120B OSCILLOSCOPE

OPERATING AND SERVICE MANUAL

HEWLETT hp PACKARD

HP 120B

OPERATING AND SERVICE MANUAL

MODEL 120B

OSCILLOSCOPE

SERIALS PREFIXED: 502-

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Table 1-1. Specifications

SWEEP

Sweep Range:
One μsec/cm to at least 0.5 sec/cm. Fifteen calibrated sweeps accurate to within ±5%, in a 1, 2, 5, 10... sequence, from 5 μsec/cm to 200 millisec/cm. Vernier control permits continuous adjustment of sweep time between calibrated steps, and extends the 200 millisec/cm to at least 0.5 sec/cm.

Sweep Expand:
X5 sweep expansion may be used on all ranges and expands fastest sweep to 1 μsec/cm. Expanded sweep accuracy is ±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 ±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 ±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 ±3 volts peak.

Phase Shift:
Vertical and horizontal amplifiers have same phase characteristics within ±2° 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 ±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 ±2° 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 ±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

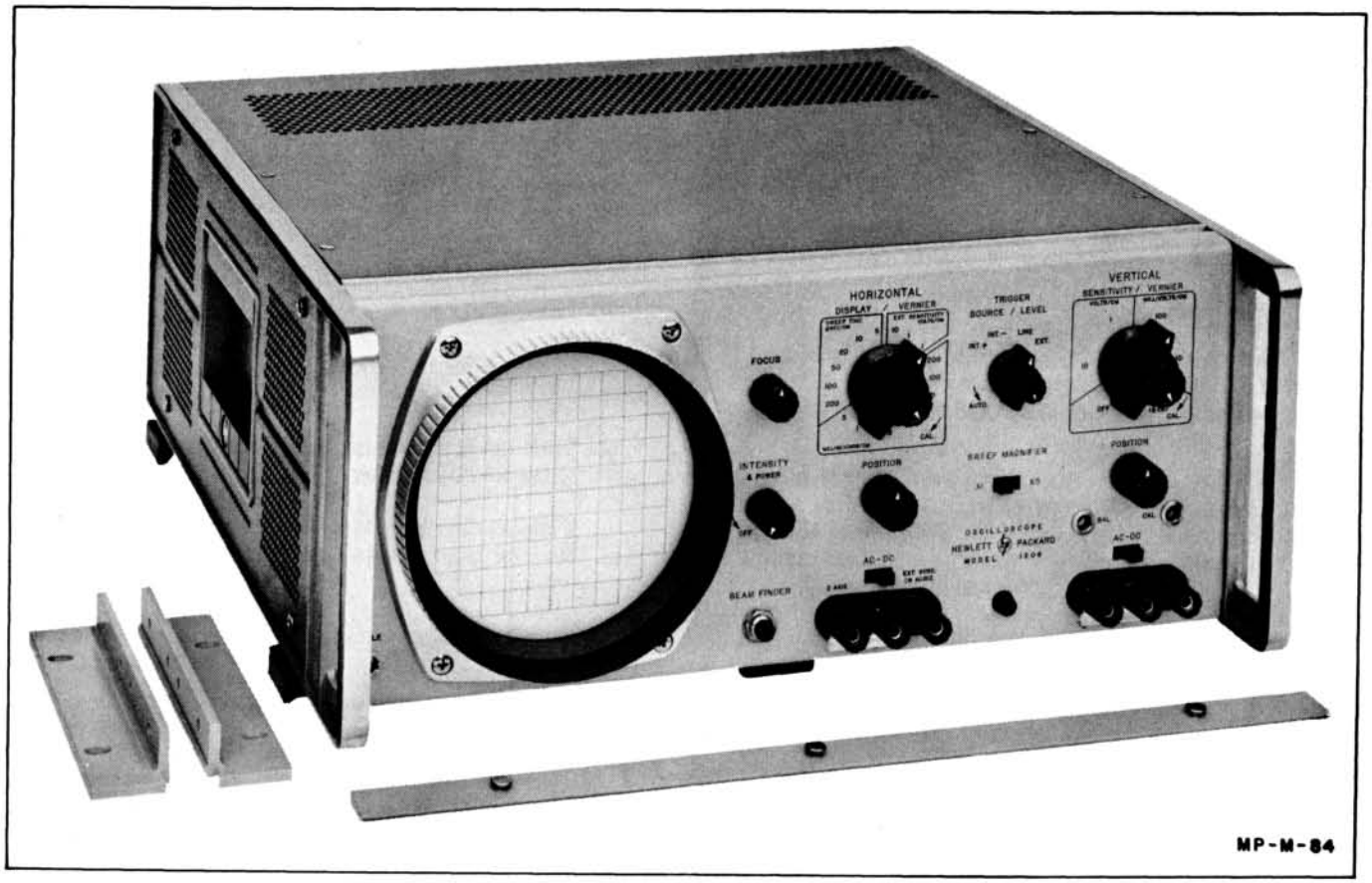


Figure 1-1. Model 120B Oscilloscope

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 ±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 reshipment 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 readjust 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.

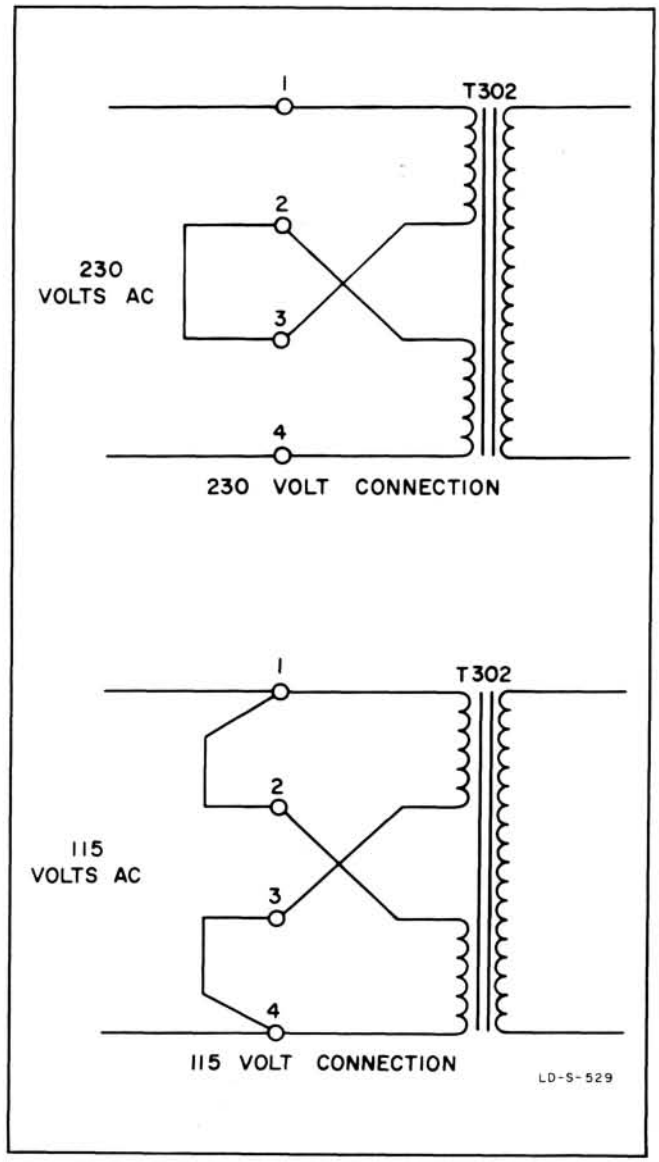


Figure 2-1. Primary-Power Connections

2-7. POWER REQUIREMENTS.

2-8. The Model 120B requires a power source of 115 or 230 volts ±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 1.5-ampere slow-blow line fuse with 1-ampere slow-blow fuse.

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.

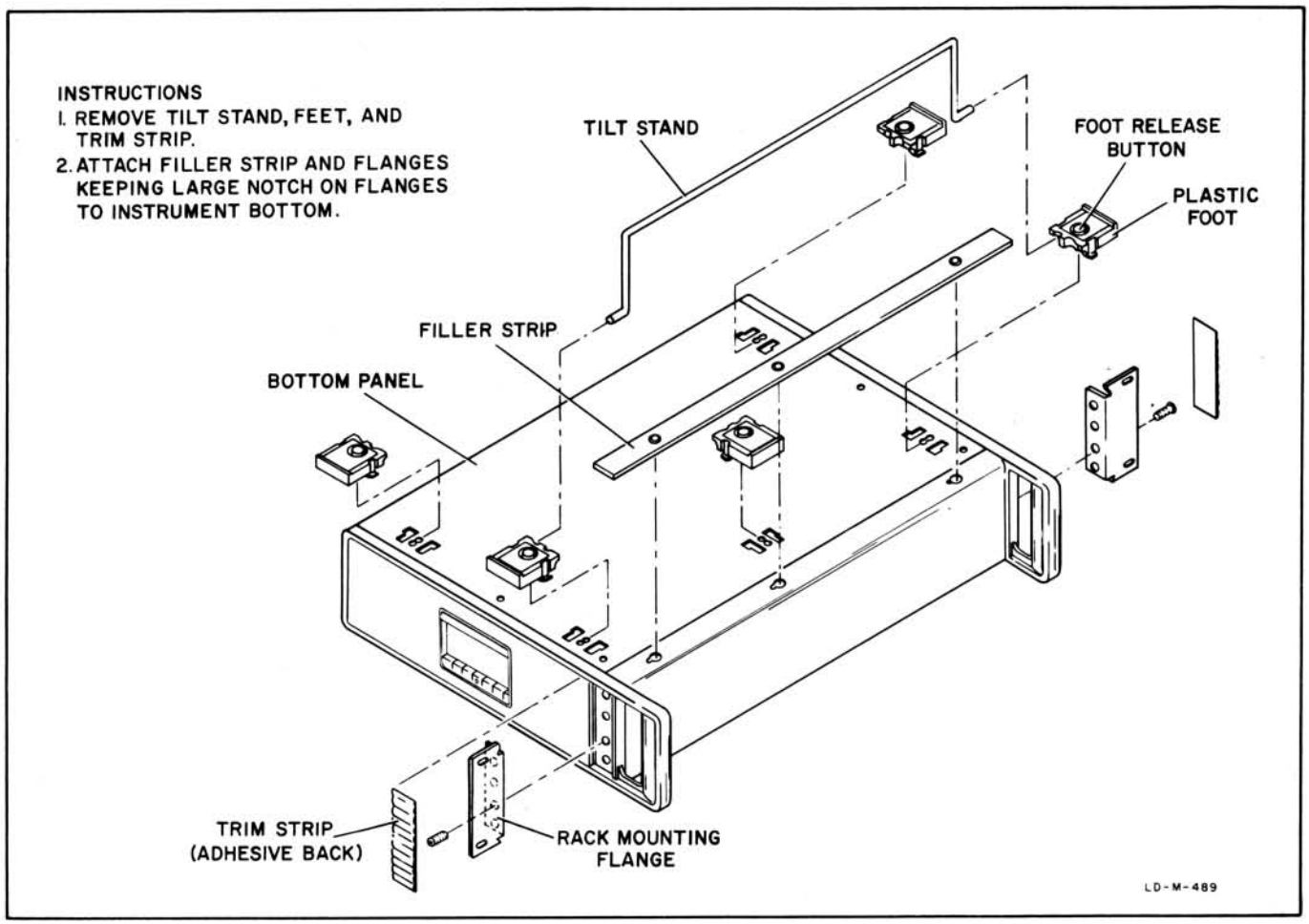


Figure 2-2. Rack Mounting

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 ±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 ±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 counter-clockwise 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.

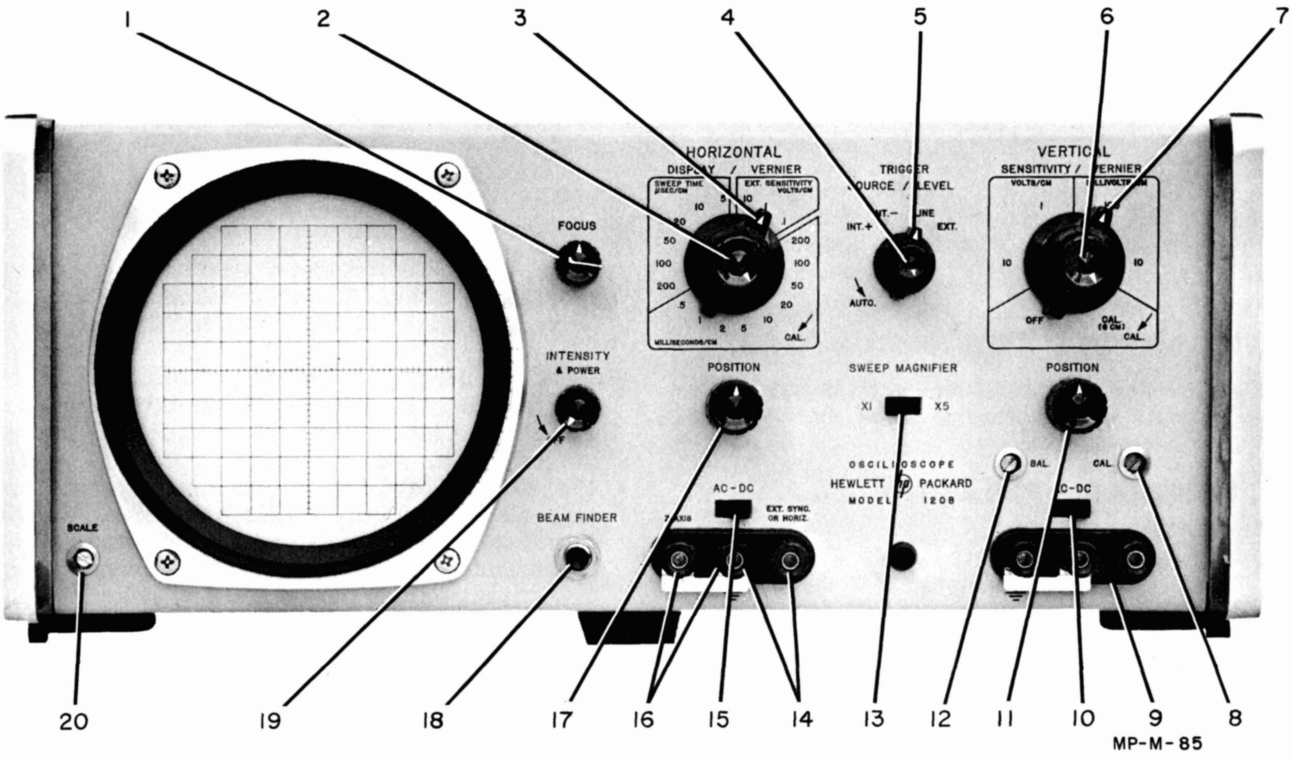
3-15. COMMON-MODE REJECTION. Balanced input to the vertical amplifier is obtained by removing the ground jumper across two of the vertical input terminals and applying a balanced signal input. Balanced input is useful in applications where it is desired to simultaneously amplify the out-of-phase (differential) 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.

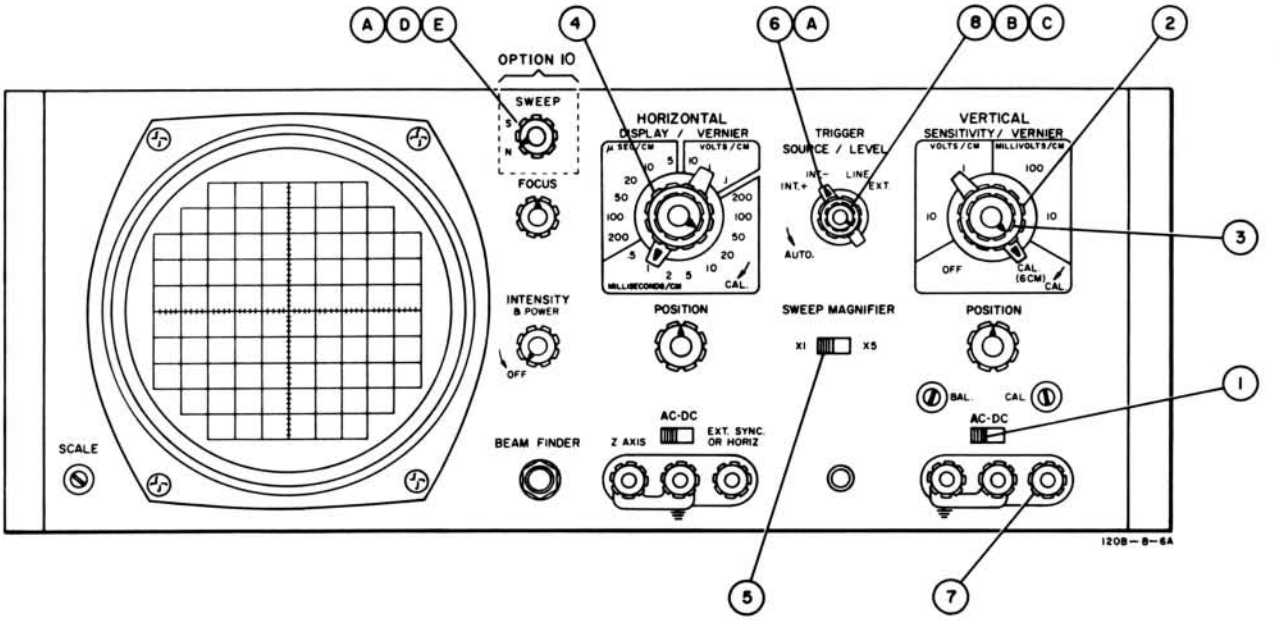
17. Horizontal POSITION: Controls horizontal position of crt display.

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.

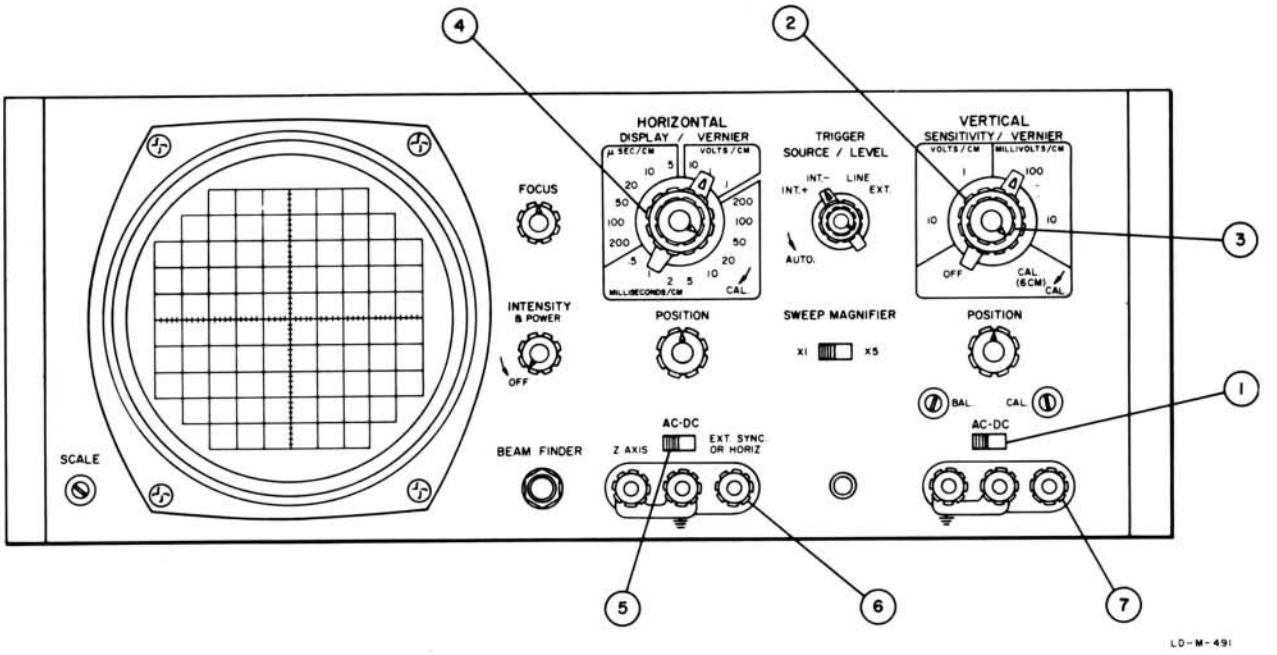
B. Adjust TRIGGER LEVEL control fully clockwise. Minimum trigger sensitivity is obtained with the control in this position.

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

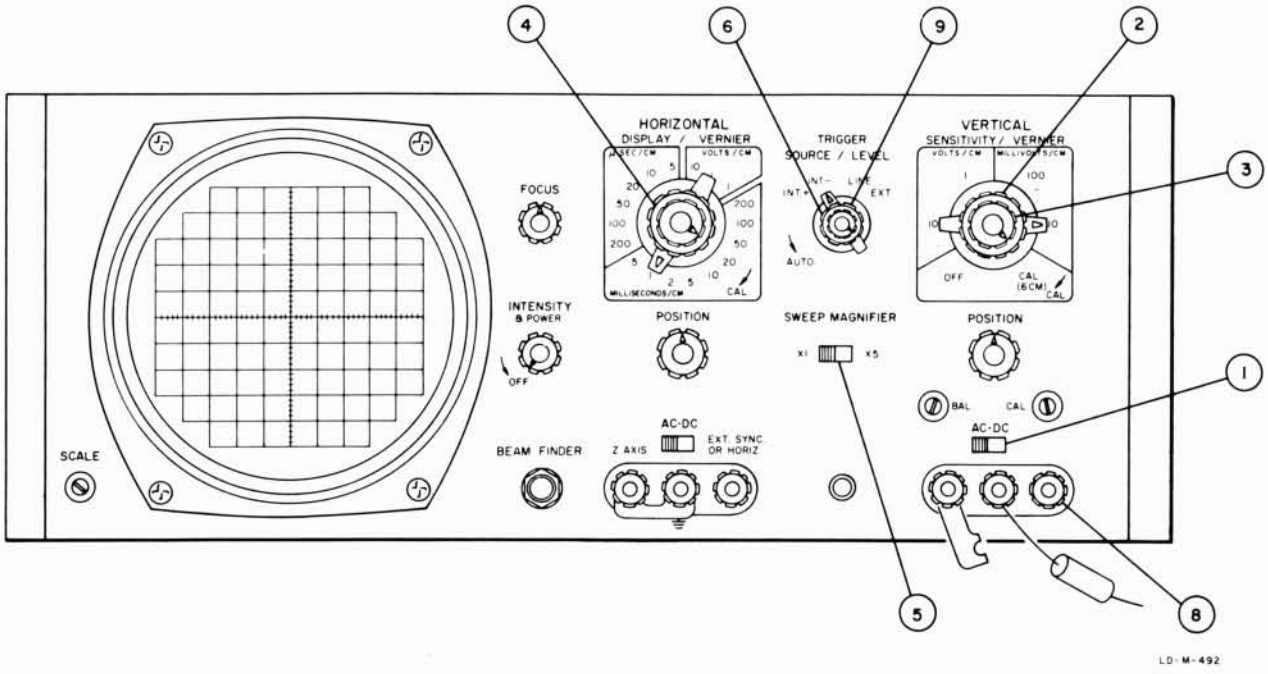


1. Set vertical AC-DC to desired type of input coupling.
2. Set VERTICAL SENSITIVITY to desired vertical sensitivity.
3. Set vertical VERNIER to CAL for calibrated sensitivity.
4. Set HORIZONTAL DISPLAY to desired VOLTS/CM. Set VERNIER to CAL for calibrated sensitivity.
5. Set horizontal AC-DC to desired 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 ±2° to 100 kc only when both VERNIER controls are set to CAL.

Figure 3-3. Operation Using External Horizontal Input



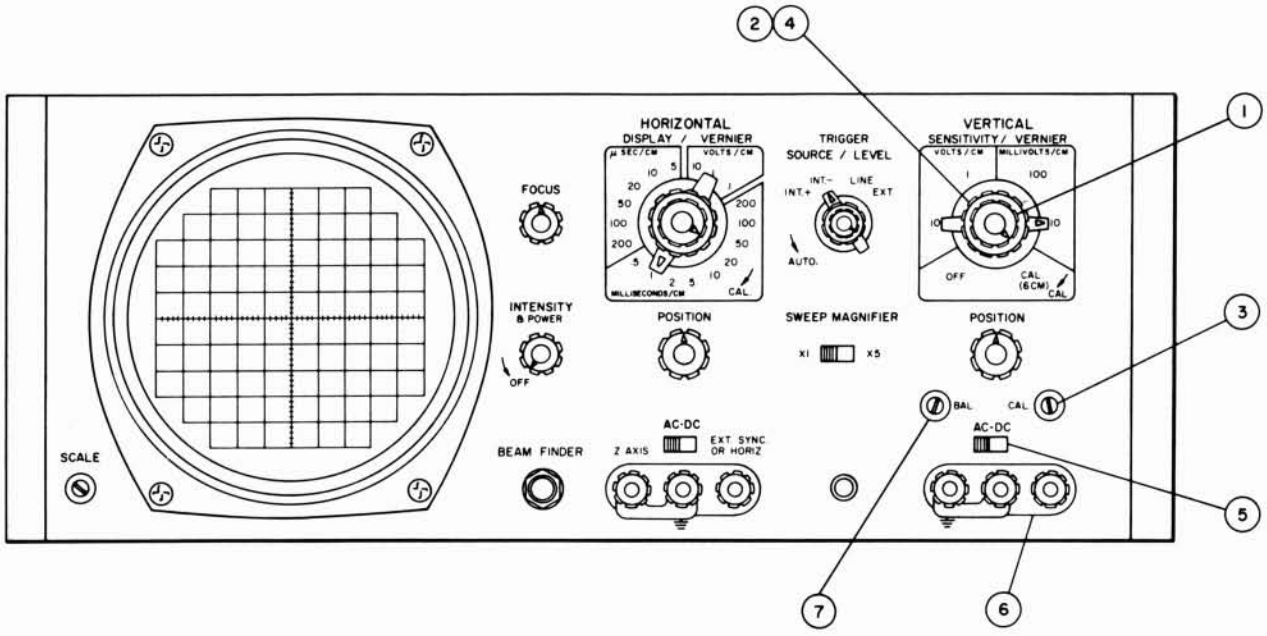
1. Set vertical AC-DC to desired type of input coupling.
2. Set VERTICAL SENSITIVITY to 10 MILLIVOLTS/CM. (Input not balanced in any other position of VERTICAL SENSITIVITY switch.)
3. Set vertical VERNIER to CAL for calibrated sensitivity.
4. Set HORIZONTAL DISPLAY to desired horizontal sweep speed.
5. Set SWEEP MAGNIFIER to X1 or X5, as desired.
6. Set TRIGGER SOURCE to desired type of horizontal sweep synchronization.
7. Remove grounding strap from vertical input terminals.
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.

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.

9. Adjust TRIGGER LEVEL for desired synchronization.

Figure 3-4. Operation Using Balanced Vertical Input



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 MILLIVOLTS/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.

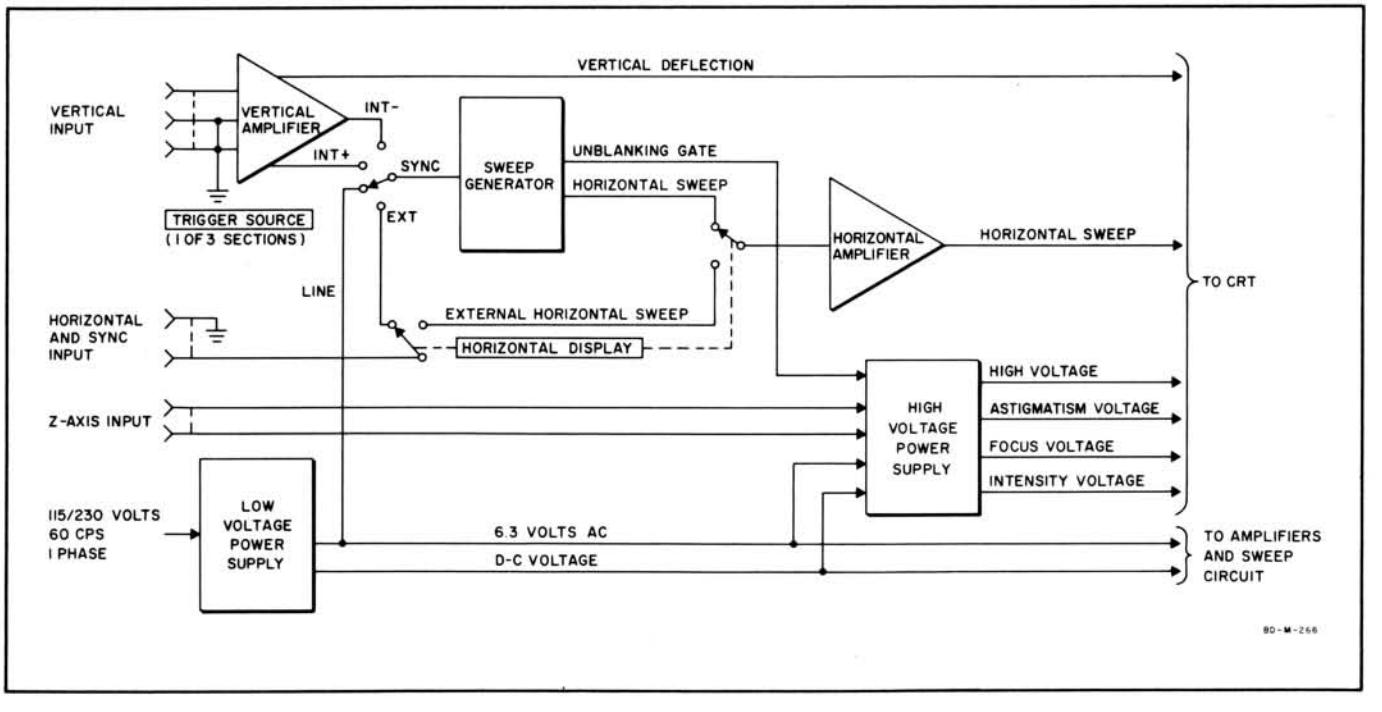


Figure 4-1. Overall Block Diagram

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 between 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 deionizes. C14 discharges through R53, and the potential across V4 increases. When the potential across

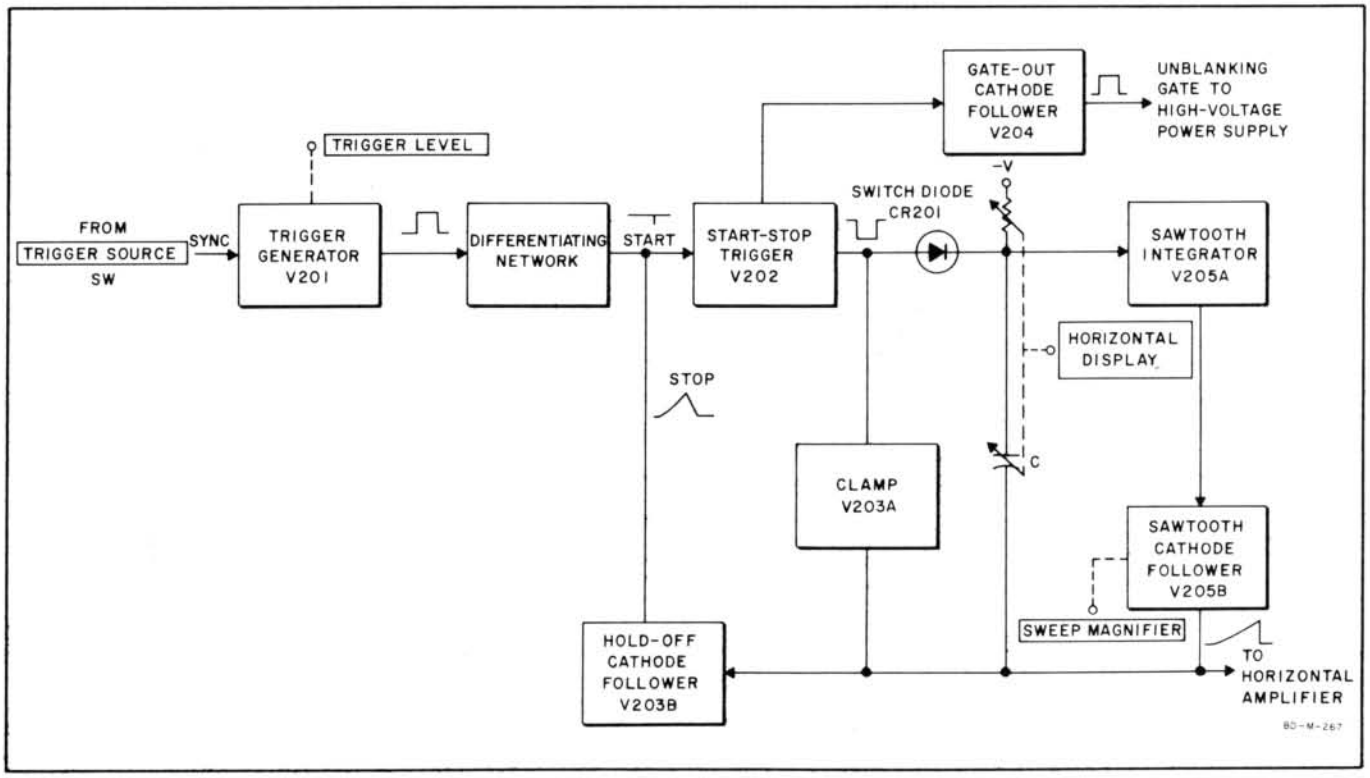


Figure 4-2. Sweep Generator, Block Diagram

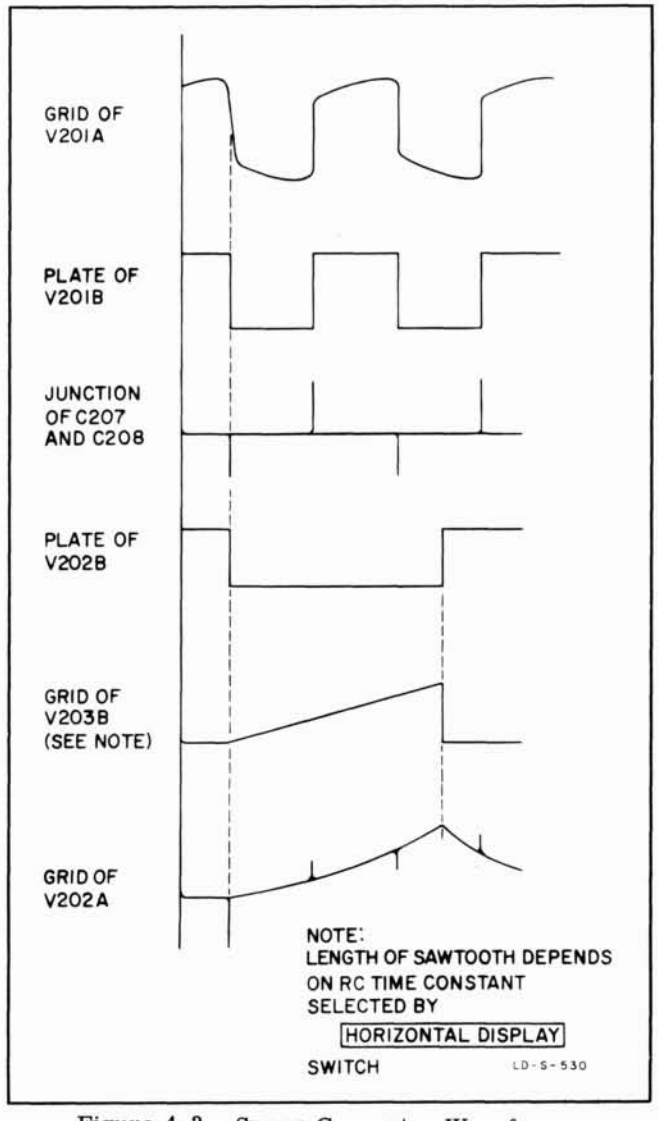


Figure 4-3. Sweep Generator Waveforms

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

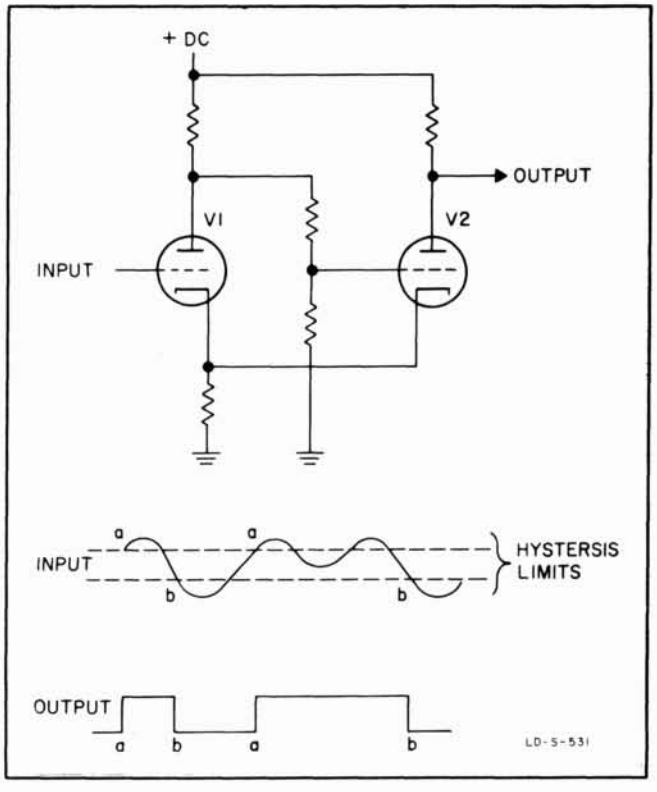


Figure 4-4. Typical Schmitt Trigger

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.

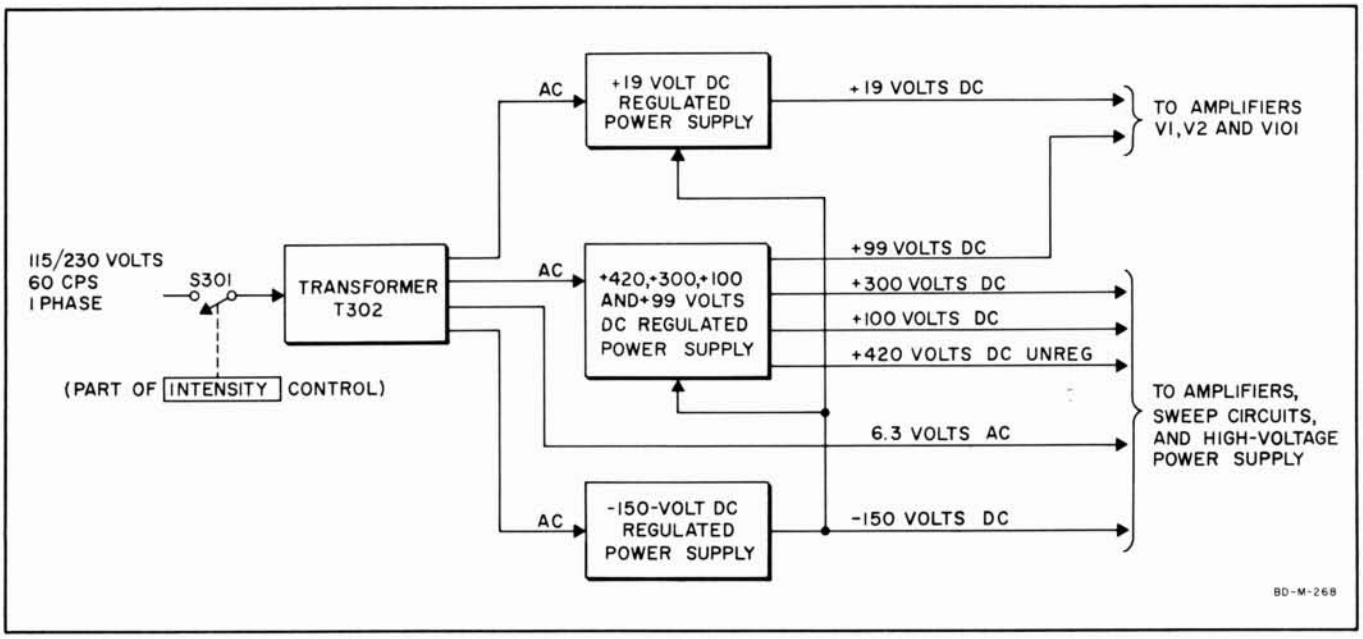


Figure 4-5. Low-Voltage Power Supply, Block Diagram

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 ac 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 capacitor C325A. The resulting dc voltage is regulated and 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.

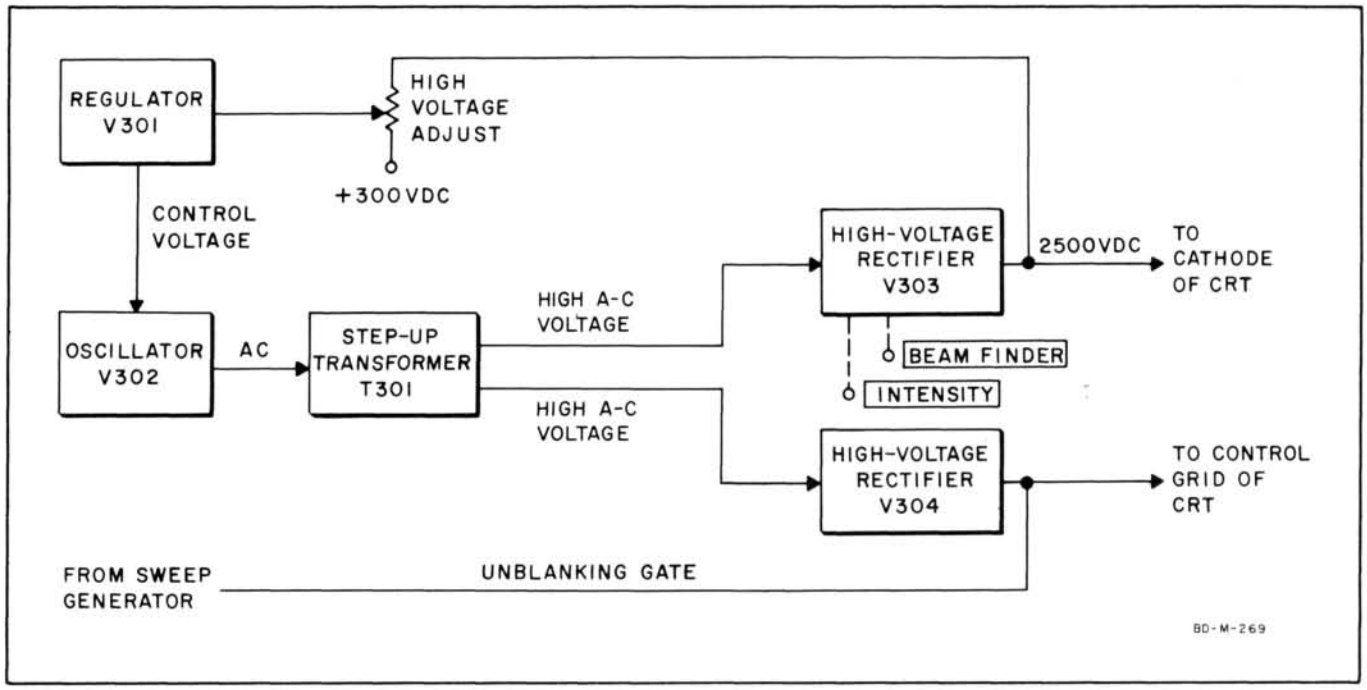


Figure 4-6. High-Voltage Power Supply, Block Diagram

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: ±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 μsec. 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 μsec 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.

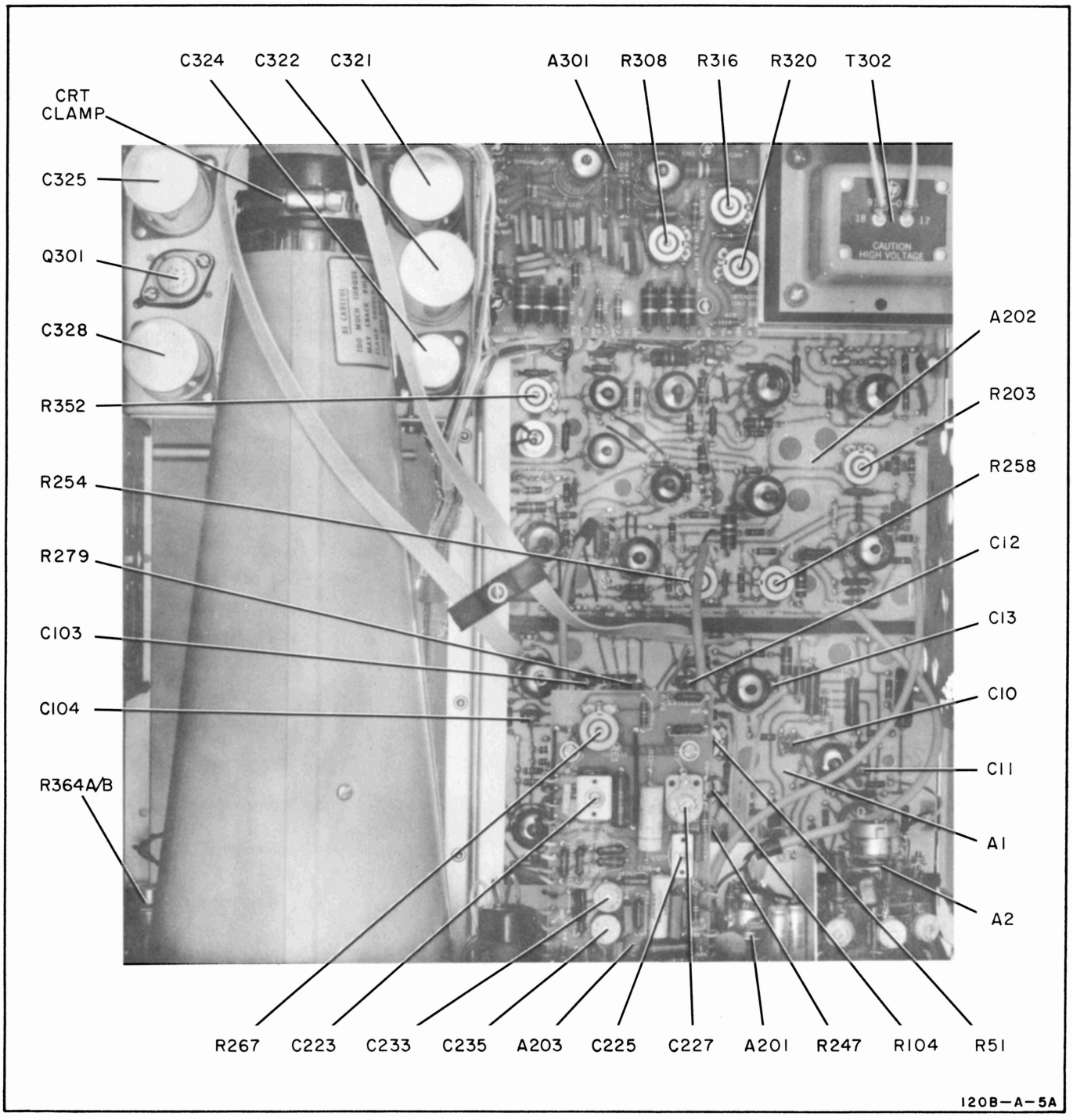


Figure 5-1. Top View, Location of Parts and Adjustments

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.

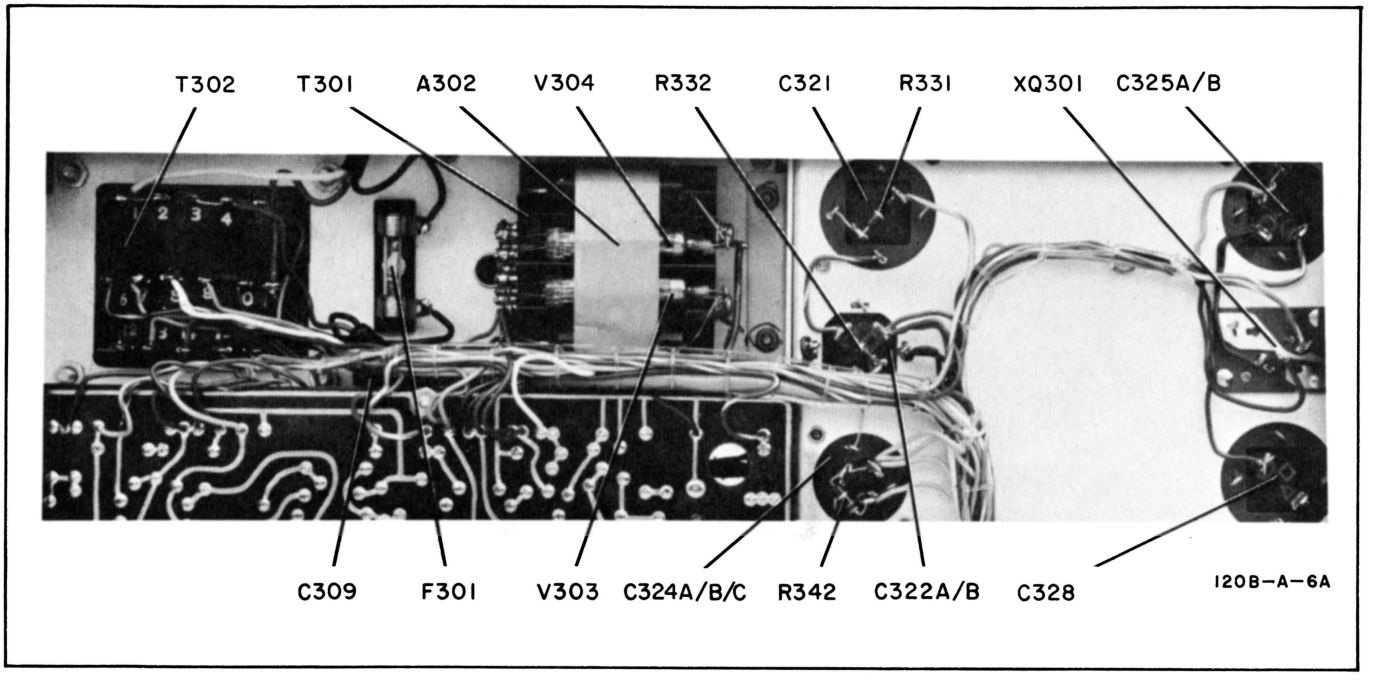


Figure 5-2. High-Voltage Power Supply, Location of Parts

Table 5-2. System Troubleshooting

Symptom	Probable Trouble	Paragraph Reference
Nothing visible on crt with BEAM FINDER pressed.	1. Low-voltage power supply.	1. Paragraphs 4-34 and 5-13
	2. Vertical amplifier.	2. Paragraphs 4-10 and 5-11
	3. Horizontal amplifier.	3. Paragraphs 4-30 and 5-11
	4. High-voltage power supply.	4. Paragraphs 4-41 and 5-14
	5. Crt.	5. Paragraph 5-21
Vertical sensitivity out of specifications on all sensitivity ranges; horizontal sweep normal.	1. Vertical amplifier.	1. Paragraphs 4-10 and 5-11
Vertical sensitivity out of specifications on one range.	2. VERTICAL SENSITIVITY switch S2.	
External horizontal sensitivity out of specifications; vertical sensitivity normal.	1. Horizontal amplifier.	1. Paragraphs 4-30 and 5-11
Faulty sweep; external horizontal deflection normal.	1. Sweep generator circuits.	1. Paragraphs 4-16 and 5-12
Poor focusing; intensity normal.	1. High-voltage power supply.	1. Paragraphs 4-41 and 5-14
	2. Crt	2. Paragraph 5-21
Poor intensity.	1. Low-voltage power supply.	1. Paragraphs 4-34 and 5-13
	2. High-voltage power supply.	2. Paragraphs 4-41 and 5-14
	3. Crt	3. Paragraph 5-21

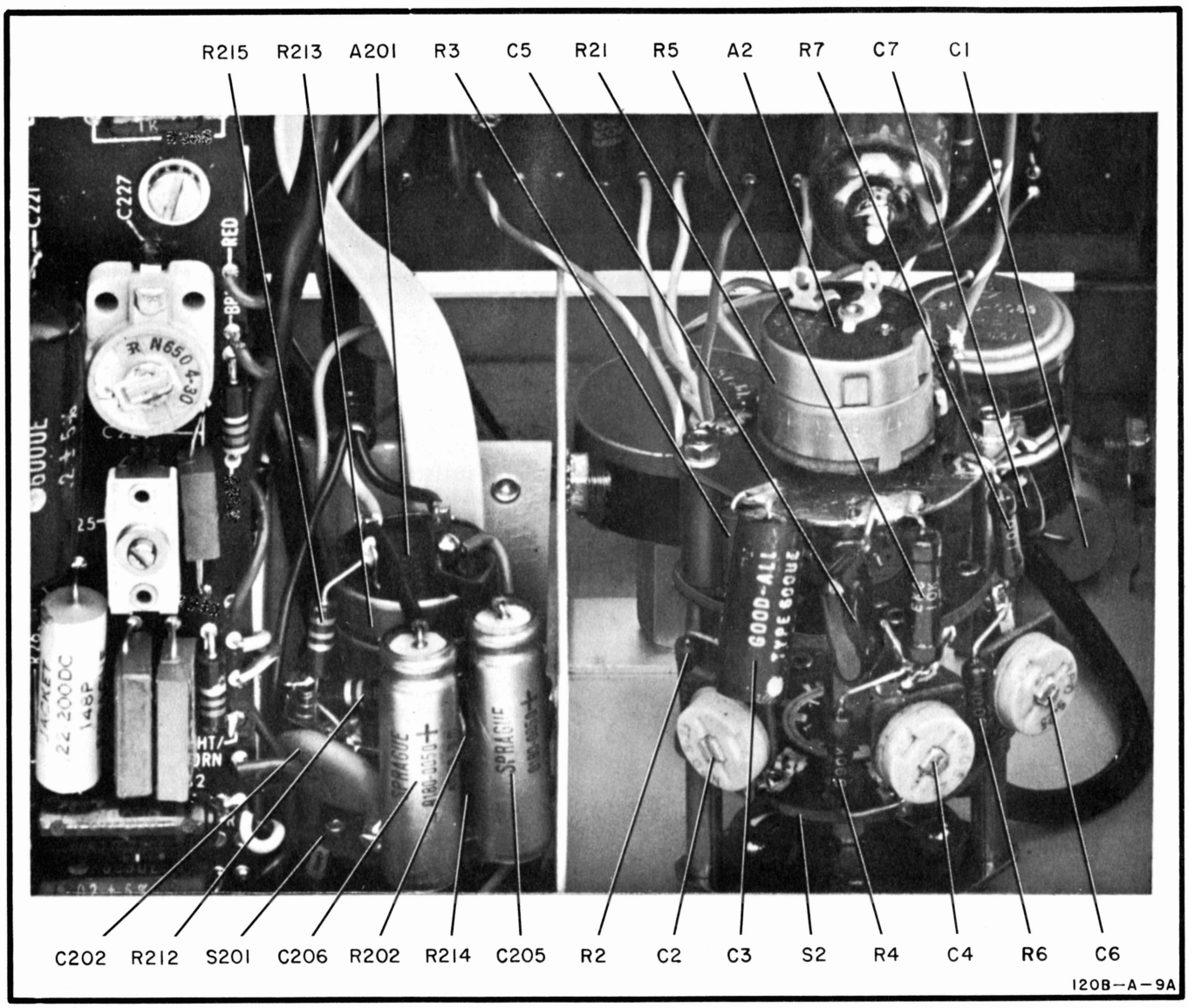


Figure 5-3. Vertical Sensitivity (A2) and Trigger Source (A201) Switches, Location of Parts and Adjustments

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 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.

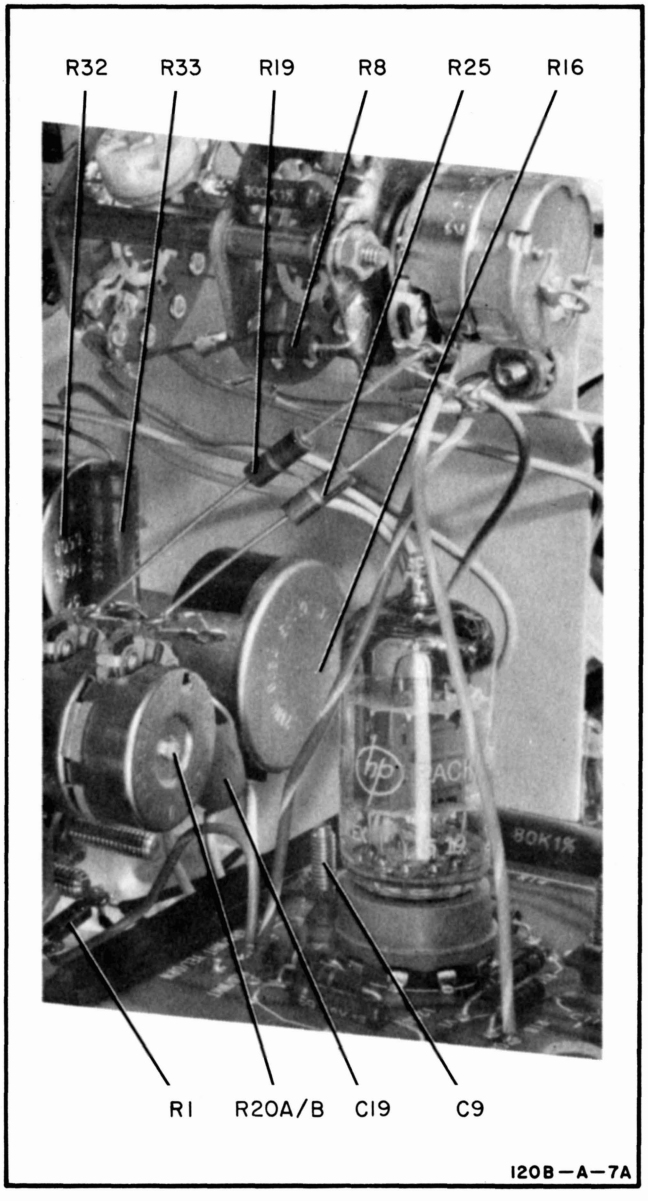


Figure 5-4. Right-Side View, Side Panel Removed, Location of Parts and Adjustments

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.

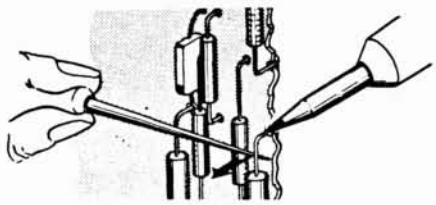
A break in the copper should be repaired by soldering a short length of tinned copper wire across the break.

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.

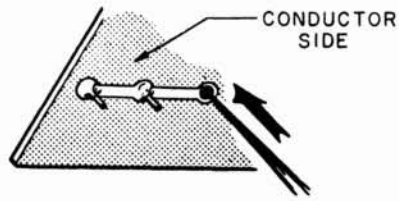
When replacing components with multiple mounting pins such as tube sockets, electrolytic capacitors, and potentiometers, it will be necessary to lift each pin slightly, working around the components several times until it is free.

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.

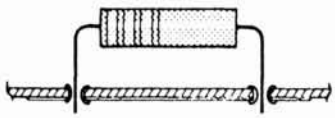
1. Apply heat sparingly to lead of component to be replaced. If lead of component passes through an eyelet in the circuit board, apply heat on component side of board. If lead of component does not pass through an eyelet, apply heat to conductor side of board.



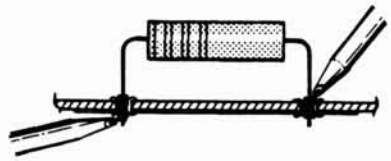
2. Reheat solder in vacant eyelet and quickly insert a small awl to clean inside of hole. If hole does not have an eyelet, insert awl or a #57 drill from conductor side of board.



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

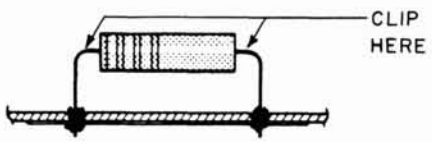


4. Hold part against board (avoid overheating) and solder leads. Apply heat to component leads on correct side of board as explained in step 1.

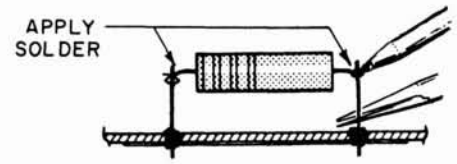


In the event that either the circuit board has been damaged or the conventional method is impractical, use method shown below. This is especially applicable for circuit boards without eyelets.

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
	Vertical Amplifier	
V1	Amplifier	1. Balance adjustment (figure 3-5) 2. Gain adjustment (paragraph 5-37) 3. Neutralization adjustment (paragraphs 5-38 and 5-40)
V2	Amplifier	1. Balance adjustment (figure 3-5) 2. Gain adjustment (paragraph 5-37) 3. Neutralization adjustment (paragraphs 5-39 and 5-40)
V3	Amplifier	1. Balance adjustment (figure 3-5) 2. Gain adjustment (paragraph 5-37) 3. Neutralization adjustment (paragraph 5-39)
V4	Calibrator	None
V5	Calibrator	1. Calibrator adjustment (paragraph 5-41)
	Horizontal Amplifier	
V101	Amplifier	1. Gain adjustment (paragraph 5-43) 2. X1 Sweep adjustment (paragraph 5-49) 3. Neutralization adjustment (paragraph 5-44)
V102	Amplifier	1. Gain adjustment (paragraph 5-43) 2. X1 Sweep adjustment (paragraph 5-49) 3. Neutralization adjustment (paragraph 5-44)
	Sweep Generator	
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 (±3%)	5 mv	10K
+ 19 volts dc	-1.5 volts; +1 volt	45 mv	4K (with V101 removed)
+300 volts dc	±9 volts	45 mv	75K
+100 volts dc	±3 volts	15 mv	50K
+ 99 volts dc	±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 MILLIVOLTS/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 μSEC/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 MILLISECONDS/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 μsec	5 μSEC/CM	C227	5
2	10 μsec	10 μSEC/CM	C227 *	10
3	10 μsec	20 μSEC/CM	C227 *	20
4	100 μsec	50 μSEC/CM	C225	5
5	100 μsec	100 μSEC/CM	C225 *	10
6	100 μsec	200 μSEC/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 ±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 MILLIVOLTS/CM.

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

h. Vertical deflection should be 10 ±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 ±0.3 cm in both cases.

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

a. Set VERTICAL SENSITIVITY to 10 MILLIVOLTS/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 MILLIVOLTS/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 MILLISECONDS/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 ±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 ±0.5 cm.

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

a. Set VERTICAL SENSITIVITY to 100 MILLIVOLTS/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 (±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 μSEC/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 MILLISECOND/CM.
d. Set TRIGGER SOURCE to INT-.
e. Turn TRIGGER LEVEL to AUTO.
f. Calibrator amplitude should be 6 ±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 μSECONDS/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 μsec	5 μSEC/CM	5
2	10 μsec	10 μSEC/CM	10
3	10 μsec	20 μSEC/CM	20
4	100 μsec	50 μSEC/CM	5
5	100 μsec	100 μSEC/CM	10
6	100 μsec	200 μSEC/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

* ±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 6 ±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.

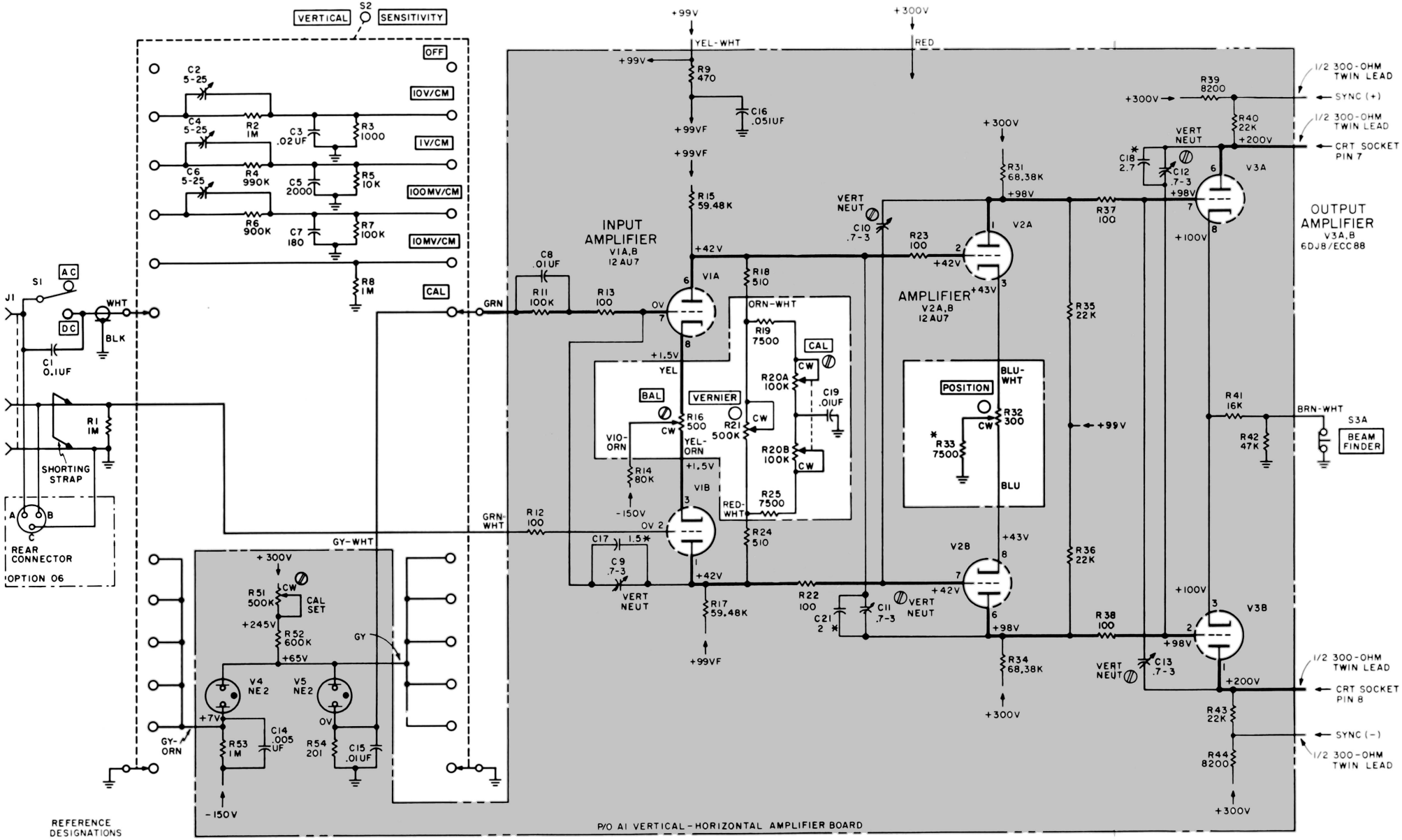
a. All values are in ohms, picofarads, and microhenries unless otherwise indicated.

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:

Control	Setting
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 μSEC/CM
HORIZONTAL VERNIER control	CAL
TRIGGER SOURCE switch	INT-
TRIGGER LEVEL control	AUTO
Horizontal AC-DC switch	AC
SWEEP MAGNIFIER switch	X1



REFERENCE DESIGNATIONS

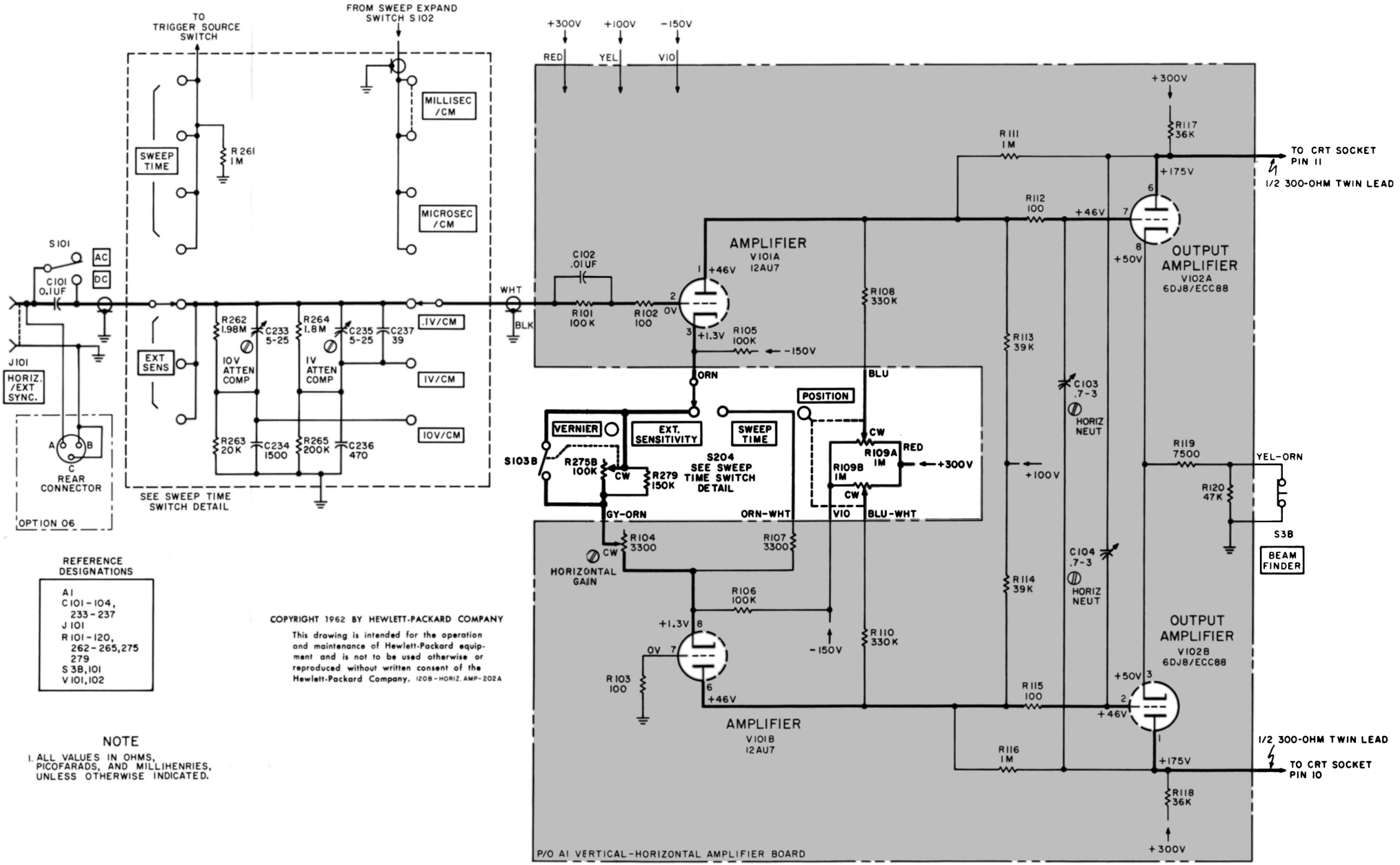
A1
C1 - 21
J1
R1 - 54
S1 - 3A
V1 - 5

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.

Figure 5-6. Vertical Amplifier



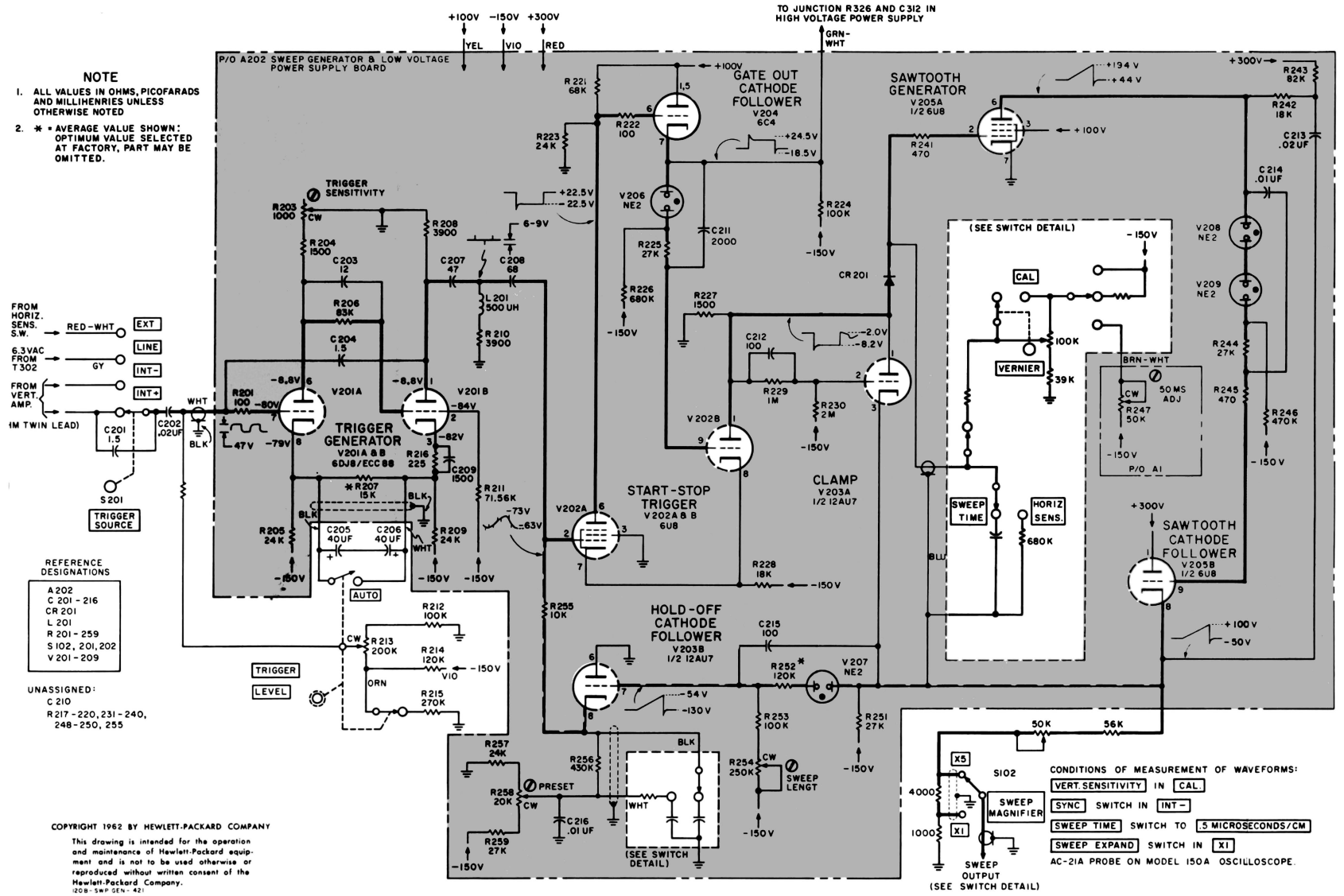
REFERENCE DESIGNATIONS

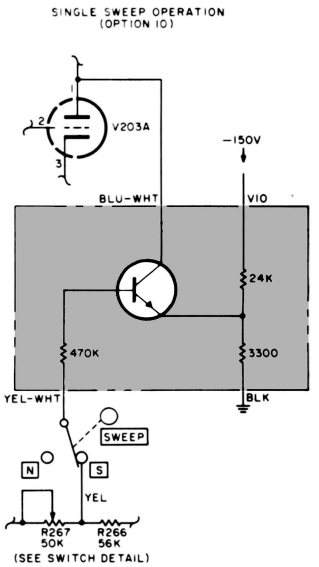
A1
C101-104, 233-237
J101
R101-120, 262-265, 275 279
S3B, 101
V101, 102

NOTE

1. 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.

Figure 5-8. Sweep Generator

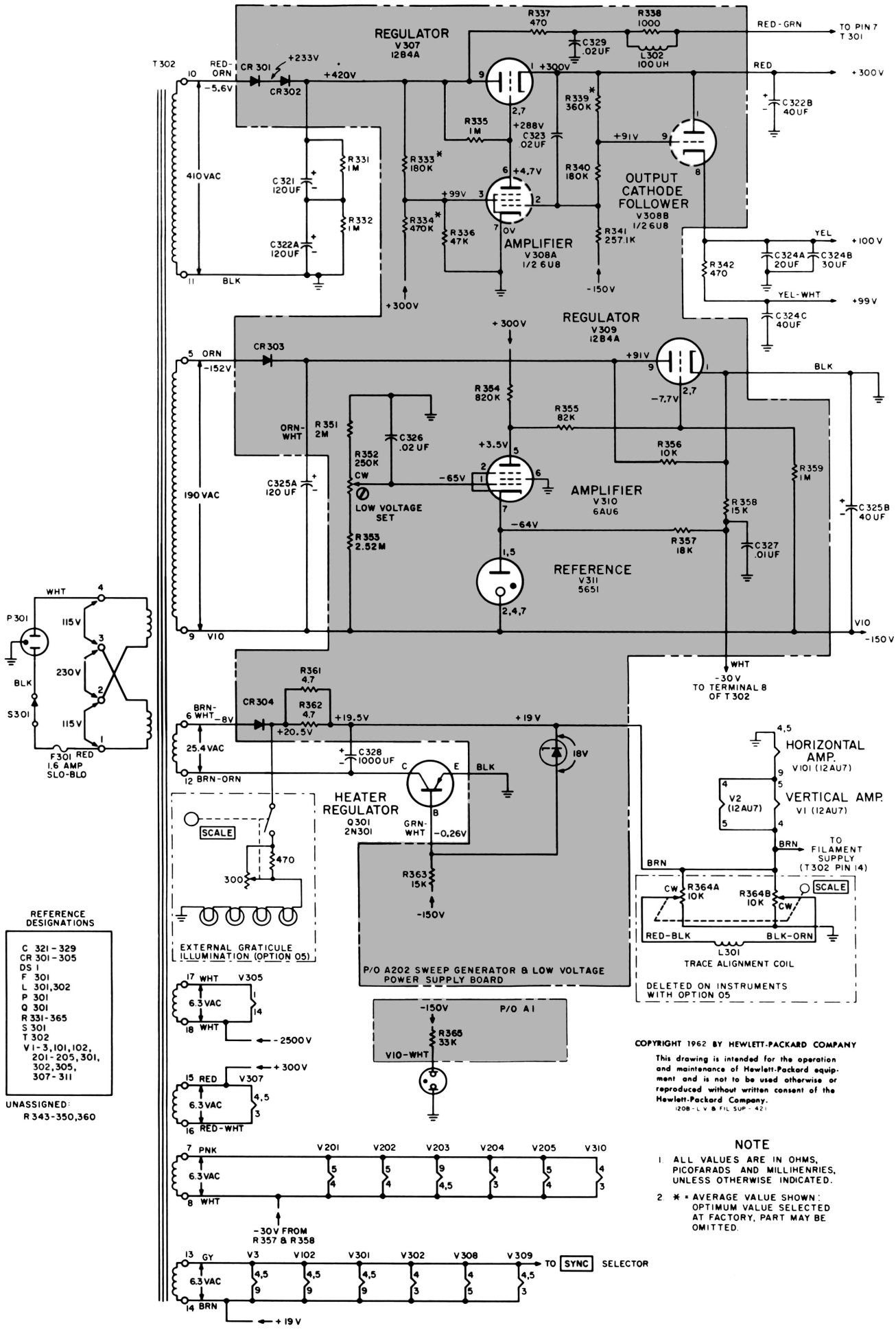


Figure 5-9. Low-Voltage Power Supply

REFERENCE DESIGNATIONS

C 321-329
CR 301-305
DS 1
F 301
L 301,302
P 301
Q 301
R 331-365
S 301
T 302
V 1-3,101,102, 201-205,301, 302,305, 307-311

UNASSIGNED:
R 343-350,360

NOTE

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.

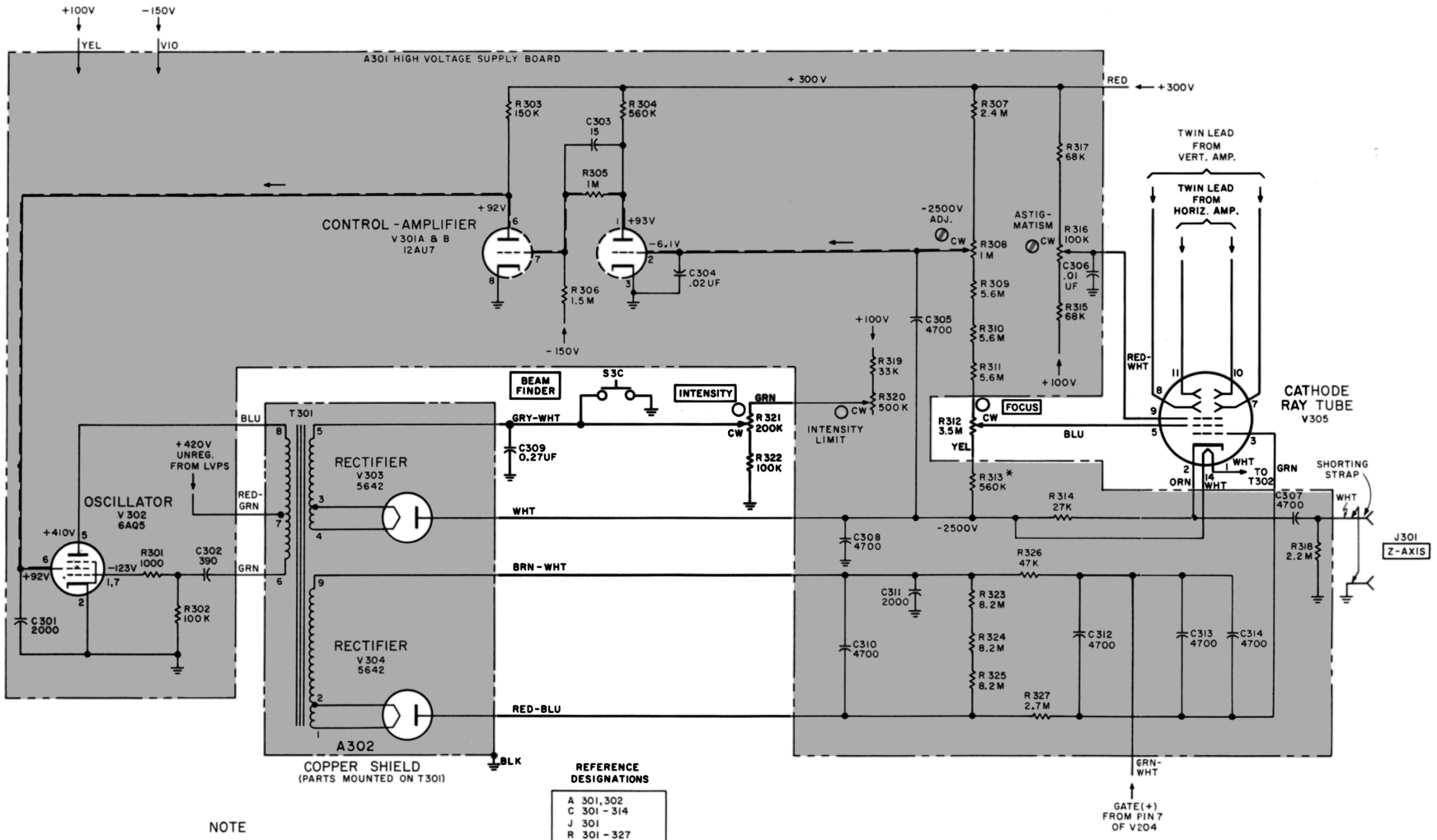


Figure 5-10. High-Voltage Power Supply

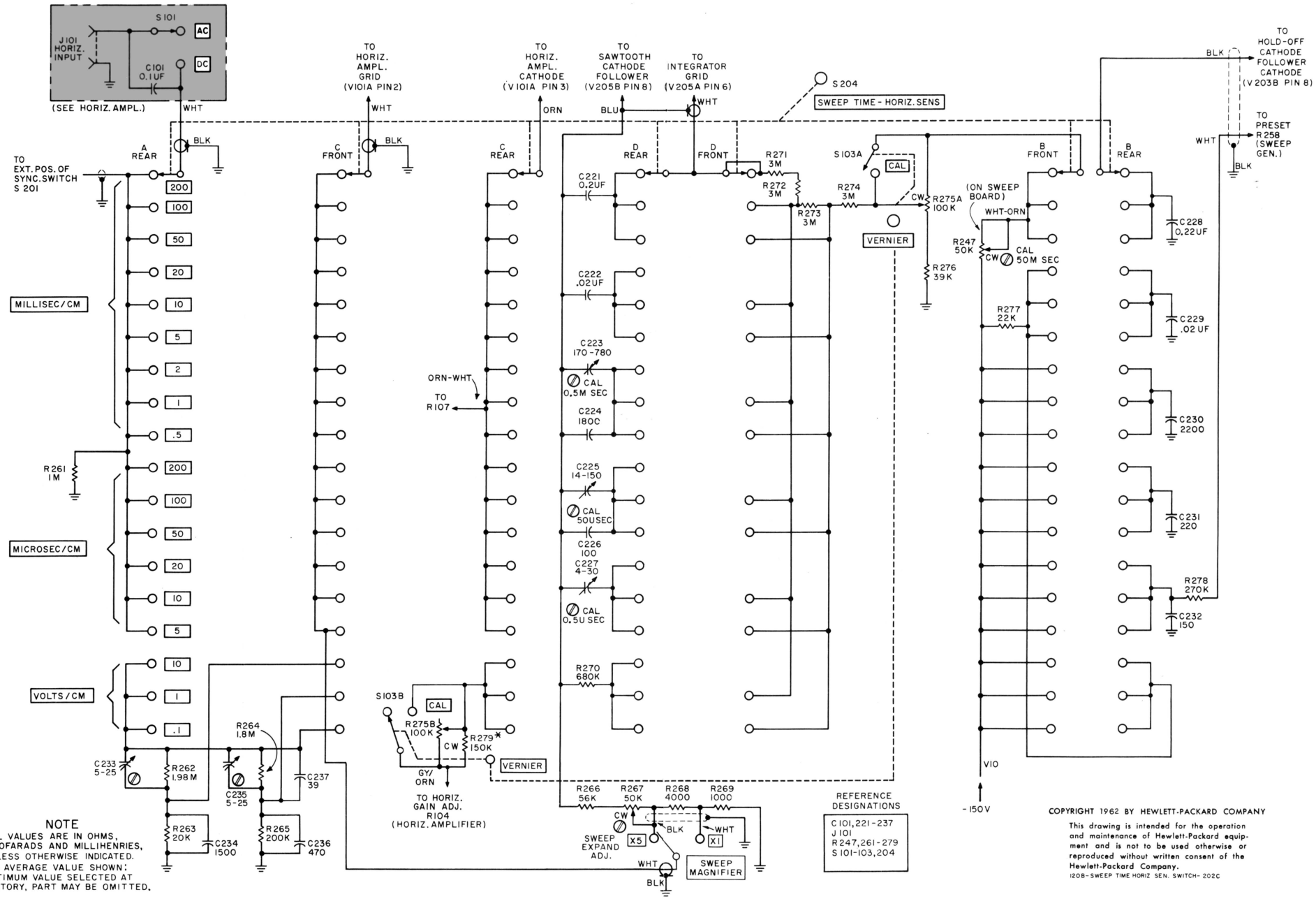


Figure 5-11. Horizontal Display Switch

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alpha-numerical order of their reference designations and indicates the description and hp part number of each component, together with any applicable notes. Parts not identified by a reference designation are listed under miscellaneous at the end of Table 6-1. Table 6-2 lists parts in alpha-numerical order of their hp part number and provides the following information on each item:

a. Description of the part (see list of abbreviations below).

b. Typical manufacturer of the part in a five-digit code, except where Hewlett-Packard Company is the manufacturer. See list of manufacturer codes in Table 6-3.

c. Manufacturer's part number.

d. Total quantity used in the instrument (TQ column)

6-3. ORDERING INFORMATION.

6-4. To order a replacement part, address order or inquiry to your local Hewlett-Packard Sales/Service Office (see list of addresses at rear of this manual), and supply the hp part number of the item(s) from the tables.

6-5. To order a part not listed in the tables, provide the following information:

a. Model number of the instrument.

b. Complete serial number (eight digits) of the instrument.

c. Description of the part including function and location.

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

REFERENCE DESIGNATORS

A = assembly	E = misc electronic part	MP = mechanical part	TB = terminal board
B = motor	F = fuse	P = plug	TP = test point
C = capacitor	FL = filter	Q = transistor	V = vacuum tube, neon bulb, photocell, etc.
CP = coupling	J = jack	R = resistor	
CR = diode	K = relay	RT = thermistor	W = cable
DL = delay line	L = inductor	S = switch	X = socket
DS = device signaling (lamp)	M = meter	T = transformer	Y = crystal

ABBREVIATIONS

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

01194-10

Table 6-1. Reference Designation Index

Reference Designation	hp Part No.	Description #	Note
A1	120B-65F	ASSY: ETCHED CIRCUIT, VERTICAL AND HORIZONTAL AMPLIFIER	
A2	120B-19A	ASSY: SWITCH, VERTICAL	
A3 THRU A200		NOT ASSIGNED	
A201	120B-19D	ASSY: SWITCH, TRIGGER SOURCE	
A202	120B-65G	ASSY: ETCHED CIRCUIT, SWEEP AND LOW VOLTAGE SUPPLY	
A203	120B-65D	ASSY: ETCHED CIRCUIT, HORIZONTAL SWITCH	
A204	120B-19B	ASSY: SWITCH, HORIZONTAL (INCLUDES A203)	
A205 THRU A300		NOT ASSIGNED	
A301	120B-65E	ASSY: ETCHED CIRCUIT, HIGH VOLTAGE SUPPLY	
A302	120B-11B	ASSY: RECTIFIER	
C1	0170-0022	C: FXD MY 0.1 µf 20% 600VDCW	
C2	0130-0014	C: VAR CER 5-25 pf	
C3	0140-0186	C: FXD MICA 20K pf 1% 300VDCW	
C4	0130-0014	C: VAR CER 5-25 pf	
C5	0140-0180	C: FXD MICA 2K pf 2%, 300VDCW	
C6	0130-0014	C: VAR CER 5-25 pf	
C7	0140-0147	C: FXD MICA 180 pf 5% 500VDCW	
C8	0150-0012	C: FXD CER 10K pf 20% 1000VDCW	
C9	0132-0004	C: VAR POLY 0.7-3 pf 350VDCW	
C10	0132-0004	C: VAR POLY 0.7-3 pf 350VDCW	
C11	0132-0004	C: VAR POLY 0.7-3 pf 350VDCW	
C12	0132-0004	C: VAR POLY 0.7-3 pf 350VDCW	
C13	0132-0004	C: VAR POLY 0.7-3 pf 350VDCW	
C14	0150-0014	C: FXD CER 0.005 µf 500VDCW	
C15	0150-0012	C: FXD CER 10K pf 20% 1000VDCW	
C16	0170-0003	C: FXD MY 0.051 µf 10% 200VDCW	
C17	0150-0011	C: FXD TI-OX 1.5 pf 20% 500VDCW	
C18	0150-0041	C: FXD TI-OX 2.7 pf 5% 500VDCW	
C19	0150-0012	C: FXD CER 10K pf 20% 1000VDCW	
C20		NOT ASSIGNED	
C21	0150-0011	C: FXD TI-OX 1.5 pf 20% 500VDCW	
C22 THRU C100		NOT ASSIGNED	
C101	0170-0022	C: FXD MY 0.1 µf 20% 600VDCW	
C102	0150-0012	C: FXD CER 10K pf 20% 1000VDCW	
C103	0132-0002	C: VAR POLY 0.7-3 pf 350VDCW	
C104	0132-0004	C: VAR POLY 0.7-3 pf 350VDCW	
C105 THRU C200		NOT ASSIGNED	
C201	0150-0011	C: FXD TI-OX 1.5 pf 20% 500VDCW	
C202	0150-0024	C: FXD CER 20K pf -20% +80% 600VDCW	
C203	0140-0201	C: FXD MICA 12 pf 5% 500VDCW	
C204	0150-0011	C: FXD TI-OX 1.5 pf 20% 500VDCW	
C205	0180-0050	C: FXD ELECT 40 µf -15% +100% 500VDCW	
C206	0180-0050	C: FXD ELECT 40 µf -15% +100% 500VDCW	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	hp Part No.	Description #	Note
C207	0140-0039	C: FXD MICA 47 pf 5% 500VDCW	
C208	0140-0082	C: FXD MICA 68 pf 5% 500VDCW	
C209	0140-0156	C: FXD MICA 1500 pf 20% 300VDCW	
C210		NOT ASSIGNED	
C211	0150-0023	C: FXD CER 2000 pf 5% 1000VDCW	
C212	0140-0041	C: FXD MICA 100 pf 5% 500VDCW	
C213	0150-0024	C: FXD CER 20K pf -20% +80% 600VDCW	
C214	0150-0012	C: FXD CER 10K pf 20% 1000VDCW	
C215	0140-0041	C: FXD MICA 100 pf 5% 500VDCW	
C216	0150-0012	C: FXD CER 10K pf 20% 1000VDCW	
C217 THRU C220		NOT ASSIGNED	
C221	0170-0028	C: FXD MY 0.2 µf 5% 200VDCW	
C222	0170-0027	C: FXD MY 0.02 µf 5% 200VDCW	
C223	0131-0003	C: VAR MICA 170-780 pf 175VDCW	
C224	0170-0026	C: FXD MY 0.0018 µf 5% 200VDCW	
C225	0131-0004	C: VAR MICA 14-150 pf 175VDCW	
C226	0140-0041	C: FXD MICA 100 pf 5% 500VDCW	
C227	0130-0019	C: VAR CER 4-30 pf 500VDCW	
C228	0170-0038	C: FXD MY 0.22 µf 10% 200VDCW	
C229	0170-0027	C: FXD MY 0.02 µf 5% 200VDCW	
C230	0160-0007	C: FXD MY 0.0022 µf 10% 600VDCW	
C231	0140-0031	C: FXD MICA 220 pf 10% 500VDCW	
C232	0140-0055	C: FXD MICA 150 pf 10% 500VDCW	
C233	0130-0016	C: VAR CER 5-25 pf 500VDCW	
C234	0140-0156	C: FXD MICA 1.5K pf 20% 300VDCW	
C235	0130-0016	C: VAR CER 5-25 pf 500VDCW	
C236	0140-0027	C: FXD MICA 470 pf 10% 500VDCW	
C237	0140-0035	C: FXD MICA 39 pf 5% 500VDCW	
C238 THRU C300		NOT ASSIGNED	
C301	0150-0023	C: FXD CER 2000 pf 20% 1000VDCW	
C302	0140-0037	C: FXD MICA 390 pf 5% 500VDCW	
C303	0140-0004	C: FXD MICA 15 pf 10% 500VDCW	
C304	0150-0024	C: FXD CER 20K pf -20% +80% 600VDCW	
C305	0160-0151	C: FXD CER 4700 pf -20% +80% 4000VDCW	
C306	0150-0012	C: FXD CER 10K pf 20% 1000VDCW	
C307	0160-0151	C: FXD CER 4700 pf -20% +80% 4000VDCW	
C308	0160-0151	C: FXD CER 4700 pf -20% +80% 4000VDCW	
C309	0160-0039	C: FXD MY 0.27 µf 10% 200VDCW	
C310	0160-0151	C: FXD CER 4700 pf -20% +80% 4000VDCW	
C311	0150-0023	C: FXD CER 2000 pf 20% 1000VDCW	
C312	0160-0151	C: FXD CER 4700 pf -20% +80% 4000VDCW	
C313	0160-0151	C: FXD CER 4700 pf -20% +80% 4000VDCW	
C314	0160-0151	C: FXD CER 4700 pf -20% +80% 4000VDCW	
C315 THRU C320		NOT ASSIGNED	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	hp Part No.	Description #	Note
C321	0180-0126	C: FXD ELECT 120 µf 300VDCW	
C322A/B	0180-0030	C: FXD ELECT 2 SECT 120 x 40 µf 450VDCW	
C323	0150-0024	C: FXD CER 20K pf -20% +80% 600VDCW	
C324A/B/C	0180-0053	C: FXD ELECT 3 SECT 40-30-20 µf 150VDCW	
C325A/B	0180-0127	C: FXD ELECT 2 SECT 120 x 40 µf -10% +50% 300VDCW	
C326	0150-0024	C: FXD CER 20K pf -20% +80% 600VDCW	
C327	0150-0012	C: FXD CER 10K pf 20% 1000VDCW	
C328	0180-0056	C: FXD ELECT 1K µf 50VDCW	
C329	0150-0024	C: FXD CER 20K pf -20% +80% 600VDCW	
CR1 THRU CR200		NOT ASSIGNED	
CR201	1901-0044	DIODE: SILICON	
CR202 THRU CR300		NOT ASSIGNED	
CR301	1901-0030	DIODE: SILICON 800 V	
CR302	1901-0030	DIODE: SILICON 800 V	
CR303	1901-0030	DIODE: SILICON 800 V	
CR304	1901-0045	DIODE: SILICON	
CR305	1902-0225	DIODE: SILICON AVALANCHE 18.7 V	
DS1	1450-0048	LAMP: INDICATOR	
F1 THRU F300		NOT ASSIGNED	
F301	2110-0005	FUSE: CARTRIDGE 1.6 AMP S-B (FOR 115 V OPERATION)	
	2110-0020	FUSE: CARTRIDGE 0.8 AMP S-B (FOR 230 V OPERATION)	
J1		NSR - CONSISTS OF:	
	5060-0633	BINDING POST: RED (2 USED)	
	5060-0632	BINDING POST: BLACK (1 USED)	
	0340-0091	INSULATOR: 3 HOLE (1 USED)	
	0340-0086	INSULATOR: 2 HOLE (1 USED)	
J2 THRU J100		NOT ASSIGNED	
J101		NSR - CONSISTS OF:	
	5060-0633	BINDING POST: RED (1 USED)	
	5060-0632	BINDING POST: BLACK (SHARED BY J101 AND J301)	
	0340-0091	INSULATOR: 3 HOLE (SHARED BY J101 AND J301)	
	0340-0087	INSULATOR: 3 HOLE (SHARED BY J101 AND J301)	
J102 THRU J300		NOT ASSIGNED	
J301		NSR - CONSISTS OF:	
	5060-0633	BINDING POST: RED (1 USED)	
	5060-0632	BINDING POST: BLACK (SHARED BY J101 AND J301)	
	0340-0091	INSULATOR: 3 HOLE (SHARED BY J101 AND J301)	
	0340-0087	INSULATOR: 3 HOLE (SHARED BY J101 AND J301)	
L1 THRU L200		NOT ASSIGNED	
L201	9140-0022	INDUCTOR: FXD RF 500 µh 10%	
L202 THRU L300		NOT ASSIGNED	
L301	5060-0409	INDUCTOR: ALIGNMENT	
L302	9140-0029	INDUCTOR: FXD RF 100 µh	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	hp Part No.	Description #	Note
P1 THRU			
P300		NOT ASSIGNED	
P301		NSR: PART OF POWER CORD W1	
Q1 THRU			
Q300		NOT ASSIGNED	
Q301	1850-0038	TRANSISTOR: 2N301	
R1	0686-1055	R: FXD COMP 1M 5% 1/2W	
R2	0727-0274	R: FXD DEPC 1M 1% 1/2W	
R3	0727-0100	R: FXD DEPC 1K OHMS 1% 1/2W	
R4	0727-0271	R: FXD DEPC 990K OHMS 1% 1/2W	
R5	0727-0157	R: FXD DEPC 10K OHMS 1% 1/2W	
R6	0727-0261	R: FXD DEPC 900K OHMS 1% 1/2W	
R7	0727-0208	R: FXD DEPC 100K OHMS 1% 1/2W	
R8	0686-1055	R: FXD COMP 1M 5% 1/2W	
R9	0687-4711	R: FXD COMP 470 OHMS 10% 1/2W	
R10		NOT ASSIGNED	
R11	0687-1041	R: FXD COMP 100K OHMS 10% 1/2W	
R12	0687-1011	R: FXD COMP 100 OHMS 10% 1/2W	
R13	0687-1011	R: FXD COMP 100 OHMS 10% 1/2W	
R14	0730-0062	R: FXD DEPC 80K OHMS 1% 1W	
R15	0727-0197	R: FXD DEPC 59.48K OHMS 1% 1/2W	
R16	2100-0054	R: VAR WW LIN 500 OHMS 10% 2W	
R17	0727-0197	R: FXD DEPC 59.48K OHMS 1% 1/2W	
R18	0686-5115	R: FXD COMP 510 OHMS 5% 1/2W	
R19	0686-7525	R: FXD COMP 7.5K OHMS 5% 1/2W	
R20A/B	2100-0339	R: VAR COMP LOG 2 SECT 100K OHMS/SECT 20% 1/4W	
R21	2100-0174	R: VAR COMP 500K OHMS 20%, 5% CW LOG TAPER 1/4W W/SPDT SWITCH	
R22	0687-1011	R: FXD COMP 100 OHMS 10% 1/2W	
R23	0687-1011	R: FXD COMP 100 OHMS 10% 1/2W	
R24	0686-5115	R: FXD COMP 510 OHMS 5% 1/2W	
R25	0686-7525	R: FXD COMP 7.5K OHMS 5% 1/2W	
R26 THRU			
R30		NOT ASSIGNED	
R31	0730-0056	R: FXD DEPC 68.38K OHMS 1% 1W	
R32	2100-1486	R: VAR COMP LIN 300 OHMS 20% 3W	
R33	0730-0024	R: FXD DEPC 7.5K OHMS 1% 1W	
R34	0730-0056	R: FXD DEPC 68.38K OHMS 1% 1W	
R35	0687-2231	R: FXD COMP 22K OHMS 10% 1/2W	
R36	0687-2231	R: FXD COMP 22K OHMS 10% 1/2W	
R37	0687-1011	R: FXD COMP 100 OHMS 10% 1/2W	
R38	0687-1011	R: FXD COMP 100 OHMS 10% 1/2W	
R39	0690-8221	R: FXD COMP 8.2K OHMS 10% 1W	
R40	0689-2235	R: FXD COMP 22K OHMS 5% 1W	
R41	0689-1635	R: FXD COMP 16K OHMS 5% 1W	
R42	0687-4731	R: FXD COMP 47K OHMS 10% 1/2W	
R43	0689-2235	R: FXD COMP 22K OHMS 5% 1W	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	hp Part No.	Description #	Note
R44	0690-8221	R: FXD COMP 8.2K OHMS 10% 1W	
R45 THRU			
R50		NOT ASSIGNED	
R51	2100-0102	R: VAR COMP LIN 500K OHMS 30% 1/5W	
R52	0727-0246	R: FXD DEPC 600K OHMS 1% 1/2W	
R53	0686-1055	R: FXD COMP 1M 5% 1/2W	
R54	0727-0055	R: FXD DEPC 201 OHMS 1% 1/2W	
R55 THRU			
R100		NOT ASSIGNED	
R101	0687-1041	R: FXD COMP 100K OHMS 10% 1/2W	
R102	0687-1011	R: FXD COMP 100 OHMS 10% 1/2W	
R103	0687-1011	R: FXD COMP 100 OHMS 10% 1/2W	
R104	2100-0182	R: VAR COMP LIN 3.3K OHMS 10% 1/3W	
R105	0690-1041	R: FXD COMP 100K OHMS 10% 1W	
R106	0690-1041	R: FXD COMP 100K OHMS 10% 1W	
R107	0687-3321	R: FXD COMP 3.3K OHMS 10% 1/2W	
R108	0687-3341	R: VAR COMP 330K OHMS 10% 1/2W	
R109A/B	2100-0258	R: VAR COMP DUAL TANDEM LIN 1M 20% 1/4W	
R110	0687-3341	R: VAR COMP 330K OHMS 10% 1/2W	
R111	0727-0274	R: FXD DEPC 1M 1% 1/2W	
R112	0687-1011	R: FXD COMP 100 OHMS 10% 1/2W	
R113	0686-3935	R: FXD COMP 39K OHMS 5% 1/2W	
R114	0686-3935	R: FXD COMP 39K OHMS 5% 1/2W	
R115	0687-1011	R: FXD COMP 100 OHMS 10% 1/2W	
R116	0727-0274	R: FXD DEPC 1M 1% 1/2W	
R117	0692-3635	R: FXD COMP 36K OHMS 5% 2W	
R118	0692-3635	R: FXD COMP 36K OHMS 5% 2W	
R119	0689-7525	R: FXD COMP 7.5K OHMS 5% 1W	
R120	0687-4731	R: FXD COMP 47K OHMS 10% 1/2W	
R121 THRU			
R200		NOT ASSIGNED	
R201	0687-1011	R: FXD COMP 100 OHMS 10% 1/2W	
R202	0687-1851	R: FXD COMP 1.8M 10% 1/2W	
R203	2100-0154	R: COMP LIN 1K OHMS 30% 3/10W	
R204	0686-1525	R: FXD COMP 1.5K OHMS 5% 1/2W	
R205	0689-2435	R: FXD COMP 24K OHMS 5% 1W	
R206	0727-0202	R: FXD DEPC 83K OHMS 1% 1/2W	
R207	0687-1531	R: FXD COMP 15K OHMS 10% 1/2W	
R208	0687-3921	R: FXD COMP 3.9K OHMS 10% 1/2W	
R209	0689-2435	R: FXD COMP 24K OHMS 5% 1W	
R210	0687-3921	R: FXD COMP 3.9K OHMS 10% 1/2W	
R211	0727-0201	R: FXD DEPC 71.56K OHMS 1% 1/2W	
R212	0687-1041	R: FXD COMP 100K OHMS 10% 1/2W	
R213	2100-0188	R: VAR COMP LIN 200K OHMS 20% 1/4W	
R214	0686-1245	R: FXD COMP 120K OHMS 5% 1/2W	
R215	0686-2745	R: FXD COMP 270K OHMS 5% 1/2W	
R216	0727-0060	R: FXD DEPC 225 OHMS 1% 1/2W	
R217 THRU			
R220		NOT ASSIGNED	
R221	0687-6831	R: FXD COMP 68K OHMS 10% 1/2W	
R222	0687-1011	R: FXD COMP 100 OHMS 10% 1/2W	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	hp Part No.	Description #	Note
R223	0686-2435	R: FXD COMP 24K OHMS 5% 1/2W	
R224	0690-1041	R: FXD COMP 100K OHMS 10% 1W	
R225	0687-2731	R: FXD COMP 27K OHMS 10% 1/2W	
R226	0687-6841	R: FXD COMP 680K OHMS 10% 1/2W	
R227	0727-0110	R: FXD DEPC 1.5K OHMS 1% 1/2W	
R228	0693-1831	R: FXD COMP 18K OHMS 10% 2W	
R229	0686-1055	R: FXD COMP 1M 5% 1/2W	
R230	0686-2055	R: FXD COMP 2M 5% 1/2W	
R231 THRU R240		NOT ASSIGNED	
R241	0687-4711	R: FXD COMP 470 OHMS 10% 1/2W	
R242	0689-1835	R: FXD COMP 18K OHMS 5% 1W	
R243	0690-8231	R: FXD COMP 82K OHMS 10% 1W	
R244	0687-2731	R: FXD COMP 27K OHMS 10% 1/2W	
R245	0687-4711	R: FXD COMP 470 OHMS 10% 1/2W	
R246	0687-4741	R: FXD COMP 470K OHMS 10% 1/2W	
R247	2100-0094	R: VAR COMP LIN 50K OHMS 3% 1/4W	
R248 THRU R250		NOT ASSIGNED	
R251	0771-0006	R: FXD MET OX 27K OHMS 10% 4W	
R252	0687-1241	R: FXD COMP 120K OHMS 10% 1/2W	
R253	0687-1041	R: FXD COMP 100K OHMS 10% 1/2W	
R254	2100-0144	R: VAR COMP 250K OHMS 30% 1/4W	
R255	0686-1035	R: FXD COMP 10K OHMS 5% 1/2W	
R256	0686-4345	R: FXD COMP 430K OHMS 5% 1/2W	
R257	0687-2731	R: FXD COMP 27K OHMS 10% 1/2W	
R258	2100-0093	R: VAR COMP LIN 20K OHMS 20% 1/4W	
R259	0687-2731	R: FXD COMP 27K OHMS 10% 1/2W	
R260		NOT ASSIGNED	
R261	0687-1051	R: FXD COMP 1M 10% 1/2W	
R262	0727-0376	R: FXD DEPC 1.98M 1% 1/2W	
R263	0727-0173	R: FXD DEPC 20K OHMS 1% 1/2W	
R264	0727-0285	R: FXD DEPC 1.8M 1% 1/2W	
R265	0727-0221	R: FXD DEPC 200K OHMS 1% 1/2W	
R266	0687-5631	R: FXD COMP 56K OHMS 10% 1/2W	
R267	2100-0094	R: VAR COMP LIN 50K OHMS 3% 1/4W	
R268	0727-0132	R: FXD DEPC 4K OHMS 1% 1/2W	
R269	0727-0100	R: FXD DEPC 1K OHMS 1% 1/2W	
R270	0687-6841	R: FXD COMP 680K OHMS 10% 1/2W	
R271	0727-0292	R: FXD DEPC 3M 1% 1/2W	
R272	0727-0292	R: FXD DEPC 3M 1% 1/2W	
R273	0727-0292	R: FXD DEPC 3M 1% 1/2W	
R274	0727-0292	R: FXD DEPC 3M 1% 1/2W	
R275A/B	2100-0338	R: VAR COMP LOG 2 SECT 100K OHMS/SECT 20% 1/4W (includes S103)	
R276	0687-3931	R: FXD COMP 39K OHMS 10% 1/2W	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	hp Part No.	Description #	Note
R277	0687-2231	R: FXD COMP 22K OHMS 10% 1/2W	
R278	0687-2741	R: FXD COMP 270K OHMS 10% 1/2W	
R279	0687-1541	R: FXD COMP 150K OHMS 10% 1/2W	
R280 THRU R300		NOT ASSIGNED	
R301	0687-1021	R: FXD COMP 1K OHMS 10% 1/2W	
R302	0687-1041	R: FXD COMP 100K OHMS 10% 1/2W	
R303	0693-1541	R: FXD COMP 150K OHMS 10% 2W	
R304	0690-5641	R: FXD COMP 560K OHMS 10% 1W	
R305	0687-1051	R: FXD COMP 1M 10% 1/2W	
R306	0687-1551	R: FXD COMP 1.5M 10% 1/2W	
R307	0686-2455	R: FXD COMP 2.4M 5% 1/2W	
R308	2100-0096	R: VAR COMP LIN 1M 30% 1/4W	
R309	0693-5651	R: FXD COMP 5.6M 10% 2W	
R310	0693-5651	R: FXD COMP 5.6M 10% 2W	
R311	0693-5651	R: FXD COMP 5.6M 10% 2W	
R312	2100-0105	R: VAR COMP LIN 3.5M 30% 1/2W	
R313	0687-5641	R: FXD COMP 560K OHMS 10% 1/2W	
R314	0687-2731	R: FXD COMP 27K OHMS 10% 1/2W	
R315	0687-6831	R: FXD COMP 68K OHMS 10% 1/2W	
R316	2100-0095	R: VAR COMP LIN 100K OHMS 30% 1/4W	
R317	0687-6831	R: FXD COMP 68K OHMS 10% 1/2W	
R318	0687-2251	R: FXD COMP 2.2M 10% 1/2W	
R319	0687-3331	R: FXD COMP 33K OHMS 10% 1/2W	
R320	2100-0102	R: VAR COMP LIN 500K OHMS 30% 1/5W	
R321	2100-0171	R: VAR COMP LIN 200K OHMS 20% 1/4W (INCLUDES S301)	
R322	0687-1041	R: FXD COMP 100K OHMS 10% 1/2W	
R323	0693-8251	R: FXD COMP 8.2M 10% 2W	
R324	0693-8251	R: FXD COMP 8.2M 10% 2W	
R325	0693-8251	R: FXD COMP 8.2M 10% 2W	
R326	0687-4731	R: FXD COMP 47K OHMS 10% 1/2W	
R327	0687-2751	R: FXD COMP 2.7M 10% 1/2W	
R328 THRU R330		NOT ASSIGNED	
R331	0687-1041	R: FXD COMP 100K OHMS 10% 1/2W	
R332	0687-1041	R: FXD COMP 100K OHMS 10% 1/2W	
R333	0690-1841	R: FXD COMP 180K OHMS 10% 1W	
R334	0690-4741	R: FXD COMP 470K OHMS 10% 1W	
R335	0687-1051	R: FXD COMP 1M 10% 1/2W	
R336	0687-4731	R: FXD COMP 47K OHMS 10% 1/2W	
R337	0687-4711	R: FXD COMP 470 OHMS 10% 1/2W	
R338	0687-1021	R: FXD COMP 1K OHMS 10% 1/2W	
R339	0727-0235	R: FXD DEPC 360K OHMS 10% 1/2W	
R340	0727-0218	R: FXD DEPC 180K OHMS 1% 1/2W	
R341	0727-0378	R: FXD DEPC 257.1K OHMS 1% 1/2W	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	hp Part No.	Description #	Note
R342	0687-4711	R: FXD COMP 470 OHMS 10% 1/2W	
R343 THRU			
R350		NOT ASSIGNED	
R351	0727-0287	R: FXD DEPC 2M 1% 1/2W	
R352	2100-0144	R: VAR COMP 250K OHMS 30% 1/4W	
R353	0727-0289	R: FXD DEPC 2.52M 1% 1/2W	
R354	0687-8241	R: FXD COMP 820K OHMS 10% 1/2W	
R355	0687-8231	R: FXD COMP 82K OHMS 10% 1/2W	
R356	0693-1031	R: FXD COMP 10K OHMS 10% 2W	
R357	0687-1831	R: FXD COMP 18K OHMS 10% 1/2W	
R358	0687-1531	R: FXD COMP 15K OHMS 10% 1/2W	
R359	0687-1051	R: FXD COMP 1M 10% 1/2W	
R360		NOT ASSIGNED	
R361	0699-0006	R: FXD COMP 4.7 OHMS 10% 1W	
R362	0699-0006	R: FXD COMP 4.7 OHMS 10% 1W	
R363	0767-0010	R: FXD MET OX 15K OHMS 5% 3W	
R364A/B	2100-0150	R: VAR COMP DUAL TANDEM 10K OHMS 20% 1/4W	
R365	0687-3331	R: FXD COMP 33K OHMS 10% 1/2W	
S1	3101-0011	SWITCH: SLIDE 1 SECT 4 POS	
S2		NSR: PART OF A2 ASSY	
S3A/B/C	3101-0010	SWITCH: PUSH DPDT	
S4 THRU			
S100		NOT ASSIGNED	
S101	3101-0011	SWITCH: SLIDE 1 SECT 4 POS	
S102	3101-0011	SWITCH: SLIDE 1 SECT 4 POS	
S103		NSR: PART OF R275A/B	
S104 THRU			
S200		NOT ASSIGNED	
S201		NSR: PART OF A201 ASSY	
S202		NSR: PART OF R213	
S203		NOT ASSIGNED	
S204	3100-0302	SWITCH: ROT 4 SECT 18 POS	
S205 THRU			
S300		NOT ASSIGNED	
S301		NSR: PART OF R321	
T1 THRU			
T300		NOT ASSIGNED	
T301	120A-11A-1	TRANSFORMER: HIGH VOLTAGE	
T302	9100-0156	TRANSFORMER: POWER	
V1	1932-0029	TUBE: ELECTRON 12AU7	
V2	1932-0029	TUBE: ELECTRON 12AU7	
V3	1932-0022	TUBE: ELECTRON 6DJ8	
V4	5080-0417	TUBE: NEON GLOW	
V5	5080-0417	TUBE: NEON GLOW	
V6 THRU			
V100		NOT ASSIGNED	
V101	1932-0029	TUBE: ELECTRON 12AU7	
V102	1932-0022	TUBE: ELECTRON 6DJ8	
V103 THRU			
V200		NOT ASSIGNED	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	hp Part No.	Description #	Note
V201	1932-0022	TUBE: ELECTRON 6DJ8	
V202	1933-0004	TUBE: ELECTRON 6U8	
V203	1932-0029	TUBE: ELECTRON 12AU7	
V204	1921-0005	TUBE: ELECTRON 6C4	
V205	1933-0004	TUBE: ELECTRON 6U8	
V206	5080-0417	TUBE: NEON GLOW	
V207	5080-0417	TUBE: NEON GLOW	
V208	5080-0419	TUBE: NEON GLOW	
V209	5080-0419	TUBE: NEON GLOW	
V210 THRU V300		NOT ASSIGNED	
V301	1932-0029	TUBE: ELECTRON 12AU7	
V302	1923-0018	TUBE: ELECTRON 6AQ5	
V303	1920-0001	TUBE: ELECTRON 5642	
V304	1920-0001	TUBE: ELECTRON 5642	
V305	5083-0353	CRT: P31 PHOSPHOR INTERNAL GRATICULE	
V306		NOT ASSIGNED	
V307	1921-0010	TUBE: ELECTRON 12B4A	
V308	1933-0004	TUBE: ELECTRON 6U8	
V309	1921-0010	TUBE: ELECTRON 12B4A	
V310	1923-0021	TUBE: ELECTRON 6AU6	
V311	1940-0001	TUBE: ELECTRON 5651	
W1	8120-0050	CORD: POWER (INCLUDES P301)	
XV1	1200-0062	TUBE: SOCKET 9 PIN MINAT	
XV2	1200-0062	TUBE: SOCKET 9 PIN MINAT	
XV3	1200-0062	TUBE: SOCKET 9 PIN MINAT	
XV4 THRU XV100		NOT ASSIGNED	
XV101	1200-0062	TUBE: SOCKET 9 PIN MINAT	
XV102	1200-0062	TUBE: SOCKET 9 PIN MINAT	
XV103 THRU XV200		NOT ASSIGNED	
XV201	1200-0062	TUBE: SOCKET 9 PIN MINAT	
XV202	1200-0062	TUBE: SOCKET 9 PIN MINAT	
XV203	1200-0062	TUBE: SOCKET 9 PIN MINAT	
XV204	1200-0053	TUBE: SOCKET 7 PIN MINAT	
XV205	1200-0062	TUBE: SOCKET 9 PIN MINAT	
XV206 THRU XV300		NOT ASSIGNED	
XV301	1200-0062	TUBE: SOCKET 9 PIN MINAT	
XV302	1200-0053	TUBE: SOCKET 7 PIN MINAT	
XV303 THRU XV306		NOT ASSIGNED	
XV307	1200-0062	TUBE: SOCKET 9 PIN MINAT	
XV308	1200-0062	TUBE: SOCKET 9 PIN MINAT	
XV309	1200-0062	TUBE: SOCKET 9 PIN MINAT	
XV310	1200-0053	TUBE: SOCKET 7 PIN MINAT	
XV311	1200-0053	TUBE: SOCKET 7 PIN MINAT	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	hp Part No.	Description #	Note
XQ1 THRU XQ300		NOT ASSIGNED	
XQ301	1200-0041	TRANSISTOR: SOCKET	
		MISCELLANEOUS	
	120A-83A	FILTER: AMBER (USED WITH CRT WITH P7 PHOSPHOR)	
	120B-44A-1	COVER: TOP	
	0370-0026	KNOB: POSITION CONTROLS	
	0370-0037	KNOB: HORIZONTAL AND VERTICAL SELECTORS	
	0370-0062	KNOB: VERNIER CONTROLS	
	0370-0084	KNOB: INTENSITY AND FOCUS CONTROLS	
	0370-0113	KNOB: TRIGGER SOURCE SELECTOR	
	0370-0114	KNOB: TRIGGER LEVEL CONTROL	
	5000-0743	COVER: SIDE	
	5020-0710	BRACKET: LEFT RACK MOUNT	
	5020-0711	BRACKET: RIGHT RACK MOUNT	
	5020-0718	STRIP: LARGE FILLER	
	5060-0625	ASSY: LEFT CONNECTOR	
	5060-0734	FRAME: ASSY SIDE	
	5060-0758	COVER: BOTTOM	
	5060-0767	ASSY: FULL MODULE FOOT	
		SPECIAL ORDER CRT'S	
	5083-0323	CRT: P2 PHOSPHOR, INTERNAL GRATICULE	
	5083-0333	CRT: P7 PHOSPHOR, INTERNAL GRATICULE	
	5083-0342	CRT: P11 PHOSPHOR, ALUMINIZED, INTERNAL GRATICULE	
		OPTION 05	
	120A-83A	FILTER: AMBER (USED WITH CRT WITH P7 PHOSPHOR)	
	120A-83B	FILTER: BLUE (USED WITH CRT WITH P11 PHOSPHOR)	
	120A-83C	GRATICULE: SCRIBED	
	120A-83G	FILTER: GREEN (USED WITH CRT WITH P31 PHOSPHOR)	
	0370-0084	KNOB: SCALE	
	0693-4711	R: FXD COMP 470 OHMS 10% 2W	
	5083-0330	CRT: P7 PHOSPHOR, WITHOUT INTERNAL GRATICULE	
	5083-0340	CRT: P11 PHOSPHOR, WITHOUT INTERNAL GRATICULE	
	5083-0350	CRT: P31 PHOSPHOR, WITHOUT INTERNAL GRATICULE	
	NONE	R: VAR 300 OHMS (CTS TYPE FGC-90)	
	NONE	LAMP: 6 VOLTS 200 MA (4 EACH) (GE 1768)	
		OPTION 06	
	1251-0038	CONNECTOR: FEMALE (TYPE MS-3106A-10SL-3S) 2 EACH	
	1251-0039	CONNECTOR: MALE (TYPE MS-3102A-10SL-3P) 2 EACH	
	1251-0041	CLAMP: CABLE (TYPE AN-3057-4) 2 EACH	
		OPTION 10	
	120B-95B-1	TERMINAL BOARD ASSY: (INCLUDES COMPONENTS)	
	0370-0084	KNOB: BLACK, 1 ARROW, 1/4 INCH SHAFT	
	0686-3325	R: FXD COMP 3300 OHMS 5% 1/2W	
	0687-4741	R: FXD COMP 470K OHMS 10% 1/2W	
	0761-0077	R: FXD METFLM 24K OHMS 5% 1W	
	1854-0015	TRANSISTOR: SILICON NPN	
	3100-0211	SWITCH: ROTARY SPDT (SWEEP)	

See introduction to this section

Table 6-2. Replaceable Parts

hp Part No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
120A-11A-1	TRANSFORMER: HIGH VOLTAGE	hp		1	1
120A-83A	FILTER: AMBER	hp		1	0
120B-11B	ASSY: RECTIFIER	hp		1	1
120B-19A	ASSY: SWITCH, VERTICAL	hp		1	1
120B-19B	ASSY: SWITCH, HORIZONTAL (INCLUDES A203)	hp		1	1
120B-19D	ASSY: SWITCH, TRIGGER SOURCE	hp		1	1
120B-44A-1	COVER: TOP	hp		1	0
120B-65D	ASSY: ETCHED CIRCUIT, HORIZONTAL SWITCH	hp		1	0
120B-65E	ASSY: ETCHED CIRCUIT, HIGH VOLTAGE SUPPLY	hp		1	0
120B-65F	ASSY: ETCHED CIRCUIT, VERTICAL AND HORIZONTAL AMPLIFIER	hp		1	0
120B-65G	ASSY: ETCHED CIRCUIT, SWEEP AND LOW VOLTAGE SUPPLY	hp		1	0
120B-95B-1	ASSY: TERMINAL BOARD	hp		1	0
0130-0014	C: VAR CER 5-25 pf 350VDCW	72982	577-030-COP-39R	3	1
0130-0016	C: VAR CER 5-25 pf 500VDCW	72982	557-019-COP-39R	2	1
0130-0019	C: VAR CER 4-30 pf 500VDCW	72982	503-015-W-650	1	1
0131-0003	C: VAR MICA 170-780 pf 175VDCW	72136	T52910	1	1
0131-0004	C: VAR MICA 14-150 pf 175VDCW	72136	T51410-3	1	1
0132-0002	C: VAR POLY 0.7-3 pf 350VDCW	72982	535-015-4R	1	1
0132-0004	C: VAR POLY 0.7-3 pf 350VDCW	72982	535-009-4R	6	2
0140-0004	C: FXD MICA 15 pf 10% 500VDCW	76433	RCM15B150K	1	1
0140-0027	C: FXD MICA 470 pf 10% 500VDCW	76433	RCM20B471K	1	1
0140-0031	C: FXD MICA 220 pf 10% 500VDCW	76433	RCM20B221K	1	1
0140-0035	C: FXD MICA 39 pf 5% 500VDCW	76433	RCM15E390J	1	1
0140-0037	C: FXD MICA 390 pf 5% 500VDCW	76433	RCM15E391J	1	1
0140-0039	C: FXD MICA 47 pf 5% 500VDCW	76433	RCM15E470J	1	1
0140-0041	C: FXD MICA 100 pf 5% 500VDCW	76433	RCM15E101J	3	1
0140-0055	C: FXD MICA 150 pf 10% 500VDCW	76433	RCM20B151K	1	1
0140-0082	C: FXD MICA 68 pf 5% 500VDCW	76433	RCM15E680J	1	1
0140-0147	C: FXD MICA 180 pf 5% 500VDCW	72136	DM15F181J	1	1
0140-0156	C: FXD MICA 1500 pf 20% 300VDCW	72136	DM19F152G	2	1
0140-0180	C: FXD MICA 2000 pf 2% 300VDCW	72136	DM19F202G	1	1
0140-0186	C: FXD MICA 20K pf 1% 300VDCW	72136	DM30F203F	1	1
0140-0201	C: FXD MICA 12 pf 5% 500VDCW	72136	DM15C120J	1	1
0150-0011	C: FXD TI-OX 1.5 pf 20% 500VDCW	78488	GA	4	1
0150-0012	C: FXD CER 10K pf 20% 1000VDCW	71590	13C DISC	8	2
0150-0014	C: FXD CER 0.005 µf 500VDCW	04222	D1-4	1	1
0150-0023	C: FXD CER 2K pf 20% 1000VDCW	91418	JF0.002-20%	3	1
0150-0024	C: FXD CER 20K pf -20% +80% 600VDCW	91418	B0.02 GMV	6	2
0150-0041	C: FXD TI-OX 2.7 pf 5% 500VDCW	78488	TYPE GA OBD#	1	1
0160-0007	C: FXD MY 0.0022 µf 10% 600VDCW	56289	160P22296	1	1
0160-0039	C: FXD MY 0.27 µf 10% 200VDCW	56289	160P27492	1	1
0160-0151	C: FXD CER 4700 pf -20% +80% 4000VDCW	71590	DA172-097CB	7	2
0170-0003	C: FXD MY 0.051 µf 10% 200VDCW	00853	33M02151	1	1
0170-0022	C: FXD MY 0.1 µf 20% 600VDCW	84411	HEW 7	2	1
0170-0026	C: FXD MY 0.0018 µf 5% 200VDCW	84411	60QUE18252	1	1

See introduction to this section

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

hp Part No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
0170-0027	C: FXD MY 0.02 μf 5% 200VDCW	84411	600UE20352	2	1
0170-0028	C: FXD MY 0.2 μf 5% 200VDCW	84411	600UE20452	1	1
0170-0038	C: FXD MY 0.22 μf 10% 200VDCW	56289	148P22492	1	1
0180-0030	C: FXD ELECT 2 SECT 120 x 40 μf 450VDCW	56289	D32352	1	1
0180-0050	C: FXD ELECT 40 μf -15% +100% 50VDCW	56289	D32538	2	1
0180-0053	C: FXD ELECT 3 SECT 40-30-20 μf 150VDCW	56289	OBD#	1	1
0180-0056	C: FXD ELECT 1K μf 50VDCW	56289	D32429	1	1
0180-0126	C: FXD ELECT 120 μf 300VDCW	56289	D36236	1	1
0180-0127	C: FXD ELECT 2 SECT 120 x 40 μf -10% +50% 300VDCW	56289	D36235	1	1
0370-0026	KNOB: POSITION CONTROLS	hp		2	0
0370-0037	KNOB: HORIZONTAL AND VERTICAL SELECTORS	hp		2	0
0370-0062	KNOB: VERNIER CONTROLS	hp		2	0
0370-0084	KNOB: INTENSITY AND FOCUS CONTROLS	hp		3	0
0370-0113	KNOB: TRIGGER SOURCE SELECTOR	hp		1	0
0370-0114	KNOB: TRIGGER LEVEL CONTROL	hp		1	0
0686-1035	R: FXD COMP 10K OHMS 5% 1/2W	01121	EB1035	1	1
0686-1055	R: FXD COMP 1M 5% 1/2W	01121	EB1055	4	1
0686-1245	R: FXD COMP 120K OHMS 5% 1/2W	01121	EB1245	1	1
0686-1525	R: FXD COMP 1.5K OHMS 5% 1/2W	01121	EB1525	1	1
0686-2055	R: FXD COMP 2M 5% 1/2W	01121	EB2055	1	1
0686-2435	R: FXD COMP 24K OHMS 5% 1/2W	01121	EB2435	1	1
0686-2745	R: FXD COMP 270K OHMS 5% 1/2W	01121	EB2745	1	1
0686-3325	R: FXD COMP 3.3K OHMS 5% 1/2W	01121	EB3325	1	0
0686-3935	R: FXD COMP 39K OHMS 5% 1/2W	01121	EB3935	2	1
0686-4345	R: FXD COMP 430K OHMS 5% 1/2W	01121	EB4345	1	1
0686-5115	R: FXD COMP 510 OHMS 5% 1/2W	01121	EB5115	2	1
0686-7525	R: FXD COMP 7.5K OHMS 5% 1/2W	01121	EB7525	2	1
0687-1011	R: FXD COMP 100 OHMS 10% 1/2W	01121	EB1011	12	3
0687-1021	R: FXD COMP 1K OHMS 10% 1/2W	01121	EB1021	2	1
0687-1041	R: FXD COMP 100K OHMS 10% 1/2W	01121	EB1041	7	2
0687-1051	R: FXD COMP 1M 10% 1/2W	01121	EB1051	6	2
0687-1241	R: FXD COMP 120K OHMS 10% 1/2W	01121	EB1241	1	1
0687-1531	R: FXD COMP 15K OHMS 10% 1/2W	01121	EB1531	2	1
0687-1541	R: FXD COMP 150K OHMS 10% 1/2W	01121	EB1541	1	1
0687-1551	R: FXD COMP 1.5M 10% 1/2W	01121	EB1551	1	1
0687-1831	R: FXD COMP 18K OHMS 10% 1/2W	01121	EB1831	2	1
0687-1851	R: FXD COMP 1.8M 10% 1/2W	01121	EB1851	1	1
0687-2231	R: FXD COMP 22K OHMS 10% 1/2W	01121	EB2231	3	1
0687-2251	R: FXD COMP 2.2M 10% 1/2W	01121	EB2251	1	1
0687-2731	R: FXD COMP 27K OHMS 10% 1/2W	01121	EB2731	5	2
0687-2741	R: FXD COMP 270K OHMS 10% 1/2W	01121	EB2741	1	1
0687-2751	R: FXD COMP 2.7M 10% 1/2W	01121	EB2751	1	1
0687-3321	R: FXD COMP 3.3K OHMS 10% 1/2W	01121	EB3321	1	1
0687-3331	R: FXD COMP 33K OHMS 10% 1/2W	01121	EB3331	2	1
0687-3341	R: FXD COMP 330K OHMS 10% 1/2W	01121	EB3341	2	1

See introduction to this section

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

hp Part No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
0687-3921	R: FXD COMP 3.9K OHMS 10% 1/2W	01121	EB3921	2	1
0687-3931	R: FXD COMP 39K OHMS 10% 1/2W	01121	EB3931	1	1
0687-4711	R: FXD COMP 470 OHMS 10% 1/2W	01121	EB4711	5	2
0687-4731	R: FXD COMP 47K OHMS 10% 1/2W	01121	EB4731	4	1
0687-4741	R: FXD COMP 470K OHMS 10% 1/2W	01121	EB4741	2	1
0687-5631	R: FXD COMP 56K OHMS 10% 1/2W	01121	EB5631	1	1
0687-5641	R: FXD COMP 560K OHMS 10% 1/2W	01121	EB5641	1	1
0687-6831	R: FXD COMP 68K OHMS 10% 1/2W	01121	EB6831	3	1
0687-6841	R: FXD COMP 680K OHMS 10% 1/2W	01121	EB6841	2	1
0687-8231	R: FXD COMP 82K OHMS 10% 1/2W	01121	EB8231	1	1
0687-8241	R: FXD COMP 820K OHMS 10% 1/2W	01121	EB8241	1	1
0689-1635	R: FXD COMP 16K OHMS 5% 1W	01121	GB1635	1	1
0689-1835	R: FXD COMP 18K OHMS 5% 1W	01121	GB1835	1	1
0689-2235	R: FXD COMP 22K OHMS 5% 1W	01121	GB2235	2	1
0689-2435	R: FXD COMP 24K OHMS 5% 1W	01121	GB2435	2	1
0689-7525	R: FXD COMP 7.5K OHMS 5% 1W	01121	GB7525	1	1
0690-1041	R: FXD COMP 100K OHMS 10% 1W	01121	GB1041	3	1
0690-1841	R: FXD COMP 180K OHMS 10% 1W	01121	GB1841	1	1
0690-4741	R: FXD COMP 470K OHMS 10% 1W	01121	GB4741	1	1
0690-5641	R: FXD COMP 560K OHMS 10% 1W	01121	GB5641	1	1
0690-8221	R: FXD COMP 8.2K OHMS 10% 1W	01121	GB8221	2	1
0690-8231	R: FXD COMP 82K OHMS 10% 1W	01121	GB8231	1	1
0692-3635	R: FXD COMP 36K OHMS 5% 2W	01121	HB3635	2	1
0693-1031	R: FXD COMP 10K OHMS 10% 2W	01121	HB1031	1	1
0693-1541	R: FXD COMP 150K OHMS 10% 2W	01121	HB1541	1	1
0693-1831	R: FXD COMP 18K OHMS 10% 2W	01121	HB1831	1	1
0693-5651	R: FXD COMP 5.6M 10% 2W	01121	HB5651	3	1
0693-8251	R: FXD COMP 8.2M 10% 2W	01121	HB8251	3	1
0699-0006	R: FXD COMP 4.7 OHMS 10% 1W	01121	GB47G1	2	1
0727-0055	R: FXD DEPC 201 OHMS 1% 1/2W	hp		1	1
0727-0060	R: FXD DEPC 225 OHMS 1% 1/2W	hp		1	1
0727-0100	R: FXD DEPC 1K OHMS 1% 1/2W	hp		2	1
0727-0110	R: FXD DEPC 1.5K OHMS 1% 1/2W	hp		1	1
0727-0132	R: FXD DEPC 4K OHMS 1% 1/2W	hp		1	1
0727-0157	R: FXD DEPC 10K OHMS 1% 1/2W	hp		1	1
0727-0173	R: FXD DEPC 20K OHMS 1% 1/2W	hp		1	1
0727-0197	R: FXD DEPC 59.48K OHMS 1% 1/2W	hp		2	1
0727-0201	R: FXD DEPC 71.56K OHMS 1% 1/2W	hp		1	1
0727-0202	R: FXD DEPC 83K OHMS 1% 1/2W	hp		1	1
0727-0208	R: FXD DEPC 100K OHMS 1% 1/2W	hp		1	1
0727-0218	R: FXD DEPC 180K OHMS 1% 1/2W	hp		1	1
0727-0221	R: FXD DEPC 200K OHMS 1% 1/2W	hp		1	1
0727-0235	R: FXD DEPC 360K OHMS 1% 1/2W	hp		1	1
0727-0246	R: FXD DEPC 600K OHMS 1% 1/2W	hp		1	1
0727-0261	R: FXD DEPC 900K OHMS 1% 1/2W	hp		1	1

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

hp Part No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
0727-0271	R: FXD DEPC 990K OHMS 1% 1/2W	hp		1	1
0727-0274	R: FXD DEPC 1M 1% 1/2W	hp		3	1
0727-0285	R: FXD DEPC 1.8M 1% 1/2W	hp		1	1
0727-0287	R: FXD DEPC 2M 1% 1/2W	hp		1	1
0727-0289	R: FXD DEPC 2.52M 1% 1/2W	hp		1	1
0727-0292	R: FXD DEPC 3M 1% 1/2W	hp		4	1
0727-0376	R: FXD DEPC 1.98M 1% 1/2W	hp		1	1
0727-0378	R: FXD DEPC 257.1K OHMS 1% 1/2W	hp		1	1
0730-0024	R: FXD DEPC 7.5K OHMS 1% 1W	hp		1	1
0730-0056	R: FXD DEPC 68.38K OHMS 1% 1W	hp		2	1
0730-0062	R: FXD DEPC 80K OHMS 1% 1W	hp		1	1
0761-0077	R: FXD METFLM 24K OHMS 5% 1W	hp		1	0
0767-0010	R: FXD MET OX 15K OHMS 5% 3W	hp		1	1
0771-0006	R: FXD MET OX 27K OHMS 10% 4W	hp		1	1
1200-0041	SOCKET: TRANSISTOR	71785	133-92-10-034	1	1
1200-0053	SOCKET: TUBE 7 PIN MINAT	71785	111-51-11-069	4	1
1200-0062	SOCKET: TUBE 9 PIN MINAT	71785	121-51-11-060	13	1
1450-0048	LAMP: INDICATOR	08717	858-R	1	1
1850-0038	TRANSISTOR: 2N301	86684	2N301	1	1
1854-0015	TRANSISTOR: SILICON NPN	hp		1	0
1901-0030	DIODE: SILICON 800V PIV	02735	OBD#	3	3
1901-0044	DIODE: SILICON	hp		1	1
1901-0045	DIODE: SILICON	hp		1	1
1902-0225	DIODE: SILICON AVALANCHE 18.7V	hp		1	1
1920-0001	TUBE: ELECTRON 5642	82219	5642	2	2
1921-0005	TUBE: ELECTRON 6C4	86684	6C4	1	1
1921-0010	TUBE: ELECTRON 12B4A	33173	12B4A	2	2
1923-0018	TUBE: ELECTRON 6AQ5	82219	6AQ5	1	1
1923-0021	TUBE: ELECTRON 6AU6	33173	6AU6	1	1
1932-0022	TUBE: ELECTRON 6DJ8	13396	6DJ8	3	3
1932-0029	TUBE: ELECTRON 12AU7	33173	12AU7	5	5
1933-0004	TUBE: ELECTRON 6U8	33173	6U8	3	3
1940-0001	TUBE: ELECTRON 5651	86684	5651	1	1
2100-0054	R: VAR WW LIN 500 OHMS 10% 2W	11237	252 OBD#	1	1
2100-0093	R: VAR COMP LIN 20K OHMS 20% 1/4W	11237	OBD#	1	1
2100-0094	R: VAR COMP LIN 50K OHMS 3% 1/4W	11237	UPE 70 SPECIAL	2	1
2100-0095	R: VAR COMP LIN 100K OHMS 30% 1/4W	11237	OBD#	1	1
2100-0096	R: VAR COMP LIN 1M 30% 1/4W	11237	UPE 70 SPECIAL	1	1
2100-0102	R: VAR COMP LIN 500K OHMS 30% 1/5W	11237	UPE 70 SPECIAL	2	1
2100-0105	R: VAR COMP LIN 3.5M 30% 1/2W	12697	OBD#	1	1
2100-0144	R: VAR COMP 250K OHMS 30% 1/4W	11237	UPE 70	2	1
2100-0150	R: VAR COMP DUAL TANDEM 10K OHMS 20%	11237	UPE 70	1	1
2100-0154	R: COMP LIN 1K OHMS 30% 3/10W	11237	UPE 70	1	1
2100-0171	R: VAR COMP LIN 200K OHMS 20% 1/4W	11237	VF-45	1	1
2100-0174	R: VAR COMP 500K OHMS 20%, 5% CW LOG TAPER 1/4W W/SPST SWITCH	11237	RGC-45	1	1

See introduction to this section

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

hp Part No.	Description #	Mfr.	Mfr. Part No.	TQ	RS
2100-0182	R: VAR COMP LIN 3.3K OHMS 10% 1/3W	11237	UPE 70	1	1
2100-0188	R: VAR COMP LIN 200K OHMS 20% 1/4W	11237	VF-45	1	1
2100-0258	R: VAR COMP DUAL TANDEM LIN 1M 20% 1/4W	11237	2-45	1	1
2100-0338	R: VAR COMP LOG 2 SECT 100K OHMS/SECT 20% 1/4W	11237	OBD#	1	1
2100-0339	R: VAR COMP LOG 2 SECT 100K OHMS/SECT 20% 1/4W	11237	OBD#	1	1
2100-1486	R: VAR COMP LIN 300 OHMS 20% 3W	hp		1	1
2110-0005	FUSE: CARTRIDGE 1.6 AMP S-B (for 115V OPERATION)	71400	MDL1.6	1	10
2110-0020	FUSE: CARTRIDGE 0.8 AMP S-B (for 230V OPERATION)	71400	OBD#		
3100-0211	SWITCH: ROT SPDT	hp		1	0
3100-0302	SWITCH: ROT 4 SECT 18 POS	76854	TYPE H	1	1
3101-0010	SWITCH: PUSH DPDT	82389	3S-1407	1	1
3101-0011	SWITCH: SLIDE 1 SECT 4 POS	71590	OBD#	3	1
5000-0743	COVER: SIDE	hp		2	0
5020-0710	BRACKET: LEFT RACK MOUNT	hp		1	0
5020-0711	BRACKET: RIGHT RACK MOUNT	hp		1	0
5020-0718	STRIP: LARGE FILLER	hp		1	0
5060-0409	INDUCTOR: ALIGNMENT	hp		1	1
5060-0625	ASSY: LEFT CONNECTOR	hp		1	1
5060-0632	BINDING POST: BLACK (SHARED BY J101 AND J301)	hp		2	1
5060-0633	BINDING POST: RED (1USED)	hp		4	1
5060-0734	FRAME: ASSY SIDE	hp		2	0
5060-0758	COVER: BOTTOM	hp		1	0
5060-0767	ASSY: FULL MODULE FOOT	hp		5	0
5080-0417	TUBE: NEON GLOW	hp		4	4
5080-0419	TUBE: NEON GLOW	hp		2	2
5083-0323	CRT: P2 PHOSPHOR INTERNAL GRATICULE	hp		1	0
5083-0333	CRT: P7 PHOSPHOR INTERNAL GRATICULE	hp		1	0
5083-0342	CRT: P11 PHOSPHOR ALUMINIZED INTERNAL GRATICULE	hp		1	0
5083-0353	CRT: P31 PHOSPHOR INTERNAL GRATICULE	hp		1	1
8120-0050	CORD: POWER	70903	CS-9941/PH-151/7.5 ft.	1	1
9100-0156	TRANSFORMER: POWER	98734	6-1691	1	1
9140-0022	INDUCTOR: FXD RF 500 μh 10%	99848	1500-15-501	1	1
9140-0029	INDUCTOR: FXD RF 100 μh	99848	3100-15-101	1	1

See introduction to this section

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
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N. Y.
00334	Humidail Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Products Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Company, Ordill Division (Capacitors)	Marion, Ill.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc. Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Ind.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N. J.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co., Electronics Division	Burbank, Calif.
04354	Precision Paper Tube Co.	Chicago, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prods., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc., Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04777	Automatic Electric Sales Corp.	Northlake, Ill.
04796	Sequoia Wire & Cable Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P. M. Motor Company	Chicago 44, Ill.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp., Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metropolitan Telecommunications Corp., Metro Cap. Division	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	The Bassick Co.	Bridgeport, Conn.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06475	Western Devices, Inc.	Inglewood, Calif.
06540	Amatom Electronic Hardware Co. Inc.	New Rochelle, N. Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06751	U. S. Semcor Division of Nuclear Corp. of America	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07115	Corning Glass Works Electronic Components Dept.	Bradford, Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N. Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	The Birtcher Corp.	Los Angeles, Calif.
07700	Technical Wire Products	Springfield, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert, Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada.
08717	Sloan Company	Burbank, Calif.
08718	Cannon Electric Co.,Phoenix Div.	Phoenix, Ariz.
08792	CBS Electronics Semiconductor Operations,Div.of C.B.S.,Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Atohm Electronics	Sun Valley, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09664	The Bristol Co.	Waterbury, Conn.
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11312	Microwave Electronics Corp.	Palo Alto, Calif.
11534	Duncan Electronic, Inc.	Santa Ana, Calif.
11711	General Instrument Corporation Semiconductor Division	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N. J.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13103	Thermolloy	Dallas, Texas
13396	Telefunken (G.M.B.H.)	Hannover, Germany
13835	Midland Mfg. Co.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14655	Cornell Dubilier Elec. Corp.	So. Plainfield, N.J.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Electronics Co. Inc.	Brooklyn, N.Y.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15909	The Daven Co.	Livingston, N.J.
16037	Spruce Pine Mica Co.	Spruce Pine, N. C.
16352	Computer Diode Corp.	Lodi, N. J.
16688	De Jur-Amsco Corporation	Long Island City 1, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
18486	Radio Industries	Des Plaines, Ill.
18583	Curtis Instrument Inc.	Mt. Kisco, N.Y.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E., Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Corp.	Hawkesbury, Ontario, Canada
37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer and Inst. Co.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
52090	Rowan Controller Co.	Baltimore, Md.
63743	Ward Leonard Electric	Mt. Vernon, N.Y.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson & Co., Inc.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas & Betts Co.	Elizabeth 1, N.J.
60741	Tripplett Electrical Inc.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Div. of Daystrom, Inc.	Newark, N.J.
66295	Wittek Manufacturing Co.	Chicago 23, Ill.
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70319	Allmetal Screw Prod. Co., Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Electronic Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71753	A.O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72092	Eitel-McCullough, Inc.	San Bruno, Calif.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
71707	Coto Coil Co., Inc.	Providence, R.I.
72354	John E. Fast & Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72699	General Instrument Corp., Semiconductor Div.	Newark, N.J.
72758	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Instruments, Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North American Phillips Co, Inc.	Hicksville, N.Y.
73490	Beckman Helipot Corp.	So. Pasadena, Calif.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
73734	Federal Screw Prod. Co.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N. Y.
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Division of Cinch Mfg. Corp.	Chicago, Ill.
75378	James Knights Co.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	Micamold Electronic Mfg. Corp.	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	Bendix Pacific Division of Bendix Corp.	No. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phaostran Instrument and Electronic Co.	South Pasadena, Calif.
77250	Phoell Mfg. Co.	Chicago, Ill.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine and Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products	Elizabeth, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Association. tube meeting EIA standards	Any brand Washington, D.C.
80207	Unimax Switch, Div. of W.L. Maxson Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Fulton Controls Co.	Columbus 16, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Adhesive Label Corp.	Monrovia, Calif.
80583	Hammerlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Electronics Co., Inc.	Norwalk, Conn.

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

Code No.	Manufacturer	Address
01349	Military Specification	.....
01413	Wilkor Products, Inc.	Cleveland, Ohio
01453	Raytheon Mfg. Co., Industrial Components Div., Industr. Tube Operations	Newton, Mass.
01483	International Rectifier Corp.	El Segundo, Calif.
01561	The Arnaux Products Co.	Cambridge, Mass.
01860	Barry Controls, Inc.	Watertown, Mass.
02062	Custer Parts Co.	Skokie, Ill.
02142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
02170	Allen B. DuMont Labs, Inc.	Clifton, N.J.
02395	Magnire Industries, Inc.	Greenwich, Conn.
02719	Sylvania Electric Prod. Inc. Electronic Tube Div.	Emporium, Pa.
02176	Avnet Co.	East Newark, N.J.
02189	Switchcraft, Inc.	Chicago, Ill.
02647	Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods.	Attleboro, Mass.
02866	Research Products Corp.	Madison, Wis.
02877	Hutton Manufacturing Co., Inc.	Woodstock, N.Y.
02893	Vector Electronic Co.	Glendale, Calif.
02953	Western Master Mfr. Co.	Los Angeles, Calif.
02958	Curr Fastener Co.	Cambridge, Mass.
02986	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
03125	Pyramid Electric Co.	Darlington, S.C.
03148	Electro Cords Co.	Los Angeles, Calif.
03186	Vickley Engineering Corp.	Springfield, N.J.
03268	Hendrix Corp., Red Bank Div.	Red Bank, N.J.
03311	Hubbell Corp.	Meadowlark, Ill.
03330	Smith, Herman H., Inc.	Brooklyn, N.Y.
03365	Central Screw Co.	Chicago, Ill.
03561	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
03994	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
03740	Eveready Battery	New York, N.Y.
03777	Model Eng. and Mfg., Inc.	Huntington, Ind.
03821	Loyd Scruggs Co.	Fenton, Mo.
04071	Arco Electronics, Inc.	New York, N.Y.
04296	A.J. Gleaner Co., Inc.	San Francisco, Calif.
04411	Good All Electric Mfg. Co.	Ogallala, Neb.
04570	Sarkes Tarzian, Inc.	Bloomington, Ind.
04694	Boonton Molding Company	Boonton, N.J.
04471	A.B. Boyd Co.	San Francisco, Calif.
05419	R.M. Bracamonte & Co.	San Francisco, Calif.
05663	Kinkel Kords, Inc.	New Haven, Conn.
05911	Seamless Rubber Co.	Chicago, Ill.
06197	Clifton Precisions Products	Clifton Heights, Pa.
06579	Precision Rubber Products Corp.	Dayton, Ohio
06604	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
07210	Philco Corporation (Lansdale Division)	Lansdale, Pa.
07471	Western Fibrous Glass Products Co.	San Francisco, Calif.
07564	Van Waters & Rogers Inc.	Seattle, Wash.
07930	Tower Mfg. Corp	Providence, R.I.
08140	Cutler-Hammer, Inc.,	Lincoln, Ill.
08220	Gould-National Batteries, Inc.	St. Paul, Minn.
08698	General Mills, Inc.	Buffalo, N.Y.
08833	Grayber Electric Co.	Oakland, Calif.
09462	Waldes Kohinoor, Inc.	Cambridge, Mass.
09673	General Electric Distributing Corp.	Schenectady, N.Y.
09636	Custer Parts Div. of Economy Baler Co.	Chicago, Ill.
09665	United Transformer Co.	Chicago, Ill.
10179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
10515	Bearing Engineering Co.	San Francisco, Calif.
11260	Connor Spring Mfg. Co.	San Francisco, Calif.
11365	Waldes Dial & Nameplate Co.	El Monte, Calif.
11418	Radio Materials Co.	Chicago, Ill.
11536	August Brothers', Inc.	Attleboro, Mass.
11637	Dale Electronics, Inc.	Columbus, Nebr.
11662	Elco Corp.	Philadelphia, Pa.
11717	Grenar Mfg. Co., Inc.	Wakefield, Mass.
11827	H F Development Co.	Redwood City, Calif.
11929	Minneapolis-Honeywell Regulator Co., Micromatch Div.	Freeport, Ill.
11961	Hahn-Bloz. Spring Co.	Oakland, Calif.
12180	Tru-Connector Corp.	Peabody, Mass.
12196	Universal Metal Prod., Inc.	Bassett Puente, Calif.
12367	Elgeet Optical Co., Inc.	Rochester, N.Y.
12697	Tinsulite Insulated Wire Co.	Tarrytown, N.Y.
12933	Sylvania Electric Prod. Inc., Semiconductor Div.	Watson, Mass.
12969	Robbins and Myers, Inc.	New York, N.Y.
13606	Stevens Mfg. Co., Inc.	Mansfield, Ohio
13788	Howard J. Smith Inc.	Port Monmouth, N.J.
13829	C. P. Clare & Co.	Chicago, Ill.
13983	Insulne-Kor Hannan Ind., Inc. Electronic Division	Manchester, N.H.
14137	General Cable Corp.	Bayonne, N.J.
14144	Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation	Quincy, Mass.
14145	Raytheon Mfg. Co., Semiconductor Div., California Street Plant	Newton, Mass.
14148	Scientific Radio Products, Inc.	Loveland, Colo.
14154	Tung-Sol Electric, Inc.	Newark, N.J.
14197	Curtiss-Wright Corp., Electronics Div.	East Paterson, N.J.
14272	Southco Div. of S. Chester Corp.	Lester, Pa.
14313	Tru Ohm Prod. Div. of Model Engineering and Mfg. Co.	Chicago, Ill.
14318	Wire Cloth Products Inc.	Chicago, Ill.
14482	Worcester Pressed Aluminum Corp.	Worcester, Mass.
15023	Photovolt Researchers, Inc.	Boston, Mass.
15236	Allen Products Corp.	Miami, Fla.
15238	Continental Connector Corp.	Woodside, N.Y.
15263	Lancraft Mfg. Co., Inc.	New York, N.Y.
15264	Lenco Electronics, Inc.	Burbank, Calif.
15265	National Coil Co.	Sheridan, Wyo.
15275	Viking Inc.	Bridgeport, Conn.
15348	Cambas Corp.	Bloomfield, N.J.
15354	Methode Mfg. Co.	Chicago, Ill.
15712	Cage Electric Co., Inc.	Frankfort, Ind.
15987	Westchester Co.	Chicago, Ill.
16067	Huggins Laboratories	Sunnyvale, Calif.
16091	H-Q Division of Aeroviox	Olean, N.Y.
16256	Thordarson-Meissner Div. of Maguire Industries, Inc.	Mt. Carmel, Ill.
16296	Solar Manufacturing Co.	Los Angeles, Calif.
16338	Cashon Screw Co.	Chicago, Ill.
16361	Microwave Associates, Inc.	Burlington, Mass.
16481	Excel Transformer Co.	Oakland, Calif.
17464	Industrial Retaining Ring Co.	Irvington, N.J.
17539	Automatic and Precision Mfg. Co.	Yonkers, N.Y.
17966	CBS Electronics, Div. of C.B.S., Inc.	Danvers, Mass.
17979	Rose Resistor Corp.	Yonkers, N.Y.
18141	Avnet Brothers Inc.	Jamaica, N.Y.
18159	Rubber Tack, Inc.	Gardena, Calif.
98220	Francis L. Wesley	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Canal Corp.	Redwood City, Calif.
98731	General Mills	Minneapolis, Minn.
98821	Huats Hicks Electric Co.	Winnetka, N.Y.
98925	Clevite Transistor Prod. Div. of Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Kentronit, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Ill.
99957	Technology Instrument Corp of Calif.	Newbury Park, Calif.

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

00000	Winchester Electronics, Inc.	Santa Monica, Calif.
00007	Wales Tool and Die	Los Angeles, Calif.
00008	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
00009	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
00012	Wilow Leather Products Corp.	Newark, N.J.
00044	British Radio Electronics Ltd.	Washington, D.C.
00048	ETA	England
00049	Indiana General Corp., Electl. Div.	Indiana
00088	Precision Instrument Components Co.	Van Nuys, Calif.
00098	Rubber Eng. & Development	Hayward, Calif.
00099	A "O" O Manufacturing Co.	San Jose 27, Calif.
00000	Coolmor	Oakland, Calif.
00055	Control of Elgin Watch Co.	Burbank, Calif.
00099	California Eastern Lab.	Burlingame, Calif.
00077	S.H. Smith Co.	Los Angeles 65, Calif.

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APPENDIX 1
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
433-	1
421-	1, 2
327-, 403-, 409-	1, 2, 3
303-	1, 2, 3, 4
242-, 247-	2, 3, 4, 5
202-, 217-, 219-, 223-	2, 3, 4, 5, 6

CHANGE 1

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

CHANGE 2

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 3

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 4

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

CHANGE 5

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 µf, 350VDCW; Mfr 56289; Mfr Part No. D3253.
C325A/B: Change to hp Part No. 0180-0030; C: fxd, elect, 2-sect, 120 x 40 µf, 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 6

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 µf.
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 µf, 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.

CATHODE RAY TUBE WARRANTY

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

Your nearest Hewlett-Packard Sales/Service Office maintains a stock of replacement tubes and, if desired, will assist in processing the warranty claim.

In order to ensure credit for a CRT under the warranty period, the reverse side of this sheet should be filled out completely and returned with the defective tube. To avoid damage to the tube while in shipment, carefully follow the shipping instructions listed below; credit is not allowed on broken tubes.

SHIPPING INSTRUCTIONS

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 four inches of packed excelsior or similar shock absorbing material; be sure the packing is tight all around the tube.
5. Tubes returned from outside the continental United States should be packed in a wooden box.
6. Ship prepaid by AIR FREIGHT or RAILWAY EXPRESS to:

   Hewlett-Packard Company
   CRT Manufacturing Dept.
   1900 Garden of the Gods Road
   Colorado Springs, Colorado 80907
   Atten: CRT Quality Assurance

CRT WARRANTY CLAIM

FROM: Date _____

NAME _____

COMPANY _____

ADDRESS _____

For additional information, contact:

NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

1. HP 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

HP SALES AND SERVICE OFFICES IN THE U.S. AND CANADA

ALABAMA

Huntsville, 35801
Hewlett-Packard
Southern Sales Division
Holiday Office Ctr., Suite 18
(205) 881-4591
TWX: 510-579-2204

ARIZONA

Scottsdale, 85251
Hewlett-Packard
Neely Sales Division
3009 No. Scottsdale Rd.
(602) 945-7601
TWX: 602-949-0111

Tucson, 85716
Hewlett-Packard
Neely Sales Division
232 So. Tucson Blvd.
(602) 623-2564
TWX: 602-792-2759

CALIFORNIA

Los Angeles Area
Hewlett-Packard
Neely Sales Division
3939 Lankershim Blvd.
North Hollywood 91604
(213) 877-1282 and 766-3811
TWX: 910-499-2170

Sacramento, 95821
Hewlett-Packard
Neely Sales Division
2591 Carlsbad Ave.
(916) 482-1463
TWX: 916-444-8683

San Diego, 92106
Hewlett-Packard
Neely Sales Division
1055 Shafter Street
(714) 223-8103
TWX-714-276-4263

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INDIANA

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Pittsburgh Area
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TWX: 801-521-2604

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Bellevue 98004
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P.O. Box 33, Vienna IX/71
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Sao Paulo, S.P.
Tel: 32-4332

CANADA
Hewlett-Packard (Canada) Ltd.
8270 Mayrand Street
Montreal, Quebec
(514) 735-2273

Hewlett-Packard (Canada) Ltd.
1762 Carling Avenue
Ottawa, Ontario
(613) 722-4223

Hewlett-Packard (Canada) Ltd.
1415 Lawrence Avenue W.
Toronto, Ontario
(416) 249-9196

CHILE
Hector Calcagni
Casilla 13942, Santiago
Tel: 6.42.26

DENMARK
Tage Olsen A/S
Rønnegade 1, Copenhagen Ø
Tel: 29.48.00

FINLAND
INTO O/Y
P. O. Box 153
11 Meritullinkatu, Helsinki
Tel: 6.11.33

FRANCE
Hewlett-Packard France
150 Blvd. Massena, Paris 13e
Tel: 707.97.19

GERMANY
Hewlett-Packard V.m.b.H.
Steindamm 35, Hamburg
Tel: 24.05.51

Hewlett-Packard V.m.b.H.
Kurhessenstrasse 95
6 Frankfurt am Main
Tel: 52.00.36

Hewlett-Packard V.m.b.H.
Regintriedstrasse 13
8 Munich 9
Tel: 49.51.21/22

Hewlett-Packard V.m.b.H.
Technisches Büro
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Tel: 6971

GREECE
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ISRAEL
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16 Kremenetski St., Tel Aviv
Tel: 35021-2-3

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Hewlett-Packard Italiana S.p.A.
Viale Lunigiana 46, Milan
Tel: 69.15.84/5/6

Hewlett-Packard Italiana S.p.A.
Palazzo Italia
Piazza Marconi, 25, Roma-Eur
Tel: 59.12.544/5

JAPAN
Yokogawa-Hewlett-Packard Ltd.
2270 Ishikawa-cho
Hachioji, Tokyo
Tel: Hachioji 0426-3-1231 (19 lines)

Yokogawa-Hewlett-Packard Ltd.
No. 3, 6-chome, Aoyama-Kitamachi
Akasaka, Minato-ku, Tokyo
Tel: 403-0073, 403-0074, 403-0075

Yokogawa-Hewlett-Packard Ltd.
No. 8, Umeda, Kita-ku, Osaka City
Tel: 361-3084, 341-2095

Yokogawa-Hewlett-Packard Ltd.
No. 4, 3-chome, Himeikedori,
Chigusa-ku, Nagoya City
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KOREA
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112-35 Sokong-Dong, Jung-ku
Seoul P. O. Box 1103, Seoul
Tel: 3-7049, 3-7613

NETHERLANDS
Hewlett-Packard Benelux N.V.
23 Burg Roellstraat, Amsterdam W.
Tel: (020) 13.28.98 and 13.54.99

NEW ZEALAND
Sample Electronics (N. Z.) Ltd.
8 Matipo Street
Onehunga S. E. 5, Auckland
Tel: 565-361

NORWAY
Morgenstierne & Co. A/S
Ingeniørfirma
6 Wessels Gate, Oslo
Tel: 20 16 35

PORTUGAL
TELECTRA
Rua Rodrigo da Fonseca 103
P. O. Box 2531, Lisbon 1
Tel: 68 60 72 and 68 60 73 and 68 60 74

PUERTO RICO & VIRGIN ISLANDS
San Juan Electronics, Inc.
150 Ponce de Leon, Stop 3
P. O. Box 5167
Pta. de Tierra Sta., San Juan 00906
Tel: 722-3342, 724-4406

SPAIN
ATAIO, Ingenieros
Enrique Larreta 12, Madrid 6
Tel: 235.43.44 and 235.43.45

SOUTH AFRICA
F. H. Flanter & Co. (Pty.), Ltd.
Rosella House
Buitencingle Street, Cape Town
Tel: 3-3817

SWEDEN
H-P Instrument AB
Centralvägen 28, Solna, Centrum
Tel: 08-83.08.30 and 10-83.08.30

SWITZERLAND
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Wankdorffeldstrasse 66, Berne
Tel: (031) 42.00.78

TAIWAN (FORMOSA)
Hwa Sheng Electronic Co., Ltd.
21 Nanking West Road, Taipei
Tel: 4 6076, 4 5936

TURKEY
TELEKOM Engineering Bureau
P.O. Box 376—Galata, Istanbul
Tel: 49.40.40

UNITED KINGDOM
Hewlett-Packard Ltd.
Dallas Rd., Bedford, England
Tel: Bedford 68052

VENEZUELA
Citec, C. A.
Edif. Arisan-Of #4
Avda. Francisco de Miranda-Chacaito
Apartado del Este 10.837, Caracas
Tel: 71.88.05

YUGOSLAVIA
Belram S.A.
83 Avenue des Mimosas
Brussels 15, Belgium
Tel: 35.29.58

For Sales and Service Assistance in Areas Not Listed Contact:

IN EUROPE
Hewlett-Packard, S. A.
54 Route des Acacias
Geneva, Switzerland
Telephone: (022) 42.81.50
Telex: 2.24.86
Cable: HEWPACKSA

IN LATIN AMERICA
Hewlett-Packard Inter-Americas
1501 Page Mill Road
Palo Alto, California 94304, U.S.A.
Telephone: (415) 326-7000
TWX: 910-373-1267
Telex: 033811 Cable: HEWPACK

ELSEWHERE
Hewlett-Packard
International Marketing Department
1501 Page Mill Road
Palo Alto, California 94304, U.S.A.
Telephone: (415) 326-7000
TWX: 910-373-1267
Telex: 033811 Cable: HEWPACK

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