

OPERATING AND SERVICE MANUAL

OSCILLOSCOPE

130C



HEWLETT  PACKARD

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OPERATING AND SERVICE MANUAL

**MODEL 130C
OSCILLOSCOPE**

SERIALS PREFIXED: 644-

**(For Other Serial Prefix Instruments
See Section I And Appendix I)**

**For Instruments With Options,
See Section I**

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Table 1-1. Specifications

SWEEP GENERATOR

INTERNAL SWEEP: 21 ranges, 1 $\mu\text{sec}/\text{cm}$ to 5 sec/cm , accuracy within $\pm 3\%$. Vernier provides continuous adjustment between ranges and extends slowest sweep to at least 12.5 sec/cm .

MAGNIFICATION: X2, X5, X10, X20, X50 overall sweep accuracy within $\pm 5\%$ for sweep rates which do not exceed a maximum rate of 0.2 $\mu\text{sec}/\text{cm}$.

AUTOMATIC TRIGGERING: Base line is displayed in the absence of an input signal.

Internal: 50 cps to 500 kc signal causing 0.5 cm or more vertical deflection and also from line voltage.

External: 50 cps to 500 kc, 0.5 volts peak-to-peak or more.

Trigger Slope: Positive or negative slope of external sync signals or internal vertical deflection signals.

AMPLITUDE SELECTION TRIGGERING:

Internal: 10 cps to 500 kc, 0.5 cm or more vertical deflection signal.

External: DC (dc to 500 kc) or AC (20 cps to 500 kc) coupled, 0.5 volts peak-to-peak or more.

Trigger Point and Slope: Internally from any point of the vertical waveform presented on screen or continuously variable from +10 volts to -10 volts on either positive or negative slope of external signal.

SINGLE SWEEP: Front panel switch permits single sweep operation.

VERTICAL AND HORIZONTAL AMPLIFIERS

BANDWIDTH:

DC Coupled: DC to 500 kc

AC Coupled (input): 2 cps to 500 kc.

AC Coupled (amplifier): 25 cps to 500 kc at 0.2 mv/cm sensitivity. Lower cut-off frequency (f_{CO}) is reduced as sensitivity is reduced; at 20 mv/cm f_{CO} is 0.25 cps. On less sensitive ranges, response extends to DC.

SENSITIVITY: 0.2 mv/cm to 20 v/cm . 16 ranges in 1,2,5,10 sequence with an attenuator accuracy within $\pm 3\%$. Vernier permits continuous adjustment of sensitivity between ranges and extends minimum sensitivity to at least 50 v/cm .

INTERNAL CALIBRATOR: Approximately 350 cps square wave. 5 $\text{mv} \pm 3\%$. Automatically connected for checking gain when the sensitivity is switched to CAL.

INPUT IMPEDANCE: 1 megohm shunted by 45 pf, constant on all sensitivity ranges.

MAXIMUM INPUT: 600 v peak (dc + ac).

BALANCED INPUT: On all sensitivity ranges.

COMMON MODE REJECTION: (dc to 50 kc) At least 40 db from 0.2 mv/cm through 0.1 v/cm sensitivity; common mode signal not to exceed 4 volts p-p. At least 30 db from 0.2 v/cm to 20 v/cm ; common mode signal not to exceed 4 volts p-p on 0.2 v/cm , 40 v p-p from .5 v/cm through 2 v/cm , or 400 volts p-p from 5 v/cm through 20 v/cm .

PHASE SHIFT: With $\pm 1^\circ$ relative phase shift at frequencies up to 100 kc with verniers in CAL position and equal input sensitivities.

GENERAL

CALIBRATOR: Approximately 350 cps, 500 mv $\pm 2\%$ available at front panel.

CATHODE RAY TUBE: hp Type 5083-0353 (P31) Internal Graticule, mono-accelerator, 3000 volts accelerating potential. P2, P7, and P11 phosphors are available. Equipped with non-glaring safety glass faceplate. Amber filter supplied with P7.

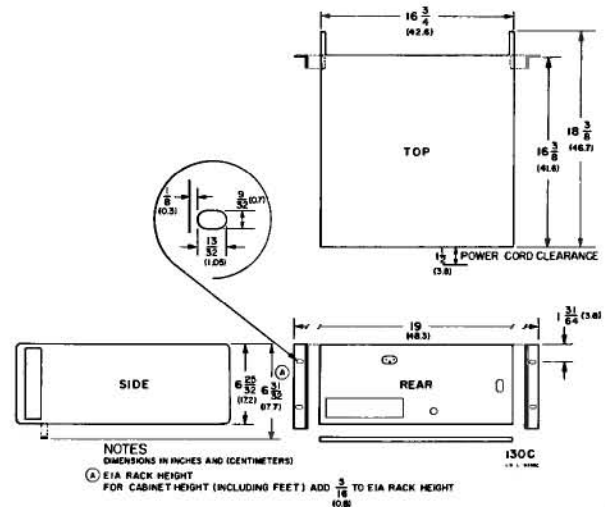
INTERNAL GRATICULE: Parallax-free 10 cm x 10 cm marked in cm squares. 2 mm subdivisions on major horizontal and vertical axis.

BEAM FINDER: Depressing Beam Finder control brings trace on CRT screen regardless of setting of balance, position or intensity controls.

INTENSITY MODULATION: Terminals on rear; +20 volt pulse blanks CRT at normal intensity.

POWER: 115 or 230 volts $\pm 10\%$, 50 to 1000 cps. Approximately 90 watts.

DIMENSIONS:



WEIGHT: Net, 31 lbs (14kg); Shipping, 38 lbs (17, 1kg).

SECTION I

GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Hewlett-Packard Company Model 130C Oscilloscope (shown in Figure 1-1) is a versatile instrument for laboratory, production line, or industrial process measurements. Horizontal and vertical display sensitivity is 200 microvolts per centimeter and the measurement bandwidth is 500 kc. A sweep magnifier of up to X50 allows expansion of a trace to the equivalent of 500 centimeters for viewing waveform details. Single sweep operation is also provided to allow observation of single shot phenomena or random occurrence events. Trigger adjustments are minimized by using either a front panel trigger-level control with preset stability or automatic triggering which provides a base line even with no input signal. Also, for fast, expanded sweep times where the automatic trigger baseline would be too dim, a free run mode may be used to provide a bright base line display. An off-screen trace may be easily located by depressing a front panel Beam Finder Button which returns the trace to the screen regardless of intensity, balance, or position settings. Careful engineering design of the Model 130C has resulted in high stability of gain and minimal DC drift. The Model 130C has an internal graticule CRT, which eliminates parallax ambiguity

and minimizes reflections and glare. The instrument is packaged in the hp modular cabinet, allowing quick, easy conversion to rack mounting and also provides easy accessibility to internal circuits for maintenance.

1-3. MANUAL IDENTIFICATION AND CHANGES.

1-4. Information in this manual applies directly to Model 130C instruments with a serial prefix of 644- (see manual title page). The serial prefix of a hp instrument is the first three digits (i. e. those before the dash, as XXX-00000) of the serial number stamped on a plate attached to the rear panel. Appendix I contains information on changes required to adapt this manual to an instrument with any serial prefix listed there. A separate change sheet (included with this manual) provides information to adapt this manual to an instrument with any serial prefix other than those mentioned in this paragraph or Appendix I. Any errors in this manual when it was printed are called ERRATA, and these corrections will appear only on the separate change sheet included.

Note: Instruments with serial prefix 226-, 235-, or 248- require a different manual, written for the 235- prefix (hp Part No. 130C-901), for correct information.



Figure 1-1. Model 130C Oscilloscope

1-5. CRT WARRANTY.

1-6. The cathode ray tube used in the Model 130C is covered by a warranty separate from the instrument warranty. The CRT warranty is included at the back of the manual for your use in the event of CRT failure during the warranty period.

1-7. EQUIPMENT SUPPLIED OR AVAILABLE.

1-8. Each instrument is supplied with detachable power cable and rack-mounting hardware. Other equipment available for use with the Model 130C is listed in Table 1-2.

1-9. OPTIONS COVERED.

1-10. This manual applies to Model 130C instruments with the options listed and described in Table 1-3. Refer to Appendix II for complete information on all options.

Table 1-2. Equipment and Accessories Available

| | |
|----------|--|
| 1110A | Clip-on AC Current Probe |
| 1111A | Current Amplifier (for 1110A) |
| 10001A/C | Compensated 10:1 divider probe (5 ft cable) |
| 10001B/D | Compensated 10:1 divider probe (10 ft cable) |
| 10002A/C | Compensated 50:1 divider probe (5 ft cable) |
| 10002B/D | Compensated 50:1 divider probe (10 ft cable) |
| 10025A | General purpose straight-through probe |
| 10100B | 100 ohm termination for 1110A |
| 10111A | Adapter, BNC female to dual banana plug |

Table 1-3. Description of Options

| Option Number | Description |
|---------------|---|
| 05 | External graticule with scale light in lieu of internal graticule. Specify phosphor: P1, P2, P7, P11, P31 available. |
| 06 | Rear terminals in parallel with front panel terminals. Three-pin AN-type connectors (supplied) for horizontal and vertical signal inputs; BNC connector for trigger source. |
| 13 | 6-31/32 in. x 19 in. x 3/16 in. front panel, suitable for attaching your own handles. |

SECTION II

INSTALLATION

2-1. INCOMING INSPECTION.

2-2. **MECHANICAL CHECK.** When the Model 130C is received, verify that the package contents are complete and as ordered. Inspect the instrument for any physical damage such as a scratched panel surface broken knob, or connector, etc., incurred in shipping. Remove the instrument covers and visually check inside for loose or damaged components. To facilitate possible reshipment, keep the original packing if recommended for reuse (see Paragraph 2-12) until a satisfactory inspection of the instrument is completed. If damage is found, file a claim with the responsible carrier or insurance company and refer to the warranty page in this manual.

2-3. **PERFORMANCE CHECK.** The Model 130C may be checked for electrical operation within the specifications of Table 1-1 by following the procedures of Paragraph 5-3. These procedures allow a complete performance check with no internal connections or adjustments. If instrument does not operate as specified, refer to the warranty page of this manual.

2-4. RACK INSTALLATION.

2-5. The Model 130C is shipped from the factory ready for use as a bench instrument. The hardware necessary to rack-mount the instrument is packaged with the instrument: 1) Remove tilt stand and plastic feet, 2) Remove adhesive-backed trim strip from sides, 3) Attach filter strip along bottom of front panel, 4) Attach mounting flanges to sides with larger notch toward bottom of instrument.

2-6. COOLING.

2-7. Leave at least two inches clearance around the instrument for free circulation of air. In enclosed rack installations, be sure that the recirculation of warm air does not result in a high ambient temperature.

2-8. POWER REQUIREMENT.

2-9. The Model 130C operates on 115 or 230 volts $\pm 10\%$, 50 to 1000 cps, single phase. The power required is approximately 90 watts. Before connecting the instrument to the power source, be sure that the 115-230 switch on the rear panel is in the proper position for the power source to be used. The line fuse is mounted behind the rear panel, and is accessible by removing the top cover. The 2 ampere fuse supplied is for either 115 or 230 volt operation.

2-10. INSTRUMENT GROUND.

2-11. To protect operating personnel, the National Electrical Manufacturer's Association recommends that the instrument panel and cabinet be grounded. The Model 130C is equipped with a three-conductor power cable which grounds the instrument when an appropriate outlet is used. The round pin on the power cable is the ground pin connection. To retain

the protection feature when operating the instrument from a two-contact outlet, use a three-conductor to two-conductor adapter and connect the adapter wire to a suitable ground.

2-12. REPACKAGING FOR SHIPMENT.

2-13. **SUGGESTED PACKING MATERIALS.** To package an instrument for shipment, some types of original packing materials may be reused, or your hp Sales Engineer will help in getting suitable packaging. The types of original packing materials which may generally be reused are: (1) foam which encloses the instrument, (2) cardboard layers separated by foam supports, and (3) laminated cardboard cut to desired packing shape. Original packing materials which are a cardboard "accordion-like" filler are not recommended for shipment because the cushioning qualities are usually gone after one use. If packing materials recommended above are not available, first protect the instrument surfaces with heavy paper or sheets of cardboard flat against the instrument. Then place instrument in a durable carton, pad all sides with approximately 4 inches of new material designed specifically for package cushioning, mark carton clearly for proper handling, and insure adequately before shipping.

2-14. **SHIPMENT FOR SERVICE OR REPAIR.** If an instrument is being returned to Hewlett-Packard Company for servicing or repair, attach a tag to the instrument specifying owner, desired action, model number, and serial number. Ship the instrument to the nearest hp Sales/Service Office (addresses at rear of this manual). All correspondence should refer to an instrument by Model number and the full (eight-digit) serial number.

2-15. INSTALLATION OF AMBER FILTER.

2-16. An amber filter (hp Part No. 120A-83A) is supplied with the Model 130C, Option 07. This filter may be used to improve the long persistence characteristics desired for observing single-shot or very low frequency displays. To install the filter remove CRT bezel and proceed as follows:

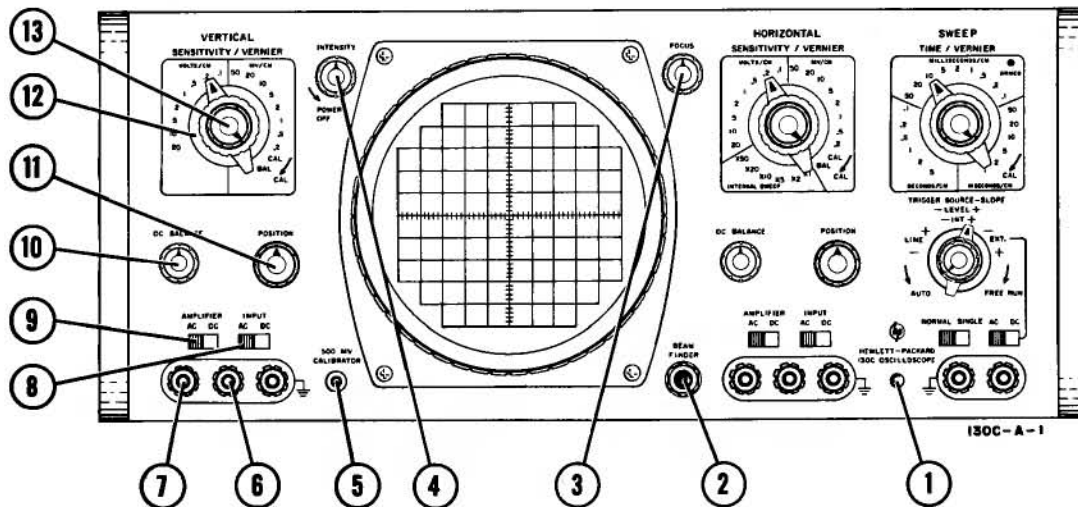
a. Set filter into bezel, aligning the large rectangular slots in the filter edge with guides in the bezel casting and sliding the filter down into the casting.

b. Loosen the clamp at the CRT socket. Carefully push the CRT toward the rear of the instrument to provide clearance for the thickness of the filter (approximately 1/8 inch).

c. Re-install the bezel and slide CRT forward until light mask on front of CRT just touches filter.

d. Tighten clamp to keep CRT from rotating. Note: Over-tightening clamp may damage CRT.

e. Check alignment of trace with graticule. If necessary adjust R329 Trace Align (rear panel).



1. Power on indicator. Glows when AC power is switched on.
2. BEAM FINDER. Returns off-screen trace to screen and intensifies trace (see Paragraph 3-14).
3. FOCUS. Adjusts trace sharpness.
4. INTENSITY. Adjusts trace brightness. When rotated fully counterclockwise, turns power off.
5. CALIBRATOR. Provides 500 mv p-p square wave for compensating probes or for use in external circuitry ($Z_{source} \approx 10 K\Omega$).
6. Vertical -input terminal. Negative-going signals applied to this terminal cause upward deflection of the trace.
7. Vertical +input terminal. Positive-going signals applied to this terminal cause upward deflection of the trace.
8. INPUT AC-DC. Selects direct or capacitive coupling of the input signal (see Paragraph 3-31).
9. AMPLIFIER AC-DC. Selects internal direct or capacitive coupling on 7 highest sensitivity ranges (see Paragraph 3-31).
10. Vertical DC BALANCE. Adjusts internal DC levels to minimize trace shift when changing sensitivity ranges (or using VERNIER).
11. Vertical POSITION. Moves trace vertically.
12. Vertical SENSITIVITY. Sets the deflection sensitivity of the trace. Calibrated SENSITIVITY when VERNIER is fully cw (detented position).
13. VERNIER. Variable portion reduces deflection sensitivity for range selected. Allows continuous adjustment between ranges; extends minimum sensitivity to 50 V/CM. Calibrated SENSITIVITY when set to CAL.

Figure 3-1. Controls and Terminals (Vertical, CRT Display and Power)

SECTION III OPERATION

3-1. INTRODUCTION.

3-2. The Model 130C may be used in either of two basic modes of operation: (1) external signal to vertical input with internal horizontal sweep or (2) external signals into both horizontal and vertical inputs. The deflection sensitivity and bandwidth of the two amplifiers is identical and the input to each amplifier may be easily changed to allow either single-ended inputs or balanced inputs. A choice of either AC or DC coupling, at the input and internally in the amplifier, is provided for both horizontal and vertical circuits. The internal horizontal sweep has 21 calibrated sweep times from $1\mu\text{sec/cm}$ to 5 sec/cm with a vernier for continuous coverage which can extend the slowest sweep speed to 12.5 sec/cm . Each sweep time may be magnified by choosing either X2, X5, X10, X20, or X50 range. The sweep can be triggered internally from the vertical deflection signal or the line frequency; external triggers can also be used, either AC or DC coupled to the sweep circuit. See Paragraph 3-16 for a brief operational check.

3-3. FRONT AND REAR PANEL FAMILIARIZATION.

3-4. FRONT PANEL. Figures 3-1 and 3-2 identify and briefly describe the Model 130C front panel controls, connectors, etc. To aid in proper operation, Paragraphs 3-6 through 3-15 provide a more extensive description of some front panel controls. Note that controls for vertical and horizontal inputs are identical in function and appearance except that the horizontal SENSITIVITY has six internal sweep positions.

3-5. REAR PANEL. The power cord connector, line fuse, and 115-230 volt switch are described in Paragraph 2-8. TRACE ALIGN is a screwdriver adjustment to align the CRT trace with the graticule. Relocating or reorienting the instrument within a magnetic field such as the earth's field may require adjustment of this control to maintain exact alignment. The Z AXIS INPUT allows trace intensity modulation by applying a modulating signal with the shorting link removed. At normal trace intensity (set on front panel), a +20 volt pulse will blank the trace. If not using the Z AXIS INPUT terminals, be sure the shorting link is in place.

3-6. SENSITIVITY.

3-7. SENSITIVITY control (vertical or horizontal) sets the deflection sensitivity of the display in millivolts per centimeter or volts per centimeter, when VERNIER is in CAL. position. In BAL position of the SENSITIVITY switch, the amplifier input is grounded and the input terminals are opened, to facilitate setting of the amplifier DC balance (see Paragraph 3-8 and Figure 3-3). In the CAL. position, an internal calibrator signal is applied to the amplifier input and the calibration accuracy can be checked by noting the deflection on the CRT as follows: (1) with

no vertical input, when HORIZONTAL SENSITIVITY and VERNIER are set to CAL, a horizontal line 5 cm long should be displayed (if not the probable cause is misadjustment of the horizontal gain; see Section V), (2) with no horizontal input, when VERTICAL SENSITIVITY is set to CAL, a vertical line 5 cm long should be displayed (if not, the probable cause is misadjustment of the vertical gain; see Section V); if an internal sweep time is used a 5 cm p-p square wave should be displayed. The INTERNAL SWEEP positions of HORIZONTAL SENSITIVITY can be used to effectively expand a trace from two screen diameters in X2 to fifty screen diameters in X50.

3-8. DC BALANCE.

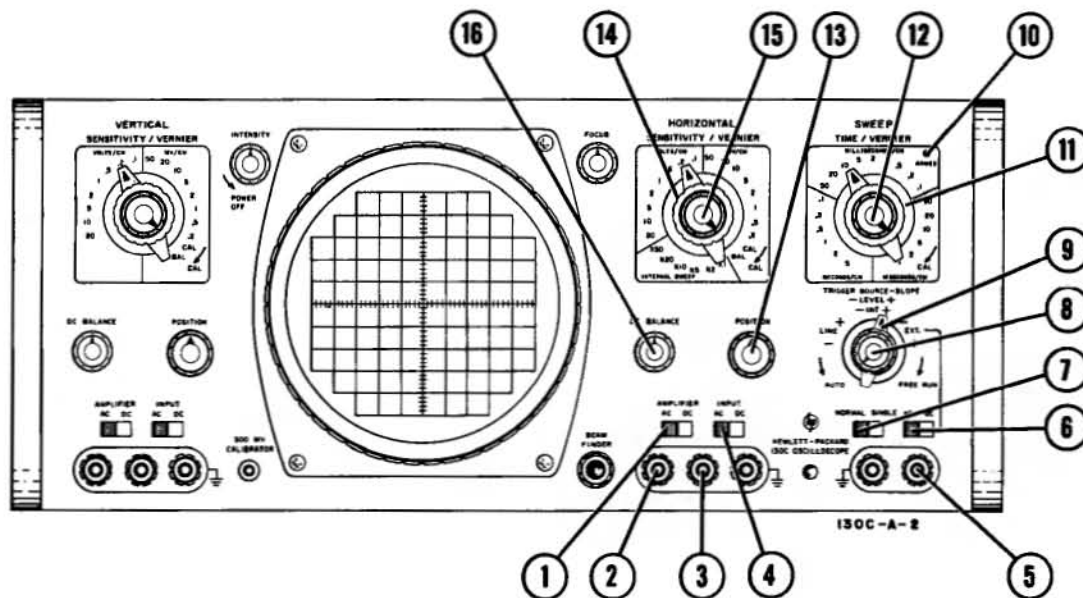
3-9. The DC BALANCE control has a range of about 40 screen diameters, i.e. it can effectively move the trace about 400 cm. Its purpose is to set internal amplifier operating conditions such that there is a minimum trace shift as SENSITIVITY is switched from range to range, or when VERNIER is used. This is especially important at the more sensitive ranges (toward 0.2 MV/CM) when the AMPLIFIER switch is set for DC coupling. Figure 3-3 provides the procedure for setting vertical and horizontal DC BALANCE properly. The setting may change during warmup or extended periods of operation and require periodic readjustment when the instrument is used DC coupled at high sensitivities.

Note

DC BALANCE is a "fine" control and should additional range be required to balance the amplifier a coarse DC balance adjustment is located within the instrument (see Section V for procedure).

3-10. LEVEL.

3-11. Through its variable range, LEVEL control determines the point on the triggering-source waveform at which the sweep starts. This trigger level is variable whether using external, internal, or line for the trigger source. By proper setting of LEVEL the sweep may be started at any point on a vertical deflection waveform (deflection $> 0.5\text{ cm}$) when triggering internally or at a point between +10v to -10v on an external trigger signal. The + or - on the LEVEL control refers to the direction the triggering point moves on a waveform, regardless of the SLOPE setting (for example, turning LEVEL ccw moves triggering level toward a more negative point on the triggering waveform). When LEVEL is set fully counterclockwise to AUTO (detented position), the sweep will free run at a low repetition rate providing a baseline in the absence of a triggering signal and then provide automatic triggering of the sweep when a signal within specifications is applied. In AUTO an external trigger is always AC coupled. When LEVEL is set fully clockwise to FREERUN (detented position),



1. **AMPLIFIER AC-DC.** Selects internal direct or capacitive coupling on 7 highest sensitivity ranges (see Paragraph 3-31).
2. **Horizontal +input terminal.** Positive-going signals applied to this terminal cause the trace to deflect to the right.
3. **Horizontal -input terminal.** Negative-going signals applied to this terminal cause the trace to deflect to the right.
4. **INPUT AC-DC.** Selects direct or capacitive coupling of the input signal (see Paragraph 3-31).
5. **Trigger Input Terminal.** Accepts external trigger signal.
6. **Trigger Input AC-DC.** Selects direct or capacitive coupling of external trigger signal (always AC coupled when LEVEL set to AUTO).
7. **NORMAL-SINGLE.** Selects normal sweep or single sweep operation (see Paragraph 3-12).
8. **LEVEL.** Selects free-running, automatic triggering, or variable amplitude triggering (see Paragraph 3-10).
9. **TRIGGER SOURCE-SLOPE.** Selects source of sweep trigger signal and slope on which trigger occurs. INT. triggers with internal

- vertical signal; LINE triggers on power line waveform; EXT. triggers on signal at trigger input terminal.
10. **ARMED.** Indicator glows when sweep is ready for trigger in SINGLE sweep operation.
11. **SWEEP TIME.** Selects time unit per centimeter of sweep. Calibrated sweep time when VERNIER is fully cw (detented position).
12. **VERNIER.** Variable portion reduces sweep time per centimeter for selected range. Allows continuous adjustment between ranges; extends slowest sweep speed to 12.5 sec/cm. Calibrated sweep when set to CAL.
13. **HORIZONTAL POSITION.** Moves trace horizontally.
14. **HORIZONTAL SENSITIVITY.** Sets the deflection sensitivity of the trace and selects internal sweep. Calibrated SENSITIVITY when VERNIER is fully cw (detented position).
15. **VERNIER.** Variable portion reduces deflection sensitivity for range selected. Allows continuous adjustment between ranges; extends minimum sensitivity to 50 V/CM. Calibrated SENSITIVITY when set to CAL.
16. **HORIZONTAL DC BALANCE.** Adjusts internal DC levels to minimize trace shift when changing sensitivity ranges (or using VERNIER).

Figure 3-2. Controls and Terminals (Horizontal, Sweep, and Triggering)

the horizontal sweep is free running at a rate determined by the sweep time setting, and cannot be controlled by a triggering signal.

3-12. NORMAL-SINGLE.

3-13. When NORMAL-SINGLE is set to NORMAL, the horizontal sweep operates recurrently as determined by the triggering signal. In SINGLE position, the sweep can be triggered only once, after which it is locked out until armed by switching to NORMAL and back to SINGLE. The ARMED light is on in SINGLE position when the sweep is armed and ready to be triggered. To use the single sweep operation, LEVEL must be set anywhere in its variable range, i.e. not in AUTO or FREE RUN. See also Paragraph 3-24.

3-14. BEAM FINDER.

3-15. This paragraph will explain operation and function of the BEAM FINDER and also discuss some causes of no CRT display. The BEAM FINDER push-button is useful for locating a display which is not visible on the CRT for these common reasons: 1) DC unbalance in amplifier at high sensitivities, (and AMPLIFIER DC coupling), 2) amplifier being overloaded at input, or 3) intensity set too low. Depressing the BEAM FINDER defocuses and intensifies the CRT trace (or spot), and reduces the sensitivity of both horizontal and vertical amplifiers so the trace appears on-screen regardless of INTENSITY, DC BALANCE, and POSITION settings. The beam finder reduces amplifier gain enough to overcome the effective positioning range of the DC BALANCE controls, which amounts to as much as 40 screen diameters (i.e. 400 cm) at the highest amplifier sensitivity, as compared to only 2 screen diameters (20 cm) range for POSITION control. Because of the desensitization required to overcome DC BALANCE range, the POSITION controls are essentially inoperative when the BEAM FINDER is depressed. Therefore, always set POSITION to approximately "12 o'clock" before using the beam finder. To get maximum usefulness from the BEAM FINDER, the selected amplifier sensitivity and coupling should also be considered. At higher amplifier sensitivities (i.e. toward 0.2 MV/CM), if AMPLIFIER is set to AC, a DC unbalance in the amplifier cannot cause an off-screen deflection. Instead, the most probable cause is amplifier overload by the input signal or intensity may be set too low. At higher sensitivities with amplifier DC coupling, and trace not on screen, switch AMPLIFIER to AC and if trace now appears on-screen then a DC unbalance exists (to make DC BALANCE setting see Figure 3-3). At lower amplifier sensitivities, DC unbalance is eliminated as a cause for off-screen trace. Another cause of no display is non-triggering sweep and this can be checked by noting if trace appears when the automatic triggering mode is used (see Table 1-1 for specifications).

3-16. OPERATIONAL CHECK.

3-17. This procedure may be followed to check operation of most controls and circuits of the Model 130C.

a. Turn INTENSITY to about 12 o'clock position (turns AC power on). Allow several minutes warmup.

- b. Set all VERNIERS to CAL.
- c. Set horizontal and vertical AMPLIFIER and INPUT to AC.
- d. Set vertical SENSITIVITY to CAL.
- e. Set the horizontal SENSITIVITY to INTERNAL SWEEP X1 and set SWEEP TIME to 1 MILLISECONDS/CM.
- f. Set TRIGGER SOURCE-SLOPE to INT. +, LEVEL to AUTO, and NORMAL-SINGLE to NORMAL.
- g. Adjust both POSITION controls to center display. Adjust FOCUS for sharp, clear trace.
- h. The height of the square wave displayed should be 5 cm.

3-18. OPERATING PROCEDURES.

3-19. Paragraphs 3-20 through 3-29, and the figures referenced, describe procedures for various operating modes and applications of the Model 130C. Before operating the Oscilloscope and following these procedures, it is recommended that Paragraphs 3-3 through 3-15 be read to become completely familiar with front panel controls. Also, Paragraphs 3-31 and 3-33 describe considerations which are important in most measurements with the Model 130C.

3-20. INTERNALLY TRIGGERED SWEEP OPERATION.

3-21. In this type operation, the sweep is triggered internally from the vertical signal or line frequency and the signal to be observed is applied to the vertical input; Figure 3-4 provides a step by step procedure. With TRIGGER SOURCE-SLOPE set to INT. + or -, the sweep is triggered when the vertical signal input causes a vertical deflection of 0.5 cm or more. With TRIGGER SOURCE-SLOPE set to LINE + or -, the sweep is triggered from the AC power line waveform. Function of LEVEL control is described in Paragraph 3-10.

3-22. EXTERNALLY TRIGGERED SWEEP OPERATION.

3-23. In this type operation the sweep is triggered from an externally applied signal and the signal to be observed is applied to the vertical input; Figure 3-5 provides the step by step procedure. With TRIGGER SOURCE-SLOPE set to EXT. + or -, the horizontal sweep is triggered by a signal of 0.5V p-p or more, applied to the trigger input terminals. Figure 3-5 explains use and specifications for AC or DC trigger input coupling; if LEVEL is set to AUTO, the external trigger signal is always AC coupled. Function of LEVEL control is explained in Paragraph 3-10.

3-24. SINGLE SWEEP OPERATION.

3-25. A step by step procedure for obtaining single sweep operation is contained in Figure 3-6. This method is useful for observing single shot phenomena or random events. With single sweep operation, the sweep occurs just once and cannot be retriggered until manually rearmed. See also Paragraph 3-12 for explanation of the SINGLE-NORMAL switch.

3-26. DIFFERENTIAL INPUT OPERATION.

3-27. Balanced inputs are provided on all SENSITIVITY ranges of both horizontal and vertical deflection amplifiers which allows measurement of the difference between two signals. This is called differential input operation and in this mode the two signals are subtracted algebraically and the difference is displayed as a single trace. This type of operation eliminates signals which are common to both inputs (referred to as the common mode signal) and displays signals peculiar to only one input. Figure 3-7 provides a step by step procedure for differential operation of the Model 130C. Common mode rejection expressed in decibels represents the ability of the amplifier to attenuate the common mode signal and this is summarized in Table 3-1 along with the maximum allowable peak-to-peak common mode signal to maintain these rejection ratios.

Table 3-1. Common Mode Rejection

| SENSITIVITY | Maximum Peak-to-Peak Input | Minimum Common Mode Rejection (DC to 50 kc) |
|------------------------------|----------------------------|---|
| 0.2 mV/CM thru 0.2 VOLTS/CM | 4 volts | 40 db |
| 0.5 VOLTS/CM thru 2 VOLTS/CM | 40 volts | 30 db |
| 5 VOLTS/CM thru 20 VOLTS/CM | 400 volts | 30 db |

3-28. X-Y OPERATION.

3-29. In the X-Y mode of operation the internal sweep is disabled and external signals are applied to both the horizontal and vertical amplifiers. Figure 3-8 provides an operating procedure for obtaining Lissajous patterns or X-Y plots. The X-Y display is a graph of the vertical signal vs. the horizontal signal and is useful for displaying plots of voltage vs. current, hysteresis loops, pressure vs. strain (using strain gages), etc. Another important application for X-Y operation is to make phase shift measurements. The vertical and horizontal amplifiers have identical characteristics and less than $\pm 1^\circ$ relative phase shift from DC to 100 kc when VERNIERS are set to CAL. and amplifier SENSITIVITY settings are equal. Application Note 29 describes a convenient method for measuring phase shift. When measuring phase shift at very low frequencies, use both AMPLIFIER DC and INPUT DC to eliminate phase differences contributed by the AC coupling capacitors.

3-30. OPERATING CONSIDERATIONS.

3-31. USE OF AMPLIFIER AND INPUT AC-DC.

3-32. Different combinations of AMPLIFIER and INPUT coupling will provide various advantages in the characteristics of operation depending on the waveform to be displayed. Table 3-2 summarizes the typical low-frequency 3 db cutoff point with different SENSITIVITY and coupling settings; typical applications are also given. The high frequency 3 db cutoff point is 500 kc in all cases. For SENSITIVITY settings from 50 mV/CM through 20 VOLTS/CM, AMPLIFIER

Table 3-2. Characteristics and Applications for AMPLIFIER and INPUT Coupling Combinations

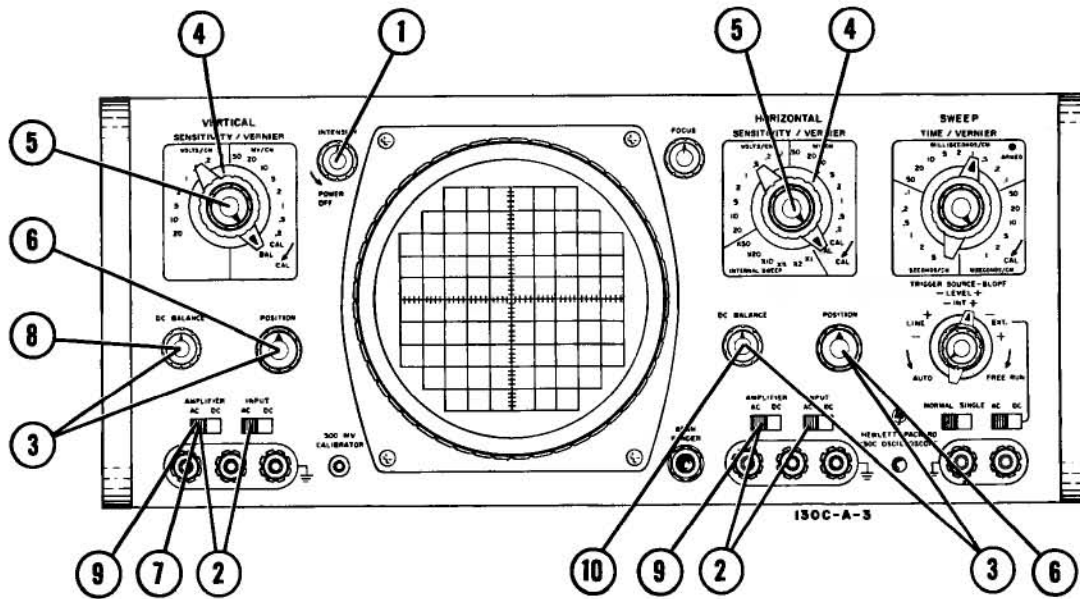
| AMPLIFIER | INPUT | SENSITIVITY (mV/CM) | | | | | | | | APPLICATIONS |
|-----------|-------|---------------------|--------|--------|------------|-------|--------|---------|----------------------|--|
| | | .2 | .5 | 1 | 2 | 5 | 10 | 20 | 50 mV to 20 VOLTS/CM | |
| AC | DC | 25 cps | 10 cps | 5 cps | 2.5 cps | 1 cps | .5 cps | .25 cps | DC | For observing the DC component of waveforms; typical drift 0.3 mV per half hour. |
| AC | AC | 25 cps | 16 cps | 11 cps | ← 10 cps → | | | | | For observing small, low-frequency components of waveforms without drift (AMPLIFIER switch has no effect on V/CM ranges) |
| DC | AC | ← 10 cps → | | | | | | | | For general-purpose measurement of AC waveforms; blocks DC components; maximum input is 600 volts peak (AC + DC) |
| DC | DC | ← DC → | | | | | | | | For observing very low frequency components at high sensitivities when large DC level is present. (Note maximum input limit) |

coupling switch has no effect; coupling is always DC for these ranges. When using amplifier AC coupling in the most sensitive range of 0.2 mV/CM at low ambient temperatures the amplifier sensitivity is reduced slightly. The reduction is noticeable only at temperatures below 25°C and reaches a maximum of approximately 3% at 0°C.

3-33. APPLYING INPUT SIGNALS.

3-34. For measurements at high amplifier sensitivities and high impedance levels a shielded input

connection to the Oscilloscope is desirable. The Model 10111A Adapter provides a shielded banana post to female BNC connector. Two adapters can be used to provide shielded connections for differential input operation. Frequency compensated divider probes (listed in Table 1-2) can be used to provide a higher input impedance and thus reduce loading effects on the circuit where measurements are made. The 500 mV CALIBRATOR output on the Model 130C front panel may be used for probe compensation adjustment (described in the Operating Note for the probe). The Model 10111A Adapter is necessary for connecting the divider probes to the Model 130C input terminals.



Note

Steps 2 through 6 are for both horizontal and vertical controls.

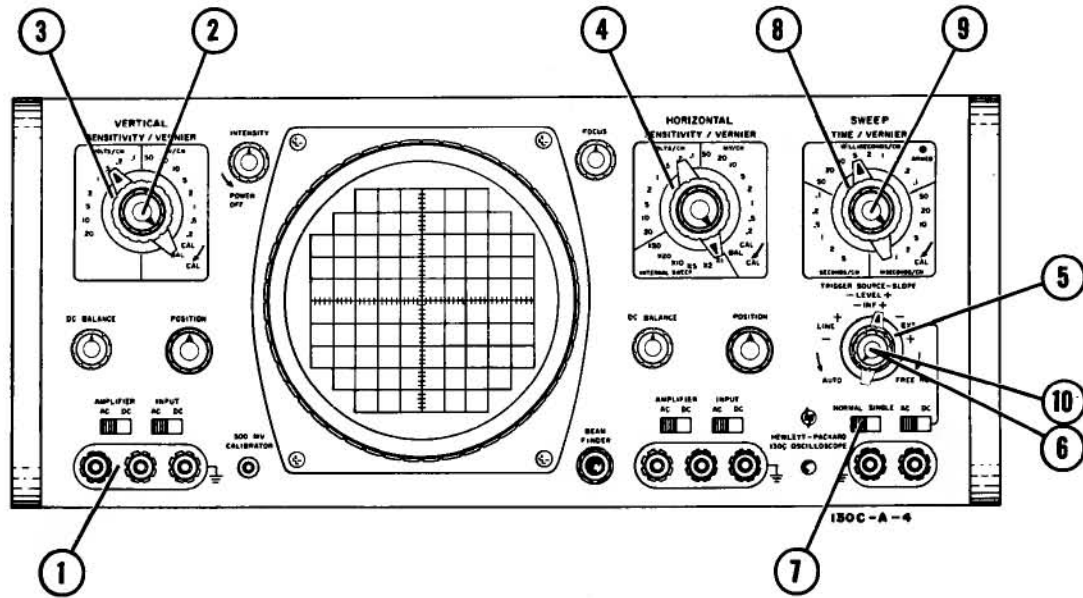
1. Set INTENSITY to mid-range.
2. Set AMPLIFIER and INPUT to AC.
3. Set DC BALANCE and POSITION to mid-range.
4. Set SENSITIVITY to BAL.
5. Set VERNIER to CAL.
6. Center spot with POSITION.
7. Set vertical AMPLIFIER to DC.
8. Center spot with vertical DC BALANCE. If spot is not on CRT, depress BEAM FINDER, and set DC BALANCE so spot is about centered on CRT. Release BEAM FINDER and if necessary, refine DC BALANCE setting so spot is centered on CRT (spot will always travel up and down near the vertical center graticule line). Vertical amplifier is now DC Balanced.

Note

If spot cannot be centered with DC BALANCE at about its mid-range, check the coarse balance adjustment (internal) according to Section V procedure.

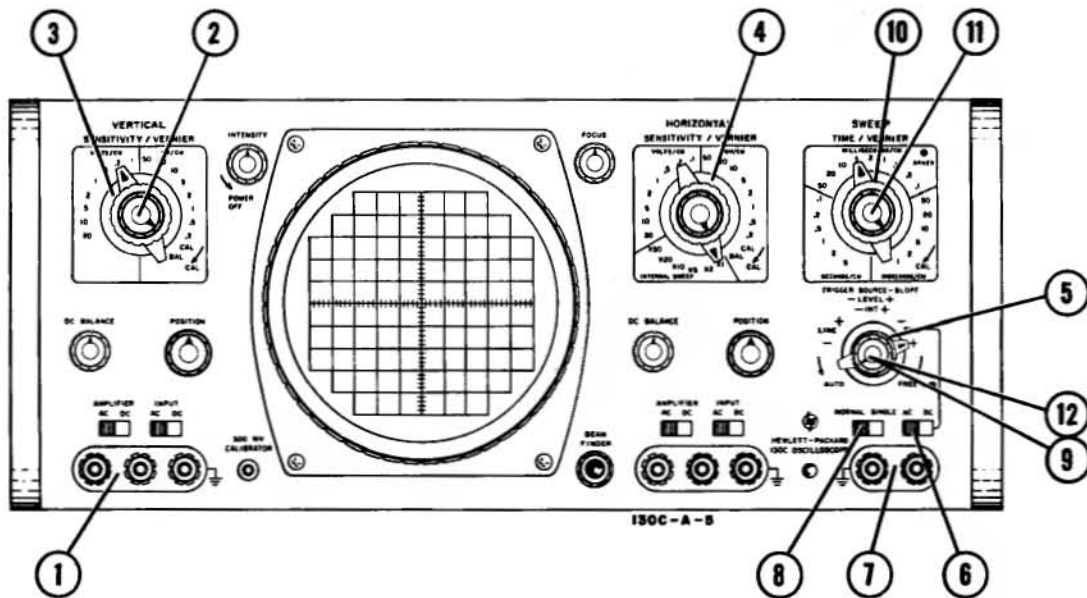
9. To balance the horizontal amplifier first set vertical AMPLIFIER to AC and horizontal AMPLIFIER to DC.
10. Center spot with horizontal DC BALANCE. If spot is not on CRT, depress BEAM FINDER, and set DC BALANCE so spot is about centered on CRT. Release BEAM FINDER and if necessary, refine DC BALANCE setting so spot is centered on CRT (spot will always travel across CRT near the horizontal center graticule line). Horizontal amplifier is now DC balanced. See note following step 8, this procedure.

Figure 3-3. DC BALANCE Procedure



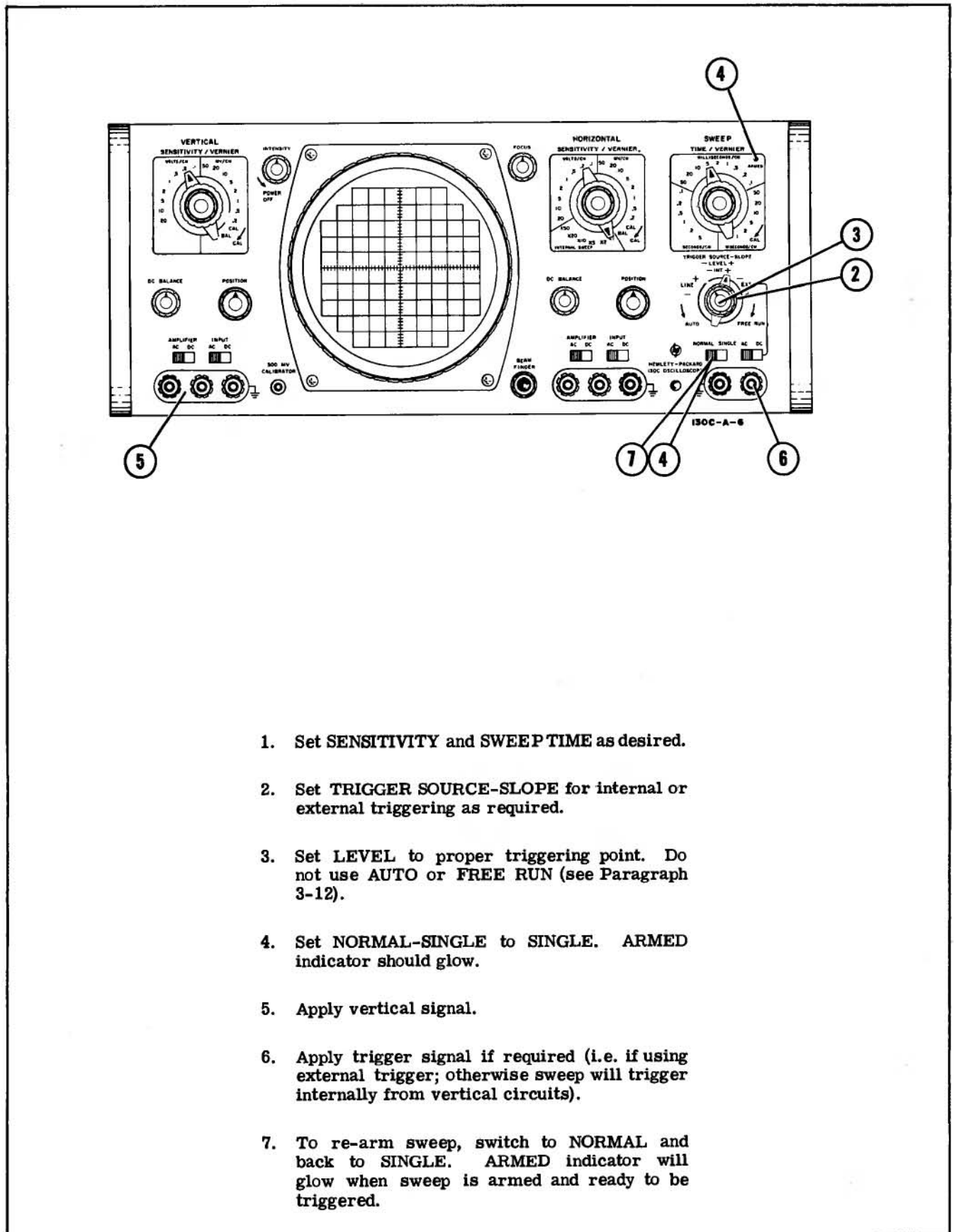
1. Connect vertical signal to input. For differential input see Figure 3-7.
2. Set SENSITIVITY for desired vertical deflection.
3. Set VERNIER to CAL for calibrated sensitivity.
4. Set SENSITIVITY to INTERNAL SWEEP X1.
5. Set TRIGGER SOURCE-SLOPE to INT + or INT -. To trigger on power line waveforms set TRIGGER SOURCE-SLOPE to LINE + or LINE -.
6. Set LEVEL to AUTO.
7. Set NORMAL-SINGLE to NORMAL.
8. Set SWEEP TIME for desired presentation of waveform.
9. Set VERNIER to CAL for calibrated sweep time.
10. Adjust LEVEL to trigger at a desired point on triggering waveform.

Figure 3-4. Internal Sweep with Internal Trigger



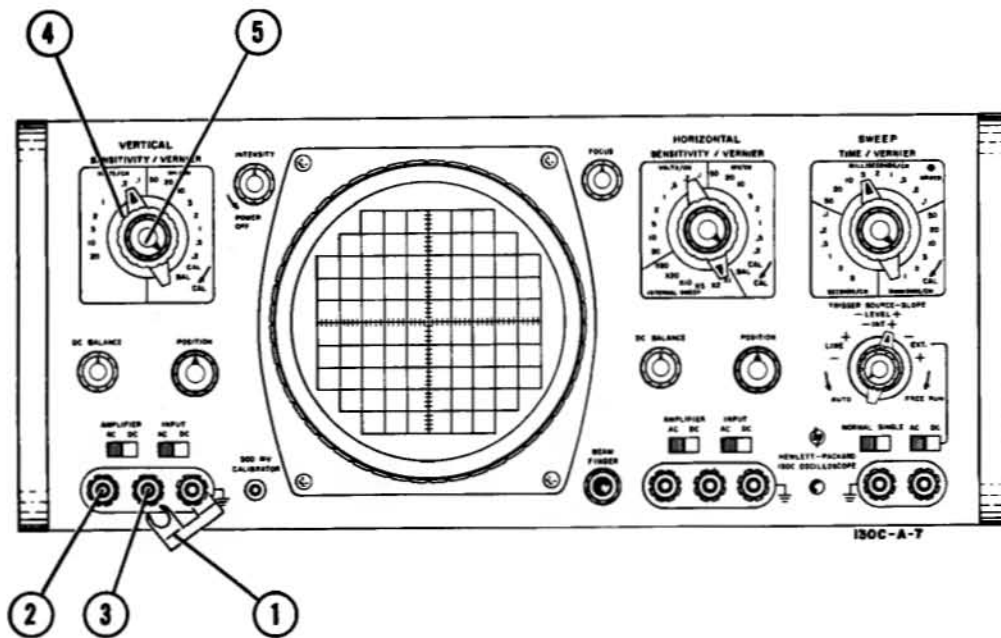
1. Connect vertical signal to input.
2. Set SENSITIVITY for desired vertical deflection.
3. Set VERNIER to CAL for calibrated sensitivity.
4. Set SENSITIVITY to INTERNAL SWEEP X1.
5. Set TRIGGER SOURCE-SLOPE to EXT + or EXT -.
6. Set AC-DC to either AC or DC for trigger signal above 20 cps; set to DC for trigger signal from DC to 20 cps.
7. Connect trigger signal to input.
8. Set NORMAL-SINGLE to NORMAL.
9. Adjust LEVEL to obtain a display on CRT. Do not use AUTO for trigger below 50 cps.
10. Set SWEEP TIME for desired presentation of waveform.
11. Set VERNIER to CAL for calibrated sweep time.
12. Adjust LEVEL to trigger at desired point on triggering waveform.

Figure 3-5. Internal Sweep with External Trigger



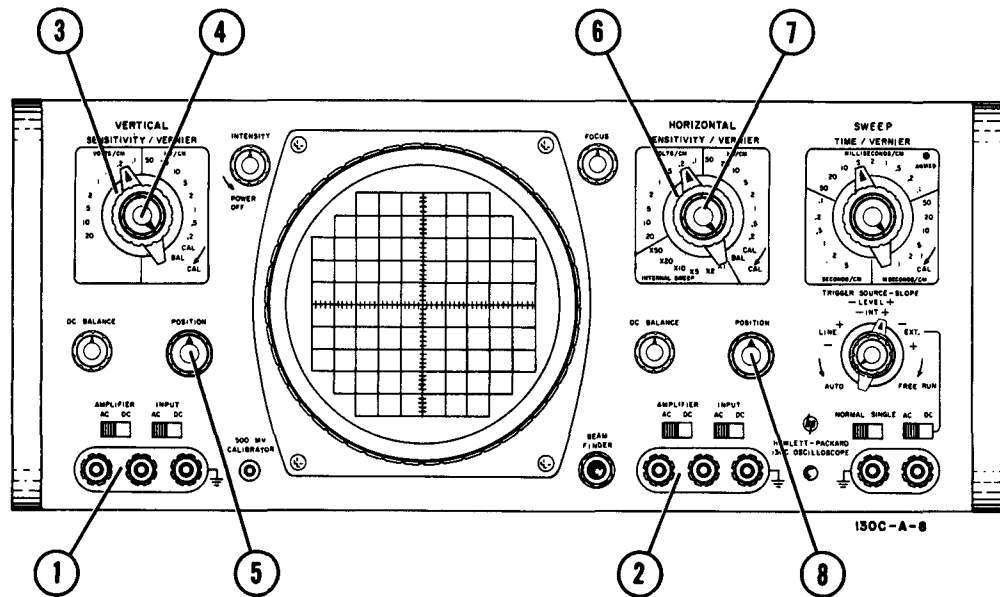
1. Set SENSITIVITY and SWEEP TIME as desired.
2. Set TRIGGER SOURCE-SLOPE for internal or external triggering as required.
3. Set LEVEL to proper triggering point. Do not use AUTO or FREE RUN (see Paragraph 3-12).
4. Set NORMAL-SINGLE to SINGLE. ARMED indicator should glow.
5. Apply vertical signal.
6. Apply trigger signal if required (i.e. if using external trigger; otherwise sweep will trigger internally from vertical circuits).
7. To re-arm sweep, switch to NORMAL and back to SINGLE. ARMED indicator will glow when sweep is armed and ready to be triggered.

Figure 3-6. Single Sweep Operation



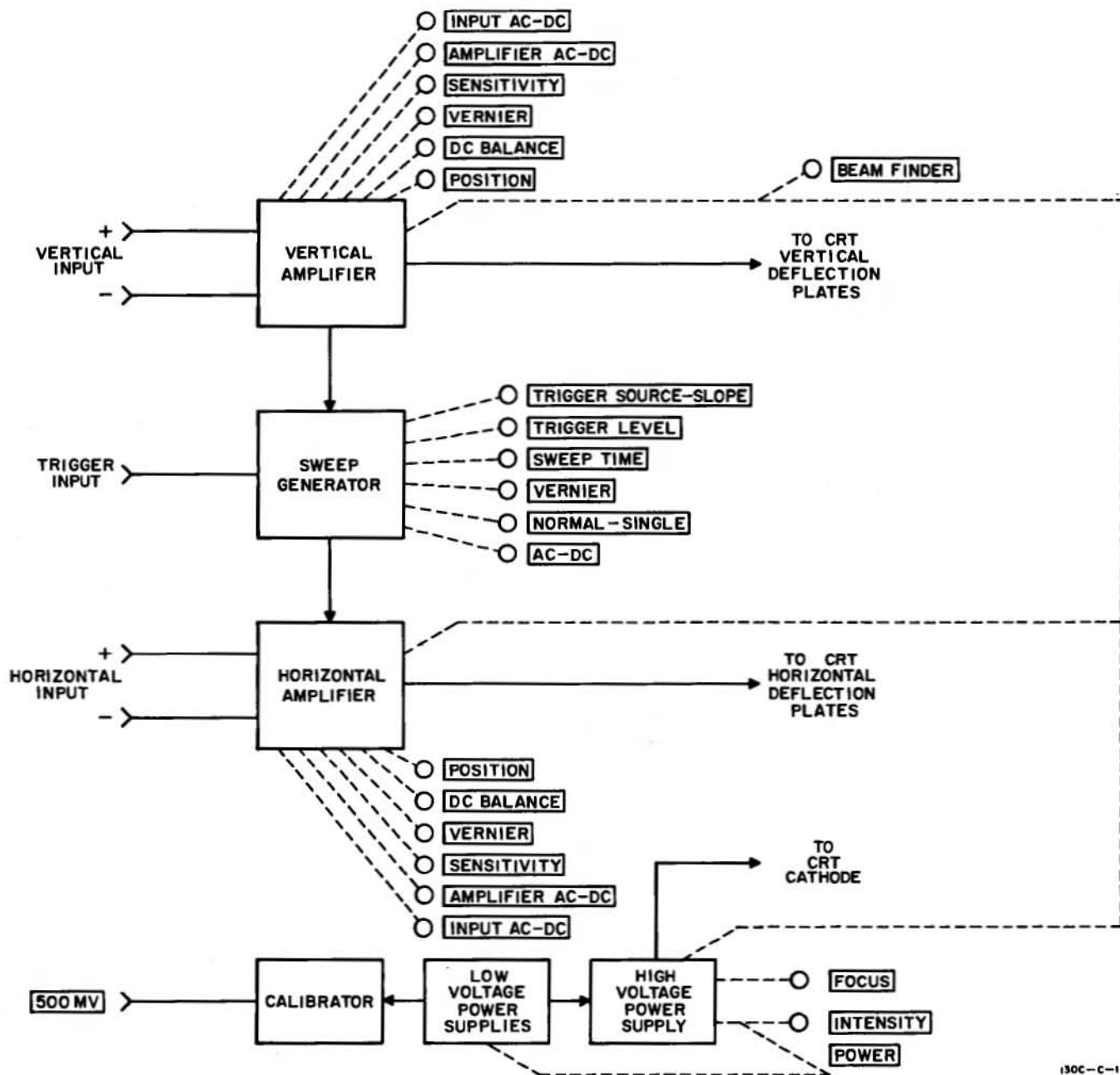
1. Disconnect grounding link from center input terminal.
2. Connect positive-going signal to left-hand terminal.
3. Connect negative-going signal to center terminal.
4. Set SENSITIVITY for desired vertical deflection. When using high sensitivities (i.e. toward 0.2 MV/CM) and internal DC coupling, check for DC BALANCE (Figure 3-3) if necessary.
5. Set VERNIER to CAL for calibrated sensitivity.
6. Follow the procedure above if differential horizontal input is desired.

Figure 3-7. Differential Operation



1. Connect Y signal to vertical input.
2. Connect X signal to horizontal input.
3. Set SENSITIVITY for desired deflection.
4. Set VERNIER to CAL for calibrated sensitivity.
5. Adjust POSITION for desired vertical position.
6. Set SENSITIVITY for desired deflection.
7. Set VERNIER to CAL for calibrated sensitivity.
8. Adjust POSITION for desired horizontal position.

Figure 3-8. X-Y Operation



130C-C-1

Figure 4-1. Model 130C Overall Functional Block Diagram

SECTION IV PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. As shown in the block diagram, Figure 4-1, the Model 130C consists of five major sections: low voltage power supply, high voltage power supply, vertical amplifier, horizontal amplifier and sweep generator.

4-3. The paragraphs of this section discuss the circuit details of the major sections of the Model 130C. Since the vertical and horizontal amplifiers are nearly identical, the horizontal amplifier is described where it differs from the vertical amplifier.

4-4. LOW VOLTAGE POWER SUPPLY.

4-5. The low voltage power supply provides operating voltages for the amplifiers and for the sweep generator circuits with outputs of -100V, +12.5V, +100V, and +250V. The regulated +12.5 volt supply provides filament voltage for the vertical and horizontal input stages and a current source for the trace alignment coil.

4-6. -100 VOLT SUPPLY.

4-7. The -100 volt supply provides regulated voltages for the amplifier and sweep circuits, and also provides a reference voltage for the +100 volt and +250 volt supplies. Refer to Figure 4-2. Differential Amplifier Q463/Q464 compares the reference voltage from Reference Tube V461 against the output voltage sample obtained by voltage divider R467/R468. The difference voltage is amplified and applied to Driver Q462 and Series Regulator Q461. The voltage applied to Series Regulator Q461 is out of phase, i.e., when the output voltage of the supply rises, the voltage applied to Q461 causes the series voltage drop to increase, returning the supply voltage to its original level. In this way, any variations in output voltage due to load change or line voltage change are sensed by the differential amplifier and corrected by the series regulator. Potentiometer R468 adjusts the output voltage to exactly -100 volts.

4-8. +100 and +250 VOLT SUPPLIES.

4-9. The +100 and +250 volt supplies operate in the same manner as the -100 volt supply. A sample of the output voltage is compared to a reference voltage (the -100 volt supply) and the difference voltage amplified and applied to a series regulator. The series regulator corrects for the variations in output voltage. The +250 volt is "stacked" on the +100V supply and the two are interdependent.

4-10. +12.5 VOLT SUPPLY.

4-11. The +12.5 volt supply is dependent only on the -100V supply and uses a single series regulator Q481 with a Zener diode reference CR482. Any variation in supply voltage is coupled through the reference diode. This results in a base current change for Q481, which is amplified and acts to vary the supply load current, providing the supply regulation.

4-12. HIGH VOLTAGE POWER SUPPLY.

4-13. The high voltage power supply provides the voltages necessary for the operation of the cathode ray tube. Refer to Figure 4-3 for the following explanation. Tube V301 is operating in a Hartley oscillator circuit, oscillating at approximately 70 kc. The oscillator voltage is applied to the primary of high voltage transformer T301. The primary voltage is stepped up by the transformer and rectified by V304 and V305. The output of the rectifiers is filtered and applied to the CRT cathode and grid. The CRT cathode voltage is compared to the +250V supply by voltage dividers R311 through R318 and applied to Control Amplifier V302. Since the cathode of V302 is

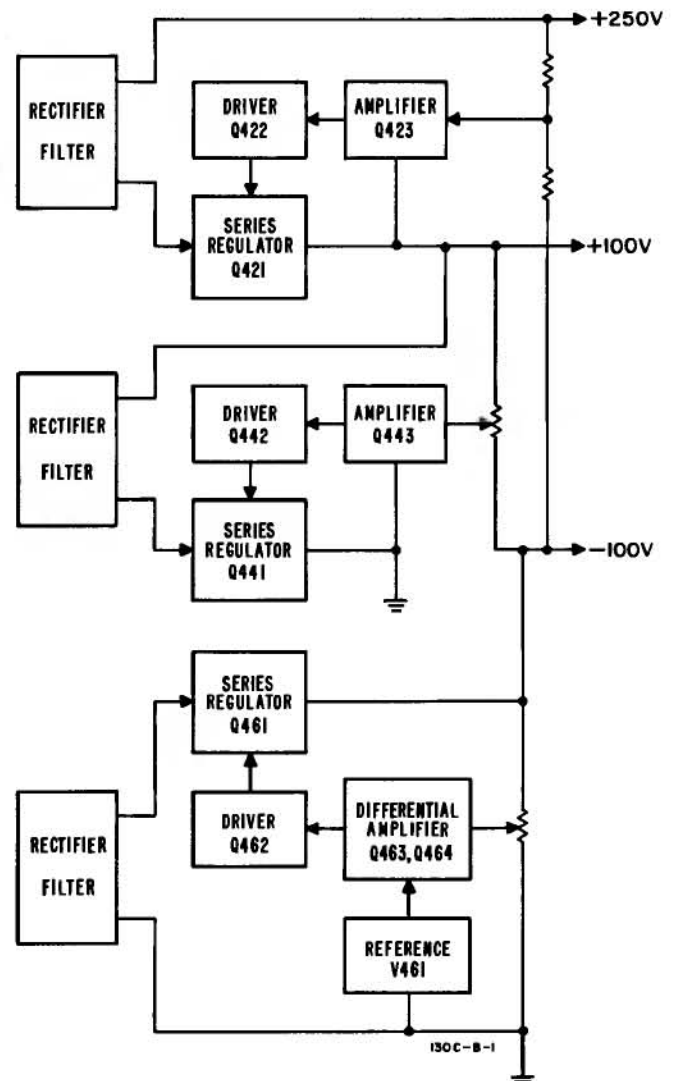


Figure 4-2. LV Power Supply Block Diagram

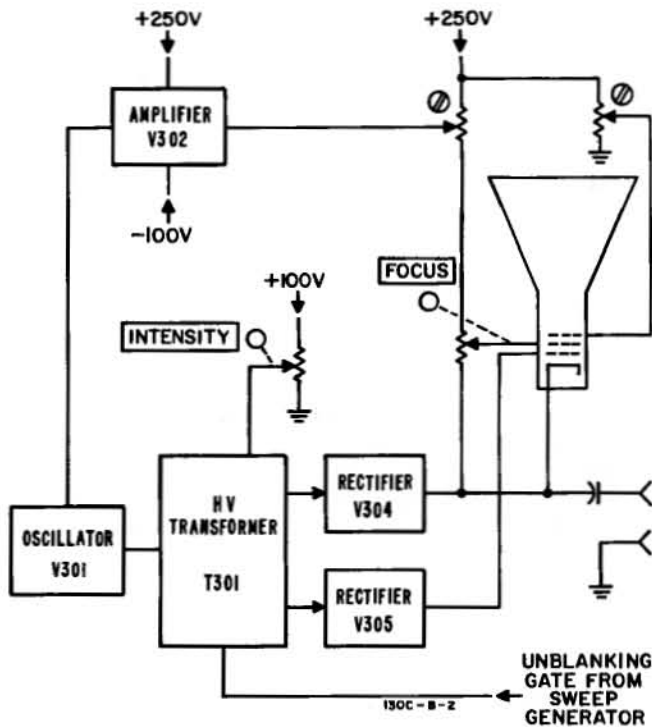


Figure 4-3. H V Power Supply Block Diagram

connected to a regulated voltage (-100 volts) any variation in high voltage is seen by V302 as a change in grid-cathode voltage. This grid-cathode voltage change is amplified and applied to the screen grid of Oscillator V301 to control the output amplitude of the oscillator. The change is always in the proper direction to correct for change in high voltage.

4-14. INTENSITY control R308 varies the CRT cathode voltage, varying the intensity of the spot or trace on the CRT screen. FOCUS control R317 varies the focus grid voltage for trace focus. Astigmatism adjustment R319 varies the voltage on the accelerator to adjust beam geometry for a round spot.

4-15. SWEEP GENERATOR.

4-16. Refer to Figure 4-4 for a block diagram of the sweep generator circuitry. The trigger generator produces signals which synchronize the sweep with internal signals from the vertical amplifier or power line, or with external trigger signals. In Figure 4-4 circuits represented in blocks to the right of the Trigger Generator produce a linear sweep voltage (sawtooth wave shape) which is amplified by the horizontal amplifier and applied to the CRT deflection plates.

4-17. TRIGGER GENERATOR.

4-18. The trigger generator consists of differential amplifier V101 and Schmitt trigger V102. The trigger

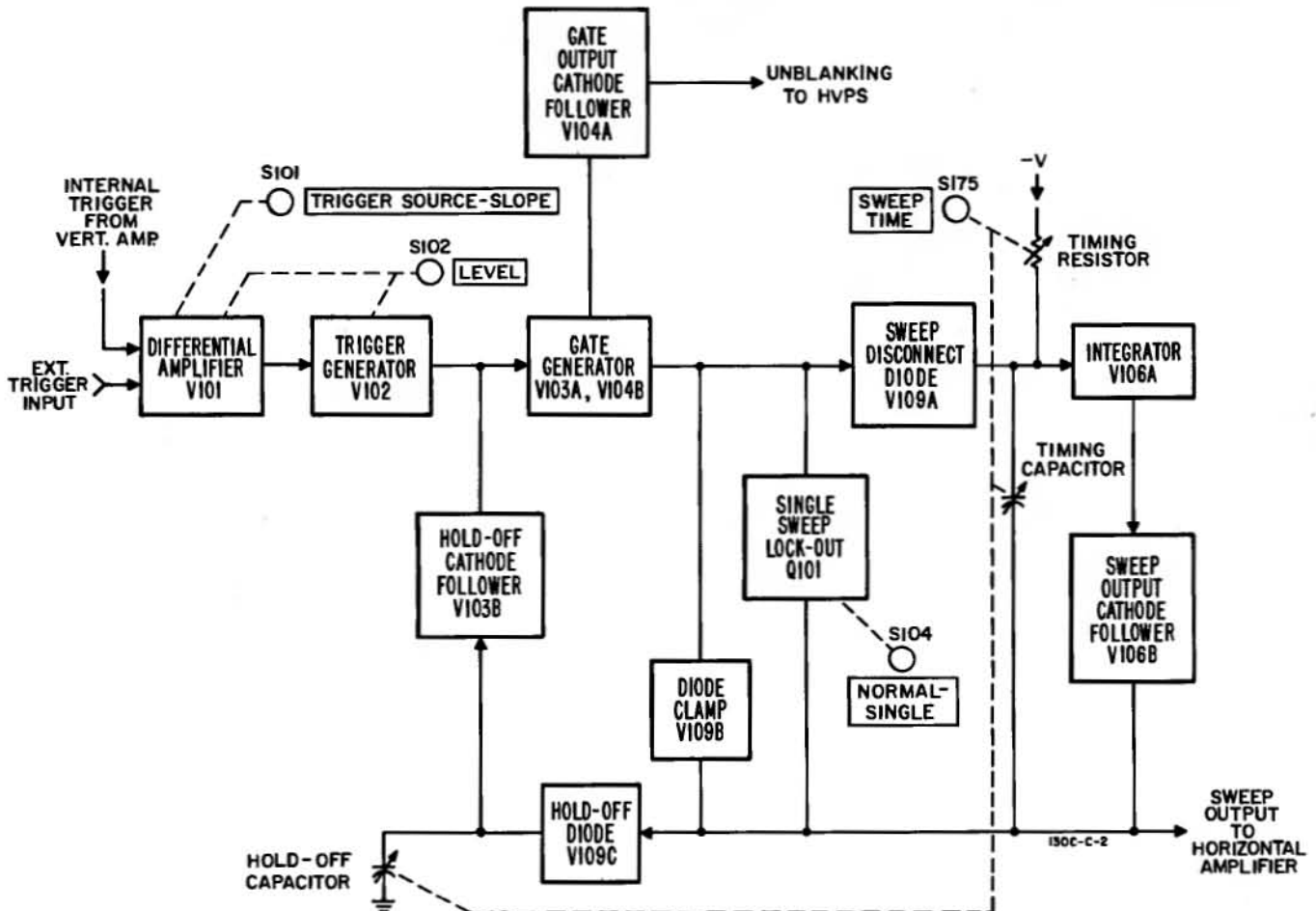


Figure 4-4. Sweep Generator Functional Block Diagram

signal, whether power line, internal, or external, is applied to one grid of V101 as determined by setting of the trigger slope control (S101). The other grid is connected to LEVEL control R116 through S101. The setting of R116 determines the DC level on one half of V101, and thus the point at which the trigger signal will cause V101 to conduct. The output of V101B drives trigger generator V102 which provides the waveform to drive the gate generator. When S102 is in FREE RUN no trigger is needed to switch the gate generator to start a new sweep; see Paragraph 4-26. When S102 is in AUTO, trigger generator V102 is converted to a free-running multivibrator (R124 is placed in circuit by S102C), with a repetition rate of 40 to 50 cps. Switch section S102B grounds one grid of V101 (depending on slope selected by S101) and AC-couples the trigger signal through C113 to V102A. This arrangement allows the trigger to be generated at the approximate zero crossing of the input signal.

4-19. GATE GENERATOR.

4-20. The square wave generated by V102 is differentiated by C115 and R130, and the positive spike is clipped by CR111. Gate Generator V103A and V104B operates as a Schmitt Trigger circuit with wide hysteresis limits. The negative spike, through C116 to the grid of V103A, causes the gate generator to change states, starting the sweep. As the gate generator switches states, the positive output at V103A plate goes to cathode follower V104A which provides the unblanking signal to the CRT (through the HV power supply).

4-21. INTEGRATOR.

4-22. As the gate generator changes states (on signal from the trigger generator), the negative gate voltage at V104B takes diodes V109A and V109B out of conduction. This allows the timing capacitor (C175 through C181, depending on sweep time set) to charge in a negative direction, since it is connected through the sweep time resistors to -100 volts. The integrator V106A amplifies and inverts this negative-going voltage at its grid (pin 2) to produce a large, positive-going output at the plate. This positive-going voltage is fed back to V106A grid through cathode follower V106B and the timing capacitor and this feedback keeps the integrator input voltage almost constant. Thus the voltage across the sweep timing resistor also remains nearly constant to produce a corresponding nearly constant current. The current charges the sweep capacitor at a linear rate to produce a linear sweep output. The sweep output is routed through switch S202 to the horizontal amplifier and then to the CRT deflection plates.

4-23. The slope of the sweep output waveforms is determined by the RC time constant of resistors (R175 to R186) and capacitors (C175 to C181) used on a selected SWEEP TIME range. VERNIER control R179 provides a fine adjustment of sweep time by altering the DC voltage to which the timing resistor is returned. Neon lamp V107 is used to reduce the average level of the sawtooth swing to a less positive value so the lower end of the sweep may be clamped to zero volts.

4-24. SWEEP TERMINATION AND HOLD-OFF.

4-25. Termination of a sweep is accomplished by feeding back the positive-going sweep voltage to the input of the gate generator. The feedback path is through hold-off diode V109C (which conducts during the sweep) and hold-off cathode follower V103B. The feedback voltage on V103B grid causes the cathode voltage to cross the upper hysteresis limit of the gate generator. The time required for this feedback to reach the upper hysteresis limit is determined by the sawtooth slope, thus setting the time between sweeps. The gate generator changes state to produce a negative voltage step at the plate of V103A and a positive voltage step at the plate of V104B. The negative voltage step is fed through gate output cathode follower V104A to the high-voltage power supply, blanking the CRT beam until a new sweep begins. The positive voltage step at the plate of V104B causes diodes V109A and V109B to conduct. The sweep timing capacitor discharges quickly through the clamp diode V109B, clamping the sweep output to a constant level and producing the retrace portion of the sweep waveform. The two diodes return the sweep output to the same reference level as the grid of integrator V106A. Hold-off diode V109C is cut off by the fast negative drop of the retrace (i.e., as timing capacitor discharges), but instead of a rapid decrease in voltage at the grid of V103B, the voltage here starts decaying at a rate determined by R148 and the value of hold-off capacitor used on a given sweep range. The cathode of V103B follows this decay rate and V103A grid voltage is kept high enough for a sufficient time to allow sweep circuit recovery. When the hold-off level from V103B decays enough, a negative trigger at V103A grid can reach the lower hysteresis limit and begin a new sweep cycle. Stability adjustment, R151, sets the DC level (just above lower hysteresis limit) at which V103B cathode quits following the hold-off decay voltage on the grid (this circuit is changed in free run operation; see Paragraph 4-26). An incoming trigger which reaches below this DC level to the lower hysteresis limit, starts the new sweep.

Note

The hold-off capacitor for a given sweep time setting is the same capacitor which is used as the timing capacitor in another sweep range (except that stray capacitance is used for hold-off purposes in the three fastest sweep speeds). For example, C176 is the hold-off capacitor in 0.1 through 5 SECOND/CM settings, but then C176 becomes the timing capacitor in 10, 20, and 50 MILLI-SECONDS/CM settings (and C177 becomes the hold-off capacitor).

4-26. FREE RUN CIRCUIT OPERATION.

4-27. When LEVEL control is set to FREE RUN, the gate generator and other sweep circuits operate without a trigger from V102. This is accomplished by allowing the hold-off decay at V103B cathode to cross the lower hysteresis limit (rather than a trigger crossing as explained in Paragraph 4-24) of the gate generator which initiates a new sweep cycle. The stability adjustment is switched out of the circuit by S102E which applies -100 volts directly to R152 in the

cathode circuit of V103B. This shifts the DC level at which V103B cathode quits following the grid hold-off voltage to a level below the lower hysteresis limit. Now as the hold-off decay voltage crosses the hysteresis limit it starts the sweep again.

4-28. SINGLE SWEEP CIRCUIT.

4-29. In single sweep operation the sweep is triggered on the first trigger received after manual arming, and further triggers are ineffective until the circuit is re-armed. This sequence is accomplished in the Model 130C by preventing the retrace from occurring. In NORMAL operation, switch S104A returns Q101 emitter to ground through R150 and the transistor is inoperative. In SINGLE operation, however, S104A connects R150 to -100 volts. This still biases Q101 off, but allows conduction when the base voltage becomes more positive during the sweep. In the SINGLE position, S104B connects +100v to neon indicator DS101. Because the sweep level is at zero volts before the sweep waveform begins, there is sufficient voltage across the neon to cause it to light (ARMED). Assuming that S104 has just been switched to SINGLE position, the first trigger to arrive at the gate generator starts a sweep in the usual way. As the sweep output voltage rises, the voltage across DS101 decreases until the light goes out. The positive-going sweep voltage is also applied by voltage divider R143 and R144 to the base of Q101, bringing the transistor into conduction and eventually driving it into saturation. As in NORMAL operation, the sweep voltage is fed back through the hold-off circuit to switch the gate generator back to its pre-sweep condition (V103A on, V104B off). With V104B cut off, the saturation current of Q101 flowing through R137 is still enough to keep

diodes V109A and V109B biased off. Integrator V106A is thus allowed to continue integrating until it reaches saturation. The sweep output waveform rounds and levels off, remaining at this high positive level until the circuit is manually re-armed. Since this positive voltage is fed back through the hold-off circuit to the input of the gate generator, triggers generated by V102 are unable to overcome this voltage and operate the gate. To re-arm the circuit, S104 is switched back to NORMAL. This cuts off Q101, which allows V109A and V109B to conduct and return the integrator to its pre-sweep condition. Setting switch S104 back to SINGLE will repeat the single sweep operation.

4-30. VERTICAL AMPLIFIER.

4-31. The vertical amplifier, as shown in the block diagram of Figure 4-5, consists of three basic sections: (1) input attenuators, (2) differential feedback amplifier, and (3) output differential amplifier. These circuits are explained in detail in Paragraphs 4-32, 4-34, and 4-36.

4-32. INPUT ATTENUATOR.

4-33. The input attenuator consists of two identical frequency-compensated voltage dividers which provide a constant input impedance of 1 megohm shunted by 45 pf on all ranges of SENSITIVITY for both + and - inputs. Switch S2 selects either capacitive (AC) or direct (DC) coupling from the input terminals to the attenuator. Capacitors C21 and C22 are used to adjust input capacitance to 45 pf on SENSITIVITY ranges 0.2 MILLIVOLTS/CM to 0.2 VOLTS/CM. A division

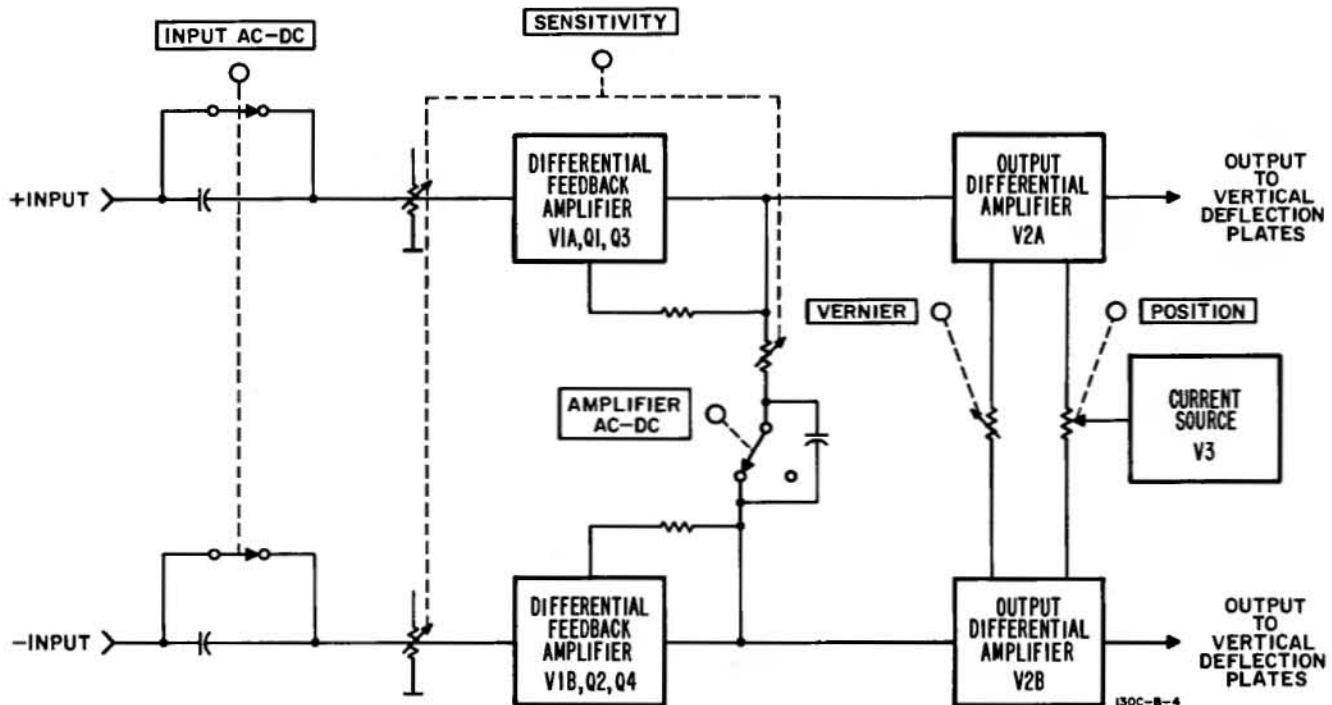


Figure 4-5. Vertical Amplifier Functional Block Diagram

ratio of 100:1 on the three least sensitive ranges (5 VOLTS/CM to 20 VOLTS/CM) is provided by R11/R13 and R12/R14 on the two inputs. Capacitors C11 and C12 maintain the ratio at high frequencies by capacitive division. Capacitors C13 and C14 are adjusted for 45 pf input capacitance on the three least sensitive ranges. A division ratio of 10:1 on the next three ranges (0.5 VOLTS/CM to 2 VOLTS/CM) is provided by R15/R17 and R16/R18 on the two inputs. Capacitors C17 and C18 maintain this ratio at high frequencies and C19 and C20 are adjusted to keep input capacitance at 45 pf on these three ranges. In the CAL. position of the SENSITIVITY switch, input terminals are opened and a 5 millivolt, $\pm 3\%$, 350 cps square wave is applied to the input of tube V1A to check amplifier calibration. Sensitivity of the amplifier in the CAL. position is 1 mv/cm. In BAL. position, the input terminals are opened and the grid circuits of V1 are grounded to allow accurate balancing of DC voltages in the amplifier.

4-34. DIFFERENTIAL FEEDBACK AMPLIFIER.

4-35. From the input attenuator, a signal is fed to the input of the differential feedback amplifier, i.e. grids of V1. Resistors R41 and R42 provide input overload protection. The gain of this amplifier (consisting of V1, and Q1 through Q4) is effectively controlled by the interstage attenuator which inserts feedback resistance (determined by S1 setting) between the emitters of Q3 and Q4. Gain is proportional to the ratio of the third-stage (Q3 and Q4) collector load to feedback resistance. The interstage attenuator and the input attenuator give the overall control of deflection sensitivity. The main DC current path for both V1 and Vernier Bal adjustment is through the feedback paths, R49-R50 or R48, to the -100 volt supply at the collectors of Q3 and Q4. The positive voltage supply with high value resistors (compared to feedback resistance) used for Vernier Bal, minimizes the effect of balance adjustments on gain. Vernier Bal is adjusted to offset any unbalance at the output stage plates resulting from the change in resistance between the cathodes of V2A and V2B when VERNIER is rotated out of CAL position. DC BALANCE, R49, and Coarse DC Bal, R48, adjustments are used to equalize the voltage on either side of the feedback resistance. When the voltages are balanced, the feedback resistors have no DC flowing through them and thus changing their values has no effect on amplifier balance. Variable resistor R59 sets Q3/Q4 collector voltages for an average of -15 volts, ensuring linear operation of the output differential amplifier. The AMPLIFIER AC-DC switch allows capacitive coupling of the interstage attenuator on the seven most sensitive ranges, minimizing the effect of dc drift by preventing DC current flow in the feedback resistors. The result is the same as if the amplifier is balanced. Gain adjustment R69 functions in the same manner as VERNIER control R70, by inserting resistance which acts as degenerative feedback. Thus the gain may be controlled in order to bring the sensitivity calibration into agreement with a voltage standard or to set intermediate sensitivities. The output of the differential feedback amplifier at Q3 and Q4 collectors drives the output differential amplifier, V2A and V2B.

4-36. OUTPUT AMPLIFIER.

4-37. The output differential amplifier, V2A and V2B, provides the voltage swing necessary to drive the deflection plates of the CRT. Cross-neutralization of the output stages is accomplished by adjustable capacitors C48 and C49 (shunted by C53), which couple in-phase signals from the plates of the tubes to the opposite grids. A voltage divider consisting of R75 and R77 in the plate circuit of V2A divides the output signal for use as an internal synchronizing signal for the sweep generator. Constant current source V3 is an active impedance, functioning as a high common cathode impedance to achieve high differential gain without the use of a large cathode resistor and negative supply. Resistor R83 sets the bias on V3, hence the current to the output differential amplifier. The setting of R83 interacts with R59. There are two front panel variable controls in the output amplifier: SENSITIVITY VERNIER and POSITION. When rotated ccw VERNIER, R70, decreases the gain (i.e. reduces sensitivity) of the amplifier by introducing degeneration in the cathodes of V2. Vertical movement of the trace is accomplished by POSITION, R78, which feeds back differential currents through R73 and R74. This results in a differential change in Q3 and Q4 collector currents and a differential voltage change at the grids of V2. Resistors R79 and R80 ensure that regardless of the POSITION setting, no DC voltage change occurs at the cathodes of V2 as VERNIER is moved. Thus, position of the trace is not affected by changes in the SENSITIVITY VERNIER.

4-38. BEAM FINDER switch S4 inserts R85 in the cathode of V3, reducing the current available to the output stage. This reduces the voltage swing of V2 and reduces the CRT deflection plate voltage swing, which brings the trace on screen regardless of signal amplitude.

4-39. HORIZONTAL AMPLIFIER.

4-40. The horizontal amplifier circuit operation is identical to that of the vertical amplifier except for the internal sweep positions of the SENSITIVITY switch, and the POSITION control R221A/B. In the INTERNAL SWEEP positions, X1 through X50, the sawtooth voltage output from the sweep generator is coupled into the amplifier input at V201A. The sweep signal gain is then controlled by the interstage attenuator (see Figure 5-16) and applied to the CRT deflection plates. To allow viewing of any portion of an expanded waveform, a greater range for POSITION control is obtained by varying the DC level at the amplifier input where the sweep is applied. For internal sweep, R221B is switched out of the circuit and replaced by two fixed resistors, R273 and R274; VERNIER R264 is also shorted out leaving V202 cathodes tied together. Resistor R221A (and its voltage divider circuit) becomes the POSITION control and changes the DC level at which the sweep waveform is applied to the amplifier. Then as amplifier gain is increased by the interstage attenuator section of S202, the sweep is expanded and the effective positioning range is increased at the same time.

Table 5-1. Required Test Equipment

| Item | Instrument Type | Required Characteristics | Measurement/Adjustment | Ref Para | Recommended Instruments |
|---|--|---|--|--|--|
| 1 | Voltmeter Calibrator | Output: 0.002 to 300V p-p | Vert. Sensitivity Ext. Calibrator Vert. Calibrator Horiz. Sensitivity Horiz. Calibrator Vert. Gain Horiz. Gain | 5-7 5-8 5-9 5-12 5-13 5-75 5-75 | Ⓜ Model 738AR (CAQI-738-A*) |
| 2 | Oscillator | Frequency: 10 cps to 500 kc | Vert. Bandwidth Vert. Common Mode Rej. Horiz. Bandwidth Horiz. Common Mode Rej. Phase Shift Triggering Trigger Point Intensity Mod. Horiz. Neut Input Cap and Freq. Comp. Sweep Length | 5-10 5-11 5-14 5-15 5-16 5-17 5-18 5-22 5-76 5-77 5-85 | Ⓜ Model 200CD (AN/URM-127*) |
| 3 | Attenuator | 0 to 110 db attenuation | Vert. Bandwidth Horiz. Bandwidth Phase Shift | 5-10 5-14 5-16 | Ⓜ Model 350D |
| 4 | AC Voltmeter | Range: 3 mv f.s. | Vert. Bandwidth Horiz. Bandwidth | 5-10 5-14 | Ⓜ Model 400D |
| 5 | Time Mark Generator | Marker Internal: 1 usec to 5 sec in 1, 2, 5, 10 sequence Output: greater than 0.1 mv p-p | Sweep Calib. Sweep Magnifier Sweep Time Calib. | 5-19 5-21 5-86 | Tektronix Type 180A (AN/USM-108*) |
| 6 | DC Voltmeter | Range: 0 to 300v f. s. Accuracy: ± 1% | LV Power Supply Vert. Output Stage Current Horiz. Output Stage Current Sweep Stability | 5-65 5-74 5-74 5-84 | Ⓜ Model 412A (CAQI-412*) |
| 7 | HV DC Voltmeter | Range: 0 to 3 kv f. s. Accuracy: ± 3% | HV Power Supply | 5-67 | Ⓜ Model 11044A Voltage Divider with Ⓜ Model 410B/C (AN/USM-116*), adjusted to ± 3% accuracy |
| 8 | Square Wave Generator | Frequency: 10 kc and 50 kc Output: 0 to 55V p-p | Vert. Neut. Vert. Atten. Comp. Horiz. Neut. Horiz. Atten. Comp. | 5-76 5-77 5-76 5-77 | Ⓜ Model 211A (TS-583B/U*) |
| 9 | L-C Meter or Alignment Attenuator | Range: 40 to 50 pf | Vert. Input Cap. Horiz. Input Cap. | 5-77 5-77 | Tektronix Type 130 (AN/URM-90*) or Ⓜ Model 10403A |
| * Designation for Military Preferred Instrument | | | | | |

c. Adjust Vertical VERNIER for exactly 10 cm deflection.

d. Disconnect Voltmeter Calibrator and apply signal from 500 MV CALIBRATOR to vertical input.

e. Deflection should be between 9.8 and 10.2 cm.

f. Disconnect the calibrator signal.

5-9. VERTICAL CALIBRATOR.

a. Set: Vertical SENSITIVITY 1 MV/CM
Voltmeter Calibrator output . . . 5 mv p-p

b. Adjust vertical VERNIER for exactly 4 cm deflection.

c. Set vertical SENSITIVITY to CAL.

d. The deflection should be between 3.88 and 4.12 cm.

e. Disconnect the Voltmeter Calibrator.

5-10. VERTICAL BANDWIDTH.

a. Set: Vertical SENSITIVITY 1 MV/CM
Vertical VERNIER CAL

b. Connect the Oscillator to the vertical input.

Note

External attenuation of the Oscillator signal is required for this check. Use a Φ Model 350D Attenuator Set or load the Oscillator output with a 50 ohm resistor.

c. Set Oscillator frequency to 5 kc.

d. Adjust Oscillator amplitude for 10 cm deflection.

e. Connect the AC Voltmeter in parallel with the vertical input.

f. Note reading of AC Voltmeter.

g. Change Oscillator frequency to 500 kc. Readjust amplitude for AC Voltmeter reading noted in step f, if necessary.

h. The deflection should be 7.1 cm or greater.

i. Disconnect the Oscillator and AC Voltmeter.

5-11. VERTICAL COMMON MODE REJECTION.

a. Set: Vertical SENSITIVITY . . . 0.2 VOLTS/CM
Vertical VERNIER CAL

b. Disconnect the grounding link from the center vertical input terminal.

c. Connect the Oscillator between the center terminal and the ground terminal.

d. Connect a short jumper between the left-hand terminal and the ground terminal.

e. Set Oscillator frequency to 50 kc.

f. Adjust Oscillator amplitude for 10 cm deflection.

g. Short center and left-hand terminals with the jumper.

h. Set vertical SENSITIVITY to 20 MV/CM.

i. The deflection should be 1 cm or less.

j. Set vertical SENSITIVITY to 1 VOLTS/CM.

k. Reconnect jumper between left-hand terminal and ground terminal.

m. Adjust Oscillator amplitude for 10 cm deflection:

n. Short center and left-hand terminals with the jumper.

p. Set vertical SENSITIVITY to 0.5 VOLTS/CM.

q. The deflection should be 0.6 cm or less.

r. Reconnect jumper between left-hand terminal and ground terminal

s. Set vertical SENSITIVITY to 10 VOLTS/CM.

t. Adjust Oscilloscope amplitude for 5cm deflection.

u. Short center and left-hand terminals with the jumper.

v. Set vertical SENSITIVITY to 5 VOLTS/CM.

w. The deflection should be 0.3 cm or less.

x. Disconnect the Oscillator. Reconnect the grounding link.

5-12. HORIZONTAL SENSITIVITY.

a. Apply a 1 volt p-p signal from the Voltmeter Calibrator to the horizontal input.

b. Set: Horizontal INPUT DC
Horizontal SENSITIVITY . . . 0.1 VOLTS/CM
Horizontal VERNIER CAL

c. Horizontal deflection should be between 9.7 and 10.3 cm.

d. Check all other SENSITIVITY ranges in the same manner as above, using the values shown in Table 5-2. The deflection in each case should be between 9.7 and 10.3 cm.

5-13. HORIZONTAL CALIBRATOR.

a. Set: Horizontal SENSITIVITY . . . 1 MV/CM
Voltmeter Calibrator output . . . 5 mv p-p

b. Adjust horizontal VERNIER for exactly 4 cm deflection.

c. Set horizontal SENSITIVITY to CAL.

d. The deflection should be between 3.88 and 4.12 cm.

e. Disconnect the Voltmeter Calibrator.

5-14. HORIZONTAL BANDWIDTH.

- a. Set: Horizontal SENSITIVITY . . . 1 MV/CM
Horizontal VERNIER CAL
 - b. Connect the Oscillator to the horizontal input.
- Note
- External attenuation of the Oscillator signal is required for this check. Use a $\text{\textcircled{P}}$ Model 350D Attenuator Set or load the Oscillator output with a 50 ohm resistor.
- c. Set Oscillator frequency to 5 kc.
 - d. Adjust Oscillator amplitude for 10 cm deflection.
 - e. Connect the AC Voltmeter in parallel with the horizontal input.
 - f. Note reading of AC Voltmeter.
 - g. Change Oscillator frequency to 500 kc. Re-adjust amplitude for AC Voltmeter reading noted in step f, if necessary.
 - h. The deflection should be 7.1 cm or greater.
 - i. Disconnect the Oscillator and AC Voltmeter.

5-15. HORIZONTAL COMMON MODE REJECTION.

- a. Set: Horizontal SENSITIVITY . . . 0.2 VOLTS/CM
Horizontal VERNIER CAL
- b. Disconnect the grounding link from the center horizontal input terminal.
- c. Connect the Oscillator between the center terminal and the ground terminal.
- d. Connect a short jumper between the left-hand terminal and the ground terminal.
- e. Set Oscillator frequency to 50 kc.
- f. Adjust Oscillator amplitude for 10 cm deflection.
- g. Short center and left-hand terminals with the jumper.
- h. Set horizontal SENSITIVITY to 20 MV/CM.
- i. The deflection should be 1 cm or less.
- j. Set horizontal SENSITIVITY to 1 VOLTS/CM.
- k. Reconnect jumper between left-hand terminal and ground terminal.
- m. Adjust Oscillator amplitude for 10 cm deflection.
- n. Short center and left-hand terminals with the jumper.
- p. Set horizontal SENSITIVITY to 0.5 VOLTS/CM.
- q. The deflection should be 0.6 cm or less.
- r. Reconnect jumper between left-hand terminal and ground terminal.
- s. Set horizontal SENSITIVITY to 10 VOLTS/CM.
- t. Adjust Oscillator amplitude for 5 cm deflection.
- u. Short center and left-hand terminals with the jumper.
- v. Set horizontal SENSITIVITY to 5 VOLTS/CM.

- w. The deflection should be 0.3 cm or less.
- x. Disconnect the Oscillator.

5-16. PHASE SHIFT.

- a. Set: Horizontal and Vertical SENSITIVITY . . .
. 10 VOLTS/CM
Horizontal and Vertical VERNIER . . . CAL
Horizontal and Vertical AMPLIFIER DC
Horizontal and Vertical INPUT . . . DC
- b. Connect the Oscillator to both horizontal and vertical input terminals.
- c. Set Oscillator frequency to 100 kc.
- d. Adjust Oscillator amplitude for 5 cm vertical and horizontal deflection.
- e. The minor diameter of the ellipse should be less than 0.1 cm.
- f. Check all other SENSITIVITY ranges, keeping deflection constant at 5 cm. The minor diameter of the ellipse should be less than 0.1 cm in each case.

Note

On the highest SENSITIVITY ranges, external attenuation of the Oscillator signal will be necessary. Use a $\text{\textcircled{P}}$ Model 350D Attenuator Set or load the Oscillator output with a 50 ohm resistor.

- g. Disconnect the Oscillator.

5-17. TRIGGERING.

- a. Set: Vertical SENSITIVITY . . . 20 VOLTS/CM
Horizontal SENSITIVITY
. INTERNAL SWEEP X1
SWEEP TIME . . . 1 MILLISECONDS/CM
TRIGGER SOURCE-SLOPE . . . EXT+
LEVEL AUTO
- b. A baseline should be displayed with no signal applied.
- c. Apply a 500 kc signal from the Oscillator to the vertical input.
- d. Set: TRIGGER SOURCE-SLOPE . . . INT+
SWEEP TIME . . . 1 μ SECONDS/CM
- e. Adjust Oscillator amplitude for 0.5 cm deflection.
- f. Vary Oscillator frequency from 500 kc to 50 cps, keeping amplitude constant at 0.5 cm. Stable triggering should occur over the entire range.
- g. Set LEVEL to +.
- h. Vary Oscillator frequency from 10 cps to 500 kc, keeping amplitude constant at 0.5 cm. Stable triggering should occur over the entire range. Note: some adjustment of LEVEL may be necessary at the high frequency end of the range.
- i. Apply a 500 kc signal from the Oscillator to the vertical input and the external trigger input.

Table 5-4. Sweep Magnifier Calibration

| (Sweep Time at 1 msec/cm) | | |
|----------------------------|-----------|-------------------|
| Time Mark Generator Output | Magnifier | Time Marks/ 10 cm |
| 1 msec | X2 | 5 |
| 100 μsec | X5 | 20 |
| 100 μsec | X10 | 10 |
| 100 μsec | X20 | 5 |
| 10 | X50 | 20 |

b. Apply a 100 kc signal from the Oscillator to the vertical input. Adjust Oscillator amplitude for 2 cm deflection.

c. Remove grounding link from Z AXIS INPUT (rear panel) and connect signal from Oscillator to Z AXIS INPUT.

d. At normal intensity, the top of the sine wave should be extinguished.

5-23. SINGLE SWEEP.

a. Set: SWEEP TIME . . . 10 MILLISECONDS/CM
NORMAL-SINGLE NORMAL
LEVEL -

b. Switch from NORMAL to SINGLE. The ARMED light should come on.

c. Set LEVEL to AUTO. A single sweep should occur, and the ARMED light should go out.

5-24. TROUBLESHOOTING.

5-25. The following paragraphs outline procedures for locating and eliminating malfunctions. Be sure that the trouble cannot be eliminated by making an adjustment, but do not make arbitrary adjustment settings; always follow the procedures given in Paragraph 5-58. To locate assemblies and other circuit components refer to Figure 5-1 and 5-2; also refer to Paragraph 5-87. Schematic diagrams for all circuits are shown in Figures 5-7, 5-11, 5-13, 5-16, 5-18, and 5-20.

5-26. ISOLATING TROUBLES TO A MAJOR SECTION.

5-27. The following checks should be performed whenever a malfunction is suspected.

5-28. POWER SUPPLIES.

a. Set: Vertical and Horizontal SENSITIVITY . . .
. 20 VOLTS/CM
Vertical and Horizontal VERNIER . CAL

b. Depress BEAM FINDER. A defocused spot should appear on the screen if the power supplies are operating properly.

5-29. AMPLIFIERS.

a. Set: Vertical and Horizontal SENSITIVITY . . .
. CAL
Vertical and Horizontal AMPLIFIER . AC

b. A trace tilted at 45° and having 5 cm vertical and horizontal deflection should appear if the amplifiers are operating properly.

5-30. SWEEP GENERATOR.

a. Set: Horizontal SENSITIVITY
. INTERNAL SWEEP X1
LEVEL AUTO
TRIGGER SOURCE-SLOPE . . . INT+
SWEEP TIME . 1 MILLISECONDS/CM
VERNIER CAL
Vertical SENSITIVITY CAL

b. A synchronized square wave, 5 cm in amplitude, should be observed if the sweep generator is operating properly.

Note

If the horizontal amplifier is not operating properly, the sweep operation will also be affected.

5-31. LOW VOLTAGE POWER SUPPLY TROUBLESHOOTING.

5-32. The two common troubles in the low voltage supplies are loss of regulation and excessive ripple. The following paragraphs outline procedures for isolating faulty components.

5-33. EXCESSIVE RIPPLE.

5-34. Excessive ripple in any of the supplies may usually be traced to two sources: defective filter capacitors or defective transistors. The ripple at the output of each supply and at the input to each regulator is given in Table 5-5. If the ripple at the output of any of the supplies is excessive, check the -100 volt supply first. If its output is normal, then check the ripple at the regulator input of the supply in question. If the ripple of the unregulated supply is excessive, check the filter capacitors and the rectifier diodes. If the ripple of the unregulated supply is normal, check for defective transistors in the amplifier series and regulator stages.

5-35. LOSS OF REGULATION.

5-36. The failure of any of the supplies is usually due to transistor failure. Table 5-6 provides a systematic procedure for troubleshooting each of the

Table 5-5. Ripple Measurements

| Supply | Unregulated Ripple | Output Ripple |
|--------|--------------------|---------------|
| -100 | 7 v p-p | 4 mv p-p |
| + 12.5 | 4 v p-p | 15 mv p-p |
| + 100 | 10 v p-p | 4 mv p-p |
| + 250 | 5 v p-p | 7 mv p-p |

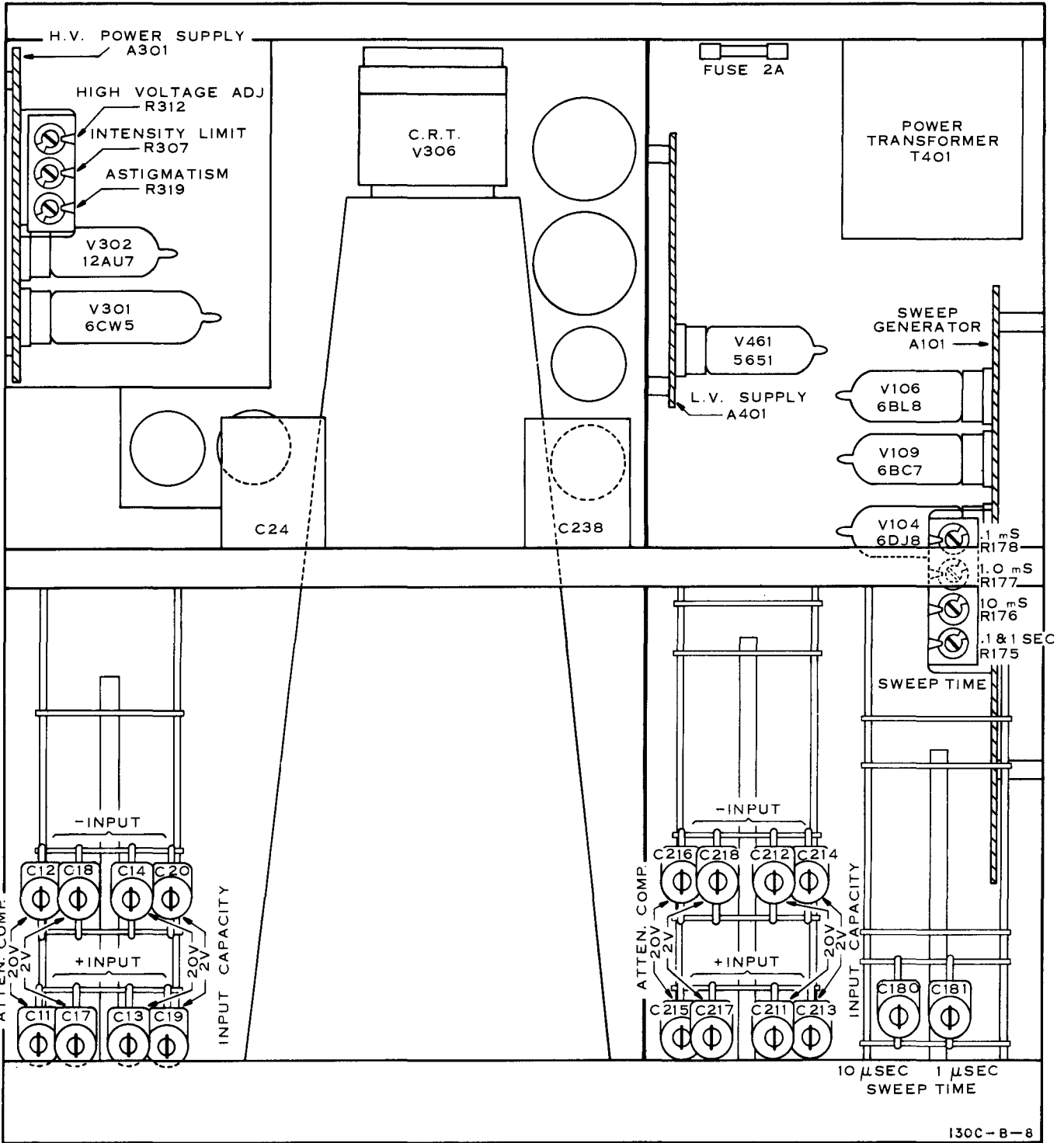


Figure 5-1. Model 130C Top View (Cover Removed)

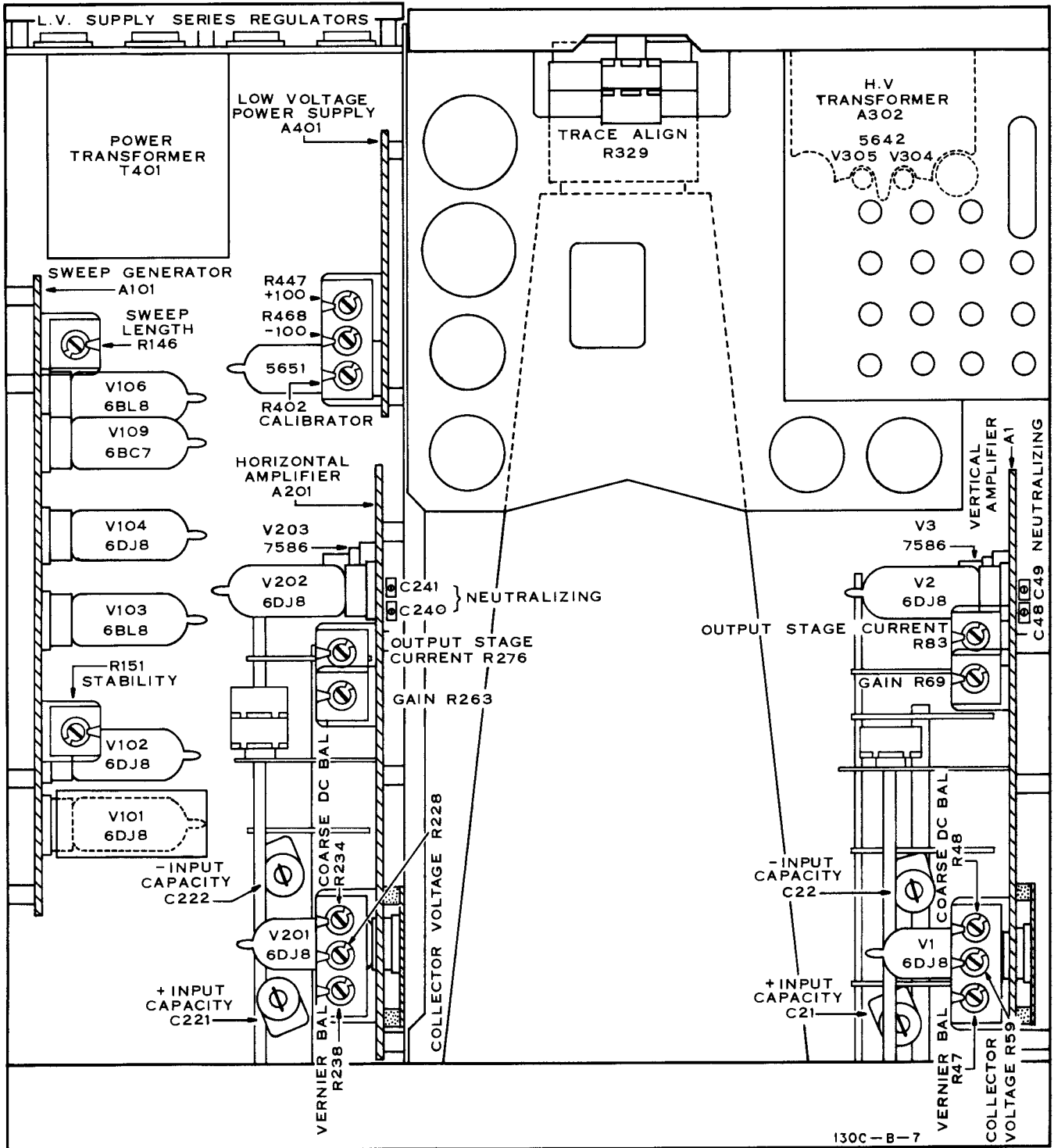


Figure 5-2. Model 130C Bottom View (Cover Removed)

Table 5-6. Low Voltage Supply Troubleshooting

| Supply | Symptom | Procedure | Result | Conclusion |
|------------|---|--|---------------------------|---------------------------|
| -100V | High Output | Disconnect base lead of Q461 (WHT/GRN/VIO lead connecting to edge of board near top of instrument). | Output remains high | Q461 shorted |
| | | | Output drops | Q461 good |
| | | Reconnect base lead. Short emitter to collector of Q464 | Output remains high | Q462 shorted |
| | | | Output drops | Q464 open or Q463 |
| | | Measure voltage across R465 | Same as output | Q463 shorted |
| | | | Less than output | Q464 open |
| | Low Output | Measure voltage across CR462 | 0 volts | CR462 shorted |
| | | | 0 volts | CR462 good |
| | | Short collector to emitter of Q462 | Output remains low | Q461 open |
| | | | Output rises | Q461 good |
| | | Short collector to emitter of Q463 | Output remains low | Q462 open |
| | | | Output rises | Q463 open or Q464 shorted |
| + 100V | High or Low Output | Short emitter to base of Q464 | Output remains low | Q464 shorted |
| | | | Output rises | Q463 open |
| | | Check output of -100 supply and/or 12.5 supply | Either abnormal | -100 and/or 12.5 supply |
| | | | Both normal | + 100 supply |
| | High Output | Disconnect base lead of Q441 (WHT/RED/GRN lead connecting to edge of board near rear of instrument). | Output remains high | Q441 shorted |
| | | | Output drops | Q441 good |
| | | Short emitter to collector of Q443 | Output remains high | Q442 open |
| | | | Output drops | Q443 open |
| Low Output | Short emitter to base of Q442 | Output rises | Q443 shorted | |
| | | Output remains low | Q442 shorted or Q441 open | |
| | Measure voltage between emitter and collector of Q442 | 0 volts | Q442 shorted | |
| | | greater than 2 volts | Q441 open | |
| + 250V | High or Low Output | Check -100 and + 100 supplies | Normal | + 250 supply |
| | | | Abnormal | -100 or + 100 supplies |
| | High Output | Disconnect base lead of Q421 (GRN lead connecting to edge of board near back of instrument) | Output remains high | Q421 shorted |
| | | | Output drops | Q421 good |
| | | Short emitter to base of Q422 | Output remains high | Q422 shorted |
| | | | Output drops | Q423 shorted |

Table 5-6. Low Voltage Supply Troubleshooting (Cont'd)

| Supply | Symptom | Procedure | Result | Conclusion |
|--------|------------|------------------------------------|--------------------|-------------------|
| | Low Output | Measure voltage across CR422 | 0 Volts | CR422 shorted |
| | | | + 6 volts | CR422 good |
| | | Short emitter to collector of Q422 | Output remains low | Q421 open |
| | | | Output rises | Q422 or Q423 open |
| | | Short emitter to collector of Q423 | Output rises | Q423 open |
| | | | Output remains low | Q422 open |

low voltage power supplies. The transistors associated with the low voltage supplies are located on the low voltage power supply circuit board and at the rear of the instrument. For the location of the circuit board, refer to Figure 5-1.

5-37. Resistors R421, R441, R461, and R481 protect the series regulator transistors in each of the supplies. If the output of one of the supplies is accidentally shorted, the resistor in series with the series regulator will dissipate excessive power and fail. Check each of the series resistors (located near the filter capacitors; note silkscreen identifiers) when a malfunction of the low voltage supplies is suspected.

5-38. HIGH VOLTAGE POWER SUPPLY TROUBLESHOOTING.

5-39. Waveforms and DC voltages which will aid in troubleshooting are shown on the schematic diagram.

5-40. Troubles in the high voltage power supply can best be isolated by DC voltage measurements. Any decrease in the regulated high voltage is amplified and inverted by V302 and applied to V301. The screen voltage of V301 controls the amplitude of the oscillator output, and thus the high voltage.

5-41. AMPLIFIER TROUBLESHOOTING.

5-42. Since the vertical and horizontal amplifiers are nearly identical, a single troubleshooting procedure may be used for both amplifiers.

5-43. UNBALANCE.

5-44. If the trace cannot be brought on screen with the DC BALANCE control, try adjusting R48 in the vertical amplifier or R234 in the horizontal amplifier. If the trace is still off-screen, use the following procedure to localize the unbalance.

- a. Set POSITION to midrange.
- b. Short grids of output tubes together (V2 in vertical, V202 in horizontal).
- c. If trace remains off-screen, trouble is in output stage. If trace returns, proceed to step d.
- d. Turn the instrument off.
- e. Switch AMPLIFIER to DC.

- f. Connect ground lead of ohmmeter to chassis.
- g. Compare resistance readings at corresponding points in both halves of the amplifier. Unsymmetrical readings will indicate a source of unbalance.
- h. If resistance readings do not point out the source of the unbalance, proceed to step i.
- i. Turn instrument on, switch AMPLIFIER to AC and set SENSITIVITY to BAL position.
- j. Measure DC voltages at corresponding points in both halves of the amplifier.
- k. Switch AMPLIFIER to DC.
- m. Repeat voltage measurements made in step j. Compare readings made in steps j and m with voltages shown on schematics. Any significant deviation should indicate location of the trouble.

5-45. GAIN.

5-46. If the gain of the amplifier cannot be set properly with Gain adjustment (R69 in vert, R263 in horiz.), try the next higher sensitivity range. If the gain cannot be set on this range, change V2 in vertical amplifier or V202 in horizontal amplifier, and check the high voltage output (ref. Paragraph 5-67).

5-47. LOW-FREQUENCY NOISE.

5-48. If low-frequency noise is visible on the trace, try changing the input tube (V1 in vert, V201 in horiz.). If this does not cure the trouble, change the second stage transistors (Q1, 2 in vert. Q201, 202 in horiz.).

5-49. COMPRESSION.

5-50. If the signal waveform is compressed in amplitude when the trace is moved to the top or bottom of the screen, check that the output stage current is adjusted properly (ref. Paragraph 5-74), then try changing the output tube.

5-51. SWEEP GENERATOR TROUBLESHOOTING.

5-52. If the horizontal amplifier is not operating properly, the sweep operation (not sweep circuit) will also be affected. If a sweep malfunction is observed, first check the horizontal amplifier. If the horizontal

amplifier is operating properly check typical waveforms shown in Figure 5-8 (located near schematic) proceed to the steps below.

a. Set LEVEL to FREE RUN. If the sweep operates, check V101, V102, and CR111. If the sweep does not operate, proceed to step b.

b. Check DC voltage in each of the states shown in Table 5-7. A 10 to 15% deviation from the values shown in the table can be expected; larger deviations indicate a source of trouble.

5-53. REPAIR AND REPLACEMENT.

5-54. Circuit boards used in the Model 130C have components on one side of the board and a plated conductive metal layer through component holes. When removing or replacing etched circuit components the important steps and considerations are (Ⓢ Service Note M-20D also contains useful information on etched circuit repair):

a. Use a low heat (37 to 47.5 watts, less than 800° F idling temperature), slightly bend chisel tip (1/16 to 1/8 inch diameter) soldering iron, and a small diameter, high tin content solder. If a rosin solder is used, clean the area thoroughly after soldering.

b. Components may be removed by placing the soldering iron on the component lead on either side of the board, and pulling up on the lead. If heat is applied to the component side of the board, greater care is required to avoid damage to the component (especially true for diodes). If heat damage may occur, grip the lead with a pair of pliers to provide a heat sink between the soldering iron and component.

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

d. Large components such as potentiometers and tube sockets may be removed by rotating the soldering iron from lead to lead and applying steady pressure to lift the part free (the alternative is to clip the leads of a damaged part).

e. Since the conductor part of the etched circuit board is a metal plated surface, covered with solder, use care to avoid overheating and lifting the conductor from the board. A conductor may be cemented back in place with a quick-drying acetate base cement (use sparingly) having good insulating properties. Another method for repair is to solder a section of good conducting wire along the damaged area.

f. Clear the solder from the circuit board hole before inserting a new component lead. Heat the solder in the hole, remove the iron, and quickly insert a pointed non-metallic object, such as a toothpick.

g. Shape the new component leads and clip to proper length. Insert the leads in the holes and apply heat and solder, preferably on the conductor side.

5-55. Most of the wire leads to the etched circuit boards have edge-on connectors. When removing or replacing these connectors, be sure they are properly aligned with the guide slot in the board edge. Applying force with the connector mis-aligned will spring the contacts and result in a faulty electrical connection.

5-56. CATHODE RAY TUBE REPLACEMENT.

5-57. To replace the cathode ray tube, use the following procedure:

WARNING

Serious injury may result if the cathode ray tube is dropped. Handle the tube carefully.

a. Remove the bezel.

b. Loosen the clamp at the CRT socket.

c. Remove the tube socket from the clamp. It may be necessary to carefully loosen socket from clamp with a narrow-blade screwdriver.

d. Slide the tube out of the instrument.

e. Install the new CRT, reversing previous steps. Note: over-tightening the clamp at the CRT socket may damage the tube.

f. Check alignment of trace with graticule. If trace is misaligned, bring into alignment with R329, TRACE ALIGN (rear panel).

g. Check Astigmatism (ref. Paragraph 5-68).

h. Check Intensity Limit (ref. Paragraph 5-69).

i. Check Vertical Gain (ref. Paragraph 5-75).

j. Check Horizontal Gain (ref. Paragraph 5-75).

5-58. ADJUSTMENTS.

5-59. The adjustment procedures are divided into three groups. Group I adjustments include procedures of Paragraphs 5-64 through 5-69; these procedures set the power supply outputs and optimize front panel

Table 5-7. Sweep Generator Troubleshooting

| Test Point | Sweep Completed* | Reset** |
|------------|------------------|------------|
| V103 Pin 2 | -100 volts | 0 volts |
| Pin 6 | 92 volts | 48 volts |
| Pin 7 | -44 volts | -1 volts |
| V104 Pin 7 | -45 volts | -57 volts |
| Pin 6 | -4.9 volts | -2.4 volts |
| V106 Pin 2 | 4.7 volts | -.15 volts |
| Pin 6 | 195 volts | 2.3 volts |
| Pin 8 | 195 volts | 16 volts |
| Pin 9 | 195 volts | 2.3 volts |
| V109 Pin 8 | -9.5 volts | -74 volts |
| Pin 9 | -9.6 volts | -74 volts |

*Sweep Completed: Connect Pin 2 of V103 to -100 volts (VIO wire).
 **Reset: Connect Pin 2 of V103 to ground.

controls for CRT display. Group II adjustments are in the procedures of Paragraphs 5-70 through 5-80; these procedures are for adjustments which are made the same way in both vertical and horizontal circuits. Group III adjustments are in the procedures of Paragraphs 5-81 through 5-86; these procedures adjust the calibrator output and the sweep generator circuit, and depend on an accurate calibration of the vertical and horizontal circuits. Refer to Figures 5-1 and 5-2 to locate adjustable components. Always make the preliminary settings of Paragraph 5-62 before following any adjustment paragraph procedure.

5-60. REQUIRED TEST EQUIPMENT.

5-61. Refer to Table 5-1 for information on instruments required for the adjustment procedures. Substitute instruments should have the characteristics described in the table.

5-62. PRELIMINARY SETTINGS.

5-63. The following settings must be made prior to following any adjustment paragraph procedure. If a setting is different from these preliminary settings, the procedure for the adjustment will specify so.

LEVEL AUTO
TRIGGER SOURCE-SLOPE INT+
ALL VERNIERS CAL
ALL AC-DC AC
Grounding links connected
NORMAL-SINGLE NORMAL

5-64. GROUP I ADJUSTMENTS.

5-65. LOW VOLTAGE POWER SUPPLY.

5-66. Use a DC Voltmeter to measure the output, with respect to chassis ground, of the low voltage power supplies and make adjustment or check tolerance as shown in Table 5-8. The voltage measurement can be made at any wire coded with the colors specified in Table 5-8.

5-67. HIGH VOLTAGE POWER SUPPLY.

- a. Connect the Model 11044A 100:1 Voltage Divider to the DC probe of the Model 410B Voltmeter.
- b. Set Voltmeter to 3-volt-DC range, and polarity to -.
- c. Set the Voltmeter Calibrator for -300 volts DC output, and connect divider tip to the output.
- d. Set the gain adjustment of the Model 410B (located at the rear of the instrument) for a reading of exactly 3 volts.
- e. Set the Voltmeter to the 30-volt range, and measure the high voltage supply output at pin 8 of transformer T401.

Table 5-8. Low Voltage Power Supply Adjustment

| Supply | Tolerance | Wire Color | Adjustment |
|--------|-----------|-----------------|------------|
| -100V | | Violet | R468 |
| +100V | | White/Red | R477 |
| +250V | +250±7V | Red | none |
| +12.5V | +12.5±1V | White/Black/Red | none |

- f. If necessary, set R312, High Voltage Adj., for a Voltmeter reading of -28.5±1.0 volts; this corresponds to -2850 volts at the high voltage output.
- g. Recalibrate the Voltmeter.

5-68. ASTIGMATISM.

- a. Set both horizontal and vertical SENSITIVITY to 20 VOLTS/CM.
- b. With POSITION controls, center a low intensity spot on the CRT.
- c. Alternately adjust FOCUS control and Astigmatism adjustment R319, for the smallest, sharply focused round spot.

5-69. INTENSITY LIMIT.

- a. Center a defocused spot on the CRT.
- b. Set INTENSITY control to "ten o'clock" position.
- c. Adjust R307, Intensity Limit, to just extinguish the spot.

5-70. GROUP II ADJUSTMENTS.

5-71. The procedures of Paragraphs 5-72 through 5-80 may be followed to calibrate either the vertical or horizontal circuits. The Preliminary settings of Paragraph 5-62 must be made first. Unless the procedure states otherwise, make only the setting or connection for the circuit being calibrated, that is, for either vertical or horizontal. The reference designator for the vertical adjustment is given first, followed by the corresponding horizontal adjustment, e.g. R47/R238.

5-72. VERNIER BALANCE.

- a. Set SENSITIVITY to 20 MV/CM.
- b. Center spot with POSITION control.
- c. Switch VERNIER out of CAL position.
- d. Adjust R47/R238 for minimum shift of spot when VERNIER is rotated.

5-73. COARSE DC BALANCE.

- a. Set: DC BALANCE mid-range
SENSITIVITY BAL
VERNIER CAL
- b. Center spot with POSITION control.
- c. Switch AMPLIFIER coupling to DC.
- d. Adjust R48/R234, Coarse Bal, to center the spot on CRT.

5-74. OUTPUT STAGE CURRENT.

- a. Set: POSITION to center spot
SENSITIVITY 20 VOLTS/CM
- b. Measure the collector voltage of transistors Q3 and Q4. Adjust R59/R228 so the average of the two voltages is -15 volts.
- c. With a DC Voltmeter, measure and note the deflection plate voltages (Green and White wires on amplifier board). Adjust R83/R276 so the average of the two voltages is +140 volts.

d. Repeat steps b and c to obtain specified voltages.

e. This step applies only to the horizontal amplifier adjustment and should be performed only when a more accurate calibration is needed for use of the 10 USECONDS/CM, INTERNAL SWEEP X50 combination setting. When more accurate calibration is desired for this one sweep combination, make same settings as in step a and proceed as follows:

- (1) Connect a shorting wire between the green and white wires (deflection plate leads) on the horizontal amplifier circuit board.
- (2) Clip the probe of a $\text{\textcircled{P}}$ Model 428A/B DC Milliammeter around the black lead from the horizontal POSITION control, R221B, to the amplifier board.
- (3) Adjust R276 for a Milliammeter reading of 15 ma.
- (4) Disconnect Milliammeter and remove shorting wire.

5-75. GAIN.

a. Connect the Voltmeter Calibrator to the amplifier input terminals (shorting bar in place).

b. Set SENSITIVITY to 0.1 VOLTS/CM.

c. Set output of Voltmeter Calibrator to 1 volt p-p.

d. Set R69/R263, Gain, for exactly 10 cm deflection on the CRT.

5-76. NEUTRALIZATION.

a. Connect the 75 Ω output of the Square Wave Generator to the Model 130C amplifier input terminals (connect between left terminal and center terminal with grounding link in place).

b. For vertical neutralization adjustment, proceed to step c (1). For horizontal neutralization adjustment only, connect the Oscillator output to the Model 130C vertical input and to the external sync input of the Square Wave Generator; proceed to step c (2).

c. Make appropriate settings as follows:

- (1) For vertical neutralization only, set
SWEEP TIME 5 μ SECONDS/CM
Horiz. SENSITIVITY · INTERNAL SWEEP X1
Vertical SENSITIVITY · 0.2 VOLTS/CM

- (2) For horizontal neutralization only set
Vertical SENSITIVITY · · 5 VOLTS/CM
Horizontal SENSITIVITY · · 0.2 VOLTS/CM

d. Set Square Wave Generator frequency to 50 kc. For horizontal neutralization, also set Oscillator frequency to 25 kc.

e. Obtain CRT display as follows:

- (1) For vertical adjustment only, set Square Wave Generator output for about 8 cm deflection.
- (2) For horizontal adjustment only, set both signal source amplitudes for about 8 centimeters deflection, horizontally and vertically. Adjust Oscillator frequency until two distinct square waves are displayed as in Figure 5-3.

f. Alternately adjust C48/C240 and C49/C241 for best rise time with no overshoot. Figure 5-3 illustrates the waveforms for the horizontal neutralization adjustment.

Note

A step input signal with a risetime much faster than the Oscilloscope risetime, such as the $\text{\textcircled{P}}$ Model 211A signal, may cause a noticeable preshoot on the trace. This does not affect the accuracy of the adjustment and does not occur for signals within the specified risetime of the Model 130C.

g. Disconnect shorting link from center input terminal and connect Square Wave Generator between center and ground (black) terminals.

h. Connect a short jumper wire from the left input terminal to the ground terminal.

i. Note the square wave response. A slight rounding on the leading edge is permissible. If desired, a compromise adjustment of C48/C240 and C49/C241 can be made with Square Wave Generator signal applied alternately to the left terminal (with center terminal grounded) and to the center terminal (with left terminal grounded).

5-77. INPUT CAPACITANCE AND ATTENUATOR FREQUENCY COMPENSATION.

5-78. There are two methods for adjusting input capacitance. One method requires a capacitance meter or bridge and the other method requires an alignment attenuator previously set (by L-C Meter or capacitance bridge) for a specific value (see item 9 in Table 5-1). Paragraphs 5-79 and 5-80 provide the procedures for these two methods.

5-79. PROCEDURE USING CAPACITANCE METER.

a. Set amplifier SENSITIVITY to 0.2 VOLTS/CM.

b. Disconnect the ground link from the center terminal of the Model 130C amplifier input.

c. Connect the L-C Meter between the left (+ input) and right (ground) terminals.

d. Adjust C21/C221, + Input Capacity, for a reading of 45 pf on the L-C Meter.

Note

For Model 130C instruments with Option 06 (see Paragraph 1-9), change all references in this procedure from "45 pf" to "85 pf". This is necessary because of input capacitance added by the cabling to the rear panel connectors.

e. Connect the L-C Meter between the center (- input) and right (ground) terminals.

f. Adjust C22/C222, -Input Capacity, for a reading of 45 pf on the L-C Meter.

g. Disconnect the L-C Meter.

h. Connect the signal lead of the Square Wave Generator 600 Ω output to the left terminal (+ input) of the amplifier input. Connect a short wire from

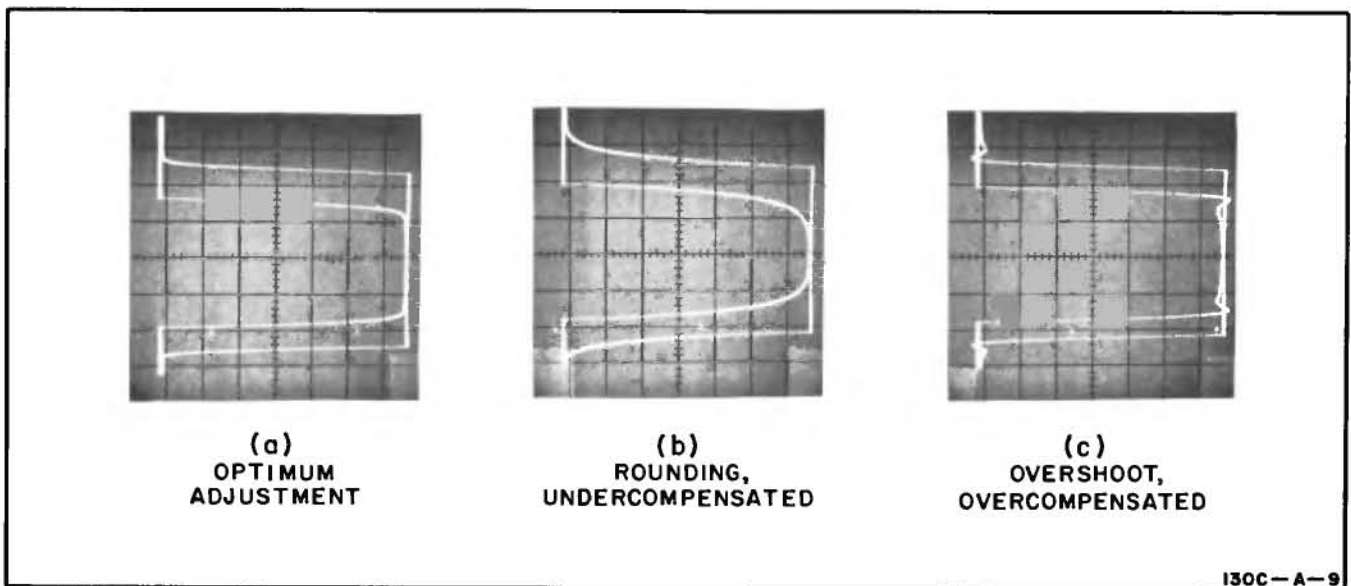


Figure 5-3. Horizontal Neutralization Adjustment Waveforms

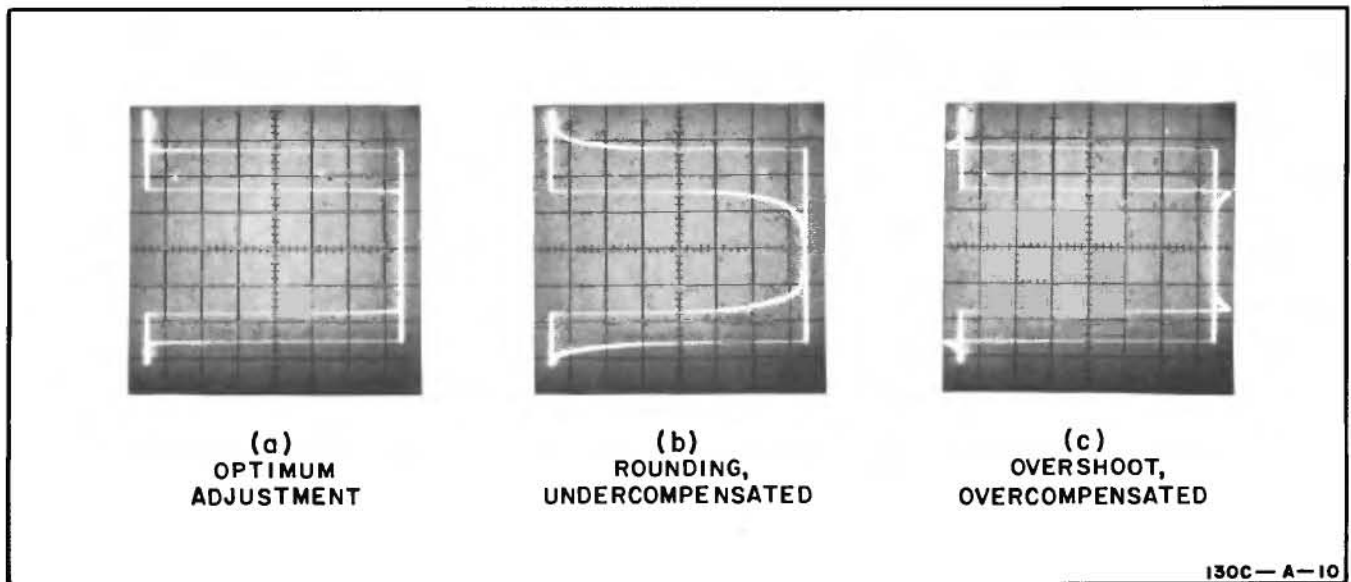


Figure 5-4. Horizontal Attenuator Compensation Waveforms

the right terminal to the ground side of the signal source. Also be sure the ground side of the signal input connector goes to the center terminal.

i. For vertical capacitance and compensation adjustment, proceed to step j (1). For horizontal adjustment only, connect the Oscillator output to the Model 130C vertical input terminals and to the external sync input of the Square Wave Generator; proceed to step j (2).

j. Make settings as follows:

- (1) For vertical adjustment only,
SWEEP TIME 20 μSECONDS/CM
Horizontal SENSITIVITY · INTERNAL SWEEP X1
Vertical SENSITIVITY · 2 VOLTS/CM

- (2) For horizontal adjustment only,
Vertical SENSITIVITY · 5 VOLTS/CM
Horizontal SENSITIVITY · 2 VOLTS/CM

k. Set Square Wave Generator frequency to 10 kc. For horizontal adjustment, also set Oscillator frequency to 5 kc.

m. Obtain CRT display as follows:

- (1) For vertical adjustment, set Square Wave Generator output for about 8 cm deflection.
- (2) For horizontal adjustment, set both signal source amplitudes for about 8 cm deflection, horizontally and vertically. Adjust Oscillator frequency until two distinct square waves are displayed (see Figure 5-4).

n. Adjust C17/C217, 2V Atten. Comp, for best square wave. Figure 5-4 illustrates the waveforms for the horizontal compensation adjustment.

p. Set SENSITIVITY to 5 VOLTS/CM. Adjust Square Wave Generator amplitude for about 8 cm deflection.

q. Adjust C11/C215, 20V Atten. Comp, for best square wave. Note that this adjustment is for the 5, 10, and 20 volt ranges.

r. Change Square Wave Generator signal lead to the center terminal of the input. Connect a short lead between the left and right terminals (lead still connected from Oscilloscope ground terminal to ground side of signal source).

s. Adjust C12/C216, 20V Atten. Comp, for best square wave. Note that this adjustment is for 5, 10, and 20 volt ranges.

t. Change SENSITIVITY to 2 VOLTS/CM. Adjust Square Wave Generator output for about 8 cm deflection.

u. Adjust C18/C218, 2V Atten. Comp, for best square wave.

v. Use appropriate procedure following:

- (1) If using an L-C Meter for capacity adjustments, disconnect the Square Wave Generator and jumper wires. Refer to Table 5-9 and make L-C Meter connections, SENSITIVITY settings, and adjustments as specified.
- (2) If using the alternate method of Paragraph 5-80, retain the same instrument setup of step u in Paragraph 5-79. Change the Square Wave Generator frequency to 1 kc. For the vertical adjustment, change SWEEP TIME to 0.2 MILLISECONDS/CM, or for the horizontal adjustment, change Oscillator frequency to 500 cps. Refer to Table 5-9 and connect the square wave through the Alignment Attenuator to the specified terminals (unused red input terminal should always be connected to Oscilloscope ground). At each SENSITIVITY setting adjust signal amplitude for about 8 cm deflection and make the adjustment shown in the table.

Table 5-9. Input Capacity Adjustment

| Amplifier Input Connections | SENSITIVITY Setting | Adjust for 45 pf or best Square Wave |
|-----------------------------|---------------------|--------------------------------------|
| left and right terminals | 2 VOLTS/CM | C19/C213 |
| left and right terminals | 5 VOLTS/CM | C13/C211 |
| center and right terminals | 5 VOLTS/CM | C14/C212 |
| center and right terminals | 2 VOLTS/CM | C20/C214 |

5-80. ALTERNATE METHOD USING ALIGNMENT ATTENUATOR.

Note

If the Alignment Attenuator has been previously adjusted to match a 45 pf input capacity, steps b and h may be omitted.

a. Disconnect ground link from amplifier input center terminal.

b. Set SENSITIVITY to 0.2 VOLTS/CM and measure input capacity (between left and right terminals) with an L-C Meter or capacitance bridge. Adjust C21/C221 for a reading of 45 pf.

c. Connect the 600Ω output of the Square Wave Generator through the Alignment Attenuator to the left (+ input) and right (ground) terminals of the input. Ground center terminal.

d. For vertical circuit adjustment, proceed to step e (1). For horizontal circuit only connect the Oscillator output to the Model 130C vertical input terminals and to the external sync input of the Square Wave Generator; proceed to step e (2).

e. Make Model 130C setting as follows:

(1) For vertical adjustment only,
 SWEEP TIME 0.2 MILLISECONDS/CM
 Horiz. SENSITIVITY INTERNAL SWEEP X1
 Vertical SENSITIVITY 0.2 VOLTS/CM

(2) For horizontal adjustment only,
 Vertical SENSITIVITY 5 VOLTS/CM
 Horizontal SENSITIVITY 0.2 VOLTS/CM

f. Set Square Wave Generator frequency to 1 kc. For horizontal adjustment, also set Oscillator frequency to 500 cps.

g. Obtain CRT display as follows:

(1) For vertical adjustment, set Square Wave Generator output for about 8 cm deflection.

(2) For horizontal adjustment, set both signal source amplitudes for about 8 cm deflection, horizontally and vertically. Adjust Oscillator frequency until two distinct square waves are displayed.

h. Set adjustment on Alignment Attenuator for best square wave response; it is now adjusted for 45 pf inputs.

i. Adjust C21/C221, + Input Capacity, for best square wave.

j. Change square wave signal lead through Alignment Attenuator to the input center terminal. Ground left terminal.

k. Adjust C22/C222, - Input Capacity, for best square wave.

m. Disconnect Alignment Attenuator and Oscillator. Proceed to Paragraph 5-79, step h, and complete the adjustment procedure there. In step v (2), use Alignment Attenuator as explained.

5-81. GROUP III ADJUSTMENTS.

5-82. The procedures of Paragraph 5-83 through 5-86 allow proper adjustment of the Calibrator circuit

and of the sweep circuit. For the Calibrator adjustment, the vertical amplifier gain must first be set accurately. For sweep generator adjustments, the horizontal amplifier must first be accurately calibrated.

5-83. CALIBRATOR.

- a. Check adjustment of the vertical amplifier gain as set in Paragraph 5-75.
- b. Set Model 130C as follows:
Vertical SENSITIVITY 50 MV/CM
Vertical INPUT DC
Horiz. SENSITIVITY INTERNAL SWEEP X1
SWEEP TIME 1 MILLISECONDS/CM
- c. Connect a short lead from 500 MV CALIBRATOR output to the vertical amplifier input terminal.
- d. Adjust R402, Calib, for exactly 10 cm deflection.

5-84. SWEEP STABILITY.

- a. Set Model 130C as follows:
LEVEL just out of AUTO
SWEEP TIME 0.2 MILLISECONDS/CM
Horiz. SENSITIVITY INTERNAL SWEEP X1
Vertical SENSITIVITY 20 VOLTS/CM
- b. Set DC Voltmeter range to -100V and check voltage at pin 2 of tube V103.
- c. Rotate R151, Stability, counter clockwise until the trace just disappears. (If no trace was present initially, first rotate R151 clockwise until trace appears, then back ccw until it just disappears).
- d. Note DC voltage reading (typically about -55 volts).
- e. Set R151 slightly ccw for a voltage reading of 2 volts less negative than noted in step d.

5-85. SWEEP LENGTH.

- a. Connect the Oscillator to the vertical input terminals.
- b. Set Model 130C as follows:
LEVEL mid-range
SWEEP TIME 0.1 MILLISECONDS/CM
Horiz. SENSITIVITY INTERNAL SWEEP X1
Vertical SENSITIVITY 1 VOLTS/CM
- c. Set Oscillator frequency to 500 kc and adjust amplitude for a 6 cm display on CRT.
- d. Observe end of sweep and adjust LEVEL control for shortest sweep.
- e. Adjust R146, Sweep Length, for a sweep length of 10.75 cm.

5-86. SWEEP TIME CALIBRATION.

- a. Check adjustment of horizontal amplifier gain as set in Paragraph 5-75.
- b. Set Model 130C as follows:
LEVEL mid-range
Horizontal SENSITIVITY INTERNAL SWEEP X1
Vertical SENSITIVITY 1 VOLTS/CM
- c. Connect Time Mark Generator to the Model 130C vertical input.
- d. Refer to Table 5-10 and at the setting shown, adjust component for one time mark per centimeter.

Table 5-10. Sweep Time Calibration

| SWEEP TIME setting | Time Mark Generator | Adjustment |
|--------------------|---------------------|------------|
| 1 μSECONDS/CM | 1 μsec | C181 |
| 10 μSECONDS/CM | 10 μsec | C180 |
| 1 MILLISECONDS/CM | 100 μsec | R178 |
| 1 MILLISECONDS/CM | 1 msec | R177 |
| 10 MILLISECONDS/CM | 10 msec | R178 |
| 1 SECONDS/CM | 100 msec | R175 |

5-87. COMPONENT LOCATION.

5-88. Figures 5-1 and 5-2 indicate the location of most tubes, assemblies, and adjustments. Components on etched circuit boards are identified by silk screened reference designators. To supplement this, figures are included near the corresponding circuit schematic diagram to help locate components where silk screening is difficult to see. Switch components are identified in pictures, also located near the corresponding schematic diagram. Refer to the List of Illustrations at the front of this manual for page references to these component location figures.

Note

Component location is identical for assemblies with different hp part numbers as listed below by reference designator.

- A1 130C-65A and 130C-85G
- A2 130C-19A and 130C-19E
- A5 130C-66F and 130C-66M
- A101 130C-65C and 130C-65J
- A102 130C-19D and 130C-19H
- A175 130C-19C and 130C-19G
- A201 130C-65B and 130C-65H
- A202 130C-19B and 130C-19F
- A205 130C-65F and 130C-65M
- A301 130C-65E and 130C-65L
- A401 130C-65D and 130C-65K

SCHEMATIC DIAGRAM NOTES

1. Unless otherwise indicated: resistance is in ohms, inductance is in microhenries, and capacitance is in picofarads.
2. Titles enclosed in boxes indicate front-panel engraving.
3. Solid weighted lines indicate signal paths. Broken weighted lines indicate feedback paths.
4. Conditions for DC Voltage Measurements (Typical values shown on schematics may vary ±10%).
a. Vertical Amplifier and Horizontal Amplifier
(1) Follow steps 1 through 10 of Figure 3-3.
b. Sweep Generator
(1) TRIGGER SOURCE-SLOPE INT+
(2) HORIZONTAL SENSITIVITY X1
(3) Monitor DC voltage at pin 2 of V101 (WHT-GRN-VIO wire) and adjust LEVEL control for 0 volts reading.
5. Sweep Generator Waveforms - see Figure 5-8 and schematic, Figure 5-11.
6. * = Factory selected part, may have been omitted; average value shown.
⚡ instrument chassis ground.

Schematic Diagram Notes Fold-out



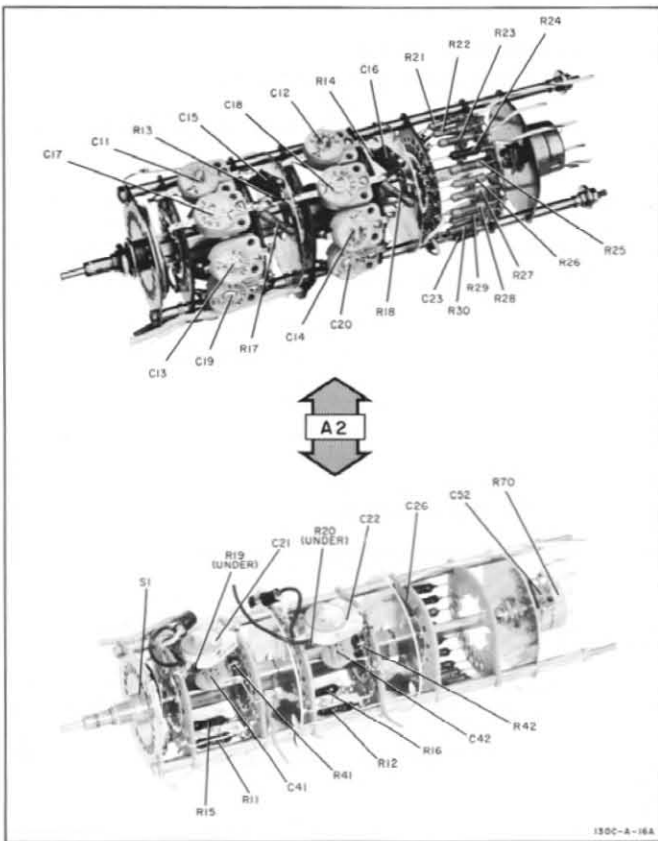


Figure 5-5. Vertical Attenuator, A2, Component Location
 5-16

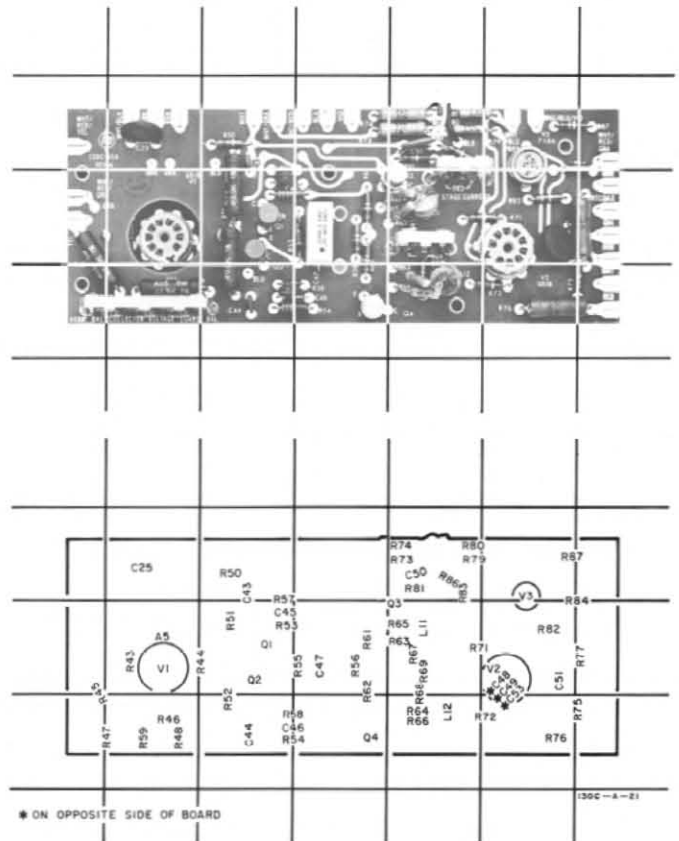


Figure 5-6. Vertical Amplifier, A1, Component Location

Model 130C

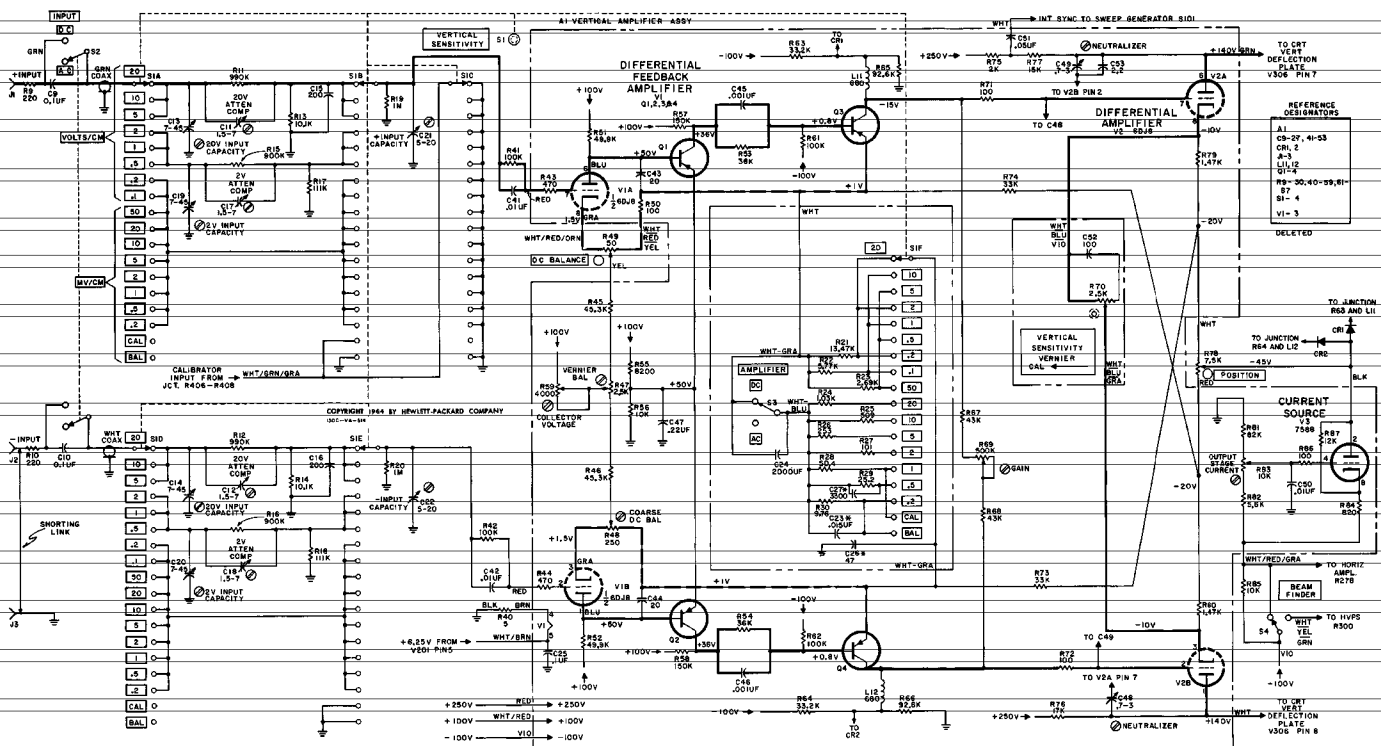


Figure 5-7. Vertical Attenuator and Amplifier Schematic

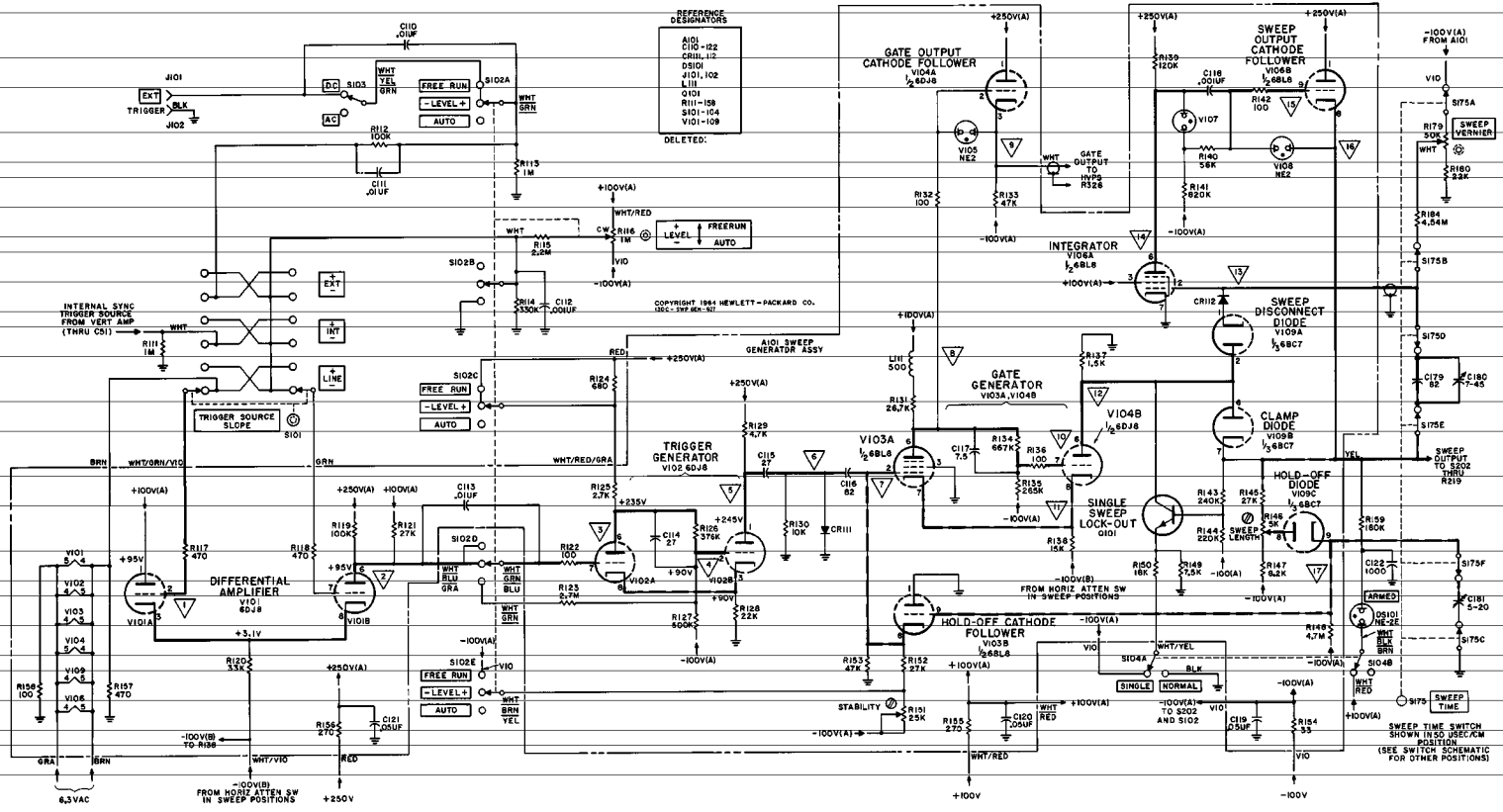


Figure 5-11. Sweep Generator Schematic

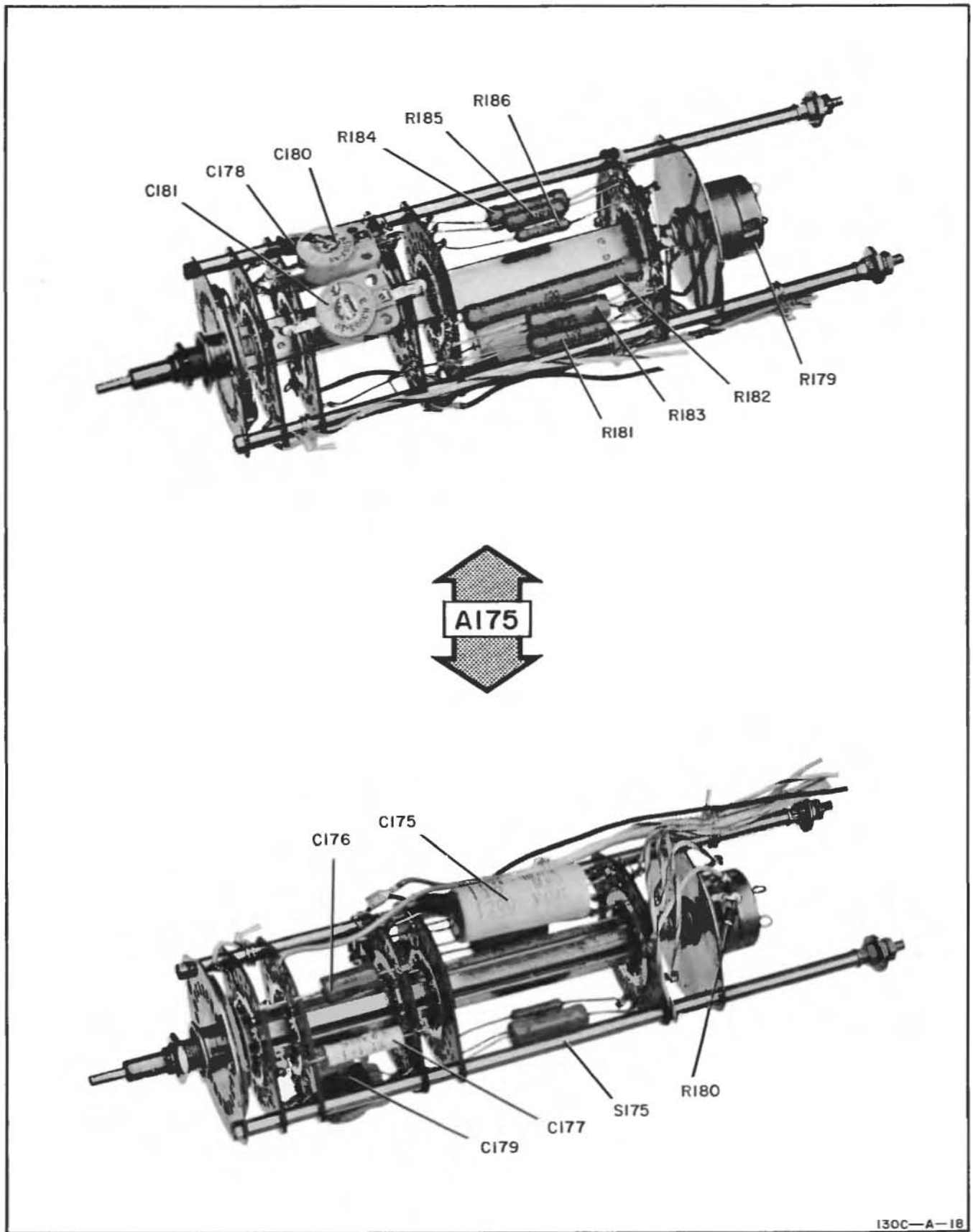


Figure 5-12. Sweep Time Switch, A175, Component Location

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150C-1 WP 54-1311

REFERENCE DESIGNATORS
C175-181
R175-186
S175

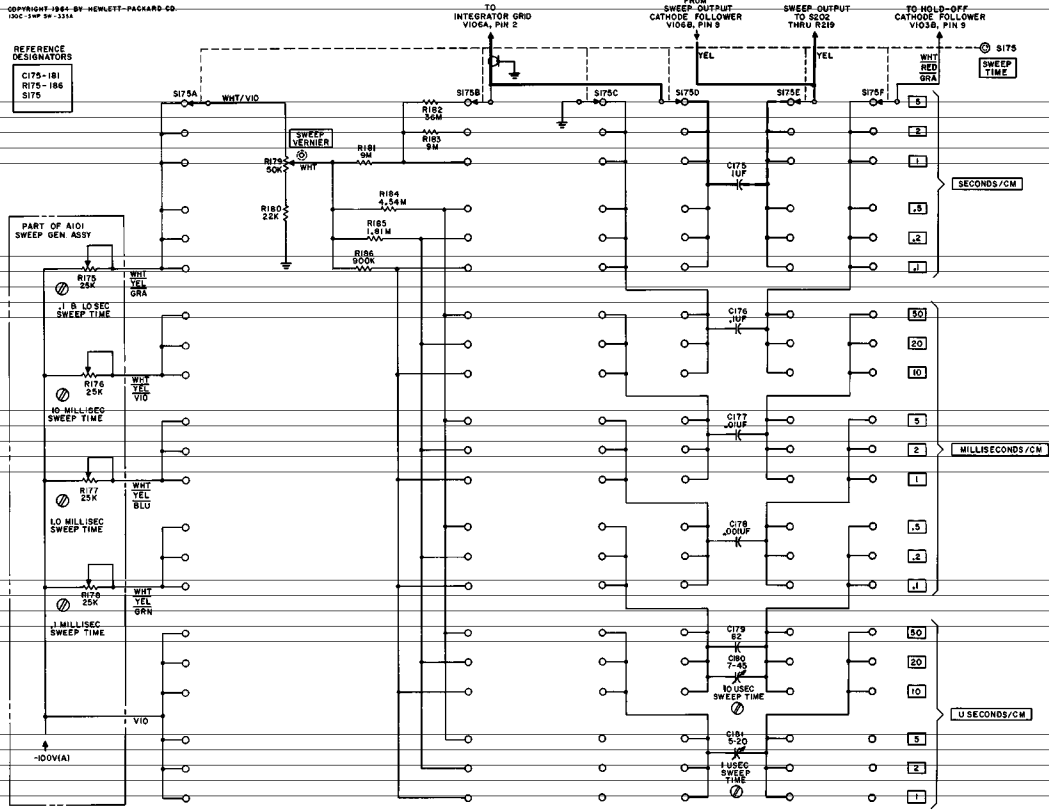


Figure 5-13. Sweep Time Schematic

Model 1500

Section 1
Figure 5-16

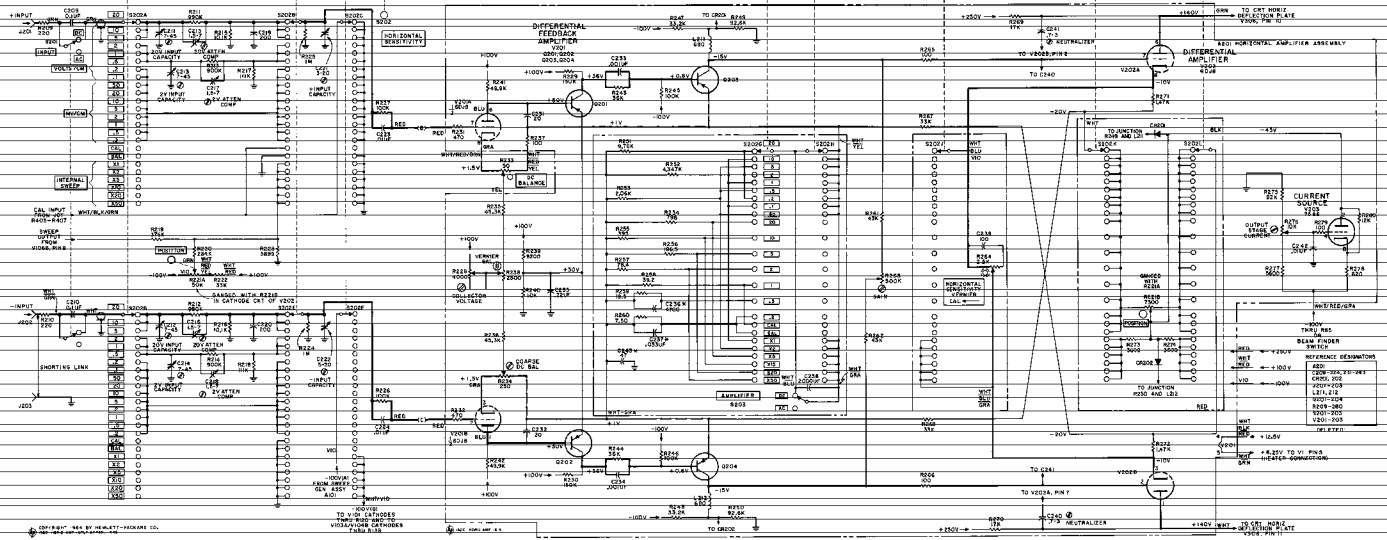


Figure 5-16. Horizontal Attenuator and Amplifier Schematic

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5-23

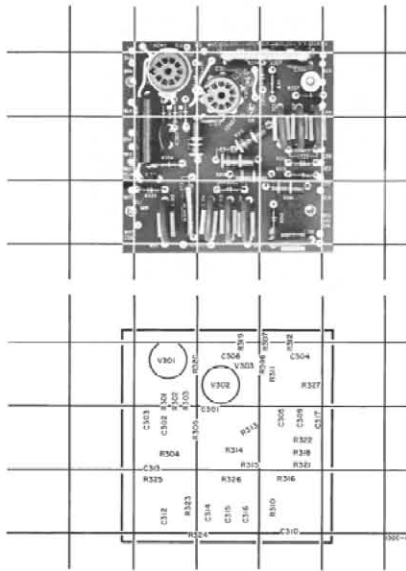
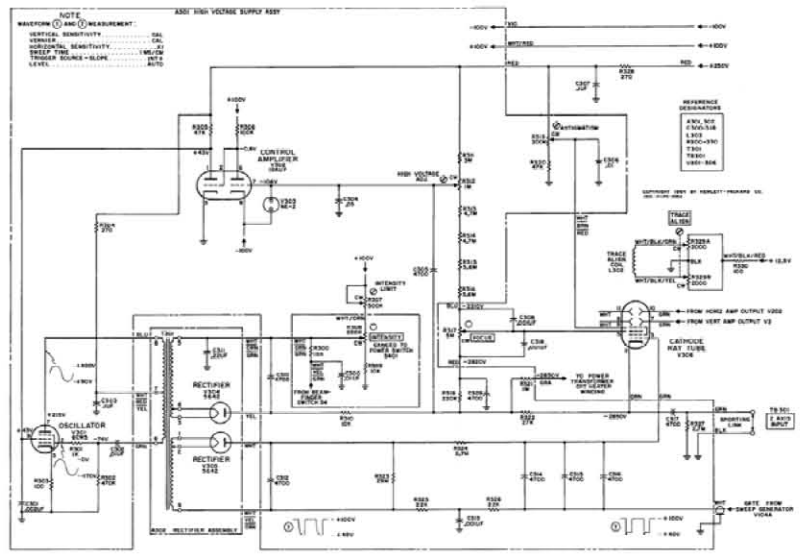
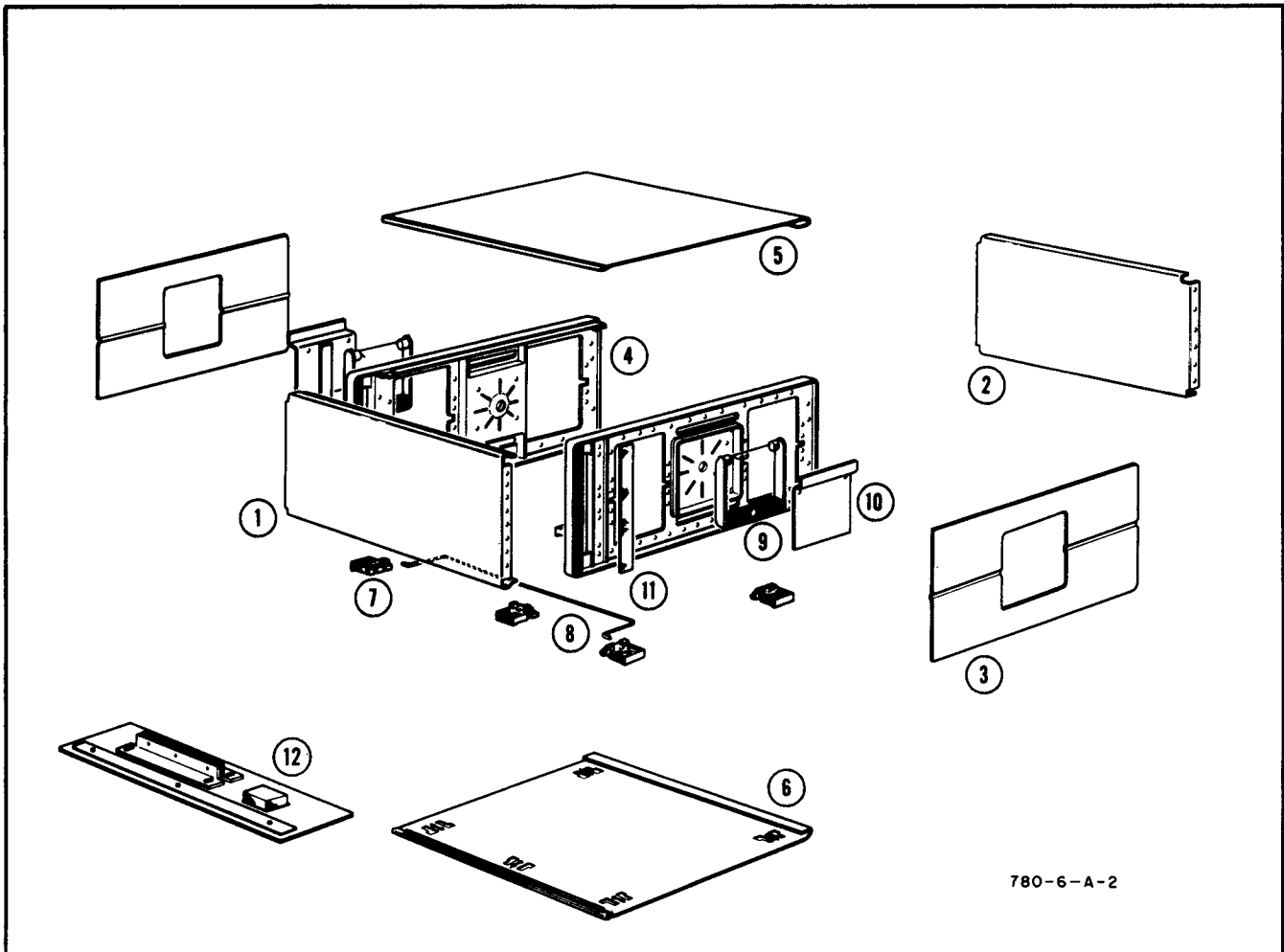


Figure 5-17. High Voltage Power Supply, A301, Component Location



01879-2

Figure 5-18. High Voltage Power Supply Schematic



780-6-A-2

| Index No. | hp Part No. | Description | TQ |
|-----------|-------------|---------------------------|----|
| 1 | 130C-2A | Panel: front | 1 |
| 2 | 130C-2B | Panel: rear | 1 |
| 3 | 5000-0743 | Cover: side | 2 |
| 4 | 5060-0734 | Casting: frame side | 2 |
| 5 | 130C-44A-1 | Cover: top | 1 |
| 6 | 5060-0761 | Cover: bottom | 1 |
| 7 | 5060-0767 | Foot: plastic | 5 |
| 8 | 1490-0030 | Stand: tilt | 1 |
| 9 | 5060-0763 | Handle: side | 2 |
| 10 | 5060-0765 | Retainer: handle | 2 |
| 11 | 5000-0052 | Plate: trim adhesive back | 2 |
| 12 | 5060-0776 | Kit: rack mount | 1 |

Figure 6-1. Modular Cabinet Replaceable Parts

SECTION VI REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replaceable parts for the Model 130C. Table 6-1 lists reference designators and abbreviations that are used in the Table 6-2 component descriptions. Table 6-2 lists the parts in alpha-numerical order of their reference designations and provides the following information for each item:

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

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

6-4. ORDERING INFORMATION.

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

- a. The hp part number of item(s).
 - b. Model number and eight-digit serial number of the instrument.
- 6-6. To order a part not listed in Table 6-2, provide the following information:
- a. Model number and eight-digit serial number of the instrument.
 - b. Description of part including function and location.

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

Table 6-1. List of Reference Designators and Abbreviations

| REFERENCE DESIGNATORS | | | |
|---|---|--|---|
| <p>A = assembly B = motor C = capacitor CP = coupling CR = diode DL = delay line DS = device signaling (lamp)</p> | <p>E = misc electronic part F = fuse FL = filter J = jack K = relay L = inductor M = meter</p> | <p>MP = mechanical part P = plug Q = transistor R = resistor RT = thermistor S = switch T = transformer</p> | <p>TB = terminal board TP = test point V = vacuum tube, neon bulb, photocell, etc W = cable X = socket Y = crystal</p> |
| ABBREVIATIONS | | | |
| <p>A = amperes A.F.C = automatic frequency control AMPL = amplifier</p> <p>B. F. O. = beat frequency oscillator BE CU = beryllium copper BH = binder head BP = bandpass BRS = brass BWO = backward wave oscillator</p> <p>CCW = counter-clockwise CER = ceramic CMO = cabinet mount only COEF = coefficient COM = common COMP = composition CONN = connector CP = cadmium plate CRT = cathode-ray tube CW = clockwise</p> <p>DEPC = deposited carbon DR = drive</p> <p>ELECT = electrolytic ENCAP = encapsulated EXT = external</p> <p>F = farads FH = flat head FIL H = fillister head FXD = fixed</p> | <p>GE = germanium GL = glass GRD = ground(ed)</p> <p>H = henries HEX = hexagonal HG = mercury HR = hour(s)</p> <p>IF = intermediate freq IMPG = impregnated INCD = incandescent INCL = include(s) INS = insulation(ed) INT = internal</p> <p>K = kilo = 1000</p> <p>LIN = linear taper LK WASH = lock washer LOG = logarithmic taper LPF = low pass filter</p> <p>M = milli = 10⁻³ MEG = meg = 10⁶ METFLM = metal film MFR = manufacturer MINAT = miniature MOM = momentary MTG = mounting MY = "mylar"</p> <p>N = nano (10⁻⁹)</p> | <p>N/C = normally closed NE = neon NI PL = nickel plate N/O = normally open NPO = negative positive zero (zero temperature coefficient) NRFR = not recommended for field replacement NSR = not separately replaceable</p> <p>OBD = order by description OH = oval head OX = oxide</p> <p>P = peak PC = printed circuit PF = picofarads = 10⁻¹² farads PH BRZ = phosphor bronze PHL = Phillips PIV = peak inverse voltage P/O = part of POLY = polystyrene PORC = porcelain POS = position(s) POT = potentiometer PP = peak-to-peak PT = point RECT = rectifier RF = radio frequency RH = round head</p> | <p>RMO = rack mount only RMS = root-mean-square</p> <p>S-B = slow-blow SCR = screw SE = selenium SECT = section(s) SEMICON = semiconductor SI = silicon SIL = silver SL = slide SPL = special SST = stainless steel SR = split ring STL = steel</p> <p>TA = tantalum TD = time delay TGL = toggle TI = titanium TOL = tolerance TRIM = trimmer TWT = traveling wave tube</p> <p>U = micro = 10⁻⁶</p> <p>VAR = variable VDCW = dc working volts</p> <p>W/ = with W = watts WW = wirewound W/O = without</p> |

Table 6-2. Replaceable Parts

| Ref Desig | hp Part No. | RS | TQ | Description (See Table 6-1.) | Mfr | Mfr Part No. |
|-----------|-------------|----|----|--|-------|--------------|
| A1 | 130C-65G | | 1 | A: vertical amplifier circuit board (includes A5) | hp | |
| A2 | 130C-19E | | 1 | A: vertical attenuator switch | hp | |
| A3 | 3101-0040 | | 3 | A: s slide dual ϕ dt | 42190 | 6603JM SPEC |
| A4 | 2100-0432 | | 2 | A: r fxd comp 2500-4000-250 ohms 30% 1/4w | hp | |
| A5 | 130C-65M | | 2 | A: amplifier input circuit board (includes R43, R44, XV1) | hp | |
| A6 | 0121-0111 | | 2 | A: c var 0.7-3.0 pf dual | hp | |
| A7 - | | | | Not assigned | | |
| A100 | | | | Not assigned | | |
| A101 | 130C-65J | | 1 | A: sweep generator circuit board | hp | |
| A102 | 130C-19H | | 1 | A: trigger source switch | hp | |
| A103 | 3101-0040 | | | A: s slide dual ϕ dt | 42190 | 6603JM SPEC |
| A104 | 2100-0347 | | 1 | A: r var comp 4 x 25k ohms 30% 1/4w | hp | |
| A105 - | | | | Not assigned | | |
| A174 | | | | Not assigned | | |
| A175 | 130C-19G | | 1 | A: sweep time switch | hp | |
| A176 - | | | | Not assigned | | |
| A200 | | | | Not assigned | | |
| A201 | 130C-65H | | 1 | A: horizontal amplifier circuit board (includes A205) | hp | |
| A202 | 130C-19F | | 1 | A: horizontal attenuator switch | hp | |
| A203 | 3101-0040 | | | A: s slide dual ϕ dt | 42190 | 6603JM SPEC |
| A204 | 2100-0432 | | | A: r fxd comp 2500-4000-250 ohms 30% 1/4w | hp | |
| A205 | 130C-65M | | | A: amplifier input circuit board (includes R231, R232, XV201) | hp | |
| A206 | 0121-0111 | | | A: c var 0.7-3.0 pf dual | hp | |
| A207 - | | | | Not assigned | | |
| A300 | | | | Not assigned | | |
| A301 | 130C-65L | | 1 | A: hvps circuit board | hp | |
| A302 | 130C-11A | | 1 | A: rectifier (includes C311, T301, V304, V305) | hp | |
| A303 | 2100-0378 | | 1 | A: r var comp 1M-500k-200k ohms 30% 1/4w | hp | |
| A304 - | | | | Not assigned | | |
| A400 | | | | Not assigned | | |
| A401 | 130C-65K | | 1 | A: lvps circuit board | hp | |
| A402 | 2100-0377 | | 1 | A: r var comp 500k-5k-3k ohms 30% 1/4w | hp | |
| C9 | 0160-0917 | | 2 | C: fxd my 0.1 μ f 20% 600 vdcw matched pair NSR: p/o C9 | hp | |
| C10 | | | | | | |
| C11 | 0130-0003 | | 8 | C: var cer 1.5-7 pf 500vdcw | hp | |
| C12 | 0130-0003 | | | C: var cer 1.5-7 pf 500vdcw | hp | |
| C13 | 0130-0001 | | 9 | C: var cer 7-45 pf 500vdcw | hp | |
| C14 | 0130-0001 | | | C: var cer 7-45 pf 500vdcw | hp | |
| C15 | 0140-0090 | | 4 | C: fxd mica 200 pf 5% 500vdcw | 00853 | RCM15E201J |
| C16 | 0140-0090 | | | C: fxd mica 200 pf 5% 500vdcw | 00853 | RCM15E201J |
| C17 | 0130-0003 | | | C: var cer 1.5-7 pf 500vdcw | hp | |
| C18 | 0130-0003 | | | C: var cer 1.5-7 pf 500vdcw | hp | |
| C19 | 0130-0001 | | | C: var cer 7-45 pf 500vdcw | hp | |
| C20 | 0130-0001 | | | C: var cer 7-45 pf 500vdcw | hp | |
| C21 | 0130-0006 | | 5 | C: var cer 5-20 pf 500vdcw | hp | |
| C22 | 0130-0006 | | | C: var cer 5-20 pf 500vdcw | hp | |
| C23 | 0160-0194 | | 1 | C: fxd my 0.015 μ f 10% 200vdcw | hp | |
| C24 | 0180-0314 | | 2 | C: fxd elect 2000 μ f 10vdcw | 56289 | D39330 6447 |
| C25 | 0150-0084 | | 4 | C: fxd cer 0.1 μ f -20% +80% 50vdcw | 56289 | 33C41 |

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

| Ref Desig | hp Part No. | RS | TQ | Description (See Table 6-1.) | Mfr | Mfr Part No. |
|----------------|-------------|----|----|--|-------|-------------------|
| C26 | 0140-0039 | | 2 | C: fxd mica 47 pf 5% 500vdcw | hp | |
| C27 | 0160-0155 | | 1 | C: fxd my 3300 pf 10% 200vdcw | hp | |
| C28- C40 | | | | Not assigned | | |
| C41 | 0150-0012 | | 16 | C: fxd cer 0.01 μ f 20% 1000vdcw | 56289 | 29C214A3 |
| C42 | 0150-0012 | | | C: fxd cer 0.01 μ f 20% 1000vdcw | 56289 | 29C214A3 |
| C43 | 0150-0035 | | 4 | C: fxd cer 20 pf 10% 600vdcw | 71590 | DD200 |
| C44 | 0150-0035 | | | C: fxd cer 20 pf 10% 600vdcw | 71590 | DD200 |
| C45 | 0150-0069 | | 6 | C: fxd cer 1000 pf -20% +100% 500vdcw | 72982 | 801010X5G0102Z |
| C46 | 0150-0069 | | | C: fxd cer 1000 pf -20% +100% 500vdcw | 72982 | 801010X5G0102Z |
| C47 | 0160-2056 | | 2 | C: fxd my 0.22 μ f 20% 200vdcw | 56289 | 224P22402 |
| C48 | | | | NSR: p/o A6 | | |
| C49 | | | | NSR: p/o A6 | | |
| C50 | 0150-0012 | | | C: fxd cer 0.01 μ f 20% 1000vdcw | 56289 | 29C214A3 |
| C51 | 0150-0052 | | 7 | C: fxd cer 0.05 μ f 20% 400vdcw | 56289 | 33C17A |
| C52 | 0140-0041 | | 2 | C: fxd mica 100 pf 5% 500vdcw | 00853 | RCM15E101J |
| C53 | 0150-0058 | | 1 | C: fxd cer 2.2 pf \pm 0.25 pf 600vdcw | 72982 | 301 000 COJO 229C |
| C54 - C109 | | | | Not assigned | | |
| C110 | 0150-0012 | | | C: fxd cer 0.01 μ f 20% 1000vdcw | 56289 | 29C214A3 |
| C111 | 0150-0012 | | | C: fxd cer 0.01 μ f 20% 1000vdcw | 56289 | 29C214A3 |
| C112 | 0150-0050 | | 4 | C: fxd cer 1000 pf 600vdcw | 84411 | Type E |
| C113 | 0150-0012 | | | C: fxd cer 0.01 μ f 20% 1000vdcw | 56289 | 29C214A3 |
| C114 | 0150-0115 | | 1 | C: fxd cer 27 pf 10% 500vdcw | 71590 | CC20 TCN 27 |
| C115 | 0140-0005 | | 1 | C: fxd mica 27 pf 10% 500vdcw | 00853 | RCM15E270K |
| C116 | 0140-0146 | | 1 | C: fxd mica 82 pf 5% 300vdcw | 04062 | RDM15F820J |
| C117 | 0150-0074 | | 1 | C: fxd cer 7 pf \pm 0.5 pf 500vdcw | 72982 | 301 000 COHO 709D |
| C118 | 0150-0050 | | | C: fxd cer 1000 pf 600 vdcw | 84411 | Type E |
| C119 | 0150-0052 | | | C: fxd cer 0.05 μ f 20% 400vdcw | 56289 | 33C17A |
| C120 | 0150-0052 | | | C: fxd cer 0.05 μ f 20% 400vdcw | 56289 | 33C17A |
| C121 | 0150-0052 | | | C: fxd cer 0.05 μ f 20% 400vdcw | 56289 | 33C17A |
| C122 | 0150-0069 | | | C: fxd cer 1000 pf -20% +100% 500vdcw | 72982 | 801010X5G0102Z |
| C123- C174 | | | | Not assigned | | |
| C175 | 0170-0018 | | 1 | C: fxd my 1 μ f 5% 200vdcw | 84411 | Type 621M 10552 |
| C176 | 0170-0019 | | 1 | C: fxd my 0.1 μ f 5% 200vdcw | hp | |
| C177 | 0160-0314 | | 1 | C: fxd my 0.01 μ f 5% 400vdcw | 01281 | Type 663UW |
| C178 | 0140-0018 | | 1 | C: fxd mica 1000 pf 5% 500vdcw | 00853 | RCM20E102J |
| C179 | 0140-0006 | | 1 | C: fxd mica 82 pf 10% 500vdcw | hp | |
| C180 | 0130-0001 | | | C: var cer 7-45 pf 500vdcw | hp | |
| C181 | 0130-0006 | | | C: var cer 5-20 pf 500vdcw | hp | |
| C182 - C208 | | | | Not assigned | | |
| C209 | 0160-0917 | | | C: fxd my 0.1 μ f 20% 600vdcw matched pair | hp | |
| C210 | | | | NSR: p/o C209 | | |
| C211 | 0130-0001 | | | C: var cer 7-45 pf 500vdcw | hp | |
| C212 | 0130-0001 | | | C: var cer 7-45 pf 500vdcw | hp | |
| C213 | 0130-0001 | | | C: var cer 7-45 pf 500vdcw | hp | |
| C214 | 0130-0001 | | | C: var cer 7-45 pf 500vdcw | hp | |
| C215 | 0130-0003 | | | C: var cer 1.5-7 pf 500vdcw | hp | |
| C216 | 0130-0003 | | | C: var cer 1.5-7 pf 500vdcw | hp | |

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

| Ref Desig | hp Part No. | RS | TQ | Description (See Table 6-1.) | Mfr | Mfr Part No. |
|----------------|-------------|----|----|--|-------|----------------|
| C217 | 0130-0003 | | | C: var cer 1.5-7 pf 500vdcw | hp | |
| C218 | 0130-0003 | | | C: var cer 1.5-7 pf 500vdcw | hp | |
| C219 | 0140-0090 | | | C: fxd mica 200 pf 5% 500vdcw | 00853 | RCM15E201J |
| C220 | 0140-0090 | | | C: fxd mica 200 pf 5% 500vdcw | 00853 | RCM15E201J |
| C221 | 0130-0006 | | | C: var cer 5-20 pf 500vdcw | hp | |
| C222 | 0130-0006 | | | C: var cer 5-20 pf 500vdcw | hp | |
| C223 | 0150-0012 | | | C: fxd cer 0.01 μ f 20% 1000vdcw | 56289 | 29C214A3 |
| C224 | 0150-0012 | | | C: fxd cer 0.01 μ f 20% 1000vdcw | 56289 | 29C214A3 |
| C225 - C230 | | | | Not assigned | | |
| C231 | 0150-0035 | | | C: fxd cer 20 pf 10% 600vdcw | 71590 | DD200 |
| C232 | 0150-0035 | | | C: fxd cer 20 pf 10% 600vdcw | 71590 | DD200 |
| C233 | 0150-0069 | | | C: fxd cer 1000 pf -20% +100% 500vdcw | 72982 | 801010X5G0102Z |
| C234 | 0150-0069 | | | C: fxd cer 1000 pf -20% +100% 500vdcw | 72982 | 801010X5G0102Z |
| C235 | 0160-2056 | | | C: fxd my 0.22 μ f 20% 200vdcw | 56289 | 224P22402 |
| C236 | 0160-0157 | | 1 | C: fxd my 4700 pf 10% 200vdcw | hp | |
| C237 | 0160-0163 | | 1 | C: fxd my 0.033 μ f 10% 200vdcw | hp | |
| C238 | 0180-0314 | | | C: fxd elect 2000 μ f 10vdcw | 56289 | D39330 6447 |
| C239 | 0140-0041 | | | C: fxd mica 100 pf 5% 500vdcw | 00853 | RCM15E101J |
| C240 | | | | NSR: p/o A206 | | |
| C241 | | | | NSR: p/o A206 | | |
| C242 | 0150-0012 | | | C: fxd cer 0.01 μ f 20% 1000vdcw | 56289 | 29C214A3 |
| C243 | 0140-0039 | | | C: fxd mica 47 pf 5% 500vdcw | hp | |
| C244 - C299 | | | | Not assigned | | |
| C300 | 0150-0012 | | | C: fxd cer 0.01 μ f 20% 1000vdcw | 56289 | 29C214A3 |
| C301 | 0150-0023 | | 1 | C: fxd cer 200 pf 20% 1000vdcw | 84411 | Type 126 |
| C302 | 0150-0012 | | | C: fxd cer 0.01 μ f 20% 1000vdcw | 56289 | 29C214A3 |
| C303 | 0160-0013 | | 2 | C: fxd my 0.1 μ f 10% 400vdcw | 56289 | 160P10494 |
| C304 | 0150-0052 | | | C: fxd cer 0.05 μ f 20% 400vdcw | 56289 | 33C17A |
| C305 | 0160-0151 | | 8 | C: fxd cer 4700 pf -20% +80% 4000vdcw | 71590 | DA172-097CB |
| C306 | 0150-0012 | | | C: fxd cer 0.01 μ f 20% 1000vdcw | 56289 | 29C214A3 |
| C307 | 0160-0013 | | | C: fxd my 0.1 μ f 10% 400vdcw | 56289 | 160P10494 |
| C308 | 0150-0050 | | | C: fxd cer 100 pf 600vdcw | 84411 | Type E |
| C309 | 0160-0151 | | | C: fxd cer 4700 pf -20% +80% 4000vdcw | 71590 | DA172-097CB |
| C310 | 0160-0151 | | | C: fxd cer 4700 pf -20% +80% 4000vdcw | 71590 | DA172-097CB |
| C311 | 0160-0018 | | 1 | C: fxd my 0.22 μ f 10% 400vdcw | 56289 | 160P22494 |
| C312 | 0160-0151 | | | C: fxd cer 4700 pf -20% +80% 4000vdcw | 71590 | DA172-097CB |
| C313 | 0150-0069 | | | C: fxd cer 1000 pf -20% +100% 500vdcw | 72982 | 801010X5G0102Z |
| C314 | 0160-0151 | | | C: fxd cer 4700 pf -20% +80% 4000vdcw | 71590 | DA172-097CB |
| C315 | 0160-0151 | | | C: fxd cer 4700 pf -20% +80% 4000vdcw | 71590 | DA172-097CB |
| C316 | 0160-0151 | | | C: fxd cer 4700 pf -20% +80% 4000vdcw | 71590 | DA172-097CB |
| C317 | 0160-0151 | | | C: fxd cer 4700 pf -20% +80% 4000vdcw | 71590 | DA172-097CB |
| C318 | 0150-0050 | | | C: fxd cer 100 pf 600vdcw | 84411 | Type E |
| C319 - C400 | | | | Not assigned | | |
| C401 | 0160-0007 | | 1 | C: fxd my 2200 pf 10% 600vdcw | hp | |
| C402 - C420 | | | | Not assigned | | |
| C421 | 0180-0147 | | 1 | C: fxd elect 150 μ f -10% +50% 250vdcw | 00853 | PLI |
| C422 | 0150-0084 | | | C: fxd cer 0.1 μ f -20% +80% 50vdcw | 56289 | 33C41 |

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

| Ref Desig | hp Part No. | RS | TQ | Description (See Table 6-1.) | Mfr | Mfr Part No. |
|-----------------|-------------|----|----|--|-------|---------------|
| C423 | 0150-0052 | | | C: fxd cer 0.05 μ f 20% 400vdcw | 56289 | 33C17A |
| C424 | 0180-0012 | | 1 | C: fxd elect 2x20 μ f 450vdcw | 56289 | D32440 |
| C425 | 0150-0012 | | | C: fxd cer 0.01 μ f 20% 1000vdcw | 56289 | 29C214A3 |
| C426- C440 | | | | Not assigned | | |
| C441 | 0180-0398 | | 1 | C: fxd elect 150 pf -10% +50% 200vdcw | 56289 | D40728-DFP |
| C442 | 0150-0012 | | | C: fxd cer 0.01 μ f 20% 1000vdcw | 56289 | 29C214A3 |
| C443 | 0150-0012 | | | C: fxd cer 0.01 μ f 20% 1000vdcw | 56289 | 29C214A3 |
| C444 | 0150-0084 | | | C: fxd cer 0.1 μ f -20% +80% 50vdcw | 56289 | 33C41 |
| C445- C460 | | | | Not assigned | | |
| C461 | 0180-0398 | | 1 | C: fxd elect 150 μ f -10% +50% 200vdcw | 56289 | D40728-DFP |
| C462 | 0150-0052 | | | C: fxd cer 0.05 μ f 20% 400vdcw | 56289 | 33C17A |
| C463 | 0180-0059 | | 1 | C: fxd elect 10 μ f -10% +100% 25vdcw | 56289 | 30D106G025BB4 |
| C464 | 0180-0132 | | 1 | C: fxd elect 60 μ f -10% +100% 200vdcw | 00853 | PLI |
| C465 | 0150-0084 | | | C: fxd cer 0.1 μ f -20% +80% 50vdcw | 56289 | 33C41 |
| C466 | 0150-0012 | | | C: fxd cer 0.01 μ f 20% 1000vdcw | 56289 | 29C214A3 |
| C467- C480 | | | | Not assigned | | |
| C481 | 0180-0056 | | 1 | C: fxd elect 1000 μ f 50vdcw | 56289 | D32429 |
| CR1 | 1901-0040 | | 4 | CR: si | hp | |
| CR2 | 1901-0040 | | | CR: si | hp | |
| CR3- CR110 | | | | Not assigned | | |
| CR111 | 1910-0016 | | 1 | CR: ge | 93332 | D2361 |
| CR112 | 1901-0044 | | 1 | CR: si | hp | |
| CR113- CR200 | | | | Not assigned | | |
| CR201 | 1901-0040 | | | CR: si | hp | |
| CR202 | 1901-0040 | | | CR: si | hp | |
| CR203- CR420 | | | | Not assigned | | |
| CR421 | 1901-0029 | | 1 | CR: si | hp | |
| CR422 | 1902-0034 | | 2 | CR: avalanche 5.76 v | hp | |
| CR423 | 1902-3385 | | 1 | CR: avalanche 69.8 v | hp | |
| CR424- CR440 | | | | Not assigned | | |
| CR441 | 1901-0028 | | 2 | CR: si | hp | |
| CR442 | | | | Not assigned | | |
| CR443 | 1902-3354 | | 1 | CR: avalanche 54.9 v | hp | |
| CR444- CR460 | | | | Not assigned | | |
| CR461 | 1901-0028 | | | CR: si | hp | |
| CR462 | 1902-0034 | | | CR: avalanche 5.76 v | hp | |
| CR463- CR480 | | | | Not assigned | | |
| CR481 | 1901-0045 | | 1 | CR: si | hp | |
| CR482 | 1902-0113 | | 1 | CR: avalanche 11.9 v | hp | |
| DS101 | 2140-0018 | | 1 | DS: NE-2E neon glow | 24455 | NE-2E |
| DS102- DS400 | | | | Not assigned | | |
| DS401 | 1450-0048 | | | DS: indicator red | 08717 | 858R |
| F401 | 2110-0002 | | 1 | F: cartridge 2 amp 250 v | 75915 | 312.002 |
| J1 | 1510-0010 | | 5 | J: red binding post | hp | |
| J2 | 1510-0010 | | | J: red binding post | hp | |
| J3 | 5060-0627 | | 2 | J: black with shorting clip | hp | |
| J4- J100 | | | | Not assigned | | |

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

| Ref Desig | hp Part No. | RS | TQ | Description (See Table 6-1.) | Mfr | Mfr Part No. |
|------------------------|-------------|----|----|--|-------|--------------|
| J101 | 1510-0010 | | | J: red binding post | hp | |
| J102 | 1510-0011 | | 1 | J: black binding post | hp | |
| J103 - J200 J201 | 1510-0010 | | | Not assigned J: red binding post | hp | |
| J202 | 1510-0010 | | | J: red binding post | hp | |
| J203 | 5060-0627 | | | J: black with shorting clip | hp | |
| J204 - J400 J401 | 1251-0148 | | 1 | Not assigned J: ac power receptacle | 60427 | H1061G-3L |
| J402 | | | | Not assigned | | |
| J403 | 1251-0202 | | 1 | J: banana jack black | 83330 | 221B |
| L11 | 9140-0157 | | 4 | L: fxd rf 680 μ h | hp | |
| L12 | 9140-0157 | | | L: fxd rf 680 μ h | hp | |
| L13 - L110 | | | | Not assigned | | |
| L111 | 9140-0022 | | 1 | L: fxd rf 500 μ h | hp | |
| L112 - L210 | | | | Not assigned | | |
| L211 | 9140-0157 | | | L: fxd rf 680 μ h | hp | |
| L212 | 9140-0157 | | | L: fxd rf 680 μ h | hp | |
| L213 - L301 L302 | 5060-0408 | | 1 | Not assigned L: alignment | hp | |
| P401 P402 | | | | NSR: p/o W401 NSR: p/o W401 | | |
| Q1 | 1853-0030 | | 4 | Q: si pnp | hp | |
| Q2 | 1853-0030 | | | Q: si pnp | hp | |
| Q3 | 1853-0036 | | 4 | Q: si pnp 2N3906 | 04713 | 2N3906 |
| Q4 | 1853-0036 | | | Q: si pnp 2N3906 | 04713 | 2N3906 |
| Q5 - Q100 | | | | Not assigned | | |
| Q101 | 1854-0003 | | 1 | Q: si npn | hp | |
| Q102 - Q200 | | | | Not assigned | | |
| Q201 | 1853-0030 | | | Q: si pnp | hp | |
| Q202 | 1853-0030 | | | Q: si pnp | hp | |
| Q203 | 1853-0036 | | | Q: si pnp 2N3906 | 04713 | 2N3906 |
| Q204 | 1853-0036 | | | Q: si pnp 2N3906 | 04713 | 2N3906 |
| Q205 - Q420 Q421 | 5080-0427 | | 3 | Not assigned Q: ge pnp (selected) | hp | |
| Q422 | 1851-0017 | | 2 | Q: ge npn 2N1304 | 01295 | 2N1304 |
| Q423 | 1850-0062 | | 5 | Q: ge pnp | hp | |
| Q424 - Q440 Q441 | 5080-0427 | | | Not assigned Q: ge pnp (selected) | hp | |
| Q442 | 1850-0062 | | | Q: ge pnp | hp | |
| Q443 | 1851-0017 | | | Q: ge npn 2N1304 | 01295 | 2N1304 |
| Q444 - Q460 Q461 | 5080-0427 | | | Not assigned Q: ge pnp (selected) | hp | |

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

| Ref Desig | hp Part No. | RS | TQ | Description (See Table 6-1.) | Mfr | Mfr Part No. |
|----------------|-------------|----|----|----------------------------------|-------|--------------|
| Q462 | 1850-0062 | | | Q: ge pnp | hp | |
| Q463 | 1850-0062 | | | Q: ge pnp | hp | |
| Q464 | 1850-0062 | | | Q: ge pnp | hp | |
| Q465 - Q480 | | | | Not assigned | | |
| Q481 | 1850-0038 | | 1 | Q: ge pnp | hp | |
| R9 | 0687-2211 | | 6 | R: fxd comp 220 ohms 10% 1/2w | 01121 | EB 2211 |
| R10 | 0687-2211 | | | R: fxd comp 220 ohms 10% 1/2w | 01121 | EB 2211 |
| R11 | 0727-0269 | | 4 | R: fxd depc 990k ohms 1% 1/2w | hp | |
| R12 | 0727-0269 | | | R: fxd depc 990k ohms 1% 1/2w | hp | |
| R13 | 0727-0158 | | 4 | R: fxd depc 10.1k ohms 1% 1/2w | hp | |
| R14 | 0727-0158 | | | R: fxd depc 10.1k ohms 1% 1/2w | hp | |
| R15 | 0727-0259 | | 5 | R: fxd depc 990k ohms 1% 1/2w | hp | |
| R16 | 0727-0259 | | | R: fxd depc 990k ohms 1% 1/2w | hp | |
| R17 | 0727-0210 | | 4 | R: fxd depc 11k ohms 1% 1/2w | hp | |
| R18 | 0727-0210 | | | R: fxd depc 11k ohms 1% 1/2w | hp | |
| R19 | 0727-0274 | | 5 | R: fxd depc 1 megohm 1% 1/2w | hp | |
| R20 | 0727-0274 | | | R: fxd depc 1 megohm 1% 1/2w | hp | |
| R21 | 0727-0435 | | 1 | R: fxd depc 13.47k ohms 1% 1/2w | hp | |
| R22 | 0727-0365 | | 1 | R: fxd depc 5770 ohms 1/2% 1/2w | hp | |
| R23 | 0727-0431 | | 1 | R: fxd depc 2690 ohms 1% 1/2w | hp | |
| R24 | 0727-0101 | | 1 | R: fxd depc 1030 ohms 1% 1/2w | hp | |
| R25 | 0727-0437 | | 1 | R: fxd depc 509 ohms 1% 1/2w | hp | |
| R26 | 0727-0432 | | 1 | R: fxd depc 253 ohms 1% 1/2w | hp | |
| R27 | 0727-0436 | | 1 | R: fxd depc 101 ohms 1% 1/2w | hp | |
| R28 | 0727-0433 | | 1 | R: fxd depc 50.4 ohms 1% 1/2w | hp | |
| R29 | 0727-0434 | | 1 | R: fxd depc 25.2 ohms 1% 1/2w | hp | |
| R30 | 0727-0900 | | 1 | R: fxd depc 9.76 ohms 1% 1/2w | hp | |
| R31 - R39 | | | | Not assigned | | |
| R40 | 0813-0017 | | 1 | R: fxd ww 5 ohms 5% 5w | hp | |
| R41 | 0687-1041 | | 7 | R: fxd comp 100k ohms 10% 1/2w | 01121 | EB 1041 |
| R42 | 0687-1041 | | | R: fxd comp 100k ohms 10% 1/2w | 01121 | EB 1041 |
| R43 | 0683-4715 | | 4 | R: fxd comp 470 ohms 5% 1/4w | 01121 | CB 4715 |
| R44 | 0683-4715 | | | R: fxd comp 470 ohms 5% 1/4w | 01121 | CB 4715 |
| R45 | 0757-0977 | | 4 | R: fxd metflm 45.3k ohms 1% 1/2w | hp | |
| R46 | 0757-0977 | | | R: fxd metflm 45.3k ohms 1% 1/2w | hp | |
| R47 | | | | NSR: p/o A4 | | |
| R48 | | | | NSR: p/o A4 | | |
| R49 | 2100-0138 | | 2 | R: var comp 50 ohms 10% 2w | hp | |
| R50 | 0687-1011 | | 16 | R: fxd comp 100 ohms 10% 1/2w | 01121 | EB 1011 |
| R51 | 0757-0370 | | 4 | R: fxd metflm 49.9k ohms 1% 1/2w | hp | |
| R52 | 0757-0370 | | | R: fxd metflm 49.9k ohms 1% 1/2w | hp | |
| R53 | 0686-3635 | | 4 | R: fxd comp 36k ohms 5% 1/2w | 01121 | EB 3635 |
| R54 | 0686-3635 | | | R: fxd comp 36k ohms 5% 1/2w | 01121 | EB 3635 |
| R55 | 0758-0048 | | 2 | R: fxd metflm 8200 ohms 5% 1/2w | hp | |
| R56 | 0686-1035 | | 2 | R: fxd comp 10k ohms 5% 1/2w | 01121 | EB 1035 |
| R57 | 0683-1545 | | 4 | R: fxd comp 150k ohms 5% 1/4w | 01121 | CB 1545 |
| R58 | 0683-1545 | | | R: fxd comp 150k ohms 5% 1/4w | 01121 | CB 1545 |
| R59 | | | | NSR: p/o A4 | | |
| R60 | | | | Not assigned | | |

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

| Ref Desig | hp Part No. | RS | TQ | Description (See Table 6-1.) | Mfr | Mfr Part No. |
|---------------|-------------|----|----|----------------------------------|-------|--------------|
| R61 | 0686-1045 | | 4 | R: fxd comp 100k ohms 5% 1/2w | 01121 | EB 1045 |
| R62 | 0686-1045 | | | R: fxd comp 100k ohms 5% 1/2w | 01121 | EB 1045 |
| R63 | 0727-0186 | | 4 | R: fxd depc 33.2k ohms 1% 1/2w | hp | |
| R64 | 0727-0186 | | | R: fxd depc 33.2k ohms 1% 1/2w | hp | |
| R65 | 0727-0205 | | 4 | R: fxd depc 92.6k ohms 1% 1/2w | hp | |
| R66 | 0727-0205 | | | R: fxd depc 92.6k ohms 1% 1/2w | hp | |
| R67 | 0686-4335 | | 4 | R: fxd comp 43k ohms 5% 1/2w | 01121 | EB 4335 |
| R68 | 0686-4335 | | | R: fxd comp 43k ohms 5% 1/2w | 01121 | EB 4335 |
| R69 | 2100-0382 | | 2 | R: var comp 500k ohms 30% 1/4w | hp | |
| R70 | 2100-0373 | | 2 | R: var comp 2500 ohms 10% 1/2w | hp | |
| R71 | 0687-1011 | | | R: fxd comp 100 ohms 10% 1/2w | 01121 | EB 1011 |
| R72 | 0687-1011 | | | R: fxd comp 100 ohms 10% 1/2w | 01121 | EB 1011 |
| R73 | 0727-0374 | | 4 | R: fxd depc 33k ohms 1% 1/2w | hp | |
| R74 | 0727-0374 | | | R: fxd depc 33k ohms 1% 1/2w | hp | |
| R75 | 0686-2025 | | 1 | R: fxd comp 2000 ohms 5% 1/2w | 01121 | EB 2025 |
| R76 | 0767-0017 | | 3 | R: fxd metflm 17k ohms 5% 3w | hp | |
| R77 | 0767-0010 | | 1 | R: fxd metflm 15k ohms 5% 3w | hp | |
| R78 | 2100-0375 | | 1 | R: var comp 7500 ohms 20% 1/2w | hp | |
| R79 | 0727-0109 | | 4 | R: fxd depc 1470 ohms 1% 1/2w | hp | |
| R80 | 0727-0109 | | | R: fxd depc 1470 ohms 1% 1/2w | hp | |
| R81 | 0687-8231 | | 2 | R: fxd comp 82k ohms 10% 1/2w | 01121 | EB 8231 |
| R82 | 0687-5621 | | 2 | R: fxd comp 5600 ohms 10% 1/2w | 01121 | EB 5621 |
| R83 | 2100-0379 | | 2 | R: var comp 10k ohms 30% 1/4w | hp | |
| R84 | 0687-8211 | | 2 | R: fxd comp 820 ohms 10% 1/2w | 01121 | EB 8211 |
| R85 | 0687-1031 | | 4 | R: fxd comp 10k ohms 10% 1/2w | 01121 | EB 1031 |
| R86 | 0687-1011 | | | R: fxd comp 100 ohms 10% 1/2w | 01121 | EB 1011 |
| R87 | 0687-1231 | | 2 | R: fxd comp 12k ohms 10% 1/2w | 01121 | EB 1231 |
| R88 - R110 | | | | Not assigned | | |
| R111 | 0687-1051 | | 2 | R: fxd comp 1 megohm 10% 1/2w | 01121 | EB 1051 |
| R112 | 0687-1041 | | | R: fxd comp 100k ohms 10% 1/2w | 01121 | EB 1041 |
| R113 | 0686-1055 | | 1 | R: fxd comp 1 megohm 5% 1/2w | 01121 | EB 1055 |
| R114 | 0687-3341 | | 1 | R: fxd comp 330k ohms 10% 1/2w | 01121 | EB 3341 |
| R115 | 0687-2251 | | 1 | R: fxd comp 2.2 megohms 10% 1/2w | 01121 | EB 2251 |
| R116 | 2100-0189 | | | R: var comp 1 megohm 30% 1/4w | hp | |
| R117 | 0687-4711 | | 2 | R: fxd comp 470 ohms 10% 1/2w | 01121 | EB 4711 |
| R118 | 0687-4711 | | | R: fxd comp 470 ohms 10% 1/2w | 01121 | EB 4711 |
| R119 | 0687-1041 | | | R: fxd comp 100k ohms 10% 1/2w | 01121 | EB 1041 |
| R120 | 0690-3331 | | 1 | R: fxd comp 33k ohms 10% 1w | 01121 | GB 3331 |
| R121 | 0687-2731 | | 3 | R: fxd comp 27k ohms 10% 1/2w | 01121 | EB 2731 |
| R122 | 0687-1011 | | | R: fxd comp 100 ohms 10% 1/2w | 01121 | EB 1011 |
| R123 | 0687-2751 | | 3 | R: fxd comp 2.7 megohms 10% 1/2w | 01121 | EB 2751 |
| R124 | 0687-6811 | | 1 | R: fxd comp 680 ohms 10% 1/2w | 01121 | EB 6811 |
| R125 | 0687-2721 | | 1 | R: fxd comp 2700 ohms 10% 1/2w | 01121 | EB 2721 |
| R126 | 0727-0237 | | 2 | R: fxd depc 376k ohms 1% 1/2w | hp | |
| R127 | 0727-0244 | | 1 | R: fxd depc 500k ohms 1% 1/2w | hp | |
| R128 | 0690-2231 | | 1 | R: fxd comp 22k ohms 10% 1w | 01121 | GB 2231 |
| R129 | 0687-4721 | | 1 | R: fxd comp 4700 ohms 10% 1/2w | 01121 | EB 4721 |
| R130 | 0687-1031 | | | R: fxd comp 10k ohms 10% 1/2w | 01121 | EB 1031 |
| R131 | 0727-0183 | | 1 | R: fxd depc 26.7k ohms 1% 1/2w | hp | |

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

| Ref Desig | hp Part No. | RS | TQ | Description (See Table 6-1.) | Mfr | Mfr Part No. |
|----------------|-------------|----|----|----------------------------------|-------|--------------|
| R132 | 0687-1011 | | | R: fxd comp 100 ohms 10% 1/2w | 01121 | EB 1011 |
| R133 | 0690-4731 | | 1 | R: fxd comp 47k ohms 10% 1w | 01121 | GB 4731 |
| R134 | 0727-0249 | | 1 | R: fxd depc 667k ohms 1% 1/2w | hp | |
| R135 | 0727-0229 | | 1 | R: fxd depc 265k ohms 1% 1/2w | hp | |
| R136 | 0687-1011 | | | R: fxd comp 100 ohms 10% 1/2w | 01121 | EB 1011 |
| R137 | 0687-1521 | | 1 | R: fxd comp 1500 ohms 10% 1/2w | 01121 | EB 1521 |
| R138 | 0687-1531 | | 2 | R: fxd comp 15k ohms 10% 1/2w | 01121 | EB 1531 |
| R139 | 0690-1241 | | 1 | R: fxd comp 120k ohms 10% 1w | 01121 | GB 1241 |
| R140 | 0687-5631 | | 2 | R: fxd comp 56k ohms 10% 1/2w | 01121 | EB 5631 |
| R141 | 0687-8241 | | 1 | R: fxd comp 820k ohms 10% 1/2w | 01121 | EB 8241 |
| R142 | 0687-1011 | | | R: fxd comp 100 ohms 10% 1/2w | 01121 | EB 1011 |
| R143 | 0686-2445 | | 1 | R: fxd comp 240k ohms 5% 1/2w | 01121 | EB 2445 |
| R144 | 0686-2245 | | 1 | R: fxd comp 220k ohms 5% 1/2w | 01121 | EB 2245 |
| R145 | 0690-2731 | | 1 | R: fxd comp 27k ohms 10% 1w | 01121 | GB 2731 |
| R146 | 2100-0383 | | 1 | R: var comp 5000 ohms 30% 1/4w | hp | |
| R147 | 0687-8221 | | 2 | R: fxd comp 8200 ohms 10% 1/2w | 01121 | EB 8221 |
| R148 | 0687-4751 | | 1 | R: fxd comp 4.7 megohms 10% 1/2w | 01121 | EB 4751 |
| R149 | 0686-7525 | | 1 | R: fxd comp 7500 ohms 5% 1/2w | 01121 | EB 7525 |
| R150 | 0689-1835 | | 1 | R: fxd comp 18k ohms 5% 1w | 01121 | GB 1835 |
| R151 | 2100-0381 | | 1 | R: var comp 25k ohms 30% 1/4w | hp | |
| R152 | 0686-2735 | | 1 | R: fxd comp 27k ohms 5% 1/2w | 01121 | EB 2735 |
| R153 | 0686-4735 | | 1 | R: fxd comp 47k ohms 5% 1/2w | 01121 | EB 4735 |
| R154 | 0687-3301 | | 2 | R: fxd comp 33 ohms 10% 1/2w | 01121 | EB 3301 |
| R155 | 0687-2711 | | 4 | R: fxd comp 270 ohms 10% 1/2w | 01121 | EB 2711 |
| R156 | 0687-2711 | | | R: fxd comp 270 ohms 10% 1/2w | 01121 | EB 2711 |
| R157 | 0686-4715 | | 1 | R: fxd comp 470 ohms 5% 1/2w | 01121 | EB 4715 |
| R158 | 0687-1011 | | | R: fxd comp 100 ohms 10% 1/2w | 01121 | EB 1011 |
| R159 | 0687-1841 | | 1 | R: fxd comp 180k ohms 10% 1/2w | 01121 | EB 1841 |
| R160 - R174 | | | | Not assigned | | |
| R175 | | | | NSR: p/o A104 | | |
| R176 | | | | NSR: p/o A104 | | |
| R177 | | | | NSR: p/o A104 | | |
| R178 | | | | NSR: p/o A104 | | |
| R179 | 2100-0107 | | 1 | R: var comp 50k ohms 30% 1/3w | hp | |
| R180 | 0687-2231 | | 4 | R: fxd comp 22k ohms 10% 1/2w | 01121 | EB 2231 |
| R181 | 0730-0138 | | 2 | R: fxd depc 9 megohms 1% 1w | hp | |
| R182 | 0733-0009 | | 1 | R: fxd depc 36 megohms 1% 2w | hp | |
| R183 | 0730-0138 | | | R: fxd depc 9 megohms 1% 1w | hp | |
| R184 | 0730-0162 | | 1 | R: fxd depc 4.54 megohms 1% 1w | hp | |
| R185 | 0727-0391 | | 1 | R: fxd depc 1.81 megohms 1% 1/2w | hp | |
| R186 | 0727-0259 | | | R: fxd depc 900k ohms 1% 1/2w | hp | |
| R187 - R208 | | | | Not assigned | | |
| R209 | 0687-2211 | | | R: fxd comp 220 ohms 10% 1/2w | 01121 | EB 2211 |
| R210 | 0687-2211 | | | R: fxd comp 220 ohms 10% 1/2w | 01121 | EB 2211 |
| R211 | 0727-0269 | | | R: fxd depc 990k ohms 1% 1/2w | hp | |
| R212 | 0727-0269 | | | R: fxd depc 990k ohms 1% 1/2w | hp | |
| R213 | 0727-0259 | | | R: fxd depc 900k ohms 1% 1/2w | hp | |
| R214 | 0727-0259 | | | R: fxd depc 900k ohms 1% 1/2w | hp | |
| R215 | 0727-0158 | | | R: fxd depc 10.1k ohms 1% 1/2w | hp | |

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

| Ref Desig | hp Part No. | RS | TQ | Description (See Table 6-1.) | Mfr | Mfr Part No. |
|-----------|-------------|----|----|----------------------------------|-------|--------------|
| R216 | 0727-0158 | | | R: fxd depc 10.1k ohms 1% 1/2w | hp | |
| R217 | 0727-0210 | | | R: fxd depc 111k ohms 1% 1/2w | hp | |
| R218 | 0727-0210 | | | R: fxd depc 111k ohms 1% 1/2w | hp | |
| R219 | 0727-0237 | | | R: fxd depc 376k ohms 1% 1/2w | hp | |
| R220 | 0727-0230 | 1 | | R: fxd depc 284k ohms 1% 1/2w | hp | |
| R221 | 2100-0376 | 1 | | R: var comp 50k ohms 20% 1/2w | hp | |
| R222 | 0687-3331 | 1 | | R: fxd comp 33k ohms 10% 1/2w | 01121 | EB 3331 |
| R223 | 0727-0130 | 1 | | R: fxd depc 3895 ohms 1/2% 1/2w | hp | |
| R224 | 0727-0274 | | | R: fxd depc 1 megohm 1% 1/2w | hp | |
| R225 | 0727-0274 | | | R: fxd depc 1 megohm 1% 1/2w | hp | |
| R226 | 0687-1041 | | | R: fxd comp 100k ohms 10% 1/2w | 01121 | EB 1041 |
| R227 | 0687-1041 | | | R: fxd comp 100k ohms 10% 1/2w | 01121 | EB 1041 |
| R228 | | | | NSR: p/o A204 | | |
| R229 | 0683-1545 | | | R: fxd comp 150k ohms 5% 1/4w | 01121 | CB 1545 |
| R230 | 0683-1545 | | | R: fxd comp 150k ohms 5% 1/4w | 01121 | CB 1545 |
| R231 | 0683-4715 | | | R: fxd comp 470 ohms 5% 1/4w | hp | |
| R232 | 0683-4715 | | | R: fxd comp 470 ohms 5% 1/4w | hp | |
| R233 | 2100-0138 | | | R: var comp 50 ohms 10% 2w | hp | |
| R234 | | | | NSR: p/o A204 | | |
| R235 | 0757-0977 | | | R: fxd metflm 45.3k ohms 1% 1/2w | hp | |
| R236 | 0757-0977 | | | R: fxd metflm 45.3k ohms 1% 1/2w | hp | |
| R237 | 0687-1011 | | | R: fxd comp 100 ohms 10% 1/2w | 01121 | EB 1011 |
| R238 | | | | NSR: p/o A204 | | |
| R239 | 0758-0048 | | | R: fxd metflm 8200 ohms 5% 1/2w | hp | |
| R240 | 0686-1035 | | | R: fxd comp 10k ohms 5% 1/2w | 01121 | EB 1035 |
| R241 | 0757-0370 | | | R: fxd metflm 49.9k ohms 1% 1/2w | hp | |
| R242 | 0757-0370 | | | R: fxd metflm 49.9k ohms 1% 1/2w | hp | |
| R243 | 0686-3635 | | | R: fxd comp 36k ohms 5% 1/2w | 01121 | EB 3635 |
| R244 | 0686-3635 | | | R: fxd comp 36k ohms 5% 1/2w | 01121 | EB 3635 |
| R245 | 0686-1045 | | | R: fxd comp 100k ohms 5% 1/2w | 01121 | EB 1045 |
| R246 | 0686-1045 | | | R: fxd comp 100k ohms 5% 1/2w | 01121 | EB 1045 |
| R247 | 0727-0186 | | | R: fxd depc 33.2k ohms 1% 1/2w | hp | |
| R248 | 0727-0186 | | | R: fxd depc 33.2k ohms 1% 1/2w | hp | |
| R249 | 0727-0205 | | | R: fxd depc 92.6k ohms 1% 1/2w | hp | |
| R250 | 0727-0205 | | | R: fxd depc 92.6k ohms 1% 1/2w | hp | |
| R251 | 0727-0371 | 1 | | R: fxd depc 9760 ohms 1/2% 1/2w | hp | |
| R252 | 0727-0429 | 1 | | R: fxd depc 4347 ohms 1% 1/2w | hp | |
| R253 | 0727-0428 | 1 | | R: fxd depc 2060 ohms 1% 1/2w | hp | |
| R254 | 0727-0427 | 1 | | R: fxd depc 798 ohms 1% 1/2w | hp | |
| R255 | 0727-0426 | 1 | | R: fxd depc 395 ohms 1% 1/2w | hp | |
| R256 | 0727-0425 | 1 | | R: fxd depc 196.5 ohms 1% 1/2w | hp | |
| R257 | 0727-0424 | 1 | | R: fxd depc 78.4 ohms 1% 1/2w | hp | |
| R258 | 0727-0423 | 1 | | R: fxd depc 39.2 ohms 1% 1/2w | hp | |
| R259 | 0727-0422 | 1 | | R: fxd depc 19.5 ohms 1% 1/2w | hp | |
| R260 | 0727-0705 | 1 | | R: fxd depc 7.50 ohms 1% 1/2w | hp | |
| R261 | 0686-4335 | | | R: fxd comp 43k ohms 5% 1/2w | 01121 | EB 4335 |
| R262 | 0686-4335 | | | R: fxd comp 43k ohms 5% 1/2w | 01121 | EB 4335 |
| R263 | 2100-0382 | | | R: var comp 500k ohms 30% 1/4w | hp | |
| R264 | 2100-0373 | | | R: var comp 2500 ohms 10% 1/2w | hp | |
| R265 | 0687-1011 | | | R: fxd comp 100 ohms 10% 1/2w | 01121 | EB 1011 |

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

| Ref Desig | hp Part No. | RS | TQ | Description (See Table 6-1.) | Mfr | Mfr Part No. |
|-----------|-------------|----|----|--|-------|--------------|
| R266 | 0687-1011 | | | R: fxd comp 100 ohms 10% 1/2w | 01121 | EB 1011 |
| R267 | 0727-0374 | | | R: fxd depc 33k ohms 1% 1/2w | hp | |
| R268 | 0727-0374 | | | R: fxd depc 33k ohms 1% 1/2w | hp | |
| R269 | 0767-0017 | | | R: fxd metflm 17k ohms 5% 3w | hp | |
| R270 | 0767-0017 | | | R: fxd metflm 17k ohms 5% 3w | hp | |
| R271 | 0727-0109 | | | R: fxd depc 1470 ohms 1% 1/2w | hp | |
| R272 | 0727-0109 | | | R: fxd depc 1470 ohms 1% 1/2w | hp | |
| R273 | 0686-3625 | | 2 | R: fxd comp 3600 ohms 5% 1/2w | 01121 | EB 3625 |
| R274 | 0686-3625 | | | R: fxd comp 3600 ohms 5% 1/2w | 01121 | EB 3625 |
| R275 | 0687-8231 | | | R: fxd comp 82k ohms 10% 1/2w | 01121 | EB 8231 |
| R276 | 2100-0379 | | | R: var comp 10k ohms 30% 1/4w | hp | |
| R277 | 0687-5621 | | | R: fxd comp 5600 ohms 10% 1/2w | 01121 | EB 5621 |
| R278 | 0687-8211 | | | R: fxd comp 820 ohms 10% 1/2w | 01121 | EB 8211 |
| R279 | 0687-1011 | | | R: fxd comp 100 ohms 10% 1/2w | 01121 | EB 1011 |
| R280 | 0687-1231 | | | R: fxd comp 12k ohms 10% 1/2w | 01121 | EB 1231 |
| R281 | | | | Not assigned | | |
| R299 | | | | Not assigned | | |
| R300 | 0687-1531 | | | R: fxd comp 15k ohms 10% 1/2w | 01121 | EB 1531 |
| R301 | 0687-1021 | | | R: fxd comp 1000 ohms 10% 1/2w | 01121 | EB 1021 |
| R302 | 0687-4741 | | 1 | R: fxd comp 470k ohms 10% 1/2w | 01121 | EB 4741 |
| R303 | 0687-1011 | | | R: fxd comp 100 ohms 10% 1/2w | 01121 | EB 1011 |
| R304 | 0687-2711 | | | R: fxd comp 270 ohms 10% 1/2w | 01121 | EB 2711 |
| R305 | 0693-4731 | | 1 | R: fxd comp 47k ohms 10% 2w | 01121 | HB 4731 |
| R306 | 0687-1041 | | | R: fxd comp 100k ohms 10% 1/2w | 01121 | EB 1041 |
| R307 | | | | NSR: p/o A303 | | |
| R308 | 2100-0171 | | 1 | R: var comp 200k ohms 20% 1/4w (includes S401) | hp | |
| R309 | 0687-1031 | | | R: fxd comp 10k ohms 10% 1/2w | 01121 | EB 1031 |
| R310 | 0687-1031 | | | R: fxd comp 10k ohms 10% 1/2w | 01121 | EB 1031 |
| R311 | 0686-3055 | | 1 | R: fxd comp 3 megohms 5% 1/2w | 01121 | EB 3055 |
| R312 | | | | NSR: p/o A303 | | |
| R313 | 0693-4751 | | 2 | R: fxd comp 4.7 megohms 10% 2w | 01121 | HB 4751 |
| R314 | 0693-4751 | | | R: fxd comp 4.7 megohms 10% 2w | 01121 | HB 4751 |
| R315 | 0693-5651 | | 2 | R: fxd comp 5.6 megohms 10% 2w | 01121 | HB 5651 |
| R316 | 0693-5651 | | | R: fxd comp 5.6 megohms 10% 2w | 01121 | HB 5651 |
| R317 | 2100-0374 | | 1 | R: var comp 5 megohms 30% 1/2w | hp | |
| R318 | 0687-2241 | | 1 | R: fxd comp 220k ohms 10% 1/2w | 01121 | EB 2241 |
| R319 | | | | NSR: p/o A303 | | |
| R320 | 0687-4731 | | 4 | R: fxd comp 47k ohms 10% 1/2w | 01121 | EB 4731 |
| R321 | 0687-1051 | | | R: fxd comp 1 megohm 10% 1/2w | 01121 | EB 1051 |
| R322 | 0687-2731 | | | R: fxd comp 27k ohms 10% 1/2w | 01121 | EB 2731 |
| R323 | 0836-0003 | | 1 | R: fxd depc 29 megohms 10% 1w | 77764 | Type BBF |
| R324 | 0687-2751 | | | R: fxd comp 2.7 megohms 10% 1/2w | 01121 | EB 2751 |
| R325 | 0687-2231 | | | R: fxd comp 22k ohms 10% 1/2w | 01121 | EB 2231 |
| R326 | 0687-2231 | | | R: fxd comp 22k ohms 10% 1/2w | 01121 | EB 2231 |
| R327 | 0687-2751 | | | R: fxd comp 2.7 megohms 10% 1/2w | 01121 | EB 2751 |
| R328 | 0687-2711 | | | R: fxd comp 270 ohms 10% 1/2w | 01121 | EB 2711 |
| R329 | 2100-0445 | | 1 | R: var comp 2 x 2000 ohms 30% | hp | |
| R330 | 0687-1011 | | | R: fxd comp 100 ohms 10% 1/2w | 01121 | EB 1011 |
| R331 | | | | Not assigned | | |
| R400 | | | | Not assigned | | |
| R401 | 0687-5631 | | | R: fxd comp 56k ohms 10% 1/2w | 01121 | EB 5631 |

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

| Ref Desig | hp Part No. | RS | TQ | Description (See Table 6-1.) | Mfr | Mfr Part No. |
|-----------|-------------|----|----|----------------------------------|-------|--------------|
| R402 | | | | NSR: p/o A402 | | |
| R403 | 0727-0284 | | 1 | R: fxd depc 1.75 megohms 1% 1/2w | hp | |
| R404 | 0666-2055 | | 1 | R: fxd comp 2 megohms 5% 1/2w | 01121 | EB 2055 |
| R405 | 0698-5150 | | 2 | R: fxd metflm 9900 ohms 1% 1/4w | hp | |
| R406 | 0698-5150 | | | R: fxd metflm 9900 ohms 1% 1/4w | hp | |
| R407 | 0757-0178 | | 2 | R: fxd metflm 100 ohms 1% 1/4w | hp | |
| R406 | 0757-0178 | | | R: fxd metflm 100 ohms 1% 1/4w | hp | |
| R409 | | | | | | |
| R420 | | | | Not assigned | | |
| R421 | 0687-3301 | | | R: fxd comp 33 ohms 10% 1/2w | 01121 | EB 3301 |
| R422 | 0693-2221 | | 1 | R: fxd comp 2200 ohms 10% 2w | 01121 | HB 2221 |
| R423 | 0693-2231 | | 1 | R: fxd comp 22k ohms 10% 2w | 01121 | HB 2231 |
| R424 | 0761-0006 | | 2 | R: fxd metflm 10k ohms 5% 1w | hp | |
| R425 | 0687-1021 | | 3 | R: fxd comp 1000 ohms 10% 1/2w | 01121 | EB 1021 |
| R426 | 0687-4731 | | | R: fxd comp 47k ohms 10% 1/2w | 01121 | EB 4731 |
| R427 | 0730-0052 | | 1 | R: fxd depc 51.6k ohms 1% 1w | hp | |
| R428 | 0730-0056 | | 1 | R: fxd depc 68.38k ohms 1% 1w | hp | |
| R429 | 0687-1011 | | | R: fxd comp 100 ohms 10% 1/2w | 01121 | EB 1011 |
| R430 | 0687-2211 | | | R: fxd comp 220 ohms 10% 1/2w | 01121 | EB 2211 |
| R431 | 0687-3311 | | 2 | R: fxd comp 330 ohms 10% 1/2w | 01121 | EB 3311 |
| R432 | | | | | | |
| R440 | | | | Not assigned | | |
| R441 | 0687-2701 | | 2 | R: fxd comp 27 ohms 10% 1/2w | 01121 | EB 2701 |
| R442 | 0767-0002 | | 1 | R: fxd metflm 560 ohms 5% 3w | hp | |
| R443 | 0687-4731 | | | R: fxd comp 47k ohms 10% 1/2w | 01121 | EB 4731 |
| R444 | 0687-1511 | | 1 | R: fxd comp 150 ohms 10% 1/2w | 01121 | EB 1511 |
| R445 | 0687-4731 | | | R: fxd comp 47k ohms 10% 1/2w | 01121 | EB 4731 |
| R446 | 0758-0020 | | 2 | R: fxd metflm 22k ohms 5% 1/2w | hp | |
| R447 | | | | NSR: p/o A402 | | |
| R448 | 0758-0020 | | | R: fxd metflm 22k ohms 5% 1/2w | hp | |
| R449 | 0687-2211 | | | R: fxd comp 220 ohms 10% 1/2w | 01121 | EB 2211 |
| R450 | 0687-3311 | | | R: fxd comp 330 ohms 10% 1/2w | 01121 | EB 3311 |
| R451 | 0687-1021 | | | R: fxd comp 1000 ohms 10% 1/2w | 01121 | EB 1021 |
| R452 | | | | | | |
| R460 | | | | Not assigned | | |
| R461 | 0687-2701 | | | R: fxd comp 27 ohms 10% 1/2w | 01121 | EB 2701 |
| R462 | 0764-0023 | | 1 | R: fxd metflm 910 ohms 5% 2w | hp | |
| R463 | 0687-2731 | | | R: fxd comp 27k ohms 10% 1/2w | 01121 | EB 2731 |
| R464 | 0727-0137 | | 1 | R: fxd depc 5180 ohms 1% 1/2w | hp | |
| R465 | 0687-3931 | | 1 | R: fxd comp 39k ohms 10% 1/2w | 01121 | EB 3931 |
| R466 | 0687-8221 | | | R: fxd comp 8200 ohms 10% 1/2w | 01121 | EB 8221 |
| R467 | 0758-0020 | | | R: fxd metflm 22k ohms 5% 1/2w | hp | |
| R468 | | | | NSR: p/o A402 | | |
| R469 | 0727-0115 | | 1 | R: fxd depc 2000 ohms 1% 1/2w | hp | |
| R470 | 0687-3311 | | | R: fxd comp 330 ohms 10% 1/2w | 01121 | EB 3311 |
| R471 - | | | | | | |
| R480 | | | | Not assigned | | |
| R481 | 0699-0006 | | 1 | R: fxd comp 4.7 ohms 10% 1w | 01121 | GB 47G1 |
| R482 | 0761-0006 | | | R: fxd metflm 10k ohms 5% 1w | hp | |

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

| Ref Desig | hp Part No. | RS | TQ | Description (See Table 6-1.) | Mfr | Mfr Part No. |
|--|---|----|-------------|--|---|---|
| S1 S2 S3 S4 S5 - S100 | 3101-0014 | | 1 | NSR: p/o A2 NSR: p/o A3 NSR: p/o A3 S: pushbutton spdt | 82389 | 4S-1106 |
| S101 S102 S103 S104 S105 - S174 | | | | Not assigned | | |
| S175 S176 - S200 S201 S202 | | | | NSR: p/o A175 | | |
| S203 S204 - S400 S401 S402 | 3101-0033 | | 1 | Not assigned NSR: p/o A203 NSR: p/o A203 NSR: p/o A203 | | |
| T301 T302 - T400 T401 TB301 | 130C-11A-1 9100-0241 0360-0104 | | 1 1 1 | Not assigned NSR: p/o R308 S: slide ϕ pd T: high voltage Not assigned T: power (low voltage) TB: terminal (z axis input) | hp hp 71785 | 4633 321-11-02-036 |
| V1 V2 V3 V4 - V100 | 5080-0424 1932-0035 1921-0017 | | 2 2 2 | V: 6DJ8 dual triode (aged) V: 6DJ8 dual triode (special) V: 7586 nuvistor | hp 13396 86684 | 6DJ8 7586 |
| V101 V102 V103 V104 V105 | 1932-0022 1932-0022 1933-0008 1932-0022 2140-0008 | | 3 2 3 | Not assigned | | |
| V106 V107 V108 V109 V110 - V200 | 1933-0008 2140-0084 2140-0008 1939-0002 | | 1 1 1 | V: 6BL8 triode pentode V: glow lamp aged V: NE2 neon glow V: 6BC7 triple diode | 73445 74276 24455 93332 | 6DJ8/ECC88 6DJ8/ECC88 6BL8/ECF80 6DJ8/ECC88 NE2 |
| V201 V202 V203 V204 - V300 | 5080-0424 1932-0035 1921-0017 | | | Not assigned | | |
| V301 V302 V303 V304 V305 | 1923-0044 1932-0029 2140-0008 1920-0001 1920-0001 | | 1 1 2 | V: 6DJ8 dual triode (aged) V: 6DJ8 dual triode (special) V: 7586 nuvistor Not assigned V: 6CW5 pentode V: 12AU7 dual triode V: NE2 neon glow V: 5642 high voltage diode V: 5642 high voltage diode | hp 13396 86684 73445 12859 24455 93332 93332 | 6DJ8 7586 6CW5/EL86 12AU7 NE2 5642 5642 |

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

| Ref Desig | hp Part No. | RS | TQ | Description (See Table 6-1.) | Mfr | Mfr Part No. |
|---|--|----|----|--|----------------------|---------------|
| V306 | 5083-0353 5083-0342 5083-0333 5083-0323 | | 1 | V: CRT P31 phosphor V: CRT P11 phosphor V: CRT P7 phosphor V: CRT P2 phosphor | hp hp hp hp | |
| V307 - V400 | | | | Not assigned | | |
| V401 | 2140-0083 | | 2 | V: glow lamp aged | 74276 | A091 |
| V402 | 2140-0083 | | | V: glow lamp aged | 74276 | A091 |
| V403 - V460 V461 | 1940-0001 | | 1 | Not assigned V: 5651A voltage reference | 86684 | 5651A |
| W401 | 8120-0078 | | 1 | W: ac power | 70903 | KH4147 |
| XQ421 | 1200-0044 | | 4 | XQ: 2 pin | 97464 | M7 PB |
| XQ422 - XQ440 XQ441 | 1200-0044 | | | Not assigned XQ: 2 pin | 97446 | M7 PB |
| XQ442 - XQ460 XQ461 XQ462 - XQ480 | 1200-0044 | | | Not assigned XQ: 2 pin Not assigned | 97446 | M7 PB |
| XQ481 | 1200-0044 | | | XQ: 2 pin | 97446 | M7 PB |
| XV1 | 1200-0062 | | 11 | XV: 9 pin miniature | 71785 | 121-51-11-060 |
| XV2 | 1200-0062 | | | XV: 9 pin miniature | 71785 | 121-51-11-060 |
| XV3 | 1200-0086 | | 2 | XV: 5 pin nuvistor | 71785 | 133-65-10-009 |
| XV4 - XV100 | | | | Not assigned | | |
| XV101 | 1200-0059 | | 1 | XV: 9 pin miniature shield base | 71785 | 121-51-11-082 |
| XV102 | 1200-0062 | | | XV: 9 pin miniature | 71785 | 121-51-11-060 |
| XV103 | 1200-0062 | | | XV: 9 pin miniature | 71785 | 121-51-11-060 |
| XV104 | 1200-0062 | | | XV: 9 pin miniature | 71785 | 121-51-11-060 |
| XV105 | | | | Not assigned | | |
| XV106 | 1200-0062 | | | XV: 9 pin miniature | 71785 | 121-51-11-060 |
| XV107 & XV108 | | | | Not assigned | | |
| XV109 | 1200-0062 | | | XV: 9 pin miniature | 71785 | 121-51-11-060 |
| XV110 - XV200 | | | | Not assigned | | |
| XV201 | 1200-0062 | | | XV: 9 pin miniature | 71785 | 121-51-11-060 |
| XV202 | 1200-0062 | | | XV: 9 pin miniature | 71785 | 121-51-11-060 |
| XV203 | 1200-0086 | | | XV: 5 pin nuvistor | 71785 | 133-65-10-009 |
| XV204 - XV300 | | | | Not assigned | | |
| XV301 | 1200-0062 | | | XV: 9 pin miniature | 71785 | 121-51-11-060 |
| XV302 | 1200-0062 | | | XV: 9 pin miniature | 71785 | 121-51-11-060 |
| XV303 - XV305 XV306 | | | | Not assigned | | |
| | 1200-0037 | | 1 | XV: CRT consists of: | 72825 | 9709-4 |
| | 1200-0050 | | 10 | Socket body | 72825 | 9553 |
| | 1200-0192 | | 1 | Pin Cover Plate | 72825 | 9709-7 |
| XV307 - XV460 XV461 | 1200-0053 | | 1 | Not assigned XV: 7 pin miniature | 71785 | 111-51-11-069 |

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

| Ref Desig | hp Part No. | RS | TQ | Description (See Table 6-1.) | Mfr | Mfr Part No. |
|----------------------|-------------|----|----|---|-------|---------------|
| <u>MISCELLANEOUS</u> | | | | | | |
| | 120A-11A-1 | | 1 | Strap: copper (for hv transformer) | hp | |
| | 120A-20A | | 1 | Bezel: crt | hp | |
| | 130C-1A | | 1 | Deck: main | hp | |
| | 130C-5A | | 1 | Rail: center divider | hp | |
| | 130C-5B | | 1 | Bracket: switch support | hp | |
| | 130C-6A | | 1 | Shield: switch (sweep and horizontal ampl) | hp | |
| | 130C-6B | | 1 | Shield: hv compartment | hp | |
| | 130C-6C | | 1 | Cover: top hv compartment | hp | |
| | 130C-6D | | 1 | Cover: bottom hv compartment | hp | |
| | 130C-6E | | 1 | Cover: power transistors | hp | |
| | 130C-6F | | 1 | Shield: switch (sync and sweep) | hp | |
| | 130C-6G | | 2 | Shield: amplifier circuit board | hp | |
| | 130C-6H | | 1 | Shield: intensity pot | hp | |
| | 130C-6J | | 1 | Shield: calibrator jack | hp | |
| | 130C-6K | | 1 | Shield: assembly (crt) | hp | |
| | 130C-16R | | 1 | Cable: gate | hp | |
| | 130C-16S | | 1 | Cable: main harness (includes XV306) | hp | |
| | 130C-61A | | 1 | Holder: neon bulb (armed) | hp | |
| | 0340-0086 | | 2 | Insulator: binding post (for J1/J2 and J201/J202) | hp | |
| | 0340-0089 | | 1 | Insulator: binding post (J101) | hp | |
| | 0340-0090 | | 1 | Insulator: captive 2 hole (for J101/J102) | hp | |
| | 0340-0091 | | 2 | Insulator: captive 3 hole (for vert and horiz inputs) | hp | |
| | 0370-0026 | | 2 | Knob: black (position) | hp | |
| | 0370-0037 | | 3 | Knob: black bar (sensitivity, time) | hp | |
| | 0370-0062 | | 2 | Knob: red (vernier) | hp | |
| | 0370-0084 | | 4 | Knob: black (focus, intensity, balance) | hp | |
| | 0370-0113 | | 1 | Knob: black bar (trigger source) | hp | |
| | 0370-0114 | | 1 | Knob: red (level) | hp | |
| | 0905-0016 | | 1 | Gasket: felt crt | hp | |
| | 1200-0043 | | 4 | Insulator: transistor socket | 76530 | 294457 |
| | 1220-0009 | | 1 | Shield: tube (V101) | 71785 | 151-11-23-012 |
| | 1251-0207 | | 32 | Connector: edge-on (p/o main cable harness) | 00779 | 42587-5 |
| | 4320-0007 | | 7" | Extrusion: rubber crt clamp | hp | |
| | 5000-0408 | | 3 | Bracket: coil trace align | hp | |
| | 5040-0401 | | 1 | Support: capacitor (hv circuit board) | hp | |
| | 5040-0417 | | 1 | Holder: tube socket | hp | |
| | 5040-0421 | | 1 | Insulator: focus pot | hp | |
| | 5040-0466 | | 1 | Retainer: crt shield | hp | |

Table 6-3. Code List of Manufacturers

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

| Code No. | Manufacturer | Address | Code No. | Manufacturer | Address | Code No. | Manufacturer | Address |
|----------|---|------------------------------------|----------|--|--------------------------------|----------|---|---------------------------------|
| 00000 | U. S. A. Common | Any supplier of U. S. | 05729 | Metro-Tel Corp. | Westbury, N. Y. | 12881 | Metex Electronics Corp. | Clark, N. J. |
| 00136 | McCoy Electronics | Mount Holly Springs, Pa. | 05783 | Stewart Engineering Co. | Santa Cruz, Calif. | 12930 | Delta Semiconductor Inc. | Newport Beech, Calif. |
| 00213 | Sage Electronics Corp. | Rochester, N. Y. | 05820 | Wakefield Engineering Inc. | Wakefield, Mass. | 12954 | Dickson Electronics Corp. | Scottsdale, Arizona |
| 00287 | Cemco Inc. | Denielson, Conn. | 06004 | Bassick Co., The | Bridgeport, Conn. | 13103 | Thermolloy | Dallas, Texas |
| 00334 | Humidial | Colton, Calif. | 06090 | Raychem Corp. | Redwood City, Calif. | 13396 | Telefunken (GmbH) | Haoover, Germany |
| 00348 | Microtron Co., Inc. | Valley Stream, N. Y. | 06175 | Bausch and Lomb Optical Co. | Rochester, N. Y. | 13835 | Midland-Wright Div. of Pacific Industries, Inc. | |
| 00373 | Garlock Inc., Electronics Products Div. | Camden, N. J. | 06402 | E. T. A. Products Co. of America | Chicago, Ill. | 14099 | Sem-Tech | Kansas City, Kansas |
| 10656 | Aerovox Corp. | New Bedford, Mass. | 06540 | Amatom Electronic Hardware Co., Inc. | New Rochelle, N. Y. | 14193 | Calif. Resistor Corp. | Newbury Park, Calif. |
| 10779 | Amp. Inc. | Harrisburg, Pa. | 06555 | Beede Electrical Instrument Co., Inc. | Penecook, N. H. | 14298 | American Components, Inc. | Conshohocken, Pa. |
| 10781 | Aircraft Radio Corp. | Boonton, N. J. | 06666 | General Devices Co., Inc. | Indianapolis, Ind. | 14433 | ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp. | West Palm Beach, Fla. |
| 10815 | Northern Engineering Laboratories, Inc. | Burlington, Wis. | 06751 | Semcor Div. Components Inc. | Phoenix, Ariz. | 14493 | Hewlett-Packard Company | Loveland, Colo. |
| 10853 | Sangamo Electric Co., Pickens Div. | Pickens, S. C. | 06812 | Torrington Mfg. Co., West Div. | Van Nuys, Calif. | 14655 | Cornell Dublier Electric Corp. | Newark, N. J. |
| 00866 | Goe Engineering Co. | Los Angeles, Calif. | 06980 | Varian Assoc. Eimac Div. | San Carlos, Calif. | 14674 | Corning Glass Works | Corning, N. Y. |
| 00891 | Carl E. Holmes Corp. | Los Angeles, Calif. | 07088 | Kelvin Electric Co. | Van Nuys, Calif. | 14752 | Electro Cube Inc. | So. Pasadena, Calif. |
| 00929 | Microlab Inc. | Livingston, N. J. | 07126 | Digitran Co. | Pasadena, Calif. | 14960 | Williams Mfg. Co. | San Jose, Calif. |
| 01009 | Alden Products Co. | Brockton, Mass. | 07137 | Transistor Electronics Corp. | Minneapolis, Minn. | 15203 | Webster Electronics Co. | New York, N. Y. |
| 01121 | Allen Bradley Co. | Milwaukee, Wis. | 07138 | Westinghouse Electric Corp. Electronic Tube Div. | Elmira, N. Y. | 15291 | Adjustable Bushing Co. | N. Hollywood, Calif. |
| 01255 | Litton Industries, Inc. | Beverly Hills, Calif. | 07149 | Filmohm Corp. | New York, N. Y. | 15558 | Micron Electronics | Garden City, Long Island, N. Y. |
| 01281 | TRW Semiconductors, Inc. | Lewndale, Calif. | 07233 | Cinch-Graphik Co. | City of Industry, Calif. | 15566 | Amprobe Inst. Corp. | Lynbrook, N. Y. |
| 01295 | Texas Instruments, Inc., Transistor Products Div. | Dallas, Texas | 07261 | Avnet Corp. | Culver City, Calif. | 15772 | Twentieth Century Coil Spring Co. | Santa Clara, Calif. |
| 01349 | The Alliance Mfg. Co. | Alliance, Ohio | 07263 | Fairchild Camera & Inst. Corp. Semiconductor Div. | Mountain View, Calif. | 15818 | Amelco Inc. | Mt. View, Calif. |
| 01589 | Pacific Relays, Inc. | Van Nuys, Calif. | 07322 | Minnesota Rubber Co. | Minneapolis, Minn. | 15909 | Daven Div. Thomas A. Edison Ind. McGraw-Edison Co. | Long Island City, N. Y. |
| 01930 | Amerock Corp. | Rockford, Ill. | 07387 | Birtcher Corp., The | Monterey Park, Calif. | 16037 | Spruce Pine Mica Co. | Spruce Pine, N. C. |
| 01961 | Pulse Engineering Co. | Santa Clara, Calif. | 07700 | Technical Wire Products Inc. | Cranford, N. J. | 16179 | Omni-Spectra Inc. | Detroit, Ill. |
| 02114 | Ferroxcube Corp. of America | Saugerties, N. Y. | 07910 | Continental Device Corp. | Hawthorne, Calif. | 16352 | Computer Diode Corp. | Lodi, N. J. |
| 02286 | Cole Rubber and Plastics Inc. | Sunnyvale, Calif. | 07933 | Raytheon Mfg. Co., Semiconductor Div. | Mountain View, Calif. | 16688 | Ideal Prec. Meter Co., Inc. De Jur Meter Div. | Brooklyn, N. Y. |
| 02660 | Amphenol-Borg Electronics Corp. | Chicago, Ill. | 07966 | Shockley Semi-Conductor Laboratories | Palo Alto, Calif. | 16758 | Delco Radio Div. of G. M. Corp. | Kokomo, Ind. |
| 02735 | Radio Corp. of America, Semiconductor and Materials Div. | Somerville, N. J. | 07980 | Hewlett-Packard Co., Boonton Radio Div. | Rockaway, N. J. | 17109 | Thermonetics Inc. | Canoga Park, Calif. |
| 02771 | Voceline Co. of America, Inc. | Old Saybrook, Conn. | 08145 | U. S. Engineering Co. | Los Angeles, Calif. | 17474 | Trenex Company | Mountain View, Calif. |
| 02777 | Hopkins Engineering Co. | San Fernando, Calif. | 08289 | Blinn, Delbert Co. | Pomona, Calif. | 17675 | Hamlin Metal Products Corp. | Akron, Ohio |
| 03508 | G. E. Semiconductor Prod. Dept. | Syracuse, N. Y. | 08358 | Burgess Battery Co. | Niagara Falls, Ontario, Canada | 17745 | Angstrom Prec. Inc. | No. Hollywood, Calif. |
| 03705 | Apex Machine & Tool Co. | Dayton, Ohio | 08664 | Bristol Co., The | Waterbury, Conn. | 18042 | Power Design Pacific Inc. | Palo Alto, Calif. |
| 03797 | Eldema Corp. | Compton, Calif. | 08717 | Sloan Company | Sun Valley, Calif. | 18476 | Ty-Car Mfg. Co., Inc. | Holliston, Mass. |
| 03877 | Transitron Electric Corp. | Wakefield, Mass. | 08718 | ITT Cannon Electric Inc., Phoenix Div. | Phoenix, Arizona | 18486 | TRW Elect. Comp. Div. | Des Plaines, Ill. |
| 03888 | Pyrofilm Resistor Co., Inc. | Cedar Knolls, N. J. | 08792 | CBS Electronics Semiconductor Operations, Div. of C. B. S. Inc. | Lowell, Mass. | 18583 | Curtis Instrument, Inc. | Mt. Kisco, N. Y. |
| 03954 | Singer Co., Diehl Div. Finderne Plant | Somerville, N. J. | 08984 | Mel-Rain | Indianapolis, Ind. | 18873 | E. I. DuPont and Co., Inc. | Wilmington, Del. |
| 04009 | Arrow, Hart and Hegeman Elect. Co. | Hartford, Conn. | 09026 | Babcock Relays Div. | Costa Mesa, Calif. | 18911 | Durant Mfg. Co. | Milwaukee, Wis. |
| 04013 | Taurus Corp. | Lambertville, N. J. | 09134 | Texas Capacitor Co. | Houston, Texas | 19315 | Bendix Corp., The Eclipse-Pioneer Div. | Teterboro, N. J. |
| 04222 | Hi-Q Division of Aerovox | Myrtle Beach, S. C. | 09145 | Atohm Electronics | Sun Valley, Calif. | 19500 | Thomas A. Edison Industries, Div. of McGraw-Edison Co. | West Orange, N. J. |
| 04354 | Precision Paper Tube Co. | Chicago, Ill. | 09250 | Electro Assemblies, Inc. | Chicago, Ill. | 19644 | LRC Electronics | Horseheads, N. Y. |
| 04404 | Dymec Division of Hewlett-Packard Co. | Palo Alto, Calif. | 09569 | Mallory Battery Co. of Canada, Ltd. | Toronto, Ontario, Canada | 19701 | Electra Mfg. Co. | Independence, Kansas |
| 04651 | Sylvania Electric Products, Microwave Device Div. | Mountain View, Calif. | 10214 | General Transistor Western Corp. | Los Angeles, Calif. | 19718 | General Atronics Corp. | Philadelphia, Pa. |
| 04713 | Motorole, Inc., Semiconductor Prod. Div. | Phoenix, Arizona | 10411 | Ti-Tal, Inc. | Berkeley, Calif. | 21226 | Executone, Inc. | Long Island City, N. Y. |
| 04732 | Filtron Co., Inc. Western Div. | Culver City, Calif. | 10646 | Carborundum Co. | Niagara Falls, N. Y. | 21335 | Fafnir Bearing Co., The | New Britain, Conn. |
| 04773 | Automatic Electric Co. | Northlake, Ill. | 11236 | CTS of Berne, Inc. | Berne, Ind. | 21520 | Fansteel Metallurgical Corp. | N. Chicago, Ill. |
| 04796 | Sequoia Wire Co. | Redwood City, Calif. | 11237 | Chicago Telephone of California, Inc. | So. Pasadena, Calif. | 23783 | British Radio Electronics Ltd. | Washington, D. C. |
| 04811 | Precision Coil Spring Co. | El Monte, Calif. | 11242 | Bay State Electronics Corp. | Waltham, Mass. | 24455 | G. E. Lamp Division | Nela Park, Cleveland, Ohio |
| 04870 | P. M. Motor Company | Westchester, Ill. | 11312 | Teledyne Inc., Microwave Div. | Pelo Alto, Calif. | 24655 | General Radio Co. | West Concord, Mass. |
| 05006 | Twentieth Century Plastics, Inc. | Los Angeles, Calif. | 11534 | Duncan Electronics Inc. | Costa Mesa, Calif. | 26365 | Gries Reproducer Corp. | New Rochelle, N. Y. |
| 05277 | Westinghouse Electric Corp. Semi-Conductor Dept. | Youngwood, Pa. | 11711 | General Instrument Corp., Semiconductor Div., Products Group | Newark, N. J. | 26462 | Grobet File Co. of America, Inc. | Carlstadt, N. J. |
| 05347 | Ultronix, Inc. | San Mateo, Calif. | 11717 | Imperial Electronic, Inc. | Buena Park, Calif. | 26992 | Hamilton Watch Co. | Lancaster, Pa. |
| 05593 | Illumintron Engineering Co. | Sunnyvale, Calif. | 11870 | Melabs, Inc. | Palo Alto, Calif. | 28480 | Hewlett-Packard Co. | Pelo Alto, Calif. |
| 05616 | Cosmo Plastic (c/o Electrical Spec. Co.) | Cleveland, Ohio | 12136 | Philadelphia Handle Co. | Camden, N. J. | 33173 | G. E. Receiving Tube Dept. | Owensboro, Ky. |
| 05624 | Barber Colman Co. | Rockford, Ill. | 12697 | Clerostat Mfg. Co. | Dover, N. H. | 35434 | Lectrohm Inc. | Chicago, Ill. |
| 05728 | Tiffen Optical Co. | Roslyn Heights, Long Island, N. Y. | 12859 | Nippon Electric Co., Ltd. | Tokyo, Japan | 36196 | Stanwyck Coil Products Ltd. | 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. |

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

| Code No. | Manufacturer | Address | Code No. | Manufacturer | Address | Code No. | Manufacturer | Address |
|----------|---|--------------------------|----------|---|-------------------------|----------|--|--|
| 44655 | Ohmite Mfg. Co. | Skokie, Ill. | 72964 | Robert M. Hadley Co. | Los Angeles, Calif. | 80031 | Mepco Division of Sessions Clock Co. | Morristown, N. J. |
| 46384 | Penn Eng. & Mfg. Corp. | Doylestown, Pa. | 72982 | Erie Technological Products, Inc. | Erie, Pa. | 80120 | Schnitzer Alloy Products Co. | Elizabeth, N. J. |
| 47904 | Polaroid Corp. | Cmbridge, Mnss. | 73061 | Hansen Mfg. Co., Inc. | Princeton, Ind. | 80130 | Times Telephoto Equipment | New York, N. Y. |
| 48620 | Precision Thermometer & Inst. Co. | Southampton, Pa. | 73076 | H. M. Harper Co. | Chicago, Ill. | 80131 | Electronic Industries Association. | Any brand Tube meeting EIA Standards-Washington, DC. |
| 49956 | Microwave & Power Tube Div. | Waltham, Mnss. | 73138 | Helipot Div. of Beckmann Inst., Inc. | Fullerton, Calif. | 80207 | Unimux Switch, Div. Mnxon Electronics Corp. | Wilmington, Conn. |
| 52090 | Rowan Controller Co. | Westminster, Md. | 73293 | Hughes Products Division of Hughes Aircraft Co. | Newport Beach, Calif. | 80223 | United Transformer Corp. | New York, N. Y. |
| 52983 | Snnborn Company | Waltham, Mass. | 73445 | Amperex Electronic Co., Div. of North American Phillips Co., Inc. | Hicksville, N. Y. | 80248 | Oxford Electric Corp. | Chicago, Ill. |
| 54294 | Shallcross Mfg. Co. | Selma, N. C. | 73506 | Bradley Semiconductor Corp. | New Haven, Conn. | 80294 | Bourns Inc. | Riverside, Calif. |
| 55026 | Simpson Electric Co. | Chicago, Ill. | 73559 | Carling Electric, Inc. | Hartford, Conn. | 80411 | Acro Div. of Robertshaw Controls Co. | Columbus, Ohio |
| 55933 | Sonotone Corp. | Elmsford, N. Y. | 73682 | George K. Garrett Co., Div. MSL Industries Inc. | Philadelphin, Pa. | 80486 | All Star Products Inc. | Defiance, Ohio |
| 55938 | Rnytheon Co. Commercial Appnratus & Systems Div. | So. Norwnk, Conn. | 73734 | Federal Screw Products Inc. | Chicago, Ill. | 80509 | Avery Adhesive Label Corp. | Monrovin, Calif. |
| 56137 | Spaulding Fibre Co., Inc. | Tonnwnda, N. Y. | 73743 | Fischer Special Mfg. Co. | Cincinnati, Ohio | 80583 | Hammrlund Co., Inc. | New York, N. Y. |
| 56289 | Sprngun Electric Co. | North Adams, Mnss. | 73793 | General Industries Co., The | Elyria, Ohio | 80640 | Stevens, Arnold, Co., Inc. | Boston, Mnss. |
| 59446 | Telex, Inc. | St. Paul, Minn. | 73846 | Goshen Stamping & Tool Co. | Goshen, Ind. | 81030 | International Instruments Inc. | Orange, Conn. |
| 59730 | Thomns & Betts Co. | Elizabeth, N. J. | 73899 | JFD Electronics Corp. | Brooklyn, N. Y. | 81073 | Gryhill Co. | LnGrange, Ill. |
| 60741 | Triplett Electrical Inst. Co. | Bluffton, Ohio | 73905 | Jennings Radio Mfg. Corp. | San Josn, Calif. | 81095 | Trind Transformer Corp. | Venice, Calif. |
| 61775 | Union Switch and Signal, Div. of Westinghouse Air Brake Co. | Pittsburgh, Pa. | 74276 | Signilite Inc. | Neptune, N. J. | 81312 | Winchester Elec. Div. Litton Ind., Inc. | Oakville, Conn. |
| 62119 | Universl Electric Co. | Owosso, Mich. | 74455 | J. H. Winns, and Sons | Winchester, Mnss. | 81349 | Military Specification | ... |
| 63743 | Ward-Leonard Electric Co. | Mt. Vernon, N. Y. | 74861 | Industrial Condenser Corp. | Chicago, Ill. | 81483 | International Rectifier Corp. | El Segundo, Calif. |
| 64959 | Western Electric Co., Inc. | New York, N. Y. | 74868 | R. F. Products Division of Amphenol-Borg Electronics Corp. | Danbury, Conn. | 81541 | Airpax Electronics, Inc. | Cmbridge, Mnss. |
| 65092 | Weston Inst. Inc. Weston-Newnrk | Newark, N. J. | 74970 | E. F. Johnson Co. | Waseca, Minn. | 81860 | Barry Controls, Div. Barry Wright Corp. | Watertown, Mnss. |
| 66295 | Wittek Mfg. Co. | Chicago, Ill. | 75042 | Internntionnl Resistance Co. | Philndelphia, Pa. | 82042 | Carter Precision Electric Co. | Skokie, Ill. |
| 66346 | Revere Wolinnsnk Div. Minn. Mining & Mfg. Co. | St. Paul, Minn. | 75378 | CTS Knights Inc. | Sndwich, Ill. | 82047 | Sperti Frndry Inc., Copper Hewitt Electric Div. | Hoboken, N. J. |
| 70276 | Allen Mfg. Co. | Hartford, Conn. | 75382 | Kulka Electric Corporation | Mt. Vernon, N. Y. | 82142 | Jeffers Electronics Division of Speer Carbon Co. | Du Bois, Pa. |
| 70318 | Almetal Screw Product Co., Inc. | Garden City, N. Y. | 75818 | Lenz Electric Mfg. Co. | Chicago, Ill. | 82170 | Fairchild Cnmera & Inst. Corp., Defense Prod. Division | Clifton, N. J. |
| 70485 | Atlantic India Rubber Works, Inc. | Chicago, Ill. | 75915 | Littlefuse, Inc. | Des Plaines, Ill. | 82209 | Maguire Industries, Inc. | Greenwich, Conn. |
| 70563 | Amperite Co., Inc. | Union City, N. J. | 76005 | Lord Mfg. Co. | Erie, Pa. | 82219 | Sylvania Electric Prod. Inc. Electronic Tube Division | Emporium, Pa. |
| 70903 | Belden Mfg. Co. | Chicago, Ill. | 76210 | C. W. Marwedel | San Francisco, Calif. | 82376 | Astron Corp. | East Newnrk, Harrison, N. J. |
| 70998 | Bird Electronic Corp. | Cleveland, Ohio | 76487 | James Millen Mfg. Co., Inc. | Malden, Mass. | 82389 | Switchcraft, Inc. | Chicago, Ill. |
| 71002 | Birnback Radio Co. | New York, N. Y. | 76493 | J. W. Miller Co. | Los Angeles, Calif. | 82647 | Metals & Controls Inc. Spencer Products | Attleboro, Mnss. |
| 71041 | Boston Gear Works Div. of Murray Co. of Texas | Quincy, Mass. | 76530 | Cinch-Monndnock, Div. of United Carr Fastener Corp. | Snn Leandro, Calif. | 82768 | Phillips-Advnce Control Co. | Joliet, Ill. |
| 71218 | Bud Radio, Inc. | Willoughby, Ohio | 76545 | Mueller Electric Co. | Cleveland, Ohio | 82866 | Resenrch Products Corp. | Mndison, Wis. |
| 71286 | Camioc Fastener Corp. | Paramus, N. J. | 76703 | Nntionnl Union | Newnrk, N. J. | 82877 | Rotron Mfg. Co., Inc. | Woodstock, N. Y. |
| 71313 | Cardwell Condenser Corp. | Lindenhurst L. I., N. Y. | 76854 | Oek Manufacturing Co. | Crystal Lake, Ill. | 82893 | Vector Electronic Co. | Glendnie, Calif. |
| 71400 | Bussmann Mfg. Div. of McGraw-Edison Co. | St. Louis, Mo. | 77075 | Pncific Mtals Co. | Snn Francisco, Calif. | 83053 | Western Washer Mfg. Co. | Los Angeles, Calif. |
| 71436 | Chicago Condenser Corp. | Chicago, Ill. | 77221 | Phanostrn Instrument and Electronic Co. | South Pnsndnna, Calif. | 83058 | Cnrr Fastener Co. | Cmbridge, Mnss. |
| 71447 | Cnlf. Spring Co., Inc. | Pico-Rivera, Calif. | 77252 | Philadelphia Steel and Wire Corp. | Philadelphin, Pa. | 83086 | New Hampshire Ball Bearing, Inc. | Peterborough, N. H. |
| 71450 | CTS Corp. | Elkhart, Ind. | 77342 | American Machine & Foundry Co. Potter & Brumfield Div. | Princetnn, Ind. | 83125 | General Instrument Corp., Capacitor Div. | Dnrllington, S. C. |
| 71468 | ITT Cannon Electric Inc. | Los Angeles, Calif. | 77630 | TRW Electronic Components Div. | Camden, N. J. | 83148 | ITT Wire and Cable Div. | Los Angeles, Calif. |
| 71471 | Cinema Plant, Hi-Q Div. Aerovox Corp. | Burbnkn, Calif. | 77638 | General Instrument Corp., Rectifier Div. | Brooklyn, N. Y. | 83186 | Victory Engineering Corp. | Springfield, N. J. |
| 71482 | C. P. Clare & Co. | Chicago, Ill. | 77764 | Resistance Products Co. | Hnrrisburg, Pa. | 83298 | Bendix Corp., Red Bank Div. | Red Bnkn, N. J. |
| 71590 | Centrnlnb Div. of Globe Union Inc. | Chicago, Ill. | 77969 | Rubbercraft Corp. of Calif. | Torrance, Calif. | 83315 | Hubbell Corp. | Mundelein, Ill. |
| 71616 | Commercial Plastics Co. | Milwaukee, Wis. | 78189 | Shakeproof Division of Illinois Tool Works | Elgin, Ill. | 83330 | Smith, Herman H., Inc. | Brooklyn, N. Y. |
| 71700 | Cornish Wire Co., The | New York, N. Y. | 78283 | Signal Indicator Corp. | New York, N. Y. | 83385 | Central Screw Co. | Chicago, Ill. |
| 71707 | Coto Coil Co., Inc. | Providence, R. I. | 78290 | Struthers-Dunn Inc. | Pitmn, N. J. | 83501 | Gavitt Wire and Cable Co. Div. of Amerace Corp. | Brookfield, Mnss. |
| 71744 | Chicago Miniature Lamp Works | Chicago, Ill. | 78452 | Thompson-Bremer & Co. | Chicago, Ill. | 83594 | Burroughs Corp. Electronic Tube Div. | Pininfeld, N. J. |
| 71753 | A. O. Smith Corp., Crowley Div. | West Orange, N. J. | 78471 | Tilley Mfg. Co. | Snn Francisco, Calif. | 83740 | Union Carbide Corp. Consumer Prod. Div. | New York, N. Y. |
| 71785 | Cinch Mfg. Co., Howard B. Jones Div. | Chicago, Ill. | 78488 | Stackpole Carbon Co. | St. Mnrys, Pa. | 83777 | Model Eng. and Mfg., Inc. | Huntington, Ind. |
| 71984 | Dow Corning Corp. | Midland, Mich. | 78493 | Stndrd Thomson Corp. | Waltham, Mass. | 83821 | Loyd Scruggs Co. | Festus, Mo. |
| 72136 | Electro Motive Mfg. Co., Inc. | Williamantic, Conn. | 78553 | Tinnermn Products, Inc. | Cleveland, Ohio | 83942 | Aeronntical Inst. & Radio Co. | Lodi, N. J. |
| 72354 | John E. Fast Co., Div. Victoreen Instr. Co. | Chicago, Ill. | 78790 | Transformer Engineers | San Gabriel, Calif. | 84171 | Arco Electronics Inc. | Great Neck, N. Y. |
| 72619 | Dialight Corp. | Brooklyn, N. Y. | 78947 | Ucinite Co. | Newtonville, Mass. | 84396 | A. J. Glesener Co., Inc. | Snn Francisco, Calif. |
| 72656 | Indinnn General Corp., Electronics Div. | Kensby, N. J. | 79136 | Waldes Kohinoor Inc. | Long Island City, N. Y. | 84411 | TRW Capacitor Div. | Ogallala, Neb. |
| 72699 | General Instrument Corp., Cnp. Div. | Newark, N. J. | 79142 | Veeder Root, Inc. | Hartford, Conn. | 84970 | Sarkes Trnzian, Inc. | Bloomington, Ind. |
| 72765 | Drake Mfg. Co. | Chicago, Ill. | 79251 | Wenco Mfg. Co. | Chicago, Ill. | 85454 | Boonton Molding Company | Boonton, N. J. |
| 72825 | Hugh H. Eby Inc. | Philndelphin, Pa. | 79272 | Continental-Wirt Electronics Corp. | Philadelphia, Pa. | | | |
| 72928 | Gudeman Co. | Chicago, Ill. | 79963 | Zierick Mfg. Corp. | New Rochelle, N. Y. | | | |

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

| Code No. | Manufacturer | Address | Code No. | Manufacturer | Address | Code No. | Manufacturer | Address |
|----------|---|--------------------------|----------|---|----------------------|----------|--|----------------------|
| 85471 | A. B. Boyd Co. | San Francisco, Calif. | 94137 | General Cable Corp. | Bayonne, N. J. | 98376 | Zero Mfg. Co. | Burbank, Calif. |
| 85474 | R. M. Bracamonte & Co. | San Francisco, Calif. | 94144 | Raytheon Co., Comp. Div., Ind. Comp. Operations | Quincy, Mass. | 98731 | General Mills Inc., Electronics Div. | Minneapolis, Minn. |
| 85660 | Koiled Kords, Inc. | Hamden, Conn. | 94148 | Scientific Electronics Products, Inc. | Loveland, Colo. | 98734 | Paeco Div. of Hewlett-Packard Co. | Palo Alto, Calif. |
| 85911 | Seamless Rubber Co. | Chicago, Ill. | 94154 | Tung-Sol Electric, Inc. | Newark, N. J. | 98821 | North Hills Electronics, Inc. | Glen Cove, N. Y. |
| 86197 | Clifton Precision Products Co., Inc. | Clifton Heights, Pa. | 94197 | Curtiss-Wright Corp. Electronics Div. | East Paterson, N. J. | 98978 | International Electronic Research Corp. | Burbank, Calif. |
| 86579 | Precision Rubber Products Corp. | Dayton, Ohio | 94222 | South Chester Corp. | Chester, Pa. | 99109 | Columbia Technical Corp. | New York, N. Y. |
| 86684 | Radio Corp. of America, Electronic Comp. & Devices Div. | Harrison, N. J. | 94310 | Tru-Ohm Products Memcor Components Div. | Huntington, Ind. | 99313 | Varian Associates | Palo Alto, Calif. |
| 87034 | Marco Industries | Anaheim, Calif. | 94330 | Wire Cloth Products, Inc. | Bellwood, Ill. | 99378 | Atlee Corp. | Winchester, Mass. |
| 87216 | Philco Corporation (Lansdale Division) | Lansdale, Pa. | 94682 | Worcester Pressed Aluminum Corp. | Worcester, Mass. | 99515 | Marshall Ind. Elect. Products Div. | San Marino, Calif. |
| 87473 | Western Fibrous Glass Products Co. | San Francisco, Calif. | 94696 | Magnecraft Electric Co. | Chicago, Ill. | 99707 | Control Switch Division, Controls Co. of America | El Segundo, Calif. |
| 87664 | Van Waters & Rogers Inc. | San Francisco, Calif. | 95023 | George A. Philbrick Researchers, Inc. | Boston, Mass. | 99800 | Delevan Electronics Corp. | East Aurora, N. Y. |
| 87930 | Tower Mfg. Corp. | Providence, R. I. | 95236 | Allies Products Corp. | Miami, Fla. | 99848 | Wilco Corporation | Indianapolis, Ind. |
| 88140 | Cutler-Hammer, Inc. | Lincoln, Ill. | 95238 | Continental Connector Corp. | Woodside, N. Y. | 99934 | Renbrandt, Inc. | Boston, Mass. |
| 88220 | Gould-National Batteries, Inc. | St. Paul, Minn. | 95263 | Leecraft Mfg. Co., Inc. | Long Island, N. Y. | 99942 | Hoffman Electronics Corp. Semiconductor Div. | El Monte, Calif. |
| 88421 | Federal Telephone & Radio Corp. | Clifton, N. J. | 95264 | Larco Electronics, Inc. | Burbank, Calif. | 99957 | Technology Instrument Corp. of Calif. | Newbury Park, Calif. |
| 88698 | General Mills, Inc. | Buffelo, N. Y. | 95265 | National Coil Co. | Sheridan, Wyo. | | | |
| 89231 | Graybar Electric Co. | Oakland, Calif. | 95275 | Vitramon, Inc. | Bridgeport, Conn. | | | |
| 89665 | United Transformer Co. | Chicago, Ill. | 95348 | Gordos Corp. | Bloomfield, N. J. | | | |
| 90179 | US Rubber Co., Consumer Ind. & Plastics Prod. Div. | Passaic, N. J. | 95354 | Methode Mfg. Co. | Chicago, Ill. | | | |
| 90970 | Bearing Engineering Co. | San Francisco, Calif. | 95712 | Dage Electric Co., Inc. | Franklin, Ind. | | | |
| 91260 | Connor Spring Mfg. Co. | San Francisco, Calif. | 95984 | Siemon Mfg. Co. | Wayne, Ill. | | | |
| 91345 | Miller Dial & Nameplate Co. | El Monte, Calif. | 95987 | Weckesser Co. | Chicago, Ill. | | | |
| 91418 | Radio Materials Co. | Chicago, Ill. | 96067 | Huggins Laboratories | Sunnyvale, Calif. | | | |
| 91506 | Augat Inc. | Attleboro, Mass. | 96095 | Hi-Q Div. of Aerovox Corp. | Olean, N. Y. | | | |
| 91637 | Dale Electronics, Inc. | Columbus, Nebr. | 96256 | Thordarson-Meissner Inc. | Mt. Carmel, Ill. | | | |
| 91662 | Elco Corp. | Willow Grove, Pa. | 96296 | Solar Manufacturing Co. | Los Angeles, Calif. | | | |
| 91737 | Gremer Mfg. Co., Inc. | Wakefield, Mass. | 96330 | Carlton Screw Co. | Chicago, Ill. | | | |
| 91827 | K F Development Co. | Redwood City, Calif. | 96341 | Microwave Associates, Inc. | Burlington, Mass. | | | |
| 91929 | Honeywell Inc., Micro Switch Div. | Freeport, Ill. | 96501 | Excel Transformer Co. | Oakland, Calif. | | | |
| 91961 | Nahm-Bros. Spring Co. | Oakland, Calif. | 97464 | Industrial Retaining Ring Co. | Irvington, N. J. | | | |
| 92180 | Tru-Connector Corp. | Peabody, Mass. | 97539 | Automatic & Precision Mfg. | Englewood, N. J. | | | |
| 92367 | Elgeet Optical Co. Inc. | Rochester, N. Y. | 97979 | Reon Resistor Corp. | Yonkers, N. Y. | | | |
| 92196 | Universal Industries, Inc. | City of Industry, Calif. | 97983 | Litton System Inc., Adler-Westrex Commun. Div. | New Rochelle, N. Y. | | | |
| 92607 | Tensolite Insulated Wire Co., Inc. | Tarrytown, N. Y. | 98141 | R-Troncis, Inc. | Jamaica, N. Y. | | | |
| 93332 | Sylvania Electric Prod. Inc. Semiconductor Div. | Woburn, Mass. | 98159 | Rubber Teck, Inc. | Gardene, Calif. | | | |
| 93369 | Robbins and Myers, Inc. | New York, N. Y. | 98220 | Hewlett-Packard Co., Moseley Div. | Pasadena, Calif. | | | |
| 93410 | Stevens Mfg. Co., Inc. | Mansfield, Ohio | 98278 | Microdot, Inc. | So. Pasadena, Calif. | | | |
| 93929 | G. V. Controls | Livingston, N. J. | 98291 | Sealectro Corp. | Mamaroneck, N. Y. | | | |

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

| | | |
|-------|--|----------------------|
| 0000F | Malco Tool and Die | Los Angeles, Calif. |
| 0000M | Western Coil Div. of Autometric Ind., Inc. | Redwood City, Calif. |
| 0000Z | Willow Leather Products Corp. | Newark, N. J. |
| 000AA | British Radio Electronics Ltd. | Washington, D. C. |
| 000AB | ETA | England |
| 000BB | Precision Instrument Components Co. | Van Nuys, Calif. |
| 000MM | Rubber Eng. & Development | Hayward, Calif. |
| 000NN | A "N" D Mfg. Co. | San Jose, Calif. |
| 000QQ | Cooltron | Oakland, Calif. |
| 000WW | California Eastern Lab. | Burlington, Calif. |
| 000YY | S. K. Smith Co. | Los Angeles, Calif. |

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APPENDIX I MANUAL CHANGES

This appendix contains information on changes required to adapt this manual to an instrument with a serial prefix listed in the table below. Check for your instrument serial prefix and make numbered 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 back 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 |
|-----------------------------|--------------------------|
| 630- | 1 |
| 627- | 1, 2 |
| 614- | 1 thru 3 |
| 548- | 1 thru 4 |
| 537- | 1 thru 5 |
| 503- | 1 thru 6 |
| 445- | 1 thru 7 |
| 438- | 1 thru 8 |
| 425- | 1 thru 9 |
| 344- | 1 thru 10 |
| 336- | 1 thru 11 |
| 335- | 1 thru 12 |
| 320-, 317- | 1 thru 13 |
| 312- | 1 thru 14 |
| 309- | 1 thru 15 |

CHANGE 1

Figure 5-20,
Change value of R405, R406 to 10k ohms.

Table 6-2,
Change R405, R406 to hp Part No. 0727-0157;
R: fxd,depc,10k ohms,1%,1/2w; Mfr hp.
Change R407, R408 to hp Part No. 0727-0043; R:
fxd,depc,100 ohms,1%,1/2w; Mfr hp.

Note: If any of these resistors must be replaced, it is recommended that all four be replaced with parts presently listed in Table 6-2.

CHANGE 2

Figure 5-20 and Table 6-2,
Delete CR423 and CR443.

CHANGE 3

Figure 5-11 and Table 6-2,
Delete CR112.

CHANGE 4

Figure 5-7,
Change value of C23* to 6800 pf.
Delete C27*.
Figure 5-16,
Change value of C236* to 100 pf.

CHANGE 4 (cont'd)

Change value of C237* to .015 μ f.
Table 6-2,
Change C23 to hp Part No. 0160-0159; C: fxd,my,
6800pf,10%,200vdcw.
Delete C27.
Change C236 to hp Part No. 0160-0153; C: fxd,my
100 pf,10%,200vdcw.
Change C237 to hp Part No. 0160-0194; C: fxd,my,
.015 μ f,10%,200vdcw.
Change Q3, Q4, Q203, Q204 to hp Part No.
1850-0097; Q: ge pnp; Mfr hp.

CHANGE 5

Figure 5-7,
Delete C26.
Figure 5-16,
Delete C243.
Table 6-2,
Delete C26 and C243.

CHANGE 6

Figure 5-7,
Delete CR1 and CR2.
Figure 5-16,
Delete CR201 and CR202.
Table 6-2,
Delete CR1, CR2, CR201, and CR202.

CHANGE 7

Figure 5-7,
Change value of C24 to 1000 μ f.
Figure 5-16,
Change value of C238 to 100 μ f.
Table 6-2,
Change C24 and C238 to C: fxd, elect, 100 μ f,
+100%-10%, 10vdcw; hp Part No. 0180-0146,
Mfr 56289; Mfr Part No. D35387.

CHANGE 8

Table 1-1,
Change specification for Bandwidth, AC coupled
(input) to read "10 cps to 500 kc".
Figure 5-7,
Change C9 and C10 each to .022 μ f.
Figure 5-16,
Change C209 and C210 each to .022 μ f.
Table 6-2,
Change C9, C10, C209, C210 to C: fxd, my,
.002 μ f, 10% 600vdcw; hp Part No. 0160-0003;
Mfr 56289; Mfr Part No. 160P22396.

CHANGE 9

Figure 5-20,

Change value of C444 and C465 to .01 μ f.

Table 6-2,

Change C444 and C465 to C: fxd, cer, .01 μ f, 20%
1000vdcw; hp Part No. 0150-0012; Mfr 56289;
Mfr Part No. H1038.**CHANGE 10**

Figure 5-7,

Change value of R40 to 9 ohms.

Table 6-2,

Change R40 to R: fxd, ww, 9 ohms, 10%, 5w; hp
Part No. 0813-0016; Mfr 35434; Mfr Part No.
C-5-9.**CHANGE 11**

Figure 5-7,

Change value of R30 to 9.76 ohms.

Figure 5-16,

Change value of R260 to 7.50 ohms.

Table 6-2,

Change Q3, Q4, Q203, Q204 to Transistor: PNP
Ge; hp Part No. 1950-0097; Mfr 73445; Mfr
Part No. 2N2084.Change R30 to R: fxd, depc, 9.93 ohms, 1%, 1/2w,
hp Part No. 0727-0430; Mfr hp.Change R260 to R: fxd, depc, 7.68 ohms, 1%, 1/2w;
hp Part No. 0727-0421; Mfr 19701; Mfr Part
No. DC 1/2 AR5.

Note: Some instruments may have a shunt resistor
to obtain correct value for R30 and R260. For re-
placement, order by new stock number above.

CHANGE 12

Table 6-2,

Change assembly part numbers as follows:

| | |
|------------------|------------------|
| A1 to 130C-65A | A201 to 130C-65B |
| A2 to 130C-19A | A202 to 130C-19B |
| A5 to 130C-65F | A205 to 130C-65F |
| A101 to 130C-65C | A301 to 130C-65E |
| A102 to 130C-19D | A401 to 130C-65D |
| A175 to 130C-19C | |

Note: This change involved a mechanical change
only, resulting in new PC board material and con-
sequently different size edge-on connectors. When
old part numbers as listed above are ordered, new
part numbers as listed in Section VI will be

shipped. The edge-on connectors may be bent to
fit when matching old and new assemblies.

CHANGE 13

Figure 5-20,

Change value of R482 to 12K ohms.

Table 6-2,

Change CR482 to hp Part No. 1902-0031.

Change R482 to R: fxd, comp, 12K ohms, 10%,
1w; hp Part No. 0690-1231; Mfr 01121; Mfr
Part No. GB 1231.**CHANGE 14**

Figure 5-11,

Delete C122, 1000 μ f.

Figure 5-13,

Change value of R184 to 4.5 megohms.

Change value of R185 to 1.8 megohms.

Figure 5-18,

Change R329A/B each to 10K ohms.

Delete R330, 100 ohms.

Table 6-2,

Delete C122, hp Part No. 0150-0069.

Change L302, hp Part No. to 5060-0409.

Change R184 to R: fxd, depc, 4.5 megohms, 1%
1w; hp Part No. 0730-0157; Mfr 19701; Mfr
Part No. DC 1 R5.Change R185 to R fxd, depc, 1.8 megohms, 1%
1/2w; hp Part No. 0727-0285; Mfr 19701; Mfr
Part No. DC 1/2 CR5.Change R329 to R: var, ganged, 10K ohms, 20%,
lin, 1/4w; hp Part No. 2100-0150; Mfr hp.

Delete R330, hp Part No. 0687-1011.

CHANGE 15

Figure 5-7,

Change wht lead from emitter of Q3 and junction
of R21-R22 to wht-gra.Change wht-gra lead from emitter of Q4 and wiper
of S1F to wht.

Figure 5-16,

Add C243, .001 μ f, in parallel with R258.Lift "WHT-YEL" lead from fixed contacts of switch
S202H and reconnect it to R251-R252 junction.Lift "WHT-GRA" lead from R259-R260 junction
and reconnect it to movable arm of switch S203.

Table 6-2,

Add C243, C: fxd, .001 μ f, 10%, hp Part No.
0160-0153; Mfr 56289; Mfr Part No.
192P10292.

APPENDIX II OPTIONS

OPTION 05

This option consists of an external graticule type CRT instead of the internal graticule type normally installed in the Oscilloscope. The graticule illuminating circuit as shown in Figure II-1 is also included in this option, while the TRACE ALIGN circuit (L302, R329A/B) has been removed. Illumination of the external graticule is controlled by the SCALE control that has been added to the front panel in place of the TRACE ALIGN control. Refer to Table II-1 for replaceable parts for this option.

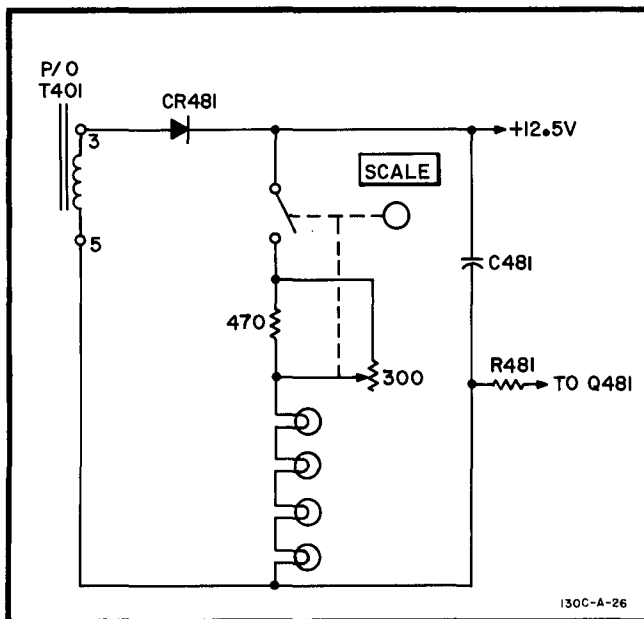


Figure II-1. Option 05 Schematic Diagram

OPTION 06

This option consists of rear panel connectors wired in parallel with the vertical, horizontal, and trigger inputs on the front panel of the Oscilloscope. Refer to

Figure II-2 for the connector wiring schematics. Mating plugs (and cable clamps) for the three-pin connectors are also supplied with this option. Refer to Table II-1 for replaceable parts of this option. The added vertical and horizontal input connectors cause some increase of input capacitance; however, this increase will not cause the input capacitance to exceed 100 pf.

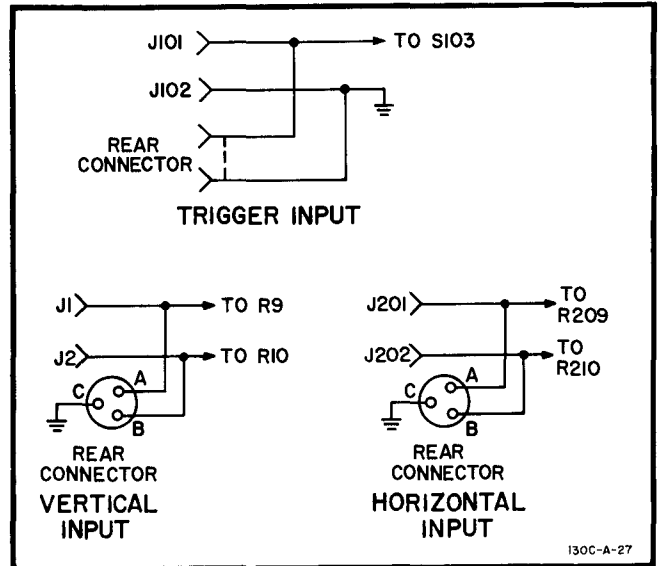


Figure II-2. Option 06 Schematic Diagram

OPTION 13

This option consists of a special front panel for the Oscilloscope. The special panel is a 6-31/32 in. x 19 in. x 3/16 in. rack-mount slab panel without handles. Installation of this special panel necessitates the removal of some of the standard components and the addition of several special components, as listed in Table II-1.

Table II-1. Replaceable Parts for Options

| Ref Desig | hp Part No. | RS | TQ | Description (See Table 6-1.) | Mfr | Mfr Part No. |
|---|-------------|----|----|--|-------|---------------------|
| OPTION 05 | | | | | | |
| | 120A-83C | 0 | | Graticule: scribed | hp | |
| | 120A-83C-1 | 0 | | Graticule: unscribed | hp | |
| | 120A-83A | 0 | | Filter: amber | hp | |
| | 120A-83B | 0 | | Filter: blue | hp | |
| | 120A-83G | 0 | | Filter: green | hp | |
| | 0170-0084 | 0 | 1 | Knob: black (scale) | hp | |
| | 0693-4711 | 1 | 1 | R: fxd comp 470 ohms 10% 2w | hp | |
| | 1450-0154 | 1 | 4 | Lampholder: miniature | hp | |
| | 2100-1838 | 1 | 1 | R: var comp 300 ohms 20% 1w with spst switch | hp | |
| | 2140-0057 | 4 | 4 | DS: 6 volt incandescent | 24455 | 1768 |
| | 5083-0310 | 0 | | V: crt P1 phosphor w/o internal graticule | hp | |
| | 5083-0320 | 0 | | V: crt P2 phosphor w/o internal graticule | hp | |
| | 5083-0330 | 0 | | V: crt P7 phosphor w/o internal graticule | hp | |
| | 5083-0340 | 0 | | V: crt P11 phosphor w/o internal graticule | hp | |
| | 5083-0350 | 0 | | V: crt P31 phosphor w/o internal graticule | hp | |
| OPTION 06 | | | | | | |
| | 1250-0083 | 0 | 1 | J: BNC (type UG-1094/U) | hp | |
| | 1251-0038 | 0 | 2 | P: female 3-pin (cable mount) | 71469 | CA310610SL-3S-A105 |
| | 1251-0039 | 0 | 2 | J: male 3-pin (bulkhead mount) | 71469 | CA3102A10SL-3P-A105 |
| | 1251-0040 | 0 | 2 | E: clamp cable | 71469 | AN3057-4 |
| | 130C-16V | 0 | 1 | Cable: rear horiz and vert input | hp | |
| | 130C-16W | 0 | 1 | Cable: rear sync input | hp | |
| OPTION 13 | | | | | | |
| Delete the following standard components: | | | | | | |
| | 130C-2A | | 1 | Panel: front | | |
| | 3101-0040 | | 3 | S: slide dual dpdt (A3, A103, and A203) | | |
| | 5060-0734 | | 2 | Casting: frame side | | |
| | 5060-0763 | | 2 | Handle: side | | |
| | 5060-0765 | | 2 | Retainer: handle | | |
| | 5060-0767 | | 5 | Foot: plastic | | |
| | 5060-0776 | | 1 | Kit: rack mount | | |
| | 5000-0052 | | 2 | Plate: trim adhesive back | | |
| Add the following special components: | | | | | | |
| | 130C-2E | 0 | 1 | Panel: front | hp | |
| | 120B-37A | 0 | 2 | Bar: panel mounting | hp | |
| | 120B-47A | 0 | 2 | Support: panel | hp | |
| | 120B-5B | 0 | 2 | Casting: frame side | hp | |
| | 3101-0928 | 1 | 3 | S: slide dual dpdt (A3, A103, and A203) | 42190 | 6603-A2 SPEC |



MANUAL CHANGES

MODEL 130C

OSCILLOSCOPE

Manual Serials Prefixed: 644-

Manual Printed: NOV 1966

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

| Serial Prefix or Number | Make Manual Changes | Serial Prefix or Number | Make Manual Changes |
|-------------------------|---------------------|-------------------------|---------------------|
| 819- | 1, 2 | | |
| 833- | 1, 3 | | |
| 938- | 1, 3, 4 | | |
| | | | |

ERRATA

Table 6-2,

Q421, Q441, Q461: Change to hp Part No. 1850-0422; Q: Ge pnp; Mfr hp (preferred replacement).

R15, R16: Change value to 900 k ohms.

Under Miscellaneous,

Add hp Part No. 5050-0440; Cover: CRT socket access; Mfr hp.

Appendix II, Table II-1, Option 13,

Delete Entry for 120B-37A.

Add hp Part No. 130C-37A; Bar: panel mounting right; Mfr hp.

Add hp Part No. 130C-37B; Bar: panel mounting left; Mfr hp.

Change hp Part No. 120B-5B to 120B-5C.

CHANGE 1

Page 1-0, Table 1-1,

Change Vertical and Horizontal Amplifiers, Internal Calibrator specification to read as follows:

"Line frequency square wave, 5 cm \pm 3%. Automatically connected . . . to CAL."

Change General, Calibrator specification to read as follows:

"Line frequency square wave, 500 mv \pm 2% available at front panel."

Page 3-3, Paragraph 3-17, step e,

Change SWEEP TIME setting to 10 MILLISECONDS/CM.

Page 4-5, Paragraph 4-33, 7th line from bottom,

Change "350 cps" to "line frequency".

Page 5-15, Paragraph 5-83, step b,

Change SWEEP TIME setting to 10 MILLISECONDS/CM.

Table 6-2,

C401: Delete.

△ Add C402: hp Part No. 0180-0376; C: fxd ta 0.47 uF 10% 35 vdcw; Mfr hp.

Add CR401: hp Part No. 1901-0040; CR: si; Mfr hp.

Add Q401: hp Part No. 1854-0215; Q: si npn; Mfr hp.

R403, R404: Delete.

Add R409: hp Part No. 0757-0449; R: fxd metflm 20 k ohms 1% 1/8w; Mfr hp.

Add R410: hp Part No. 0757-0765; R: fxd metflm 36.5 k ohms 1% 1/4w; Mfr hp.

Add R412: hp Part No. 0757-0438; R: fxd metflm 5110 ohms 1% 1/8w; Mfr hp.

Add R413: hp Part No. 0698-3132; R: fxd metflm 261 ohms 1% 1/8w; Mfr hp.

V401, V402: Delete.

9 January 1970

Supplement A for
130C-905

△ = Latest additions to this change sheet.

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

| Instrument Serial Prefix | Make Manual Changes | Instrument Serial Prefix | Make Manual Changes |
|--------------------------|---------------------|--------------------------|---------------------|
| 819- | 1, 2 | | |
| 833- | 1, 3 | | |
| 938- | 1, 3, 4 | | |
| | | | |

CHANGE 2

Page 5-25, Figure 5-20,

Replace Calibrator portion of schematic with Figure 1 (cut out and permanently attach in manual). Note: New calibrator components are located in same area of LVPS circuit board, A401.

Table 6-2,

A401: Change to hp Part No. 130C-65N, Mfr hp.

Add R411: hp Part No. 0757-0441; R: fxd metflm 8250 ohms 1% 1/8w; Mfr hp.

Add R412: hp Part No. 0757-0438; R: fxd metflm 5110 ohms 1% 1/8w; Mfr hp.

CHANGE 3

Page 5-25, Figure 5-20,

Replace Calibrator portion of schematic with Figure 2 (cut out and permanently attach in manual). Note: New calibrator components are located in same area of LVPS circuit board, A401.

Table 6-2,

A401: Change to hp Part No. 130C-65P; Mfr hp.

A402: Change to hp Part No. 2100-2743 var 5000-5000-3000 ohms, 3%, 1/4w; Mfr hp.

Add R411: hp Part No. 0757-0443 fxd metflm 11 k ohms 1% 1/8w; Mfr hp.

Δ CHANGE 4

Page 5-25, Figure 5-20,

Add diodes CR424, CR444, and CR464, respectively, between bases and emitters of Q421, Q441, and Q461, In each case connect the anodes of the diodes to the bases of the transistors and the cathodes of the diodes to the emitters of the transistors.

Page 6-5, Table 6-2,

Add CR424, CR444, and CR464: hp Part No. 1901-0026.

Change Reference Designators not assigned to CR425-CR440, CR445-CR460, and CR464-CR480.

Page 6-6, Table 6-2,

Change Q421, Q441, and Q461 to Q: si pnp 2N3792; no hp Part No.

9 January 1970

Δ = Latest additions to this change sheet.

Figure 1.

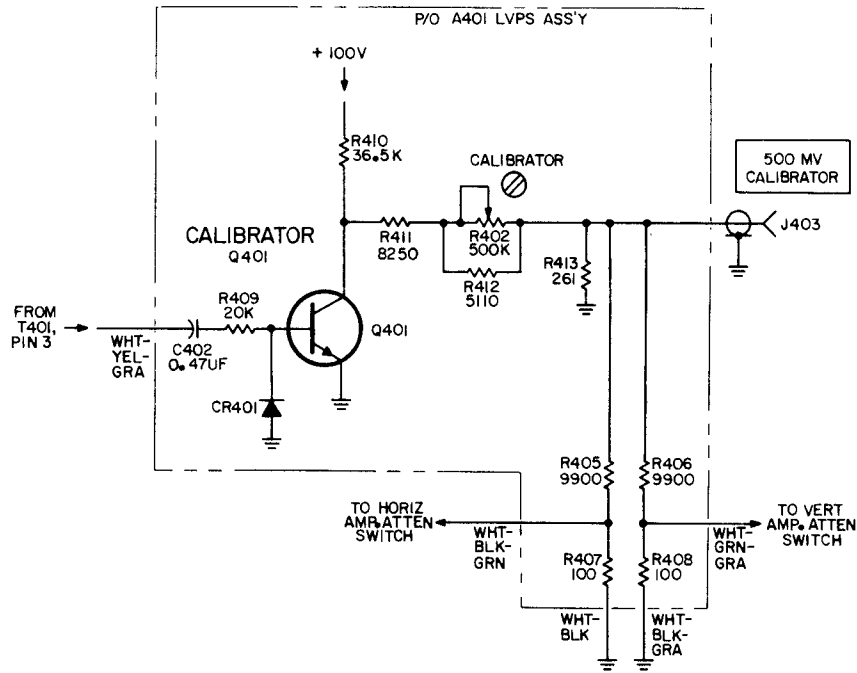
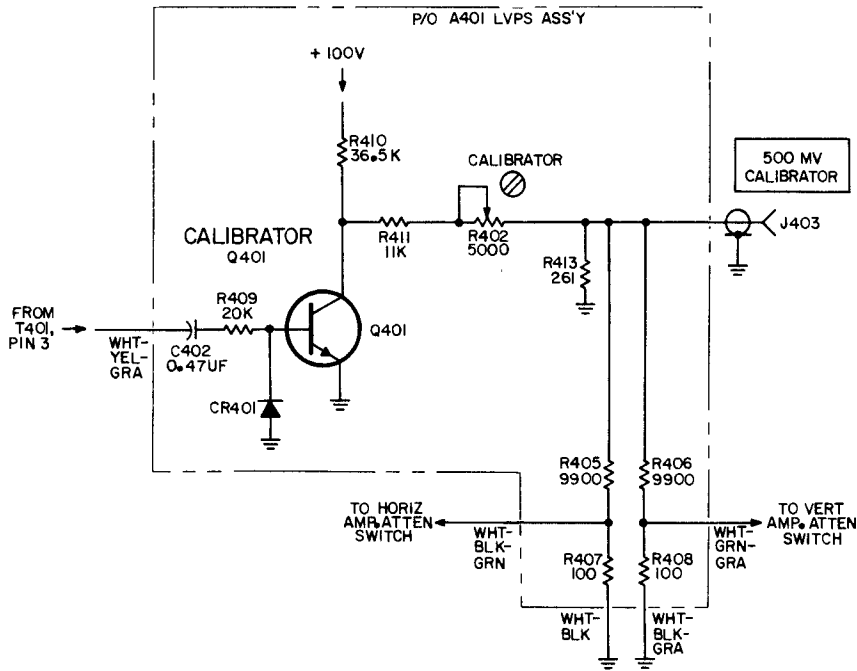


Figure 2.





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