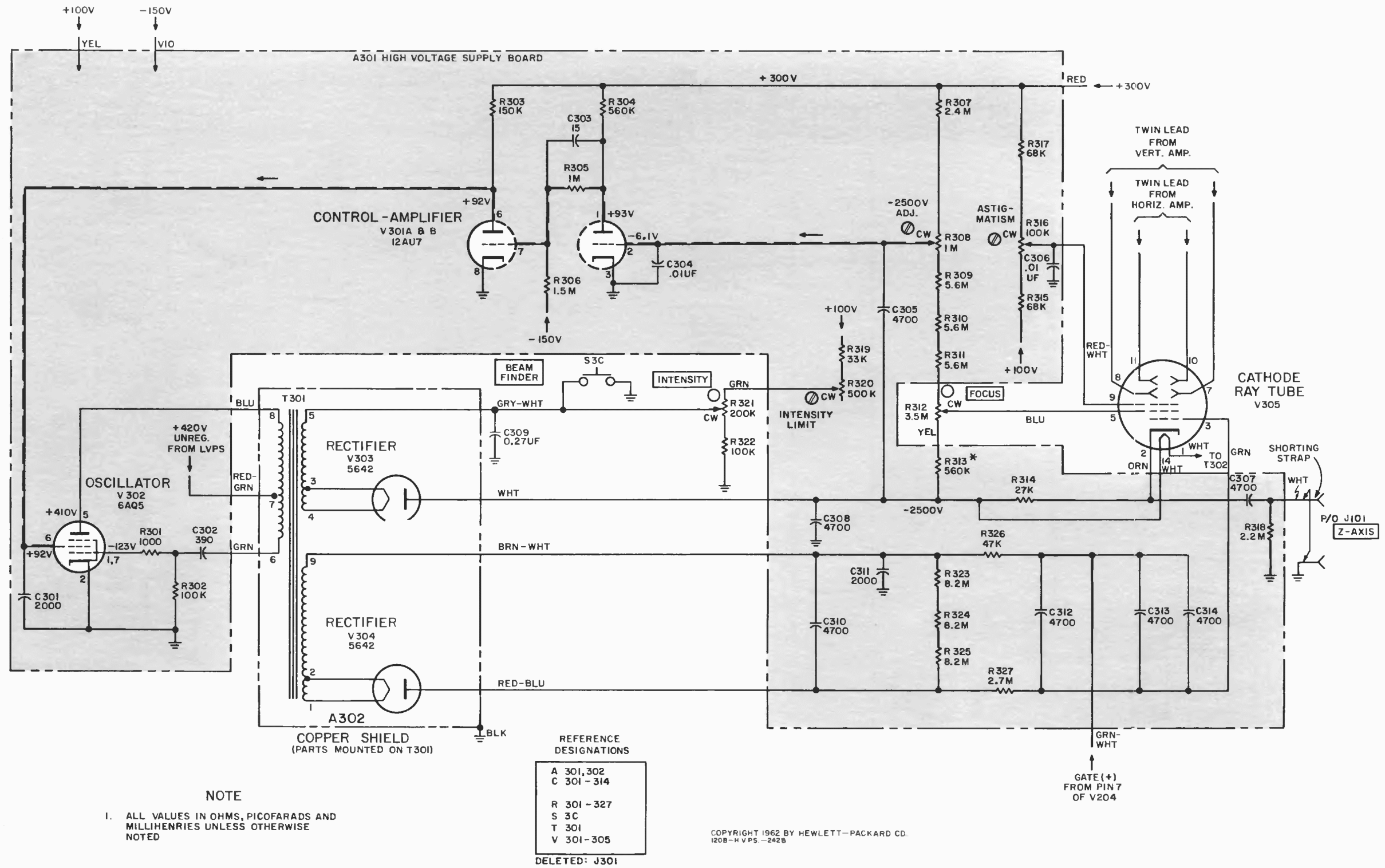


Figure 5-10. High-Voltage Power Supply

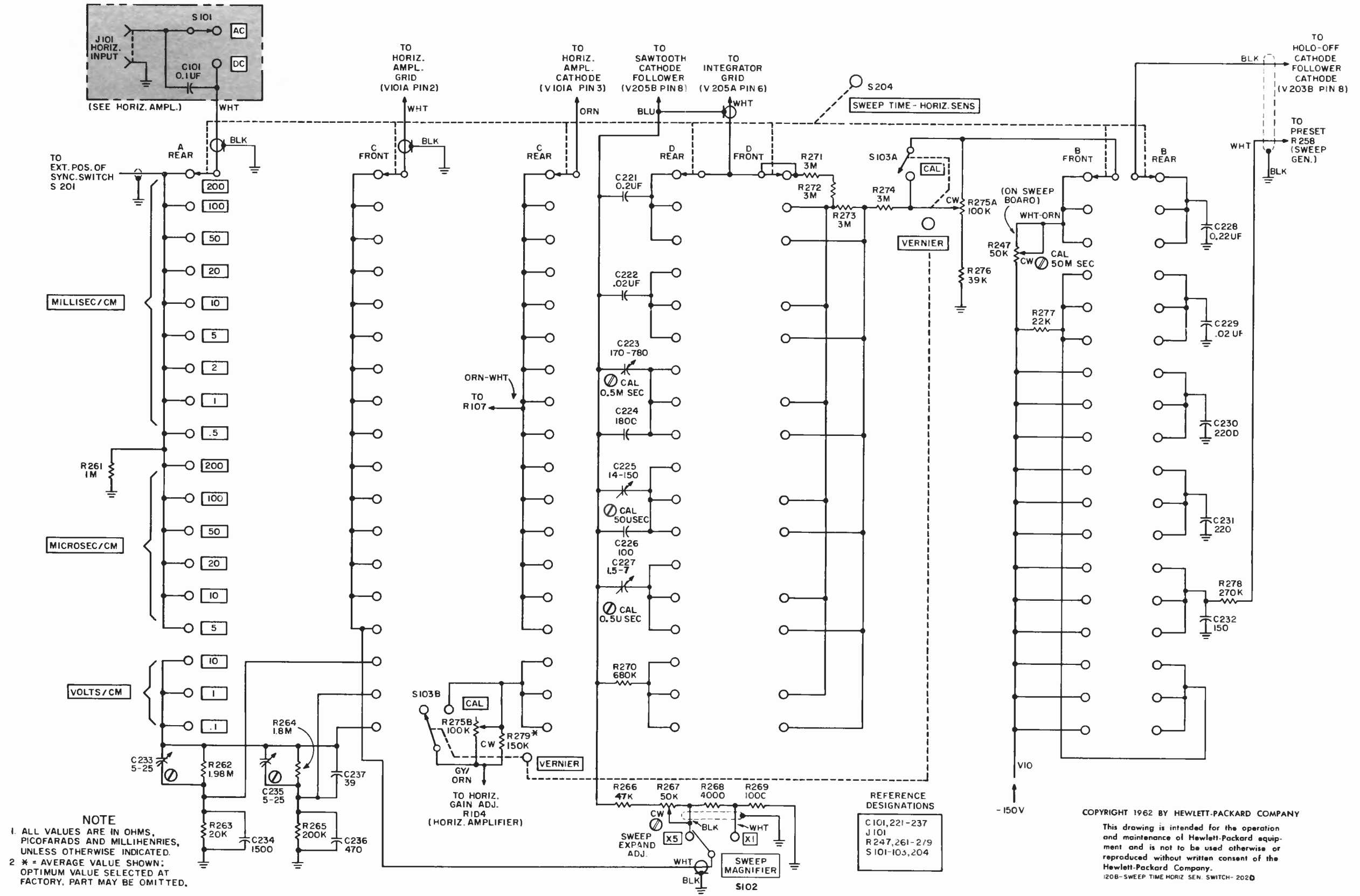


Figure 5-11. Horizontal Display Switch

## SECTION VI REPLACEABLE PARTS

### 6-1. INTRODUCTION.

6-2. This section contains information for ordering replaceable parts for the Model 120B. Table 6-1 lists reference designators and abbreviations that are used in the Table 6-2 component descriptions. Table 6-2 lists the parts in alpha-numerical order of their reference designations and provides the following information for each item:

- a. The hp part number.
- b. Total quantity (TQ) used in the instrument; given only first time the part number is listed.
- c. Description of part (refer to Table 6-1).
- d. Typical manufacturer of the part in a five-digit code, except for Hewlett-Packard Company; see code list of manufacturers, Table 6-3, for name.
- e. Manufacturer's part number.

6-3. Parts not identified by a reference designation are listed at the end of Table 6-2, under miscellaneous. Cabinet parts and the rack mounting kit for the instrument are illustrated and listed in Figure 6-1.

### 6-4. ORDERING INFORMATION.

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

- a. The hp part number of item(s).
- b. Model number and eight-digit serial number of the instrument.

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

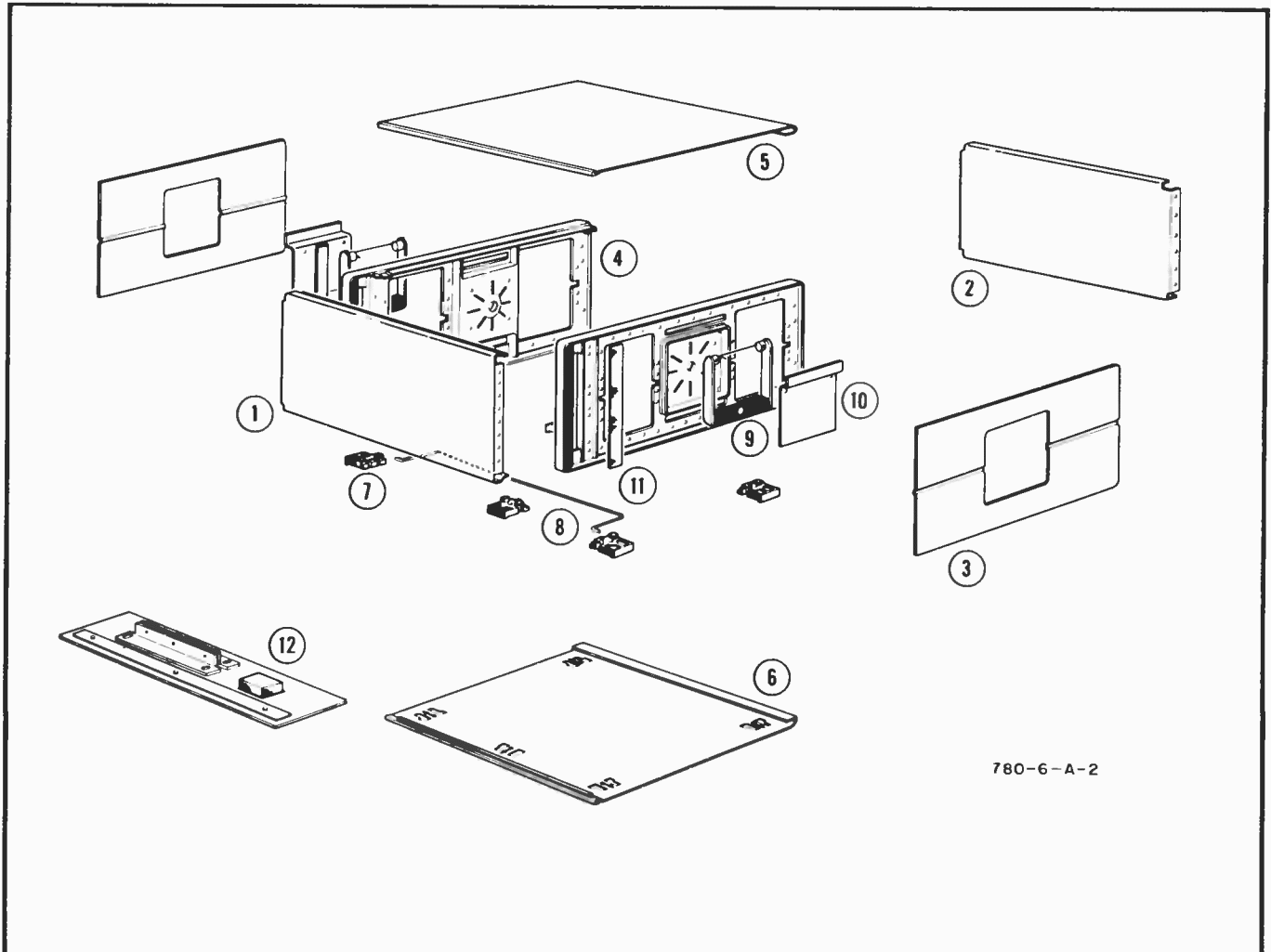
- a. Model number and eight digit serial number of the instrument.
- b. Description of part including function and location.

6-7. To order a part from a manufacturer other than the Hewlett-Packard Company, provide the complete part description and the manufacturer's part number from Table 6-2.

Table 6-1. List of Reference Designators and Abbreviations

REFERENCE DESIGNATORS			
A = assembly B = motor C = capacitor CP = coupling CR = diode DL = delay line DS = device signaling (lamp)	E = misc electronic part F = fuse FL = filter J = jack K = relay L = inductor M = meter	MP = mechanical part P = plug Q = transistor R = resistor RT = thermistor S = switch T = transformer	TB = terminal board TP = test point V = vacuum tube, neon bulb, photocell, etc. W = cable X = socket Y = crystal
ABBREVIATIONS			
A = amperes A.F.C = automatic frequency control AMPL = amplifier  B.F.O. = beat frequency oscillator BE CU = beryllium copper BH = binder head BP = bandpass BRS = brass BWO = backward wave oscillator  CCW = counter-clockwise CER = ceramic CMO = cabinet mount only COEF = coefficient COM = common COMP = composition CONN = connector CP = cadmium plate CRT = cathode-ray tube CW = clockwise  DEPC = deposited carbon DR = drive  ELECT = electrolytic ENCAP = encapsulated EXT = external  F = farads FH = flat head FIL H = fillister head FXD = fixed	GE = germanium GL = glass GRD = ground(ed)  H = henries HEX = hexagonal HG = mercury HR = hour(s) hp = Hewlett-Packard IF = intermediate freq IMPG = impregnated INCD = incandescent INCL = include(s) INS = insulation(ed) INT = internal  K = kilo = 1000  LIN = linear taper LK WASH = lock washer LOG = logarithmic taper LPF = low pass filter  M = milli = 10 <sup>-3</sup> MEG = meg = 10 <sup>6</sup> METFLM = metal film MFR = manufacturer MINAT = miniature MOM = momentary MTG = mounting MY = "mylar"  N = nano (10 <sup>-9</sup> )	N/C = normally closed NE = neon NI PL = nickel plate N/O = normally open NPO = negative positive zero (zero temperature coefficient) NRFR = not recommended for field replacement NSR = not separately replaceable  OBD = order by description OH = oval head OX = oxide  P = peak PC = printed circuit PF = picofarads = 10 <sup>-12</sup> farads PH BRZ = phosphor bronze PHL = Phillips PIV = peak inverse voltage P/O = part of POLY = polystyrene PORC = porcelain POS = position(s) POT = potentiometer PP = peak-to-peak PT = point RECT = rectifier RF = radio frequency RH = round head	RMO = rack mount only RMS = root-mean-square  S-B = slow-blow SCR = screw SE = selenium SECT = section(s) SEMICON = semiconductor SI = silicon SIL = silver SL = slide SPL = special SST = stainless steel SR = split ring STL = steel  TA = tantalum TD = time delay TGL = toggle TI = titanium TOL = tolerance TRIM = trimmer TWT = traveling wave tube  U = micro = 10 <sup>-6</sup>  VAR = variable VDCW = dc working volts  W/ = with W = watts WW = wirewound W/O = without





780-6-A-2

Index No.	hp Part No.	Description	QT
1	120B-2D	Panel: front	1
2	120B-2C	Panel: rear	1
3	5000-0743	Cover: side	2
4	5060-0734	Casting: frame side	2
5	120B-44A-1	Cover: top	1
6	5060-0758	Cover: bottom	1
7	5060-0767	Foot: plastic	5
8	1490-0030	Stand: tilt	1
9	5060-0763	Handle: side	2
10	5060-0765	Retainer: handle	2
11	5000-0052	Plate: trim adhesive back	2
12	5060-0776	Kit: rack mount	1

Figure 6-1. Modular Cabinet Replaceable Parts

Table 6-2. Replaceable Parts

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
A1	120B-65F		1	A: pc vert and horiz amplifiers	hp	
A2	120B-19A		1	A: switch vertical	hp	
A3	120B-12E		2	A: ac-dc switch (incl bracket and S1)	hp	
A101	120B-6C		1	A: vert shield (incl bracket and S102)	hp	
A102	120B-12E			A: ac-dc switch (incl bracket and S101)	hp	
A201	120B-19D		1	A: switch trigger source	hp	
A202	120B-65G		1	A: pc sweep and lv supply	hp	
A204	120B-19B		1	A: switch horiz	hp	
A301	120B-65E		1	A: pc hv supply	hp	
A302	120B-11B		1	A: rectifier (incl T301, C309, V303, V304)	hp	
C1	0170-0022		2	C: fxd my 0.1 uf 20% 600vdcw	84411	HEW 7
C2	0130-0014		3	C: var cer 5-25 pf 500vdcw	72982	577-030-COP-39R
C3	0170-0027		3	C: fxd my 0.02 uf 5% 200vdcw	84411	600UE20352
C4	0130-0014			C: var cer 5-25 pf 500vdcw	72982	577-030-COP-39R
C5	0160-2566		1	C: fxd mica 2000 pf 2% 300vdcw	hp	
C6	0130-0014			C: var cer 5-25 pf 500vdcw	72982	577-030-COP-39R
C7	0140-0147		1	C: fxd mica 180 pf 5% 500vdcw	72136	DM15F181J
C8	0150-0012		9	C: fxd cer .01 uf 20% 1000vdcw	71590	13C DISC
C9	0132-0004		6	C: var poly 0.7-3 pf 350vdcw	72982	535-009-4R
C10	0132-0004			C: var poly 0.7-3 pf 350vdcw	72982	535-009-4R
C11	0132-0004			C: var poly 0.7-3 pf 350vdcw	72982	535-009-4R
C12	0132-0004			C: var poly 0.7-3 pf 350vdcw	72982	535-009-4R
C13	0132-0004			C: var poly 0.7-3 pf 350vdcw	72982	535-009-4R
C14	0150-0014		1	C: fxd cer 0.005 uf 500vdcw	04222	D1-4
C15	0150-0012			C: fxd cer .01 uf 20% 1000vdcw	71590	13C DISC
C16	0170-0003		1	C: fxd my 0.051 uf 10% 200vdcw	00853	33M02151
C17	0150-0011		3	C: fxd ti-ox 1.5 pf 20% 500vdcw	78488	TYPE GA OBD
C18	0150-0041		1	C: fxd ti-ox 2.7 pf 5% 500vdcw	78488	TYPE GA OBD
C19	0150-0012			C: fxd cer .01 uf 20% 1000vdcw	71590	13C DISC
C21	0150-0031		1	C: fxd ti-ox 2 pf 5% 500vdcw	78488	TYPE GA OBD
C101	0170-0022			C: fxd my 0.1 uf 20% 600vdcw	84411	HEW 7
C102	0150-0012			C: fxd cer .01 uf 20% 1000vdcw	71590	13C DISC
C103	0132-0004			C: var poly 0.7-3 pf 350vdcw	72982	535-009-4R
C104	0132-0002		1	C: var poly 0.7-3 pf 350vdcw	72982	535-015-4R
C201	0150-0011			C: fxd ti-ox 1.5 pf 20% 500vdcw	78488	TYPE GA OBD
C202	0150-0024		5	C: fxd cer 0.02 uf -20%+80% 600vdcw	91418	BO.02 GMV
C203	0140-0201		1	C: fxd mica 12 pf 5% 500vdcw	72136	DM15C120J
C204	0150-0011			C: fxd ti-ox 1.5 pf 20% 500vdcw	78488	TYPE GA OBD
C205	0180-0050		2	C: fxd elect 40 uf -15%+100% 500vdcw	56289	D 32538

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

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
C206	0180-0050			C: fxd elect 40 $\mu$ f -15%+100% 500vdcw	56289	D 32538
C207	0140-0039		1	C: fxd mica 47 pf 5% 500vdcw	76433	RCM15E470J
C208	0140-0082		1	C: fxd mica 68 pf 5% 500vdcw	76433	RCM15E680J
C209	0140-0156		2	C: fxd mica 1500 pf 2% 300vdcw	72136	DM19F152G
C211	0150-0023		3	C: fxd cer 2000 pf 20% 1000vdcw	91418	JFO.002-20%
C212	0140-0041		3	C: fxd mica 100 pf 5% 500vdcw	76433	RCM15E101J
C213	0150-0024			C: fxd cer .02 $\mu$ f -20%+80% 600vdcw	91418	BO.02 GMV
C214	0150-0012			C: fxd cer .01 $\mu$ f 20% 1000vdcw	71590	13C DISC
C215	0140-0041			C: fxd mica 100 pf 5% 500vdcw	78488	TYPE GA OBD
C216	0150-0012			C: fxd cer .01 $\mu$ f 20% 1000vdcw	71590	13C DISC
C221	0170-0028		1	C: fxd my 0.2 $\mu$ f 50% 200vdcw	84411	600UE20452
C222	0170-0027			C: fxd my 0.02 $\mu$ f 5% 200vdcw	84411	600UE20352
C223	0131-0003		1	C: var mica 170-780 pf 175vdcw	72136	T52910
C224	0170-0026		1	C: fxd my 1800 pf 5% 200vdcw	84411	60QUE18252
C225	0131-0004		1	C: var mica 14-150 pf 175vdcw	72136	T51410-3
C226	0140-0041			C: fxd mica 100 pf 5% 500vdcw	76433	RCM15E101J
C227	0130-0003		1	C: var cer 1.5-7 pf NPO 500vdcw	hp	
C228	0160-0380		1	C: fxd my 0.22 $\mu$ f 10% 200vdcw	hp	
C229	0170-0027			C: fxd my 0.02 $\mu$ f 5% 200vdcw	84411	600UE20352
C230	0160-0007		1	C: fxd my 2200 pf 10% 600vdcw	56289	160P22296
C231	0140-0031		1	C: fxd mica 220 pf 10% 500vdcw	76433	RCM20B221K
C232	0140-0055		1	C: fxd mica 150 pf 10% 500vdcw	76433	RCM20B151K
C233	0130-0016		2	C: var cer 5-25 pf 500vdcw	72982	557-019-COP-39R
C234	0140-0156			C: fxd mica 1500 pf 2% 300vdcw	72136	DM19F152G
C235	0130-0016			C: var cer 5-25 pf 500vdcw	72985	557-019-COP-39R
C236	0140-0027		1	C: fxd mica 470 pf 10% 500vdcw	76433	RCM20B471K
C237	0140-0035		1	C: fxd mica 39 pf 5% 500vdcw	76433	RCM15E390J
C301	0150-0023			C: fxd cer 2000 pf 20% 1000vdcw	91418	JFO.002-20%
C302	0140-0037		1	C: fxd mica 390 pf 5% 500vdcw	76433	RCM15E391J
C303	0140-0004		1	C: fxd mica 15 pf 10% 500vdcw	72982	535-009-4R
C304	0150-0012			C: fxd cer .01 $\mu$ f 20% 1000vdcw	71590	13C DISC
C305	0160-0151		7	C: fxd cer 4700 pf -20%+80% 4000vdcw	71590	DA172-097CB
C306	0150-0012			C: fxd cer .01 $\mu$ f 20% 1000vdcw	71590	13C DISC
C307	0160-0151			C: fxd cer 4700 pf -20%+80% 4000vdcw	71590	DA172-097CB
C308	0160-0151			C: fxd cer 4700 pf -20%+80% 4000vdcw	71590	DA172-097CB
C309	0160-0039		1	C: fxd my 0.27 $\mu$ f 10% 200vdcw	56289	160P27492
C310	0160-0151			C: fxd cer 4700 pf -20%+80% 4000vdcw	71590	DA172-097CB
C311	0150-0023			C: fxd cer 2000 pf 20% 1000vdcw	91418	JFO.002-20%
C312	0160-0151			C: fxd cer 4700 pf -20%+80% 4000vdcw	71590	DA172-097CB
C313	0160-0151			C: fxd cer 4700 pf -20%+80% 4000vdcw	71590	DA172-097CB
C314	0160-0151			C: fxd cer 4700 pf -20%+80% 4000vdcw	71590	DA172-097CB
C321	0180-0126		1	C: fxd elect 120 $\mu$ f 300vdcw	56289	D36236
C322A/B	0180-0030		1	C: fxd elect 2 sect 120 - 40 $\mu$ f 450vdcw	56289	D32352
C323	0150-0024			C: fxd cer .02 $\mu$ f -20%+80% 600vdcw	91418	BO.02 GMV
C324A/B/C	0180-0053		1	C: fxd elect 3 sect 40-30-20 $\mu$ f 150vdcw	56289	OBD
C325A/B	0180-0127		1	C: fxd elect 2 sect 120 - 40 $\mu$ f -10%+50% 300vdcw	56289	D36235
C326	0150-0024			C: fxd cer .02 $\mu$ f -20%+80% 600vdcw	91418	BO.02 GMV
C327	0150-0012			C: fxd cer .01 $\mu$ f 20% 1000vdcw	71590	13C DISC
C328	0180-0056		1	C: fxd elect 1000 $\mu$ f 50vdcw	56289	D32429
C329	0150-0024			C: fxd cer .02 $\mu$ f -20%+80% 600vdcw	91418	BO.02 GMV

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

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
CR201	1901-0044		1	CR: si	hp	
CR301	1901-0030		3	CR: si	02735	OBD
CR302	1901-0030			CR: si	02735	OBD
CR303	1901-0030			CR: si	02735	OBD
CR304	1901-0045		1	CR: si	hp	
CR305	1902-0225		1	CR: si breakdown 18.7v	hp	
DS1	1450-0048		1	DS: neon indicator	08717	858-R
F301	2110-0005		1	F: cartridge 1.6 amp s-b (for 115 v operation)	71400	MDL1.6
	2110-0020			F: cartridge 0.8 amp s-b (for 230 v operation)	71400	OBD
J1				NSR - consists of:		
	5060-0633		4	Binding Post: red (2 required)	hp	
	5060-0625		1	Binding Post: black	hp	
	0340-0091		2	Insulator: 3 hole	hp	
	0340-0086		1	Insulator: 2 hole	hp	
J101				NSR - consists of:		
	5060-0633			Binding Post: red (2 required)	hp	
	5060-0626		1	Binding Post: black	hp	
	0340-0091			Insulator: 3 hole	hp	
	0340-0087		1	Insulator: 3 hole	hp	
L201	9140-0022		1	L: fxd rf 500 $\mu$ h 10%	99848	1500-15-501
L301	5060-0409		1	L: coil (trace align)	hp	
L302	9140-0029		1	L: fxd rf 100 $\mu$ h	99848	3100-15-101
P301				NSR: part of power cord W1		
Q301	1850-0038		1	Q: ge pnp	hp	
R1	0686-1055		4	R: fxd comp 1 megohm 5% 1/2w	01121	EB1055
R2	0757-0059		3	R: fxd metflm 1 megohm 1% 1/2w	hp	
R3	0757-0159		1	R: fxd metflm 1000 ohms 1% 1/2w	hp	
R4	0757-0057		1	R: fxd metflm 990 ohms 1% 1/2w	hp	
R5	0757-0839		1	R: fxd metflm 10k ohms 1% 1/2w	hp	
R6	0757-0054		1	R: fxd metflm 900k ohms 1% 1/2w	hp	
R7	0757-0367		1	R: fxd metflm 100k ohms 1% 1/2w	hp	
R8	0686-1055			R: fxd comp 1 megohm 5% 1/2w	01121	EB1055
R9	0687-4711		5	R: fxd comp 470 ohms 10% 1/2w	01121	EB4711
R11	0687-1041		6	R: fxd comp 100k ohms 10% 1/2w	01121	EB1041
R12	0687-1011		12	R: fxd comp 100 ohms 10% 1/2w	01121	EB1011
R13	0687-1011			R: fxd comp 100 ohms 10% 1/2w	01121	EB1011
R14	0730-0062		1	R: fxd depc 80k ohms 1% 1w	hp	
R15	0727-0197		2	R: fxd depc 59.48k ohms 1% 1/2w	hp	

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

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
R16	2100-0054		1	R: var ww 500 ohms 10% 2w	11237	252 OBD
R17	0727-0197			R: fxd depc 59.48k ohms 1% 1/2w	hp	
R18	0758-0030		2	R: fxd met ox 510 ohms 5% 1/2w	hp	
R19	0758-0047		3	R: fxd met ox 7500 ohms 5% 1/2w	hp	
R20A/B	2100-0339		1	R: var comp log dual 100k ohms 20% 1/4w	11237	OBD
R21	2100-0174		1	R: var comp 500k ohms 20% , 5% cw log taper,1/4w w/spdt switch	11237	RGC-45
R22	0687-1011			R: fxd comp 100 ohms 10% 1/2w	01121	EB1011
R23	0687-1011			R: fxd comp 100 ohms 10% 1/2w	01121	EB1011
R24	0758-0030			R: fxd met ox 510 ohms 5% 1/2w	hp	
R25	0758-0047			R: fxd met ox 7500 ohms 5% 1/2w	hp	
R31	0730-0056		2	R: fxd depc 68.38k ohms 1% 1w	hp	
R32	2100-1486		1	R: var comp 300 ohms 20% 3w	hp	
R33	0730-0024		1	R: fxd depc 7500 ohms 1% 1w	hp	
R34	0730-0056			R: fxd depc 68.38k ohms 1% 1w	hp	
R35	0687-2231		3	R: fxd comp 22k ohms 10% 1/2w	01121	EB2231
R36	0687-2231			R: fxd comp 22k ohms 10% 1/2w	01121	EB2231
R37	0687-1011			R: fxd comp 100 ohms 10% 1/2w	01121	EB1011
R38	0687-1011			R: fxd comp 100 ohms 10% 1/2w	01121	EB1011
R39	0690-8221		2	R: fxd comp 8200 ohms 10% 1w	01121	GB8221
R40	0758-0020		2	R: fxd met ox 22k ohms 5% 1/2w	hp	
R41	0689-1635		1	R: fxd comp 16k ohms 5% 1w	01121	GB1635
R42	0687-4731		5	R: fxd comp 47k ohms 10% 1/2w	01121	EB4731
R43	0758-0020			R: fxd met ox 22k ohms 5% 1/2w	hp	
R44	0690-8221			R: fxd comp 8200 ohms 10% 1w	01121	GB8221
R51	2100-0102		2	R: var comp 500k ohms 30% 0.1w	11237	UPE 70 SPECIAL
R52	0727-0246		1	R: fxd depc 600k ohms 1% 1/2w	hp	
R53	0686-1055			R: fxd comp 1 megohm 5% 1/2w	01121	EB1055
R54	0727-0055		1	R: fxd depc 201 ohms 1% 1/2w	hp	
R101	0687-1041			R: fxd comp 100k ohms 10% 1/2w	01121	EB1041
R102	0687-1011			R: fxd comp 100 ohms 10% 1/2w	01121	EB1011
R103	0687-1011			R: fxd comp 100 ohms 10% 1/2w	01121	EB1011
R104	2100-0182		1	R: var comp 3300 ohms 10% 1/3w	11237	UPE 70
R105	0690-1041		3	R: fxd comp 100k ohms 10% 1w	01121	GB1041
R106	0690-1041			R: fxd comp 100k ohms 10% 1w	01121	GB1041
R107	0687-3321		1	R: fxd comp 3300 ohms 10% 1/2w	01121	EB3321
R108	0687-2741		3	R: fxd comp 270k ohms 10% 1/2w	01121	EB2741
R109A/B	2100-0258		1	R: var comp dual 1 megohm 20% 1/4w	11237	2-45
R110	0687-2741			R: fxd comp 270k ohms 10% 1/2w	01121	EB2741
R111	0757-0059			R: fxd metflm 1 megohm 1% 1/2w	hp	
R112	0687-1011			R: fxd comp 100 ohms 10% 1/2w	01121	EB1011
R113	0757-0050		2	R: fxd met ox 39k ohms 5% 1/2w	hp	
R114	0758-0050			R: fxd met ox 39k ohms 5% 1/2w	hp	
R115	0687-1011			R: fxd comp 100 ohms 10% 1/2w	01121	EB1011
R116	0757-0059			R: fxd metflm 1 megohm 1% 1/2w	hp	

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

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mlr	Mlr Part No.
R117	0692-3635		2	R: fxd comp 36k ohms 5% 2w	01121	HB3635
R118	0692-3635			R: fxd comp 36k ohms 5% 2w	01121	HB3635
R119	0758-0047			R: fxd met ox 7500 ohms 5% 1/2w	hp	
R120	0687-4731			R: fxd comp 47k ohms 10% 1/2w	01121	EB4731
R201	0687-1011			R: fxd comp 100 ohms 10% 1/2w	01121	EB1011
R202	0687-1851		1	R: fxd comp 1.8 megohms 10% 1/2w	01121	EB1851
R203	2100-0154		1	R: var comp 1000 ohms 30% 0.1w	11237	UPE 70
R204	0758-0017		1	R: fxd met ox 1500 ohms 5% 1/2w	hp	
R205	0758-0073		4	R: fxd met ox 24k ohms 5% 1/2w	hp	
R206	0727-0202		1	R: fxd depc 83k ohms 1% 1/2w	hp	
R207	0687-1531		2	R: fxd comp 15k ohms 10% 1/2w	01121	EB1531
R208	0687-3921		2	R: fxd comp 3900 ohms 10% 1/2w	01121	EB3921
R209	0758-0073			R: fxd met ox 24k ohms 5% 1/2w	hp	
R210	0687-3921			R: fxd comp 3900 ohms 10% 1/2w	01121	EB3921
R211	0727-0201		1	R: fxd depc 71.56k ohms 1% 1/2w	hp	
R212	0687-1041			R: fxd comp 100k ohms 10% 1/2w	01121	EB1041
R213	2100-0188		1	R: var comp 200k ohms 20% 1/4w	11237	VF-45
R214	0686-1245		1	R: fxd comp 120k ohms 5% 1/2w	01121	EB1245
R215	0686-2745		1	R: fxd comp 270k ohms 5% 1/2w	01121	EB2745
R216	0727-0060		1	R: fxd depc 225 ohms 1% 1/2w	hp	
R221	0687-6831		3	R: fxd comp 68k ohms 10% 1/2w	01121	EB6831
R222	0687-1011			R: fxd comp 100 ohms 10% 1/2w	01121	EB1011
R223	0758-0073			R: fxd met ox 24k ohms 5% 1/2w	hp	
R224	0690-1041			R: fxd comp 100k ohms 10% 1w	01121	GB1041
R225	0687-2731		4	R: fxd comp 27k ohms 10% 1/2w	01121	EB2731
R226	0687-6841		2	R: fxd comp 680k ohms 10% 1/2w	01121	EB6841
R227	0727-0110		1	R: fxd depc 1500 ohms 1% 1/2w	hp	
R228	0761-0076		1	R: fxd met ox 18k ohms 5% 1w	hp	
R229	0686-1055			R: fxd comp 1 megohm 5% 1/2w	01121	EB1055
R230	0686-2055		1	R: fxd comp 2 megohm 5% 1/2w	01121	EB2055
R241	0687-4711			R: fxd comp 470 ohms 10% 1/2w	01121	EB4711
R242	0689-1835		1	R: fxd comp 18k ohms 5% 1w	01121	GB1835
R243	0690-8231		1	R: fxd comp 82k ohms 10% 1w	01121	GB8231
R244	0687-2731			R: fxd comp 27k ohms 10% 1/2w	01121	EB2731
R245	0687-4711			R: fxd comp 470 ohms 10% 1/2w	01121	EB4711
R246	0687-4741		1	R: fxd comp 470k ohms 10% 1/2w	01121	EB4741
R247	2100-0094		2	R: var comp 50k ohms 30% 0.1w	11237	UPE 70 SPECIAL
R251	0771-0006		1	R: fxd met ox 27k ohms 10% 4w	hp	
R252	0687-1241		1	R: fxd comp 120k ohms 10% 1/2w	01121	EB1241
R253	0687-1041			R: fxd comp 100k ohms 10% 1/2w	01121	EB1041
R254	2100-0144		2	R: var comp 250k ohms 30% 0.1w	11237	UPE 70
R255	0758-0006		1	R: fxd met ox 10k ohms 5% 1/2w	hp	
R256	0686-4345		1	R: fxd comp 430k ohms 5% 1/2w	01121	EB4345

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

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
R257	0758-0073			R: fxd met ox 24k ohms 5% 1/2w	hp	
R258	2100-0093		1	R: var comp 20k ohms 20% 0.1w	11237	OBD
R259	0687-2731			R: fxd comp 27k ohms 10% 1/2w	01121	EB2731
R261	0687-1051		6	R: fxd comp 1 megohm 10% 1/2w	01121	EB1051
R262	0727-0376		1	R: fxd depc 1.98 megohm 1% 1/2w	hp	
R263	0727-0173		1	R: fxd depc 20k ohms 1% 1/2w	hp	
R264	0727-0285		1	R: fxd depc 1.8 megohm 1% 1/2w	hp	
R265	0757-0128		1	R: fxd met flm 200k ohms 1% 1/2w	hp	
R266	0687-4731			R: fxd comp 47k ohms 10% 1/2w	01121	EB4731
R267	2100-0094			R: var comp 50k ohms 30% 0.1w	11237	UPE 70 SPECIAL
R268	0727-0132		1	R: fxd depc 4000 ohms 1% 1/2w	hp	
R269	0727-0100		1	R: fxd depc 1000 ohms 1% 1/2w	hp	
R270	0687-6841			R: fxd comp 680k ohms 10% 1/2w	01121	EB6841
R271	0727-0292		4	R: fxd depc 3 megohm 1% 1/2w	hp	
R272	0727-0292			R: fxd depc 3 megohm 1% 1/2w	hp	
R273	0727-0292			R: fxd depc 3 megohm 1% 1/2w	hp	
R274	0727-0292			R: fxd depc 3 megohm 1% 1/2w	hp	
R275A/B	2100-0338		1	R: var comp log dual 100k ohms 20% 1/4w (includes S103)	11237	OBD
R276	0687-3931		1	R: fxd comp 39k ohms 10% 1/2w	01121	EB3931
R277	0687-2231			R: fxd comp 22k ohms 10% 1/2w	01121	EB2231
R278	0687-2741			R: fxd comp 270k ohms 10% 1/2w	01121	EB2731
R279	0687-1541		1	R: fxd comp 150k ohms 10% 1/2w	01121	EB1541
R301	0687-1021		2	R: fxd comp 1000 ohms 10% 1/2w	01121	EB1021
R302	0687-1041			R: fxd comp 100k ohms 10% 1/2w	01121	EB1041
R303	0693-1541		1	R: fxd comp 150k ohms 10% 2w	01121	HB1541
R304	0690-5641		1	R: fxd comp 560k ohms 10% 1w	01121	GB5641
R305	0687-1051			R: fxd comp 1 megohm 10% 1/2w	01121	EB1051
R306	0687-1551		1	R: fxd comp 1.5 megohm 10% 1/2w	01121	EB1551
R307	0686-2455		1	R: fxd comp 2.4 megohm 5% 1/2w	01121	EB2455
R308	2100-0096		1	R: var comp 1 megohm 30% 0.1w	11237	UPE 70 SPECIAL
R309	0693-5651		3	R: fxd comp 5.6 megohm 10% 2w	01121	HB 5651
R310	0693-5651			R: fxd comp 5.6 megohm 10% 2w	01121	HB 5651
R311	0693-5651			R: fxd comp 5.6 megohm 10% 2w	01121	HB 5651
R312	2100-0105		1	R: var comp 3.5 megohm 30% 1/2w	11237	UPE 70
R313	0687-5641		1	R: fxd comp 560k ohms 10% 1/2w	01121	EB5641
R314	0687-2731			R: fxd comp 27k ohms 10% 1/2w	01121	EB2731
R315	0687-6831			R: fxd comp 68k ohms 10% 1/2w	01121	EB6831
R316	2100-0095		1	R: var comp 100k ohms 30% 0.1w	11237	OBD
R317	0687-6831			R: fxd comp 68k ohms 10% 1/2w	01121	EB6831
R318	0687-2251		1	R: fxd comp 2.2 megohm 10% 1/2w	01121	EB2251
R319	0687-3331		2	R: fxd comp 33k ohms 10% 1/2w	01121	EB3331
R320	2100-0102			R: var comp 500k ohms 30% 0.1w	11237	UPE 70 SPECIAL
R321	2100-0171		1	R: var comp 200k ohms 20% 1/4w (includes S301)	11237	VF-45
R322	0687-1041			R: fxd comp 100k ohms 10% 1/2w	01121	EB1041
R323	0693-8251		3	R: fxd comp 8.2 megohm 10% 2w	01121	HB8251
R324	0693-8251			R: fxd comp 8.2 megohm 10% 2w	01121	HB8251
R325	0693-8251			R: fxd comp 8.2 megohm 10% 2w	01121	HB8251

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

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
R326 R327	0687-4731 0687-2751		1	R: fxd comp 47k ohms 10% 1/2w R: fxd comp 2.7 megohm 10% 1/2w	01121 01121	EB4731 EB2751
R331 R332 R333 R334 R335	0687-1051 0687-1051 0690-1841 0690-4741 0687-1051		1 1 1	R: fxd comp 1 megohm 10% 1/2w R: fxd comp 1 megohm 10% 1/2w R: fxd comp 180k ohms 10% 1w R: fxd comp 470k ohms 10% 1w R: fxd comp 1 megohm 10% 1/2w	01121 01121 01121 01121 01121	EB1051 EB1051 GB1841 GB4741 EB1051
R336 R337 R338 R339 R340	0687-4731 0687-4711 0687-1021 0727-0236 0727-0218		1 1	R: fxd comp 47k ohms 10% 1/2w R: fxd comp 470 ohms 10% 1/2w R: fxd comp 1000 ohms 10% 1/2w R: fxd depc 360k ohms 10% 1/2w R: fxd depc 180k ohms 1% 1/2w	01121 01121 01121 hp hp	EB4731 EB4711 EB1021
R341 R342	0727-0378 0687-4711		1	R: fxd depc 257.1k ohms 1% 1/2w R: fxd comp 470 ohms 10% 1/2w	hp 01121	EB4711
R351 R352 R353 R354 R355	0727-0287 2100-0144 0727-0289 0687-8241 0687-8231		1 1 1 1	R: fxd depc 2 megohm 1% 1/2w R: var comp 250k ohms 30% 0.1w R: fxd depc 2.52 megohm 1% 1/2w R: fxd comp 820k ohms 10% 1/2w R: fxd comp 82k ohms 10% 1/2w	hp 11237 hp 01121 01121	UPE 70 EB8241 EB8231
R356 R357 R358 R359	0761-0006 0687-1831 0687-1531 0687-1051		1 1	R: fxd met ox 10k ohms 5% 1w R: fxd comp 18k ohms 10% 1/2w R: fxd comp 15k ohms 10% 1/2w R: fxd comp 1 megohm 10% 1/2w	hp 01121 01121 01121	EB1831 EB1531 EB1051
R361 R362 R363 R364A/B R365	0699-0006 0699-0006 0767-0010 2100-0150 0687-3331		2 1 1	R: fxd comp 4.7 ohms 10% 1w R: fxd comp 4.7 ohms 10% 1w R: fxd met ox 15k ohms 5% 3w R: var comp dual 10k ohms 20% 1/4w R: fxd comp 33k ohms 10% 1/2w	01121 01121 hp 11237 01121	GB47G1 GB47G1 UPE 70 EB3331
S1 S2 S3A/B/C	3101-0011 3101-0010		3 1	S: slide dpdt (p/o A3) NSR: part of A2 S: pushbutton dpdt	82389 82389	11A-1013 3S-1407
S101 S102 S103	3101-0011 3101-0011			S: slide dpdt (p/o A102) S: slide dpdt (p/o A101) NSR: part of R275A/B	82389 82389	11A-1013 11A-1013
S201 S202				NSR: part of A201 NSR: part of R213		
S204				NSR: part of A204		
S301				NSR: part of R321		
T301 T302	120A-11A-1 9100-0156		1 1	T: high voltage T: power	hp 98734	6-1691



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

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
V1	1932-0029		5	V: electron dual triode 12AU7	hp	
V2	1932-0029			V: electron dual triode 12AU7	hp	
V3	1932-0035		3	V: electron dual triode 6DJ8	hp	
V4	2140-0084		6	V: glow lamp aged	74276	A092
V5	2140-0084			V: glow lamp aged	74276	A092
V101	1932-0029			V: electron dual triode 12AU7	hp	
V102	1932-0035			V: electron dual triode 6DJ8	hp	
V201	1932-0035			V: electron dual triode 6DJ8	hp	
V202	1933-0014		3	V: electron triode - pentode 6GH8A	hp	
V203	1932-0029			V: electron dual triode 12AU7	hp	
V204	1921-0005		1	V: electron triode 6C4	hp	
V205	1933-0014			V: electron triode - pentode 6GH8A	hp	
V206	2140-0084			V: glow lamp aged	74276	A092
V207	2140-0084			V: glow lamp aged	74276	A092
V208	2140-0084			V: glow lamp aged	74276	A092
V209	2140-0084			V: glow lamp aged	74276	A092
V301	1932-0029			V: electron dual triode 12AU7	hp	
V302	1923-0018		1	V: electron beam power pentode 6AQ5	hp	
V303	1920-0001		2	V: electron high voltage diode 5642	hp	
V304	1920-0001			V: electron high voltage diode 5642	hp	
V305	5083-0353		1	CRT: P31 phosphor internal graticule	hp	
V307	1921-0010		2	V: electron low-mu triode 12B4A	hp	
V308	1933-0014			V: electron triode - pentode 6GH8A	hp	
V309	1921-0010			V: electron low-mu triode 12B4A	hp	
V310	1923-0021		1	V: electron pentode 6AU6	hp	
V311	1940-0001		1	V: electron voltage reference 5651A	hp	
W1	8120-0050		1	W: power cord (includes P301)	70903	CS-9941/PH-151/ 7.5 ft
XV1	1200-0062		12	XV: 9 pin minat	71785	121-51-11-060
XV2	1200-0062			XV: 9 pin minat	71785	121-51-11-060
XV3	1200-0062			XV: 9 pin minat	71785	121-51-11-060
XV101	1200-0062			XV: 9 pin minat	71785	121-51-11-060
XV102	1200-0062			XV: 9 pin minat	71785	121-51-11-060
XV201	1200-0062			XV: 9 pin minat	71785	121-51-11-060
XV202	1200-0062			XV: 9 pin minat	71785	121-51-11-060
XV203	1200-0062			XV: 9 pin minat	71785	121-51-11-060
XV204	1200-0053		4	XV: 7 pin minat	71785	111-51-11-069
XV205	1200-0062			XV: 9 pin minat	71785	121-51-11-060

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

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
XV301	1200-0062			XV: 9 pin minat	71785	121-51-11-060
XV302	1200-0053			XV: 7 pin minat	71785	111-51-11-069
XV305	1200-0037			NSR - consists of:		
	1200-0050			Socket: crt	hp	
	1200-0192			Pin: crt socket	hp	
	1200-0062			Cover: crt socket	hp	
XV307	1200-0062			XV: 9 pin minat	71785	121-51-11-060
XV308	1200-0062			XV: 9 pin minat	71785	121-51-11-060
XV309	1200-0062			XV: 9 pin minat	71785	121-51-11-060
XV310	1200-0053			XV: 7 pin minat	71785	111-51-11-069
XV311	1200-0053			XV: 7 pin minat	71785	111-51-11-069
XQ301	1200-0041	1		XQ: 2 pin	71785	133-92-10-034
<b>MISCELLANEOUS</b>						
	0370-0026	2		Knob: 3/4 inch black w/arrow	hp	
	0370-0037	2		Knob: 1 inch skirted black w/arrow	hp	
	0370-0062	2		Knob: 3/4 inch red w/arrow	hp	
	0370-0084	2		Knob: 5/8 inch black w/arrow	hp	
	0370-0113	1		Knob: 3/4 inch skirted black w/arrow	hp	
	0370-0114	1		Knob: 5/8 inch red w/arrow	hp	
	0905-0016	1		Gasket: felt (crt)	hp	
	1200-0043	1		Insulator: anodized alum (for Q301)	76530	293011
	1205-0003	1		Insulator: transistor (Q301)	hp	
	1205-0007	1		Dissipator: heat (nut)	hp	
	1205-0008	1		Dissipator: heat (body)	hp	
	5000-0408	3		Bracket: coil alignment	hp	
	5040-0401	7		Support: hv capacitor	hp	
	5040-0421	1		Insulator: hv (intensity pot)	hp	
	5040-0466	1		Retainer: crt shield	hp	
	120A-20A	1		Bezel: crt	hp	
	120B-1A	1		Deck: main	hp	
	120B-1B	1		Deck: capacitor	hp	
	120B-5A	1		Bracket: angle center	hp	
	120B-6D	1		Shield: sync	hp	
	120B-16B	1		Cable: vertical input	hp	
	120B-6F	1		Assy: crt shield	hp	
	120B-16F	1		Cable: main harness	hp	
	120B-83D	1		Support: pc board stiffener	hp	
<b>SPECIAL ORDER CRT'S</b>						
	5083-0323			CRT: P2 phosphor internal graticule	hp	
	5083-0333			CRT: P7 pyosphor internal graticule	hp	
	5083-0342			CRT: P11 phosphor aluminized internal graticule	hp	
<b>OPTION 05</b>						
(Parts required in addition to, or instead of, standard parts.)						
	0693-4711	1		R: fxd comp 470 ohms 10% 2w	hp	
	1370-0084	1		Knob: 5/8 inch black w/arrow	hp	
	1450-0084	4		Lampholder: screw base miniature	hp	
	2100-1838	1		R: var comp 300 ohms 20% 1w, with spst switch	hp	
	2140-0057	4		Lamp: 6 v incd miniature screw base	24455	1768

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

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
<b>OPTION 05 (cont'd)</b>						
	5040-0420		1	Mask: light	hp	
	5083-0310			CRT: P1 phosphor w/o internal graticule	hp	
	5083-0320			CRT: P2 phosphor w/o internal graticule	hp	
	5083-0330			CRT: P7 phosphor w/o internal graticule	hp	
	5083-0340			CRT: P11 phosphor w/o internal graticule	hp	
	5083-0350		1	CRT: P31 phosphor w/o internal graticule	hp	
	9100-1108		1	T: power	hp	
	120A-83A			Filter: light amber (for P7 phosphor)	hp	
	120A-83B			Filter: light blue (for P31 phosphor)	hp	
	120A-83C			Graticule: external scribed	hp	
	120A-83G		1	Filter: light green (for P1, P2, P31 phosphor)	hp	
	120B-2F		1	Panel: front	hp	
	120B-83C-1			Graticule: external unscribed	hp	
	120B-83E		1	Retainer: crt	hp	
<b>OPTION 06</b>						
(Parts required in addition to, or instead of, standard parts.)						
	2151-0038		2	Connector: 3 pin female	71468	CA3106A10SL-3S-A105 AN3057-4
	2151-0040		2	Clamp: cable	71468	
	120B-2G		1	Panel: rear	hp	
	120B-16J		1	Cable: 20 inch	hp	
	120B-16K		1	Cable: 26 inch	hp	
					hp	
<b>OPTION 13</b>						
(Parts required in addition to, or instead of, standard parts.)						
	120B-2H		1	Panel: front	hp	
	120B-5B		2	Casting: frame side	hp	
	120B-6G		1	Assy: vertical shield (A101)	hp	
	120B-12P		2	Assy: ac/dc switch (A3, A102)	hp	
	120B-37A		2	Bar: panel mounting	hp	
	120B-47A		2	Support: panel	hp	

Table 6-3. Code List of Manufacturers

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 handbooks.

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
00000	U. S. A. Common	Any supplier of U. S.	07126	Digitran Co.	Pasadena, Calif.	17474	Tranex Company	Mountain View, Calif.	71707	Coto Coil Co. Inc.	Providence, R. I.
00136	McCoy Electronics	Mount Holly Springs, Pa.	07137	Transistor Electronics Corp.	Minneapolis, Minn.	18042	Power Design Pacific Inc.	Palo Alto, Calif.	71744	Chicago Miniature Lamp Works	Chicago, Ill.
00213	Sage Electronics Corp.	Rochester, N. Y.	07138	Westinghouse Electric Corp.	Elmira, N. Y.	18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.	71753	A. O. Smith Corp.	Crowley Div. West Orange, N. J.
00287	Canco Inc.	Danielson, Conn.	07149	Filmohm Corp.	New York, N. Y.	18486	Radio Industries	Des Plaines, Ill.			
00374	Humifal	Colton, Calif.	07233	Cinch-Graphix Co.	City of Industry, Calif.	18503	Curtis Instrument, Inc.	Mt. Kisco, N. Y.	71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
00373	Garlock Inc., Electronics Products Div.	Camden, N. J.	07261	Avnet Corp.	Los Angeles, Calif.	18873	E. J. DuPont and Co., Inc.	Wilmington, Del.	71984	Dow Corning Corp.	Midland, Mich.
00656	Aerovox Corp.	New Bedford, Mass.	07263	Fairchild Camera & Inst. Corp.	Mountain View, Calif.	18913	Dutant Mfg. Co.	Milwaukee, Wis.	72136	Electro Motive Mfg. Co., Inc.	Williamatic, Conn.
00779	Amp. Inc.	Harrisburg, Pa.	07322	Minnesota Rubber Co.	Minneapolis, Minn.	19315	Bondix Corp., The	Teterboro, N. J.	72354	John E. Fast Co., Div. Victoreen Instr. Co.	Chicago, Ill.
00781	Aircraft Radio Corp.	Boonton, N. J.	07387	Bircher Corp., The	Monterey Park, Calif.	19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N. J.			
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.	07700	Technical Wire Products Inc.	Cranford, N. J.	19644	LRC Electronics	Horseheads, N. Y.	72619	Dialight Corp.	Brooklyn, N. Y.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S. C.	07910	Continental Device Corp.	Hawthorne, Calif.	19701	Electra Mfg. Co.	Independence, Kansas	72656	Indiana General Corp., Electronics Div.	Keasby, N. J.
			07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.	20183	General Atomics Corp.	Philadelphia, Pa.	72765	Drake Mfg. Co.	Chicago, Ill.
00866	Goe Engineering Co.	Los Angeles, Calif.	87966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.	21226	Execulone, Inc.	New York, N. Y.	72825	Hugh H. Eby Inc.	Philadelphia, Pa.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.	07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N. J.	21335	Falmr Bearing Co., The	New Britain, Conn.	72928	Gudeman Co.	Chicago, Ill.
01121	Allen Bradley Co.	Milwaukee, Wis.	08145	U. S. Engineering Co.	Los Angeles, Calif.	21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.	72982	Eric Technological Products, Inc.	Enne, Pa.
01255	Litton Industries, Inc.	Beverly Hills, Calif.	08289	Blinn, Delbert Co.	Pomona, Calif.	24655	General Radio Co.	West Concord, Mass.	73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.	08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada	26462	Grabel File Co. of America, Inc.	New Rochelle, N. Y.	73076	H. M. Harper Co.	Chicago, Ill.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas						73138	Helipot Div. of Beckman Inst., Inc.	Fuллертон, Calif.	
01349	The Alliance Mfg. Co.	Alliance, Ohio	08664	Bristol Co., The	Waterbury, Conn.	26992	Hamilton Watch Co.	Carlstadt, N. J.	73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
01589	Pacific Relays, Inc.	Van Nuys, Calif.	08717	Sloan Company	Sun Valley, Calif.	28480	Hewlett-Packard Co.	Palo Alto, Calif.	73445	Ampetec Electronic Co., Div. of North American Philips Co., Inc.	Hicksville, N. Y.
01930	Aerocorp Corp.	Rockford, Ill.	08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona	33173	G. E. Receiving Tube Dept.	Owensboro, Ky.	73506	Bradley Semi-conductor Corp.	New Haven, Conn.
01961	Pulse Engineering Co.	Santa Clara, Calif.	88792	CBS Electronics Semiconductor Operations, Div. of C. B. S. Inc.	Lowell, Mass.	35434	Lectrohm Inc.	Chicago, Ill.	73559	Cardling Electric, Inc.	Hatfield, Conn.
02114	Ferriacube Corp. of America	Saugerties, N. Y.				36196	Starwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada	73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.
02286	Colo Rubber and Plastics Inc.	Sunnyvale, Calif.	08984	Mel-Rain	Indianapolis, Ind.	37942	P. R. Malloy & Co. Inc.	Indianapolis, Ind.	73734	Federal Screw Products Inc.	Chicago, Ill.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.	09026	Babcock Relays Div.	Costa Mesa, Calif.	39543	Mechanical Industries Prod. Co.	Akron, Ohio	73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N. J.	09134	Texas Capacitor Co.	Houston, Texas	40920	Miniature Precision Bearings, Inc.	Keene, N. H.	73793	General Industries Co., The	Elyria, Ohio
			09145	Altoh Electronics	Sun Valley, Calif.	42190	Muter Co.	Chicago, Ill.	73846	Goshen Stamping & Tool Co.	Goshen, Ind.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.	09250	Electro Assemblies, Inc.	Chicago, Ill.	43990	C. A. Horgren Co.	Englewood, Colo.	73859	JFD Electronics Corp.	Brooklyn, N. Y.
02777	Hopkins Engineering Co.	San Fernando, Calif.	09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada	44555	Ohmrite Mfg. Co.	Skokie, Ill.	73905	Jennings Radio Mfg. Corp.	San Jose, Calif.
03508	G. E. Semiconductor Prod. Dept.	Syracuse, N. Y.	10214	General Transistor Western Corp.	Los Angeles, Calif.	47904	Polaron Corp.	Cambridge, Mass.	74276	Signalite Inc.	Neptune, N. J.
03705	Apx Machine & Tool Co.	Dayton, Ohio	10411	Ti-Tal, Inc.	Berkeley, Calif.	48620	Precision Thermometer & Inst. Co.	Southampton, Pa.	74455	J. H. Wynn, and Sons	Winchester, Mass.
03797	Eldema Corp.	Compton, Calif.	10646	Carborundum Co.	Niagara Falls, N. Y.	49956	Microwave & Power Tube Div.	Waltham, Mass.	74861	Industrial Condenser Corp.	Chicago, Ill.
03877	Transitron Electric Corp.	Wakfield, Mass.	11236	CTS of Berne, Inc.	Berne, Ind.	52983	Ranoh Company	Waltham, Mass.	74868	R. F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N. J.	11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.	54924	Shaltcross Mfg. Co.	Selma, N. C.	74970	E. F. Johnson Co.	Wassa, Minn.
03954	Singer Co., Diehl Div. Findene Plant	Sumerville, N. J.	11242	Bay State Electronics Corp.	Waltham, Mass.	55026	Simpson Electric Co.	Chicago, Ill.	75042	International Resistance Co.	Philadelphia, Pa.
84009	Arrow, Harl and Hegeman Elect. Co.	Hartford, Conn.	11534	Duncan Electronics Inc.	Costa Mesa, Calif.	55933	Sonolone Corp.	Elmsford, N. Y.	75378	James Knight Co.	Sandwich, Ill.
			11711	Div., Products Group	Newark, N. J.	56289	Sprague Electric Co.	North Adams, Mass.	75382	Kulka Electric Corporation	Mt. Vernon, N. Y.
04013	Taurus Corp.	Lambertville, N. J.	11717	Imperial Electronic, Inc.	Buena Park, Calif.	59446	Telex, Inc.	St. Paul, Minn.	75818	Lentz Electric Mfg. Co.	Chicago, Ill.
04062	Element Products Co.	New York, N. Y.	11870	Melabs, Inc.	Palo Alto, Calif.	59730	Thomas & Betts Co.	Elizabeth, N. J.	76005	Lord Mfg. Co.	Eric, Pa.
04222	Hi-Q Division of Aerovox	Chicago, Ill.	12659	Claroat Mfg. Co.	Camden, N. J.	60741	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Bluffton, Ohio	76210	C. W. Marwedel	San Francisco, Calif.
04354	Precision Paper Tube Co.	Chicago, Ill.	12859	Nippon Electric Co., Ltd.	Dover, N. H.	61775	Universal Electric Co.	Pittsburgh, Pa.	76433	General Instrument Corp., Micamold Div.	Newark, N. J.
84404	Dynac Division of Hewlett-Packard Co.	Palo Alto, Calif.	12881	Metex Electronics Corp.	Tokyo, Japan	62119	Western Electric Co.	Dwoss, Mich.	76487	James Millen Mfg. Co., Inc.	Malden, Mass.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.	12930	Delta Semiconductor Inc.	Clark, N. J.	63743	Ward-Leonard Electric Co.	Mt. Vernon, N. Y.	76493	J. W. Miller Co.	Los Angeles, Calif.
04713	Molofola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona	12954	Dickson Electronics Corp.	Newport Beach, Calif.	64555	Western Electric Co., Inc.	New York, N. Y.	76530	Monadnock Mills	San Leandro, Calif.
04732	Fitron Co., Inc. Western Div.	Culver City, Calif.	13103	Thermolloy	Scottsdale, Arizona	65092	Weston Inst. Inc. Weston-Newark Mtl. Co.	Newark, N. J.	76545	Mueller Electric Co.	Cleveland, Ohio
04773	Automatic Electric Co.	Northlake, Ill.	13396	Telefunken (GmbH)	Dallas, Texas	66295	Wiltek Mfg. Co.	Chicago, Ill.	76854	Dak Manufacturing Co.	Crystal Lake, Ill.
04796	Sequia Wire Co.	Redwood City, Calif.	13835	Midland-Wright Div. of Pacific Industries, Inc.	Hanover, Germany	66346	Revere Wollansak Div. Minn. Mining & Mtl. Co.	St. Paul, Minn.	77068	Bondix Corp., The	Brooklyn, N. Y.
04811	Precision Coil Spring Co.	El Monte, Calif.				70276	Allen Mfg. Co.	Hartford, Conn.	77075	Bondix Pacific Div.	N. Hollywood, Calif.
04870	P. M. Motor Company	Westchester, Ill.	14059	Sem-Tech	Kansas City, Kansas	70318	Allmetal Screw Product Co., Inc.	Garden City, N. Y.	77221	Phonetic Metal Co.	San Francisco, Calif.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.	14193	Calif. Resistor Corp.	Newbury Park, Calif.	70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.	77221	Phonetic Instrument and Electronic Co.	South Pasadena, Calif.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.	14298	American Components, Inc.	Santa Monica, Calif.	70563	Angstrim Co., Inc.	Chicago, Ill.	77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
05347	Ultrinox, Inc.	San Mateo, Calif.	14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Co.	West Palm Beach, Fla.	70903	Belden Mtl. Co.	Chicago, Ill.	77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
05593	Usonic Electronic Engineering Co.	Sunnyvale, Calif.	14493	Hewlett-Packard Company	Loveland, Colo.	70958	Bird Electronic Corp.	Chicago, Ill.	77630	TRW Electronic Components Div.	Camden, N. J.
05616	Homo Plastic (C/o Electrical Spec. Co.)	Cleveland, Ohio	14655	Cornell Dublier Electric Corp.	Newark, N. J.	71002	Birnbach Radio Co.	New York, N. Y.	77638	General Instrument Corp., Rectifier Div.	Brooklyn, N. Y.
05624	Barber Colman Co.	Rockford, Ill.	14674	Corning Glass Works	Corning, N. Y.	71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.	77764	Resistance Products Co.	Harrisburg, Pa.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N. Y.	14752	Electro Cube Inc.	So. Pasadena, Calif.	71218	Bud Radio, Inc.	Willoughby, Ohio	77899	Rubberairl Corp. of Calif.	Torrance, Calif.
05729	Metro-Tel Corp.	Westbury, N. Y.	14960	Williams Mfg. Co.	San Jose, Calif.	71286	Camloc Fastener Corp.	Paranau, N. J.	78189	Shakproof Division of Illinois Tool Works	Elgin, Ill.
05783	Stewart Engineering Co.	Sania Cruz, Calif.	15203	Webster Electronics Co.	New York, N. Y.	71313	Cardwell Condenser Corp.	Lindenhurst L. I., N. Y.	78283	Signal Indicator Corp.	New York, N. Y.
05820	Wakfield Engineering Inc.	Wakfield, Mass.	15558	Micron Electronics	N. Hollywood, Calif.	71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.	78290	Struthers-Dunn Inc.	Patman, N. J.
06004	Bausch Co., The	Bridgeport, Conn.	15772	Twentieth Century Coil Spring Co.	Sanita Clara, Calif.	71436	Chicago Condenser Corp.	Chicago, Ill.	78452	Thompson-Bremer & Co.	Chicago, Ill.
06175	Bausch and Lomb Optical Co.	Rochester, N. Y.	15818	Amelco Inc.	Ht. View, Calif.	71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.	78471	Tilley Mfg. Co.	San Francisco, Calif.
06402	E. T. A. Products Co. of America	Chicago, Ill.	15909	Daven Div. Thomas A. Edison Inc.	Long Island City, N. Y.	71450	CTS Corp.	Elkhart, Ind.	78488	Slackpole Carbon Co.	San Jose, Calif.
06475	Western Devices Inc.	Burbank, Calif.	16037	Spruce Pine Mica Co.	Spruce Pine, N. C.	71468	ITT Cannon Electric Inc.	Los Angeles, Calif.	78553	Standard Thomson Corp.	Waltham, Mass.
06540	Anatom Electronic Hardware Co., Inc.	New Rochelle, N. Y.	16179	Omni-Spectra Inc.	Detroit, Ill.	71471	Cinema Plant, Hi-Q Div. Aerovox Corp.	Chicago, Ill.	78790	Transformer Engineers	San Gabriel, Calif.
06555	Beebe Electrical Instrument Co., Inc.	Penacook, N. H.	16352	Computer Diode Corp.	Lodi, N. J.	71482	C. P. Clare & Co.	Burbank, Calif.	78947	Ucinite Co.	Newtonville, Mass.
06666	General Devices Co., Inc.	Indianapolis, Ind.	16568	Ideal Prec. Meter Co., Inc.	De Jui Meter Div. Brooklyn, N. Y.	71590	Centralab Div. of Globe Union Inc.	Chicago, Ill.	79136	Waldes Kohnoor Inc.	Long Island City, N. Y.
06751	Nuclear Corp. of America	Phoenix, Arizona	16758	Delco Radio Div. of G. M. Corp.	Kokomo, Ind.	71616	Commercial Plastics Co.	Milwaukee, Wis.	79142	Veeder Root, Inc.	Hartford, Conn.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.	17109	Thermometrics Inc.	Canoga Park, Calif.	71700	Corush Wire Co., The	New York, N. Y.	79251	Wenco Mfg. Co.	Chicago, Ill.
06980	Eitel-McCloughlin Inc.	San Carlos, Calif.						79272	Continental-Wire Electronics Corp.	Philadelphia, Pa.	
07088	Keivn Electric Co.	Van Nuys, Calif.						79963	Zierick Mfg. Corp.	New Rochelle, N. Y.	

00015-41  
Revised November, 1965

From: FSC Handbook Supplements  
H4-1 Dated JULY 1965  
H4-2 Dated NOV 1962

Table 6-3. Code List of Manufacturers (Cont'd)

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
81349	Military Specification	.....	85474	R. M. Bracamonte & Co.	San Francisco, Calif.	93929	G. V. Contois	Livingston, N. J.	98220	Francis L. Mosley	Pasadena, Calif.
81415	Wilkor Products, Inc.	Cleveland, Ohio	85660	Korled Kords, Inc.	New Haven, Conn.	93983	Insuline-Van Norman Ind., Inc.	.....	98278	Microlot, Inc.	So. Pasadena, Calif.
81453	Raytheon Mfg. Co., Industrial Components Div. Industr Tube Operations	Newton, Mass.	85911	Seamless Rubber Co.	Chicago, Ill.		Electronic Division	Manchester, N. H.	98291	Sealectro Corp.	Mamaroneck, N. Y.
81483	International Rectifier Corp.	El Segundo, Calif.	86197	Clifton Precision Products	Clifton Heights, Pa.	94137	General Cable Corp.	Bayonne, N. J.	98405	Carad Corp.	Redwood City, Calif.
81541	The Ampac Products Co.	Cambridge, Mass.	86579	Precision Rubber Products Corp.	Dayton, Ohio	94144	Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation	Quincy, Mass.	98481	General Mills	Minneapolis, Minn.
81860	Barry Controls, Inc.	Watertown, Mass.	86684	Radio Corp. of America, RCA	.....	94145	Raytheon Mfg. Co., Semiconductor Div., California Street Plant	Newton, Mass.	98821	North Hills Electric Co.	Mineola, N. Y.
82042	Cartor Parts Co.	Stokie, Ill.	87216	Phico Corporation (Lansdale Division)	Lansdale, Pa.	94148	Scientific Radio Products, Inc.	.....	98925	Clevite Transistor Prod.	.....
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.	87473	Western Fibrous Glass Products Co.	San Francisco, Calif.		Tung-Sol Electric, Inc.	Loveland, Colo.	98978	International Electronic Research Corp.	Waltham, Mass.
82170	Allen B. DuMont Labs. Inc.	Clifton, N. J.	87664	Van Waters & Rogers Inc.	Seattle, Wash.	94154	Curtiss-Wright Corp., Electronics Div.	Newark, N. J.	99109	Columbia Technical Corp.	Burbank, Calif.
82209	Magure Industries, Inc.	Greenwich, Conn.	87930	Tower Mfg. Corp.	Providence, R. I.	94197	Southco Div. of S. Chester Corp.	East Palms, N. J.	99131	Varian Associates	New York, N. Y.
82219	Sylvania Electric Prod., Inc. Electronic Tube Div.	Emporium, Pa.	88140	Cutler-Hammer, Inc.	Lincoln, Ill.	94222	Tri Dhm Prod. Div. of Model Engineering and Mfg. Co.	Chicago, Ill.	99315	Marshall Industries, Electron Products Division	Pasadena, Calif.
82376	Astron Co.	East Newark, N. J.	88220	Coult-National Batteries, Inc.	St. Paul, Minn.	94310	Wire Cloth Products Inc.	Chicago, Ill.	99370	Control Switch Division, Controls Co.	.....
82389	Switchcraft, Inc.	Chicago, Ill.	88698	General Mills, Inc.	Buffalo, N. Y.	94330	Worcester Pressed Aluminum Corp.	Worcester, Mass.	99800	Delevan Electronics Corp.	East Aurora, N. Y.
82647	Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods.	Atleboro, Mass.	89231	Graybar Electric Co.	Dakland, Calif.	94682	Philbrick Researches, Inc.	Boston, Mass.	99848	Wilco Corporation	Indianapolis, Ind.
82866	Research Products Corp.	Madison, Wis.	89462	Waltes Kohinor, Inc.	Cambridge, Mass.	95023	Allies Products Corp.	Miami, Fla.	99934	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Boston, Mass.
82877	Rotron Manufacturing Co., Inc.	Woodstock, N. Y.	89473	General Electric Distributing Corp.	Schenectady, N. Y.	95236	Continental Connector Corp.	Woodside, N. Y.	99942	Hoffman Instrument Corp. of Calif.	Evanston, Ill.
82893	Vector Electronic Co.	Glendale, Calif.	89636	Carter Parts Div. of Economy Baler Co.	Chicago, Ill.	95238	Leecraft Mfg. Co., Inc.	New York, N. Y.	99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, Calif.	89665	United Transformer Co.	Chicago, Ill.	95263	Lercro Electronics, Inc.	Burbank, Calif.		THE FOLLOWING H-P VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.	
83058	Car Fastener Co.	Cambridge, Mass.	90179	U. S. Rubber Co., Mechanical Goods Div.	Passaic, N. J.	95265	National Coil Co.	.....	10000	Winchester Electronics, Inc.	.....
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N. H.	90970	Bearing Engineering Co.	San Francisco, Calif.	95275	Vitramon, Inc.	Bridgeport, Conn.	00000	Malco Tool and Die	Santa Monica, Calif.
83125	Plyamid Electric Co.	Darlington, S. C.	91260	Connor Spring Mfg. Co.	San Francisco, Calif.	95348	Gondas Corp.	Bloomfield, N. J.	0000F	Western Coil Div. of Automatic Ind., Inc.	Los Angeles, Calif.
83148	Electro Cords Co.	Los Angeles, Calif.	91345	Miller Dial & Nameplate Co.	El Monte, Calif.	95354	Methode Mfg. Co.	Chicago, Ill.	0000P	Ty-Car Mfg. Co., Inc.	Redwood City, Calif.
83186	Victory Engineering Corp.	Springfield, N. J.	91418	Radio Materials Co.	Chicago, Ill.	95712	Dage Electric Co., Inc.	Franklin, Ind.	0000Q	Willow Leather Products Corp.	Holliston, Mass.
83298	Bandix Corp., Red Bank Div.	Red Bank, N. J.	91506	Agat Brothers, Inc.	Attleboro, Mass.	95987	Wekesser Co.	Chicago, Ill.	0000A	British Radio Electronics Ltd.	Newark, N. J.
83315	Hubbell Corp.	Mundelein, Ill.	91637	Dale Electronics, Inc.	Columbus, Neb.	96067	Huggins Laboratories	Suneyvale, Calif.	000AA	ETA	England
83338	Smith, Herman H., Inc.	Brooklyn, N. Y.	91662	Elco Corp.	Philadelphia, Pa.	96095	Hi-Q Division of Aerovox	Dlean, N. Y.	000AB	Indiana General Corp., Elect. Div.	Indiana
83385	Central Screw Co.	Chicago, Ill.	91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.	96256	Thordarson-Messner Div. of Magure Industries, Inc.	MI. Carmel, Ill.	000AC	Precision Instrument Components Co.	Van Nuys, Calif.
83501	Gavit Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.	91827	K F Development Co.	Redwood City, Calif.	96296	Solar Manufacturing Co.	Los Angeles, Calif.	000BB	Rubber Eng. & Development	Hayward, Calif.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N. J.	91929	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freepor, Ill.	96330	Cariton Screw Co.	Chicago, Ill.	000BN	A "M" D Manufacturing Co.	San Jose 27, Calif.
83740	Eveready Battery	New York, N. Y.	91961	Nahm-Bros. Spring Co.	Dakland, Calif.	96341	Microwave Associates, Inc.	Burlington, Mass.	000CQ	Control of Elgin Watch Co.	Burbank, Calif.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.	92180	Tri-Connector Corp.	Peabody, Mass.	96501	Excel Transformer Co.	Oakland, Calif.	000DQ	California Eastern Lab.	Burlingame, Calif.
83821	Loyd Scuggs Co.	Festus, Mo.	92196	Universal Metal Prod., Inc.	Bassett Puente, Calif.	97464	Industrial Retaining Ring Co.	Irvine, N. J.	000EY	S. K. Smith Co.	Los Angeles 45, Calif.
84171	Arco Electronics, Inc.	New York, N. Y.	92367	Elgeet Optical Co., Inc.	Rochester, N. Y.	97539	Automatic and Precision Mfg. Co.	Yonkers, N. Y.			
84396	A. J. Giesener Co., Inc.	San Francisco, Calif.	92607	Tinsolite Insulated Wire Co.	Tarrytown, N. Y.		CBS Electronics, Div. of C. B. S., Inc.	Danvers, Mass.			
84411	Good All Electric Mfg. Co.	Dgallala, Neb.	93332	Sylvania Electric Prod., Inc., Semiconductor Div.	Woburn, Mass.	97979	Reon Resistor Corp.	Yonkers, N. Y.			
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.	93369	Robbins and Myers, Inc.	New York, N. Y.	98141	Axel Brothers Inc.	Jamaica, N. Y.			
85454	Boonton Molding Company	Boonton, N. J.	93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio	98159	Rubber Teck, Inc.	Gardene, Calif.			
85471	A. B. Boyd Co.	San Francisco, Calif.	93788	Howard J. Smith Inc.	Port Monmouth, N. J.						
00144	ADC Products Inc.	Minneapolis, Minn.									
	Subsidiary of Magnetic Controls Co.										
01002	General Electric Co. Capacitor Dept.	Goinville, Fla.									
05397	Union Carbide Corp. Linde Division Kemet Dept.	Cleveland, Ohio									
52983	Sanborn Co.	Waltham, Mass.									
73586	Circle F Mfg. Co.	Trenton, N. J.									
91886	Malco Mfg. Co., Inc.	Chicago, Ill.									

## APPENDIX I MANUAL CHANGES

This appendix contains information on changes required to adapt this manual to an instrument with a serial prefix listed in the table below. Check for your instrument serial prefix and make the changes indicated. Note that these changes adapt the manual to cover a particular instrument as manufactured and therefore will not apply to an instrument subsequently modified in the field. Refer to Section I for information on errata in this manual and on any other instrument serial prefix not covered in this appendix.

Instrument Serial Prefix	Make Numbered Changes
502-	1
433-	1, 2
421-	1, 2, 3
327-, 403-, 409-	1, 2, 3, 4
303-	1, 2, 3, 4, 5
242-, 247-	1, 3, 4, 5, 6
202-, 217-, 219-, 223-	1, 3, 4, 5, 6, 7

### CHANGE 1

Page 5-16, Figure 5-7,  
R108, R110: Change value to 330K.  
Tables 6-1 and 6-2,  
R108, R110: Change to hp Part No. 0687-3341;  
R: fxd, comp, 330K ohms, 10%, 1/2W; Mfr  
01121; Mfr Part No. EB3341.

### CHANGE 2

Tables 6-1 and 6-2,  
C322A/B: Change to hp Part No. 0180-0127; C:  
fxd, elect 2-sect, 120 x 40  $\mu$ f, -10% +50%  
300VDCW; Mfr 56289; Mfr Part No. D36235.

### CHANGE 3

Tables 6-1 and 6-2,  
A1: Change to hp Part No. 120B-65A.  
A202: Change to hp Part No. 120B-65B.  
CR305: Change to hp Part No. 1902-0759; Mfr  
04713; Mfr Part No. 1N2983B.

### CHANGE 4

Page 5-17, Figure 5-8,  
R207: Change value to 18K ohms.  
Page 5-18, Figure 5-9,  
R351: Change value to 1.88M ohms.  
Tables 6-1 and 6-2,  
R207: Change to hp Part No. 0687-1031; R: fxd,  
comp, 10K ohms, 10% 1/2W; Mfr 01121; Mfr  
Part No. EB1031.  
R351: Change to hp Part No. 0727-0286; R: fxd,  
depc, 1.88M ohms, 1% 1/2W; Mfr hp.

### CHANGE 5

Tables 6-1 and 6-2,  
CR201: Change to hp Part No. 1901-0034; Diode:  
Si; Mfr 07933; Mfr Part No. DW204A.

### CHANGE 6

Tables 6-1 and 6-2,  
A201: Change to hp Part No. 120B-19C.  
C321: Change to hp Part No. 0180-0042; C: fxd,  
elect, 120  $\mu$ f, 350VDCW; Mfr 56289; Mfr Part  
No. D3253.  
C325A/B: Change to hp Part No. 0180-0030; C: fxd,  
elect, 2-sect, 120 x 40  $\mu$ f, 450VDCW; Mfr 56289;  
Mfr Part No. D32352.  
MISCELLANEOUS,  
Knob: TRIGGER SOURCE selector: Change to  
hp Part No. 0370-0099.  
Knob: TRIGGER LEVEL control: Change to hp  
Part No. 0370-0134.

### CHANGE 7

Page 5-19, Figure 5-10,  
C305, C307: Change value to 6800 pf.  
C308: Relocate into A302 in parallel with T301  
pin 5 and plate of V303, and change value to  
1500 pf.  
C310: Relocate into A302 in parallel with T301  
pin 9 and plate of V304, and change value to  
1500 pf.  
C312: Change value to .015  $\mu$ f.  
C313, C314: Delete.  
R313: Change value to 680K ohms.  
R322: Change value to 47K ohms.  
R327: Change value to 1.5M ohms.

Tables 6-1 and 6-2,  
A301: Change to hp Part No. 120B-65C.  
A302: Change to hp Part No. 120B-11A.  
C305, C307: Change to hp Part No. 0160-0110;  
C: fxd, paper, 6800 pf, 20% 3000VDCW; Mfr  
56289; Mfr Part No. 184P682030.  
C308, C310: Change to hp Part No. 0160-0061; C:  
fxd, paper, 1500 pf, 20% 500VDCW; Mfr 56289;  
Mfr Part No. 184P152050.  
C312: Change to hp Part No. 0160-0062; C: fxd,  
paper, .015  $\mu$ f, 10% 3000VDCW; Mfr 56289;  
Mfr Part No. 184P153930.  
C313, C314: Delete.  
CR304: Change to hp Part No. 1901-0026; Diode:  
Si; Mfr hp.  
R313: Change to hp Part No. 0687-6841; R: fxd,  
comp, 680K ohms, 10% 1/2W; Mfr 01121; Mfr  
Part No. EB6841.  
R322: Change to hp Part No. 0687-4731; R: fxd,  
comp, 47K ohms, 10% 1/2W; Mfr 01121; Mfr  
Part No. EB4731.  
R327: Change to hp Part No. 0687-1551; R: fxd,  
comp, 1.5M ohms, 10% 1/2W; Mfr 01121; Mfr  
Part No. EB1551.



# MANUAL CHANGES

MODEL 120B

OSCILLOSCOPE

Manual Serials Prefixed: 601-

Manual Printed: NOV 1966

Make all changes in this manual according to the Errata below. Also check the following table for your instrument serial prefix (3 digits) and/or serial number (8 digits) and make any listed change(s) in the manual:

Serial Prefix or Number	Make Manual Changes	Serial Prefix or Number	Make Manual Changes

## ERRATA

Δ

- Page 5-17, Figure 5-8,  
R204: Change value to 1800 ohms, and delete asterisk.
- Page 5-18, Figure 5-9,  
V308: Change tube type to 6GH8A.
- Table 6-2,  
C8, C15, C102, C304, C306: Change to hp Part No. 0160-2902; same description; Mfr 56289; Mfr Part No. 29C214A3CDH. (Preferred replacement.)
- C14: Change to hp Part No. 0160-2983; same description, Mfr and Mfr Part No. (Preferred replacement.)
- C211, C301, C311: Change to hp Part No. 0160-2892; same description; Mfr 05447; Mfr Part No. Type 126. (Preferred replacement.)
- C213, C323, C326, C329: Change to hp Part No. 0160-2897; same description; Mfr 71590; Mfr Part No. DD203. (Preferred replacement.)
- R204: Change to hp Part No. 0758-0043; R: fxd met ox 1800 ohms 5% 1/2w; Mfr hp. (Preferred replacement.)
- Option 05: Change hp Part No. for lamp holder to 1450-0154.
- Option 06:  
Change hp Part No. for 3-pin female connector to 1250-0038.  
Add: hp Part No. 1251-0039; TQ 2; Connector: 3 contact male; Mfr 71468; Mfr Part No. CA3102A10SL-3P-A105.  
Change hp Part No. for cable clamp to 1251-0040.
- Option 13: Change hp Part No. 120B-5B to 120B-5C.



## 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





# CRT WARRANTY CLAIM

FROM: \_\_\_\_\_ Date \_\_\_\_\_

NAME \_\_\_\_\_

COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

For additional information, contact:

NAME \_\_\_\_\_

TITLE \_\_\_\_\_

COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

1. <sup>hp</sup> INSTRUMENT a) MODEL \_\_\_\_\_

b) SERIAL NO. \_\_\_\_\_

2. CRT a) TYPE (on bulb) \_\_\_\_\_

b) SERIAL NO. (on CRT base) \_\_\_\_\_

3. Is defective tube original. YES \_\_\_\_\_ NO \_\_\_\_\_

4. Date purchased (if available) \_\_\_\_\_

5. Describe nature and/or symptoms of trouble. \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

6. Describe operating conditions prior to and at time of failure.  
(Please estimate CRT "on-time" since purchase.)

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

CUT ALONG DOTTED LINE

## UNITED STATES

### ALABAMA

P.O. Box 4207  
2003 Byrd Spring Road S.W.  
Huntsville 35802  
Tel: (205) 881-4591  
TWX: 810-726-2204

### ARIZONA

3009 North Scottsdale Road  
Scottsdale 85251  
Tel: (602) 945-7601  
TWX: 910-950-1282

232 South Tucson Boulevard  
Tucson 85716  
Tel: (602) 623-2564  
TWX: 910-952-1162

### CALIFORNIA

3939 Lankershim Boulevard  
North Hollywood 91604  
Tel: (213) 877-1282  
TWX: 910-499-2170

1101 Embarcadero Road  
Palo Alto 94303  
Tel: (415) 327-6500  
TWX: 910-373-1280

2591 Carlsbad Avenue  
Sacramento 95821  
Tel: (916) 482-1463  
TWX: 910-367-2092

1055 Shafter Street  
San Diego 92106  
Tel: (714) 223-8103  
TWX: 910-335-2000

### COLORADO

7965 East Prentice  
Englewood 80110  
Tel: (303) 771-3455  
TWX: 910-935-0705

### CONNECTICUT

508 Tolland Street  
East Hartford 06108  
Tel: (203) 289-9394  
TWX: 710-425-3416

111 East Avenue  
Norwalk 06851  
Tel: (203) 853-1251  
TWX: 710-468-3750

### DELAWARE

3941 Kennett Pike  
Wilmington 19807  
Tel: (302) 655-6161  
TWX: 510-666-2214

### FLORIDA

P.O. Box 545  
Suite 106  
9999 N.E. 2nd Avenue  
Miami Shores 33153  
Tel: (305) 758-3626  
TWX: 810-848-7262

P.O. Box 20007  
Herndon Station 32814  
621 Commonwealth Avenue  
Orlando  
Tel: (305) 841-3970  
TWX: 810-850-0113

P.O. Box 8128  
Madeira Beach 33708  
410 150th Avenue  
St. Petersburg  
Tel: (813) 391-0211  
TWX: 810-863-0366

### GEORGIA

P.O. Box 28234  
450 Interstate North  
Atlanta 30328  
Tel: (404) 436-6181  
TWX: 810-766-4890

### ILLINOIS

3500 Howard Street  
Skokie 60076  
Tel: (312) 677-0400  
TWX: 910-223-3613

### INDIANA

4002 Meadows Drive  
Indianapolis 46205  
Tel: (317) 546-4891  
TWX: 810-341-3263

### LOUISIANA

P.O. Box 856  
1942 Williams Boulevard  
Kenner 70062  
Tel: (504) 721-6201  
TWX: 810-955-5524

### MARYLAND

6707 Whitestone Road  
Baltimore 21207  
Tel: (301) 944-5400  
TWX: 710-862-0850

P.O. Box 1648  
2 Choke Cherry Road  
Rockville 20850  
Tel: (301) 948-6370  
TWX: 710-828-9684

### MASSACHUSETTS

32 Hartwell Ave.  
Lexington 02173  
Tel: (301) 948-6370  
TWX: 710-332-0382

### MICHIGAN

24315 Northwestern Highway  
Southfield 48075  
Tel: (313) 353-9100  
TWX: 810-232-1532

### MINNESOTA

2459 University Avenue  
St. Paul 55114  
Tel: (612) 645-9461  
TWX: 910-563-3734

### MISSOURI

9208 Wyoming Place  
Kansas City 64114  
Tel: (816) 333-2445  
TWX: 910-771-2087

2812 South Brentwood Blvd.  
St. Louis 63144  
Tel: (314) 644-0220  
TWX: 910-760-1670

### NEW JERSEY

W. 120 Cetry Road  
Paramus 07652  
Tel: (201) 265-5000  
TWX: 710-990-4951

10508 N. Kings Highway  
Cherry Hill 08034  
Tel: (609) 667-4000  
TWX: 710-892-4945

### NEW MEXICO

P.O. Box 8366  
Station C  
6501 Lomas Boulevard N.E.  
Albuquerque 87108  
Tel: (505) 255-5586  
TWX: 910-989-1665

156 Wyatt Drive  
Las Cruces 88001  
Tel: (505) 526-2485  
TWX: 910-983-0550

### NEW YORK

1702 Central Avenue  
Albany 12205  
Tel: (518) 869-8462  
TWX: 710-441-8270

1219 Campville Road  
Endicott 13764  
Tel: (607) 754-0050  
TWX: 510-252-0890

82 Washington Street  
Poughkeepsie 12601  
Tel: (914) 454-7330  
TWX: 510-248-0012

39 Saginaw Drive  
Rochester 14623  
Tel: (716) 473-9500  
TWX: 510-253-5981

1025 Northern Boulevard  
Reslyn, Long Island 11576  
Tel: (516) 869-8400  
TWX: 510-223-0811

5858 East Molloy Road  
Syracuse 13211  
Tel: (315) 454-2486  
TWX: 710-541-0482

### NORTH CAROLINA

P.O. Box 5187  
1923 North Main Street  
High Point 27262  
Tel: (919) 882-6873  
TWX: 510-926-1516

### OHIO

5579 Pearl Road  
Cleveland 44129  
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