OPERATING AND SERVICE MANUAL

OSCILLOSCOPE

130C

HEWLETT hp PACKARD

HP 130C

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

OPERATING AND SERVICE MANUAL

MODEL 130C
OSCILLOSCOPE

SERIALS PREFIXED: 644-

(For Other Serial Prefix Instruments See Section I And Appendix 1)

For Instruments With Options,
See Section I

01879-5

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Table 1-1. Specifications

SWEEP GENERATOR

INTERNAL SWEEP: 21 ranges, 1 μsec/cm to 5 sec/cm, accuracy within ±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 ±5% for sweep rates which do not exceed a maximum rate of 0.2 μsec/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 ±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 mv ±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 ±1° 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 ±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.

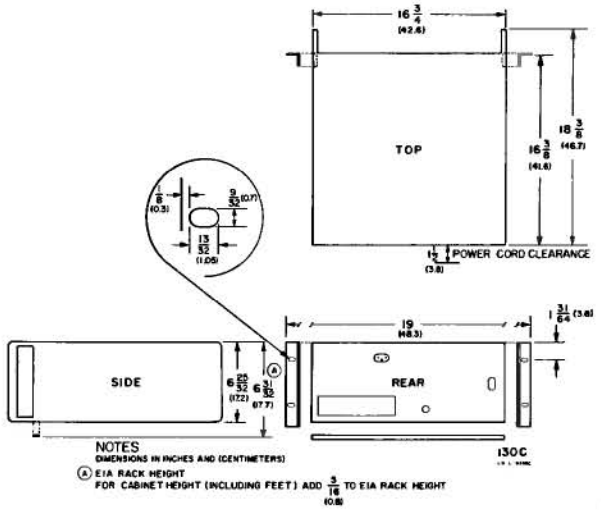
INTERNAL GRATICULE: Parallax-free 10 cm x 10 cm marked in cm squares. 2 mm subdivisions on major horizontal and vertical axis.

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 ±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.

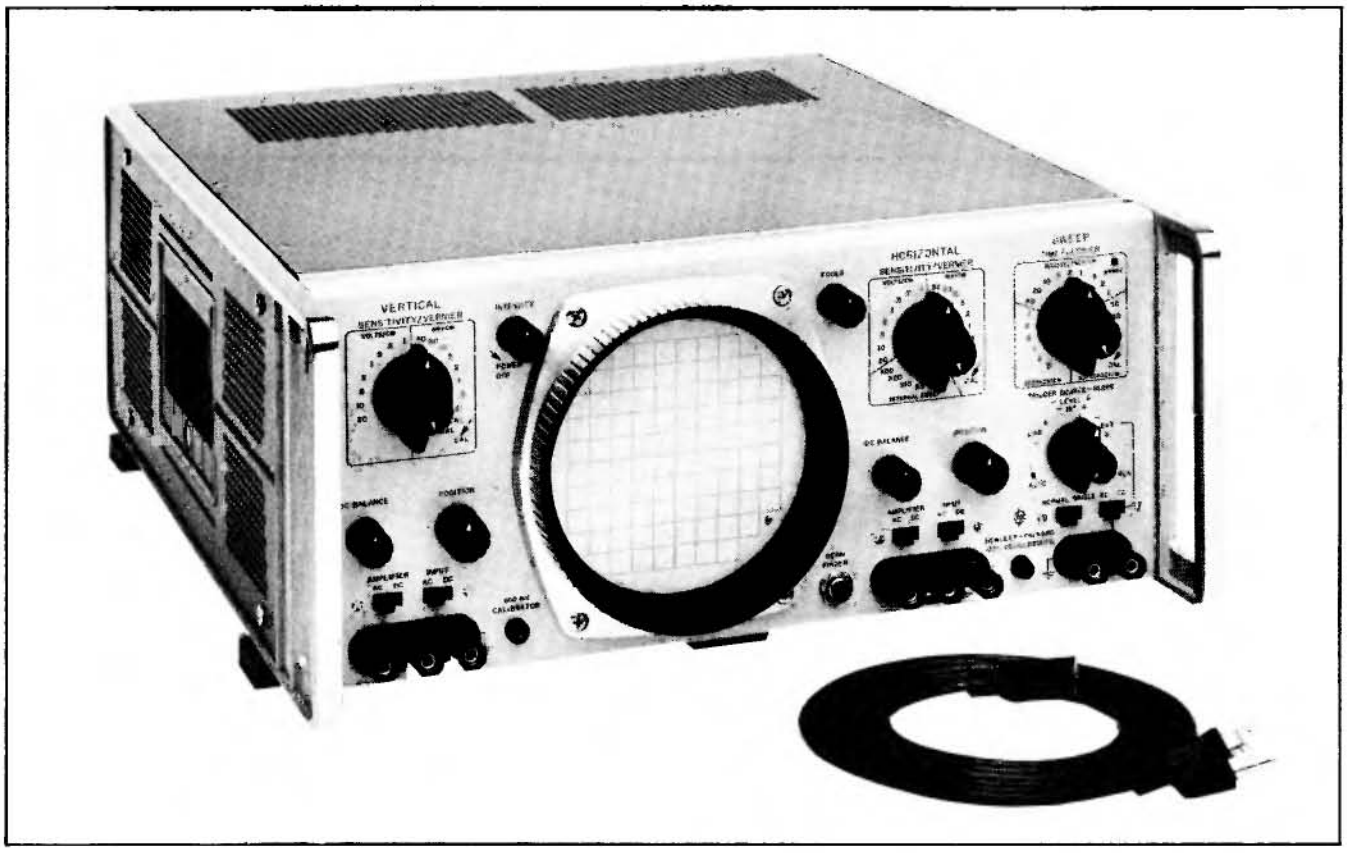


Figure 1-1. Model 130C Oscilloscope

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 ±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 since 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:

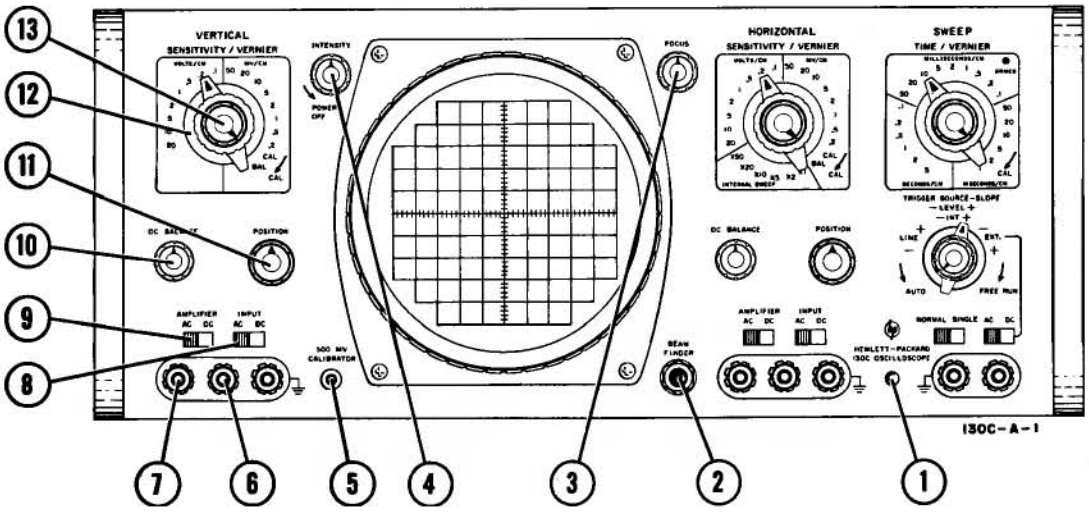
a. Set filter into bezel, aligning the large rectangular slots in the filter edge with guides in the bezel casting and sliding the filter down into the casting.

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 indentical 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 1μsec/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.

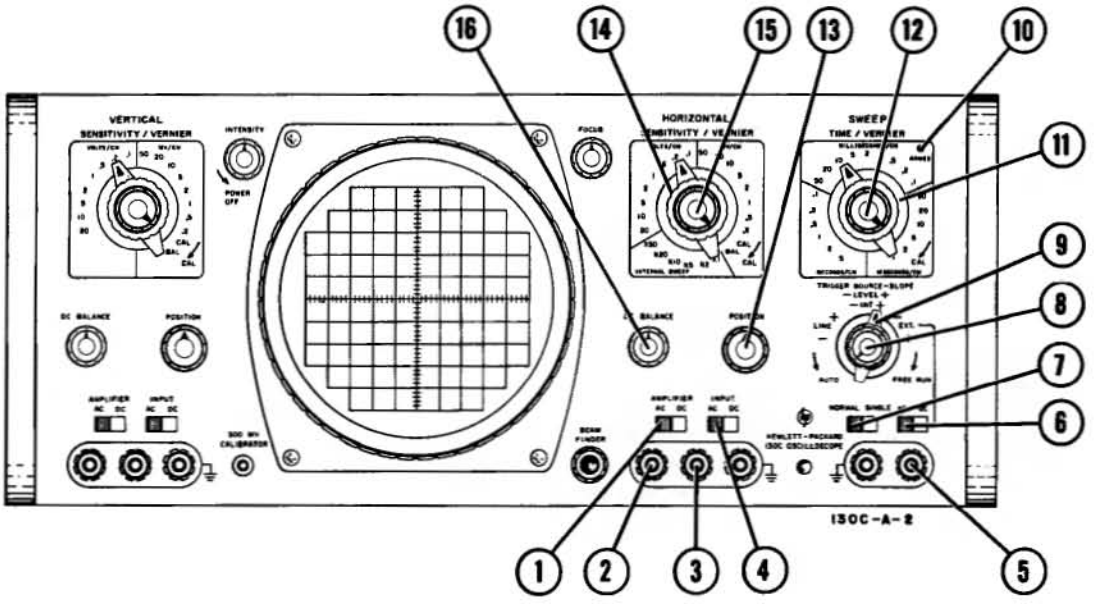
3-9. The DC BALANCE control has a range of about 40 screen diameters, i.e. it can effectively move the trace about 400 cm. Its purpose is to set internal amplifier operating conditions such that there is a minimum trace shift as SENSITIVITY is switched from range to range, or when VERNIER is used. This 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 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 FREE RUN (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 pushbutton 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 ±1° 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

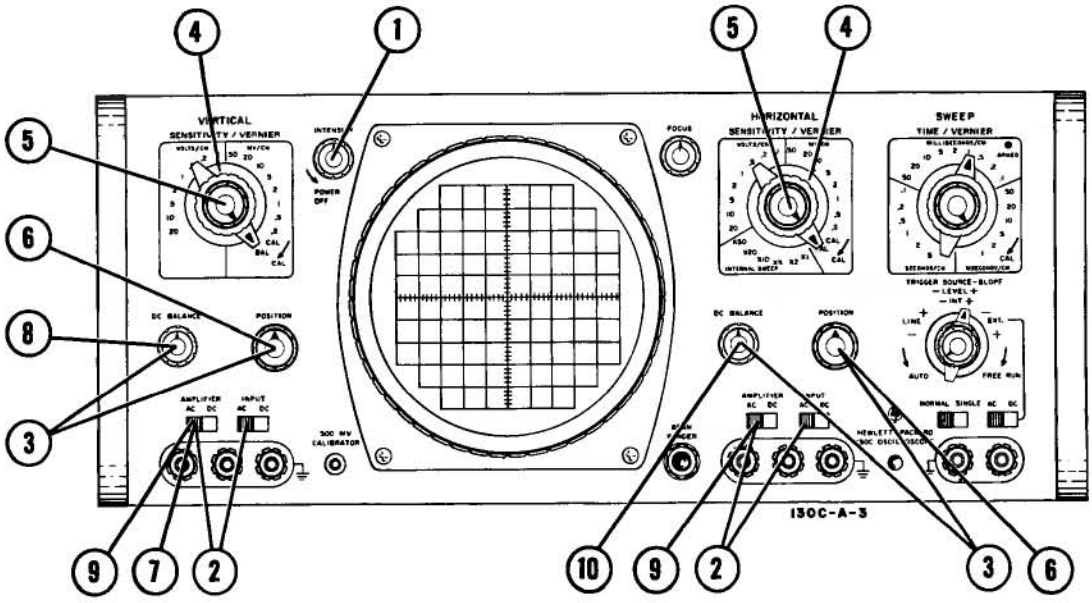
Table 3-2. Characteristics and Applications for AMPLIFIER and INPUT Coupling Combinations

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.

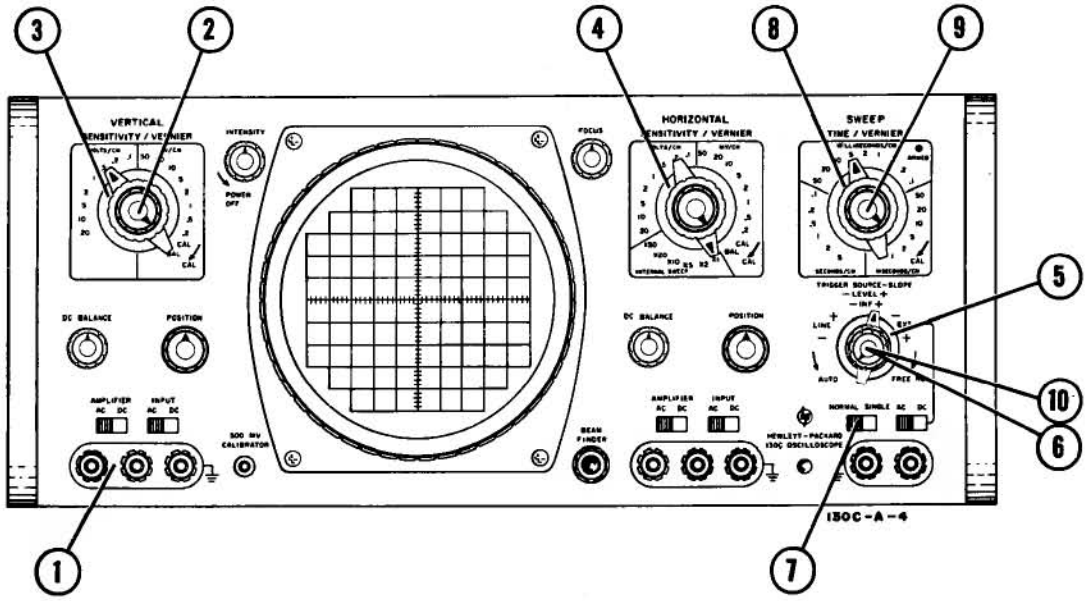
1. Set INTENSITY to mid-range.
2. Set AMPLIFIER and INPUT to AC.
3. Set DC BALANCE and POSITION to mid-range.
4. Set SENSITIVITY to BAL.
5. Set VERNIER to CAL.
6. Center spot with POSITION.
7. Set vertical AMPLIFIER to DC.
8. Center spot with vertical DC BALANCE. If spot is not on CRT, depress BEAM FINDER, 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.

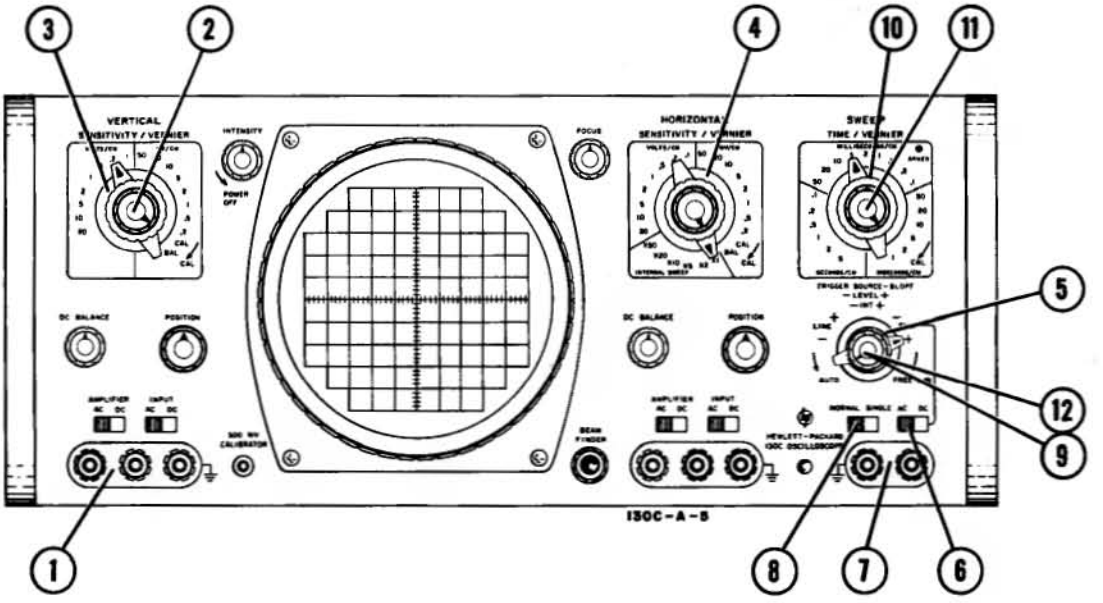
9. To balance the horizontal amplifier first set vertical AMPLIFIER to AC and horizontal AMPLIFIER to DC.
10. Center spot with horizontal DC BALANCE. If spot is not on CRT, depress BEAM FINDER, and set DC BALANCE so spot is about centered on CRT. Release BEAM FINDER and if necessary, refine DC BALANCE 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



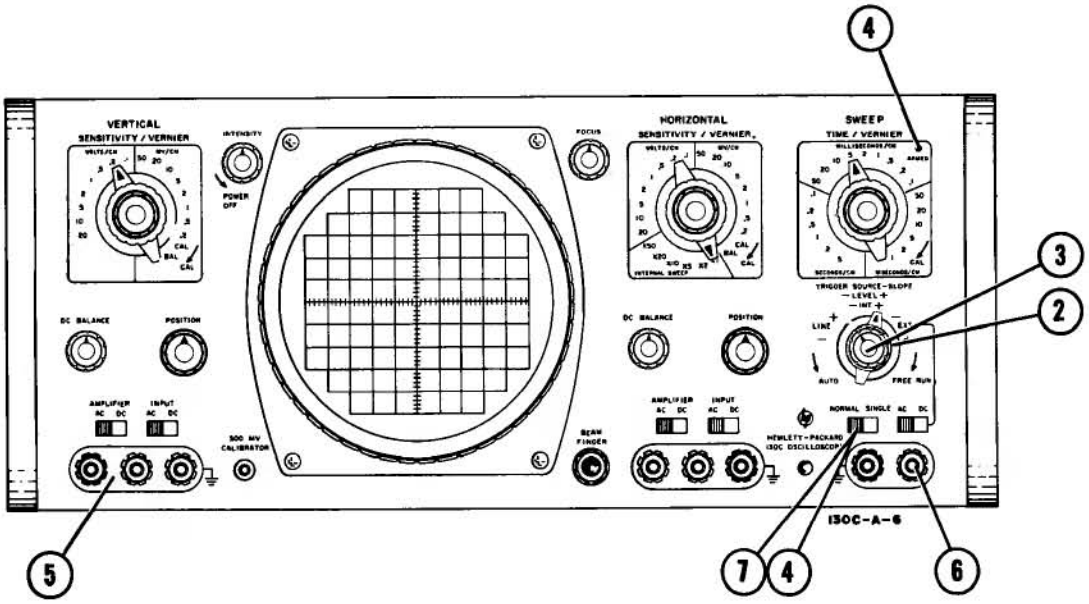
1. Connect vertical signal to input. For differential input see Figure 3-7.
2. Set SENSITIVITY for desired vertical deflection.
3. Set VERNIER to CAL for calibrated sensitivity.
4. Set SENSITIVITY to INTERNAL SWEEP X1.
5. Set TRIGGER SOURCE-SLOPE to INT + or INT -. To trigger on power line waveforms 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).

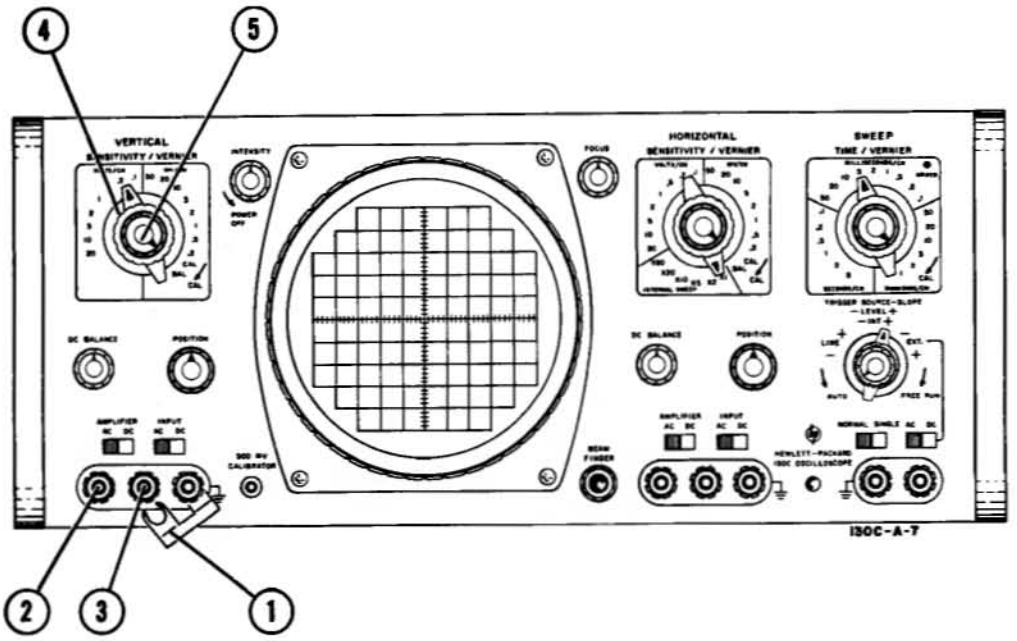
4. Set NORMAL-SINGLE to SINGLE. ARMED indicator should glow.

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.

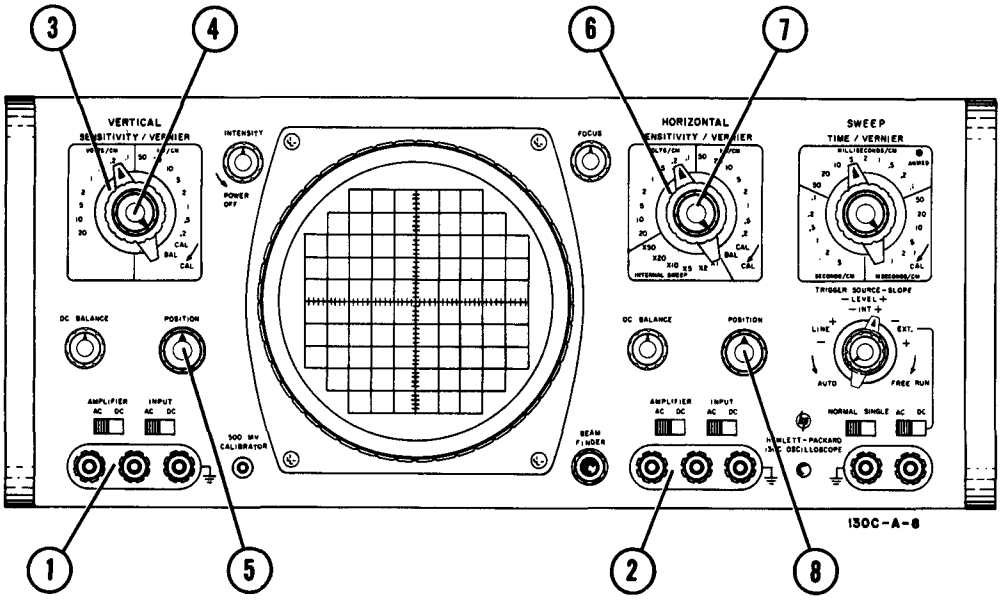
3. Connect negative-going signal to center terminal.

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

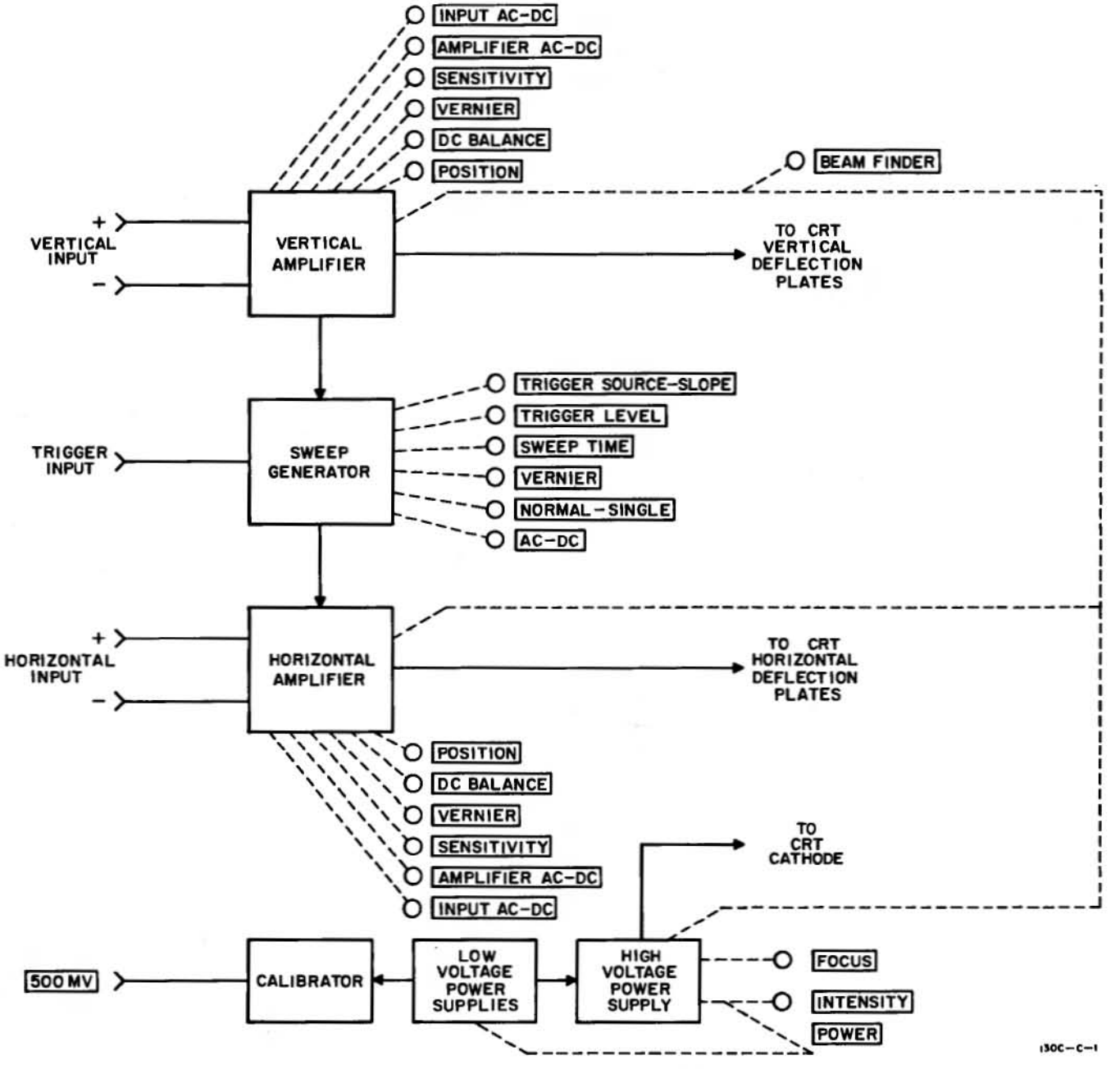


Figure 4-1. Model 130C Overall Functional Block Diagram

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/R469. 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

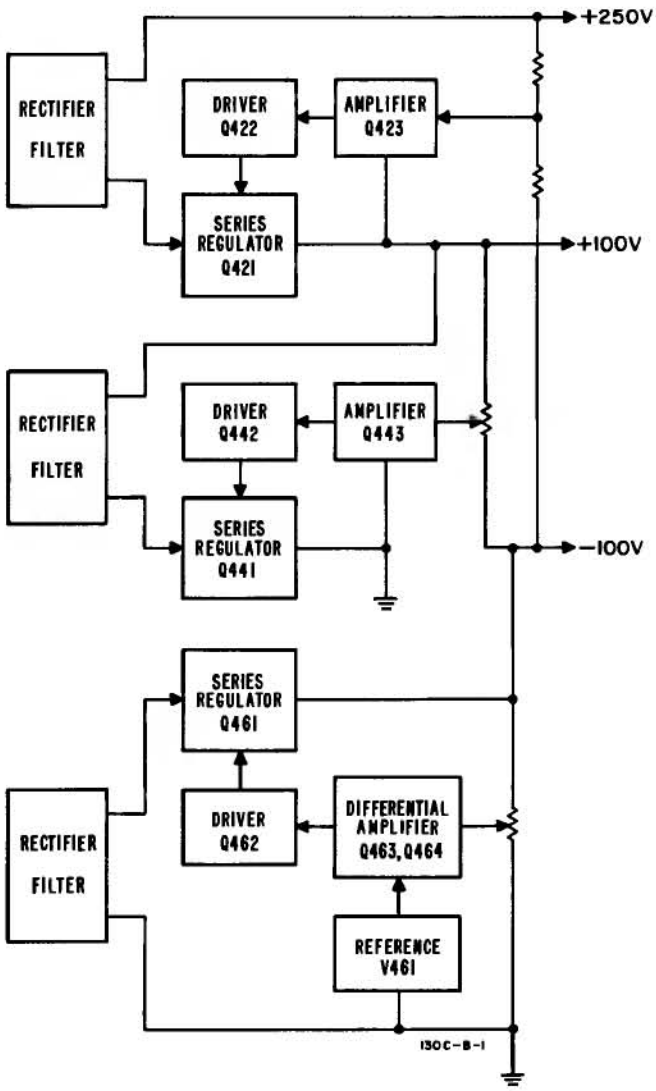


Figure 4-2. LV Power Supply Block Diagram

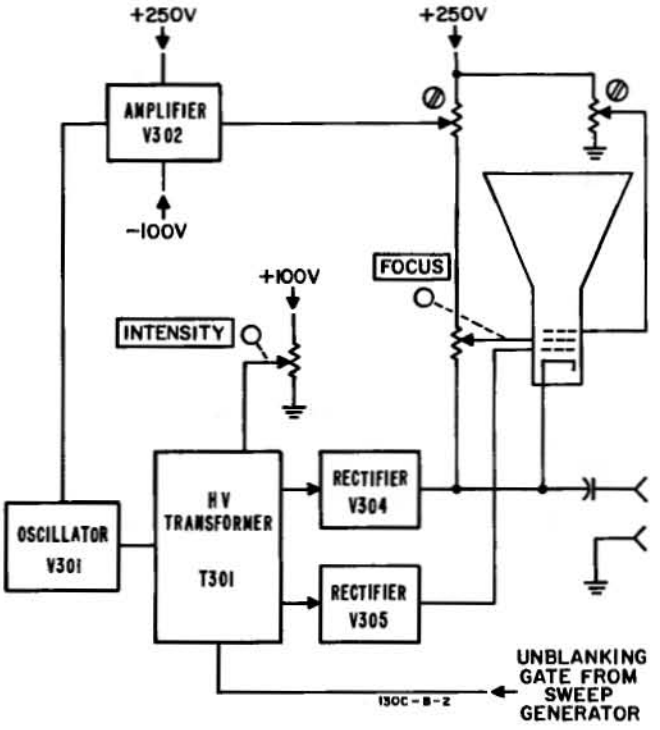


Figure 4-3. H V Power Supply Block Diagram

tied 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

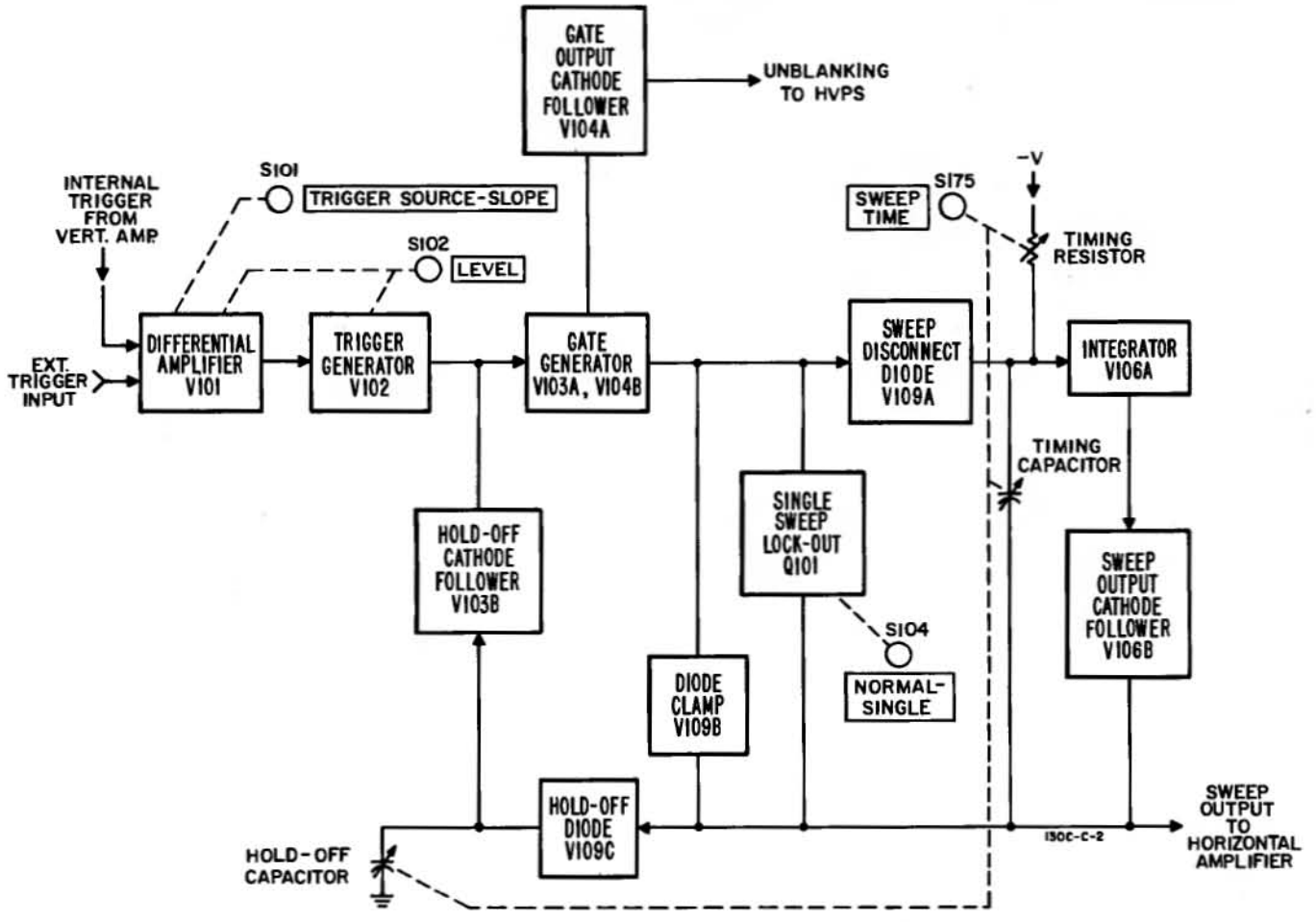


Figure 4-4. Sweep Generator Functional Block Diagram

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 MILLISECONDS/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

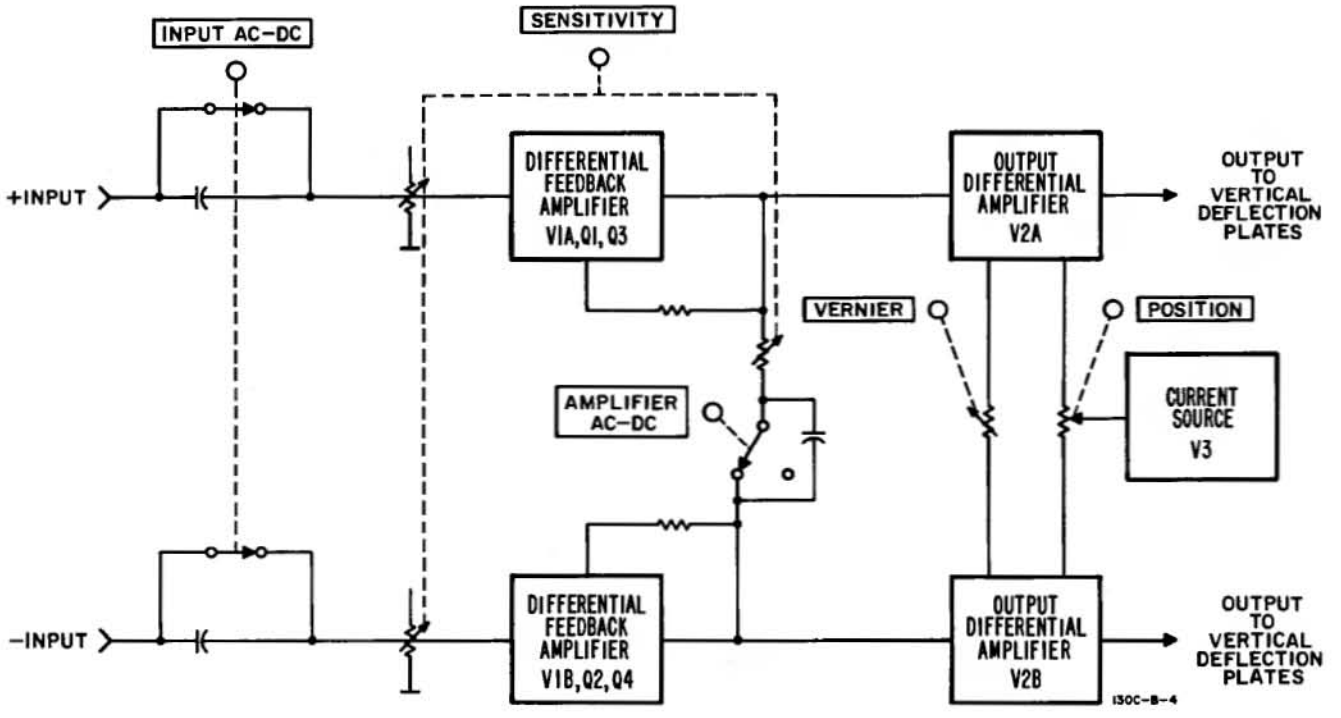


Figure 4-5. Vertical Amplifier Functional Block Diagram

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, ±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 hp 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 5 cm 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 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. 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.

5-15. 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 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 μSECONDS/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.

j. Set: LEVEL . . . . . AUTO
External trigger input . . . . . DC
TRIGGER SOURCE-SLOPE . . . EXT+
Vertical SENSITIVITY . . 1 VOLTS/CM
Vertical VERNIER . . . . . CAL
SWEEP TIME . . . . 1 μSECONDS/CM

k. Vary Oscillator frequency from 500 kc to 50 cps, keeping amplitude constant at 0.5 cm. Stable triggering should occur over the entire range.

m. Set TRIGGER LEVEL to +.

n. Vary Oscillator frequency from 5 cps to 500 kc, keeping deflection constant at 0.5 cm. Stable triggering should occur over the entire range.

p. Set external trigger input to AC

q. Vary Oscillator frequency from 500 kc to 20 cps, keeping amplitude constant a 0.5 p-p. Stable triggering should occur over the entire range.

r. Disconnect the Oscillator.

s. Set: TRIGGER SOURCE-SLOPE LINE+
LEVEL AUTO

t. Observe a power-line frequency waveform. The display should be synchronized.

5-18. TRIGGER POINT AND SLOPE.

a. Apply a 100 cps signal from the Oscillator to both the vertical input and the external trigger input.

b. Set: Vertical SENSITIVITY . . 2 VOLTS/CM
TRIGGER SOURCE-SLOPE . . . INT+
LEVEL . . . . . AUTO
SWEEP TIME . . 2 MILLISECONDS/CM

c. Adjust Oscillator amplitude for 10 cm deflection.

d. The sweep should trigger on the positive-going part of the waveform.

e. Check INT-, EXT+, and EXT- positions. The sweep should trigger on the proper slope for each position.

f. Vary LEVEL throughout its range. The starting point of the sweep should vary along all points on the 10 cm waveform.

5-19. SWEEP CALIBRATION.

a. Set: Vertical SENSITIVITY . . 2 VOLTS/CM
Horizontal SENSITIVITY . . . . . .
. . . . . INTERNAL SWEEP X1
TRIGGER SOURCE-SLOPE . . . INT+
LEVEL . . . . . +
SWEEP TIME . . . . 1 μSECONDS/CM
SWEEP VERNIER . . . . . CAL

b. Apply the output of the Time Mark Generator to the vertical input. Set the output of the Time Mark Generator to 1 microsecond.

c. Adjust horizontal POSITION so that the first marker coincides with the left graticule edge.

d. The 11th marker (or the 21st marker) should occur within 0.3 cm of the right graticule edge.

e. Check all the remaining SWEEP TIME ranges, using the values shown in Table 5-3.

f. Disconnect the Time Mark Generator.

5-20. SWEEP VERNIER.

a. Set: SWEEP TIME . . . . 5 SECONDS/CM
SWEEP VERNIER . . . . . .
. . . . . Fully counterclockwise
LEVEL . . . . . FREE RUN

b. Measure the time for the spot to travel 1 cm. The time should be 12.5 seconds or greater.

5-21. SWEEP MAGNIFIER.

a. Set: SWEEP TIME . . 1 MILLISECONDS/CM
SWEEP VERNIER . . . . . CAL
Horizontal SENSITIVITY . . . . . .
. . . . . INTERNAL SWEEP X2
TRIGGER SOURCE-SLOPE . . . INT+
LEVEL . . . . . +

b. Apply a signal from the Time Mark Generator to the vertical input. Set the output of the Time Mark Generator to 1 millisecond.

c. Adjust horizontal POSITION so that the first marker coincides with the left graticule edge. The fifth marker should occur within 0.5 cm of the right hand graticule edge.

d. Check the remaining magnifier ranges, using the values shown in Table 5-4. The fifth, eleventh, or the 21st marker should occur within 0.5 cm of the right hand graticule edge.

5-22. INTENSITY MODULATION.

a. Set: Vertical SENSITIVITY . 10 VOLTS/CM
Vertical VERNIER . . . . . CAL
Horizontal SENSITIVITY . . . . . .
. . . . . INTERNAL SWEEP X1
SWEEP TIME . . . 10 μSECONDS/CM

Table 5-3. Sweep Calibration

Time Mark Generator	SWEEP TIME Setting	Time Mark /10 cm
1 μsec	1 μSECONDS/CM	10
1 μsec	2 μSECONDS/CM	20
5 μsec	5 μSECONDS/CM	10
10 μsec	10 μSECONDS/CM	10
10 μsec	20 μSECONDS/CM	20
50 μsec	50 μSECONDS/CM	10
100 μsec	.1 MILLISECONDS/CM	10
100 μsec	.2 MILLISECONDS/CM	20
500 μsec	.5 MILLISECONDS/CM	10
1 msec	1 MILLISECONDS/CM	10
1 msec	2 MILLISECONDS/CM	20
5 msec	5 MILLISECONDS/CM	10
10 msec	10 MILLISECONDS/CM	10
10 msec	20 MILLISECONDS/CM	20
50 msec	50 MILLISECONDS/CM	10
100 msec	.1 SECONDS/CM	10
100 msec	.2 SECONDS/CM	20
500 msec	.5 SECONDS/CM	10
1 sec	1 SECONDS/CM	20
1 sec	2 SECONDS/CM	20
5 sec	5 SECONDS/CM	10

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

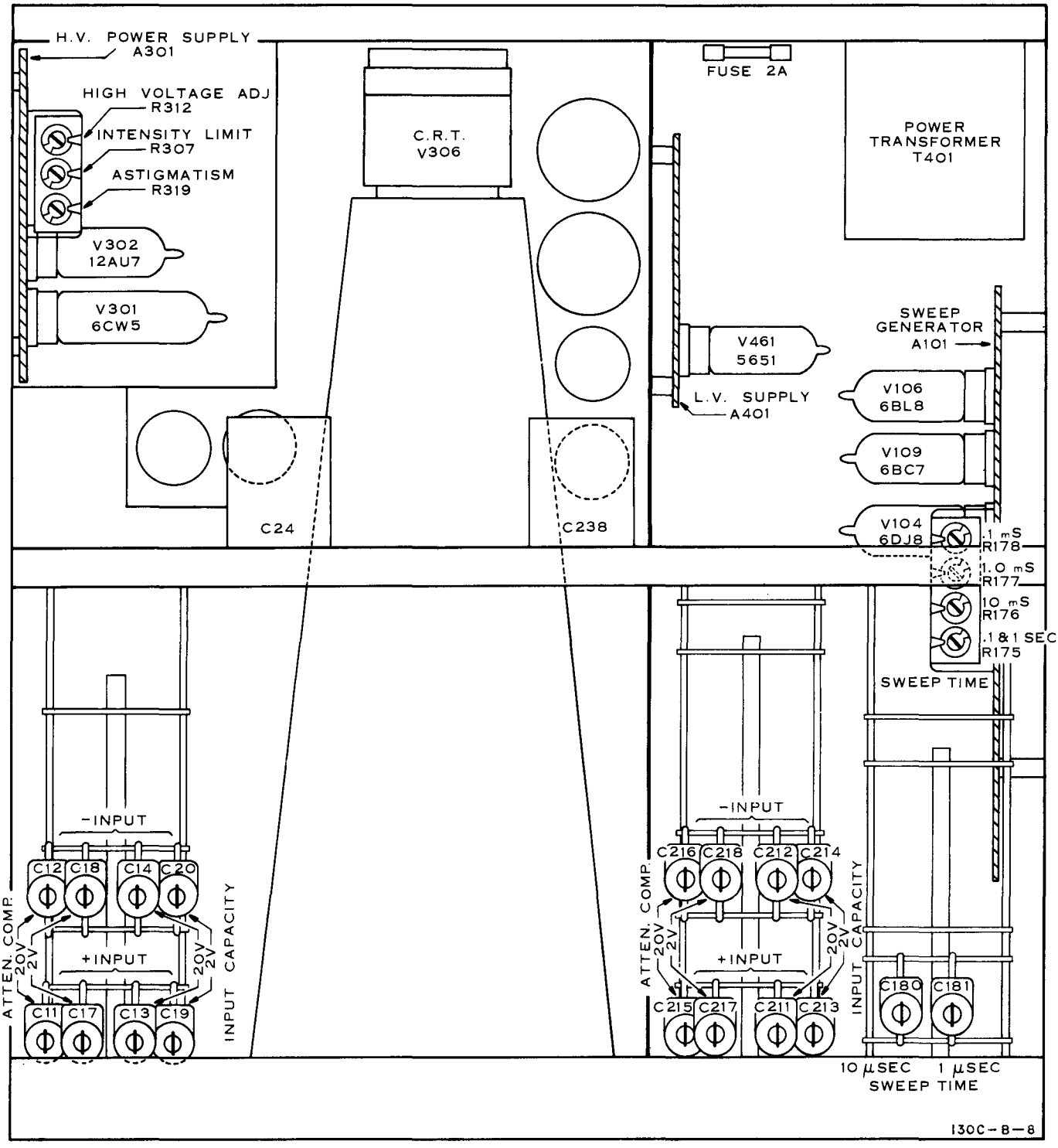


Figure 5-1. Model 130C Top View (Cover Removed)

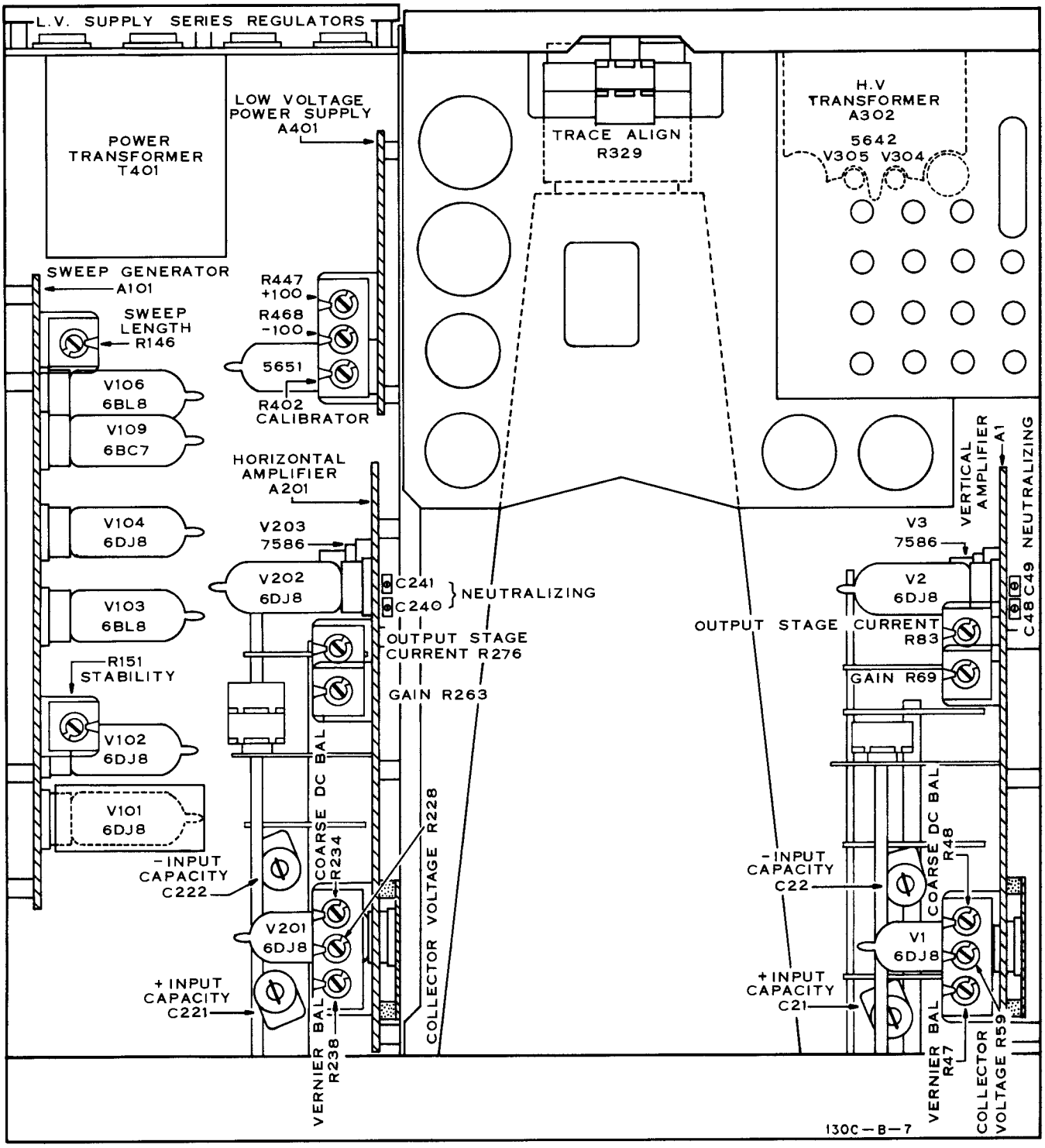


Figure 5-2. Model 130C Bottom View (Cover Removed)

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.

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.

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

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 USEC-ONDS/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 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 75Ω 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 μSECONDS/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 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 600Ω output to the left terminal (+ input) of the amplifier input. Connect a short wire from

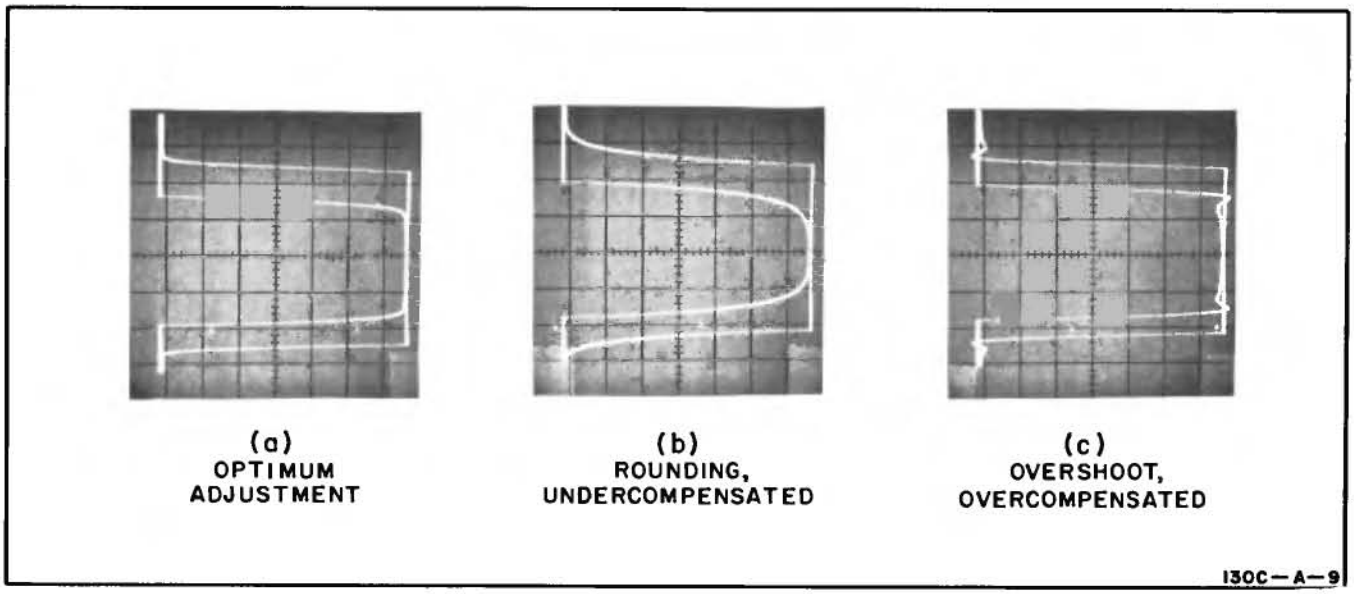


Figure 5-3. Horizontal Neutralization Adjustment Waveforms

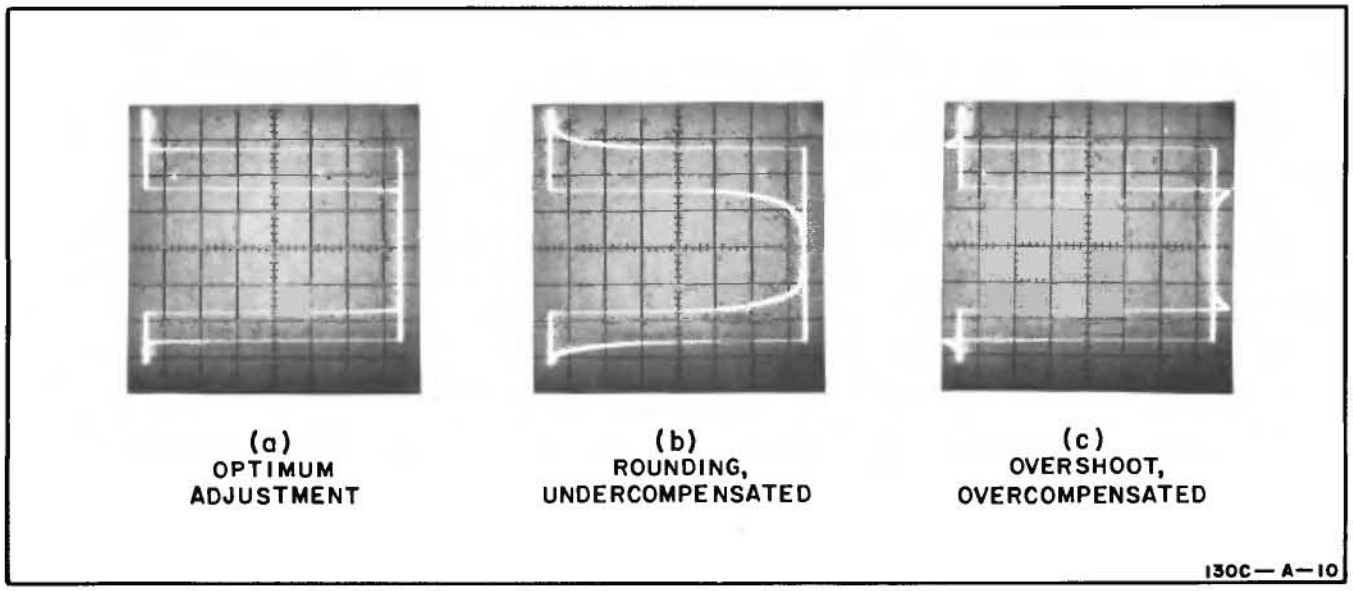


Figure 5-4. Horizontal Attenuator Compensation Waveforms

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 initally, 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	R176
.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-65G
A2 . . . . 130C-19A and 130C-19E
A5 . . . . 130C-65F and 130C-65M
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

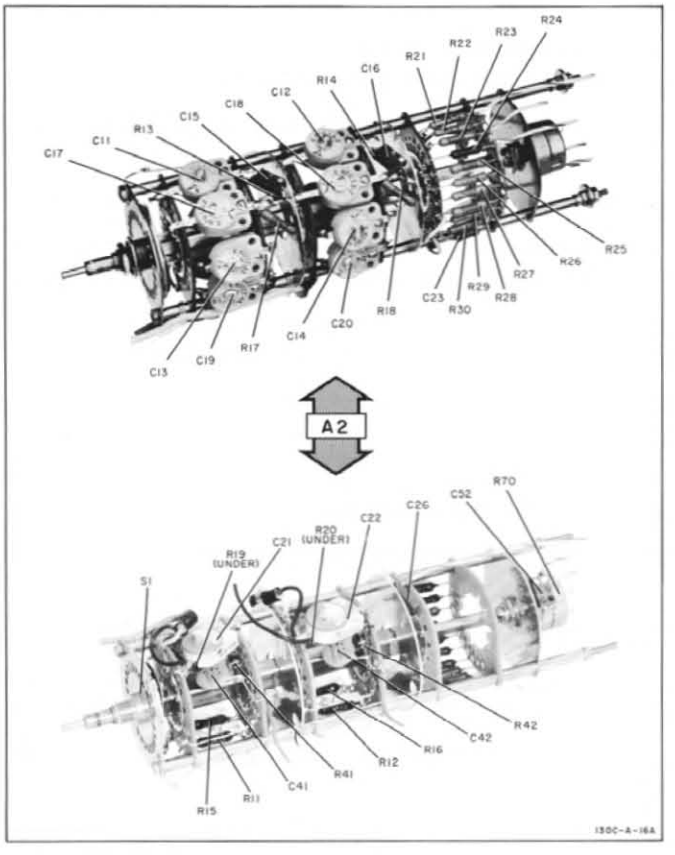


Figure 5-5. Vertical Attenuator, A2, Component Location

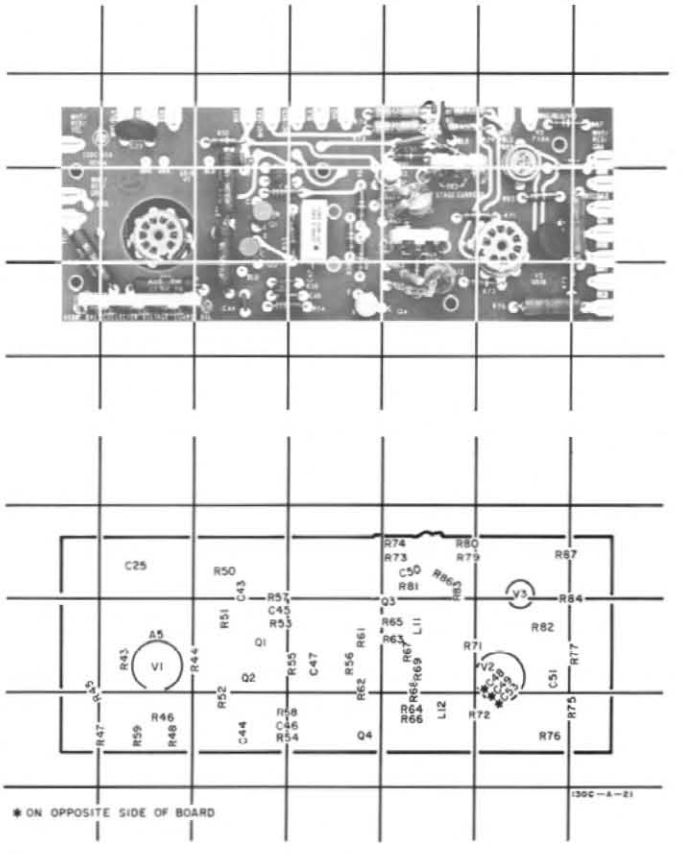


Figure 5-6. Vertical Amplifier, A1, Component Location

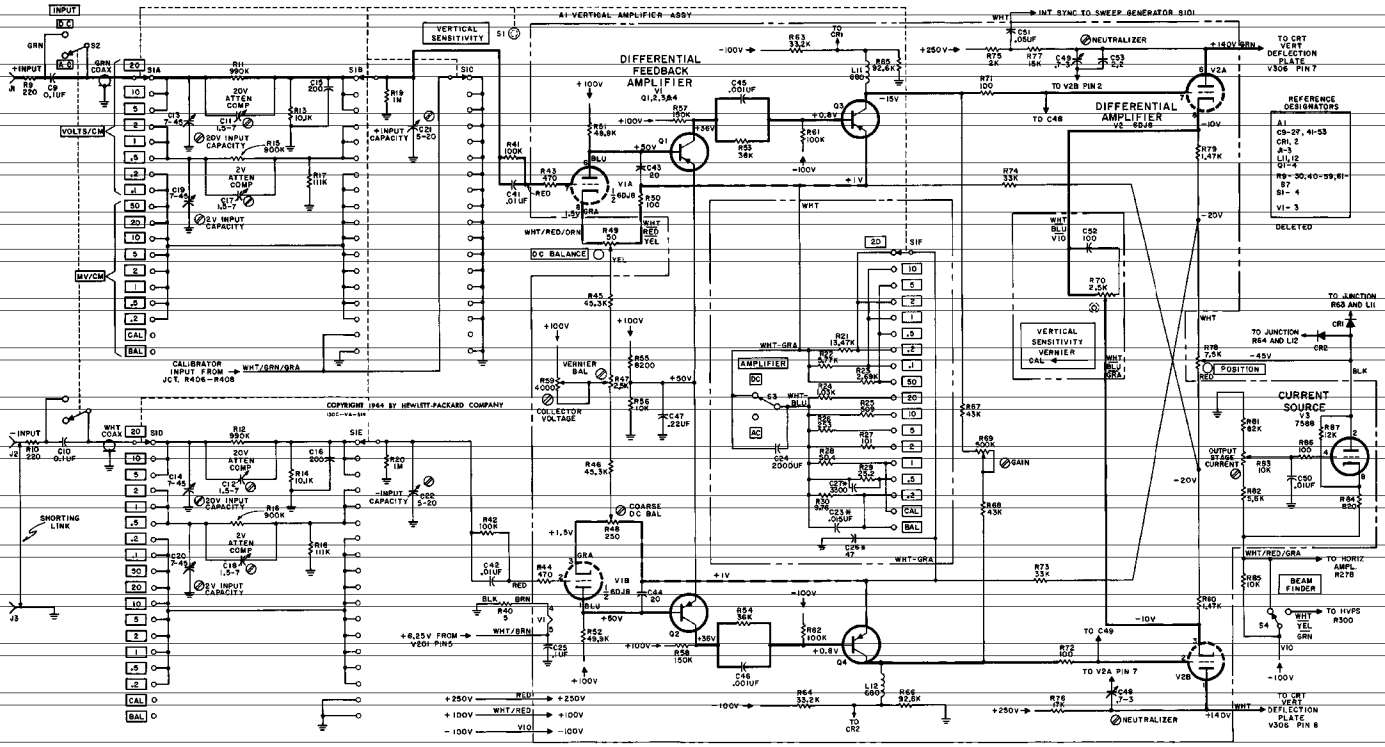
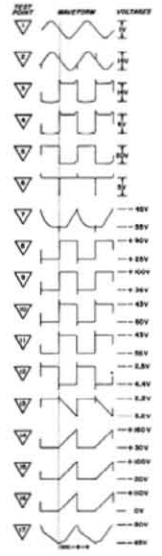


Figure 5-7. Vertical Attenuator and Amplifier Schematic



Note: Waveforms taken with a 2 kc, 1 volt peak-to-peak sine wave applied to the Trigger Input terminal (number 5 in Figure 5-2). Make the following settings on Model 130C:

TRIGGER SENSITIVITY	EXT.
LEVEL	AUTO
SWEEP	20 μseconds/cm
SWEEP VERNIER	CAL
Horizontal POSITION	center trace

Figure 5-8. Sweep Generator Circuit Waveforms

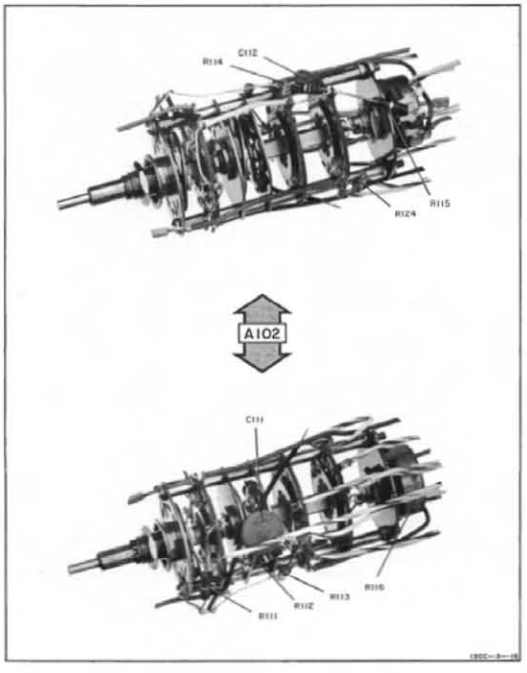


Figure 5-9. Trigger Source – Level Switch, A101, Component Location

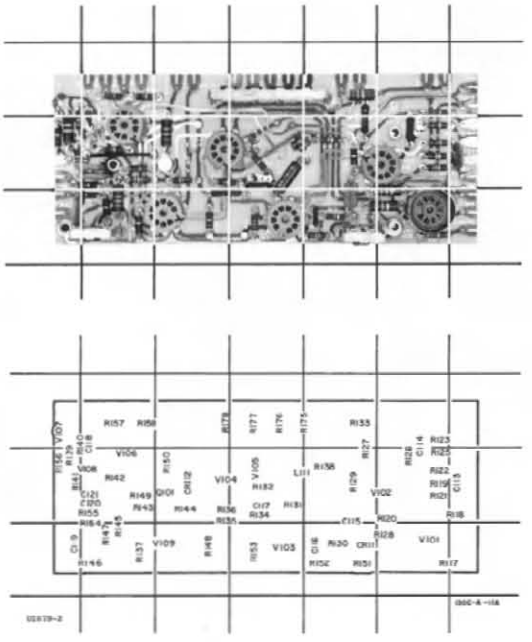


Figure 5-10. Sweep Generator, A101, Component Location

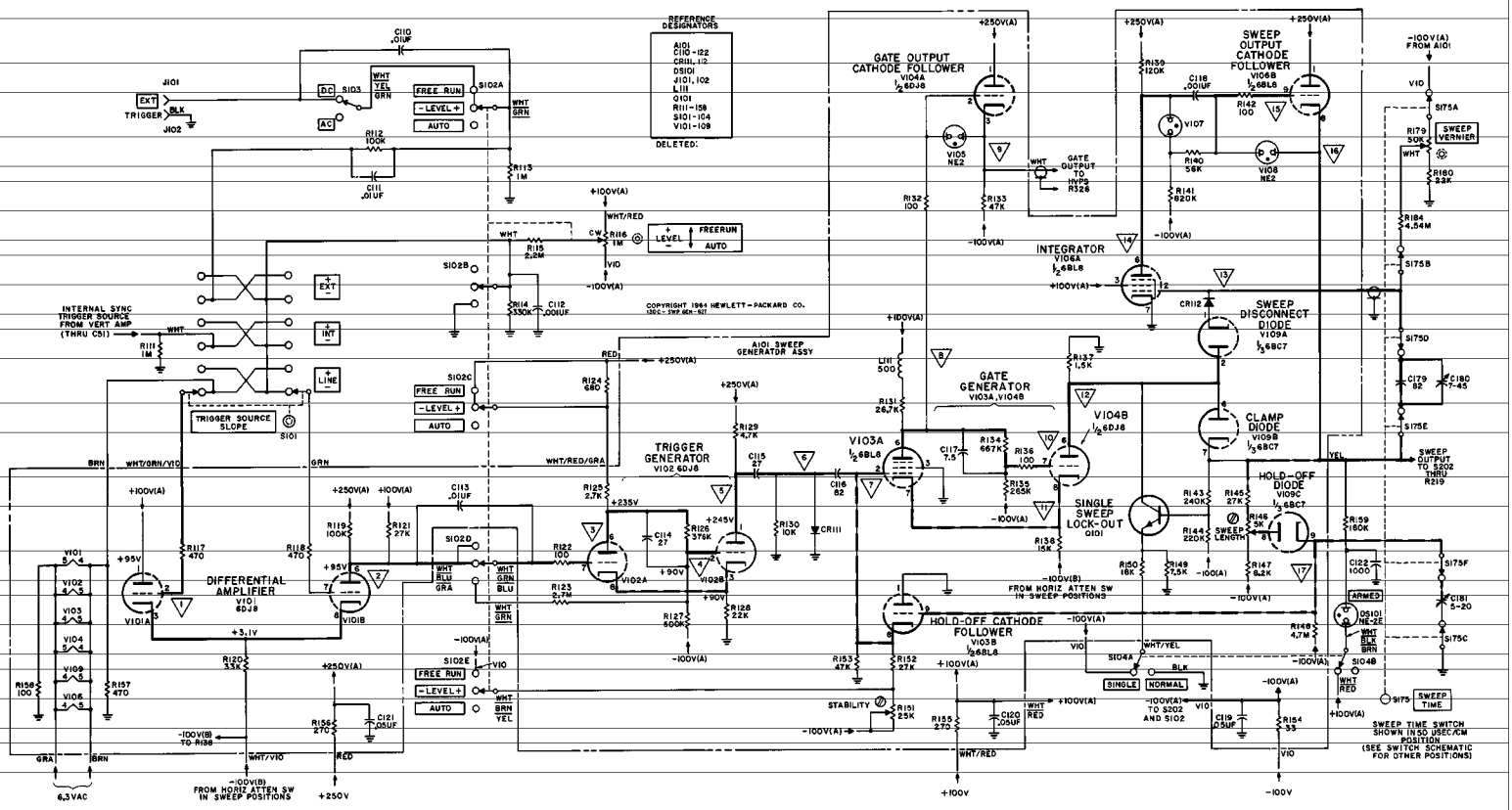


Figure 5-11. Sweep Generator Schematic

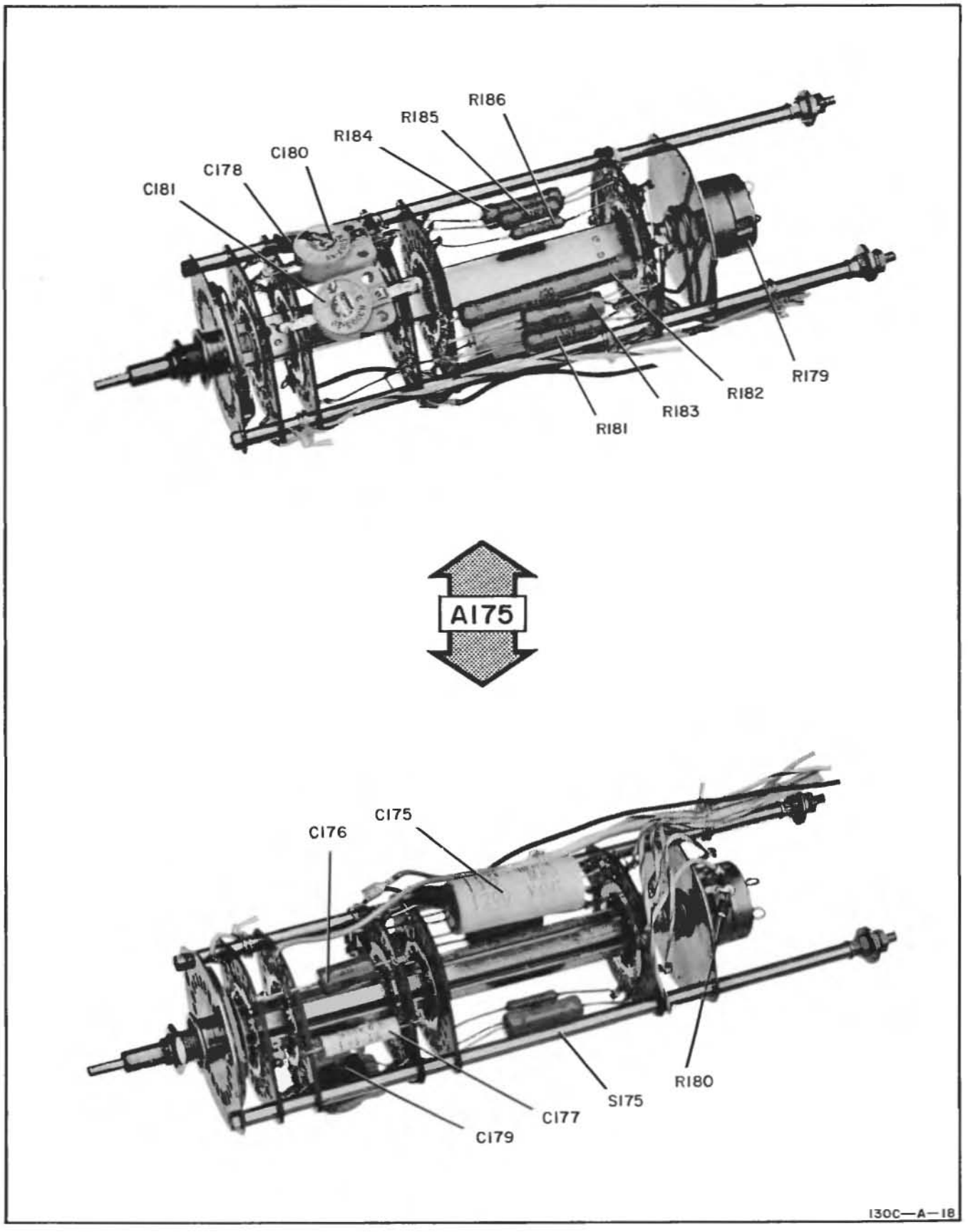


Figure 5-12. Sweep Time Switch, A175, Component Location

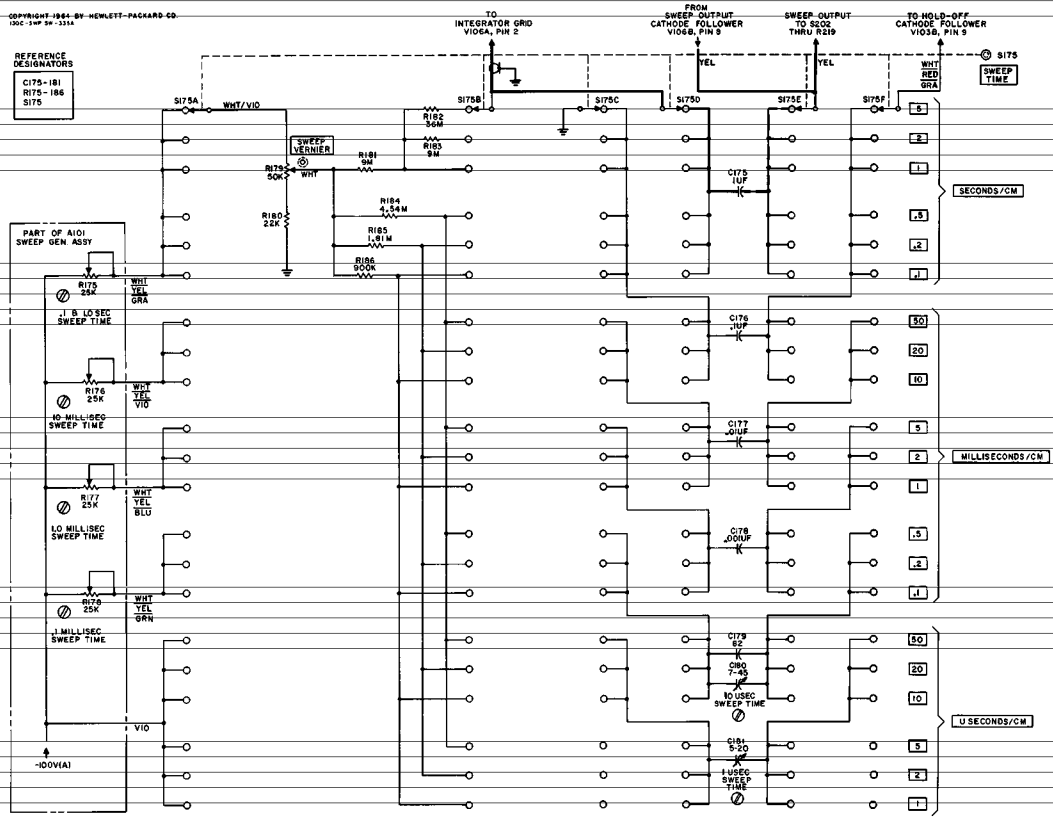


Figure 5-13. Sweep Time Schematic

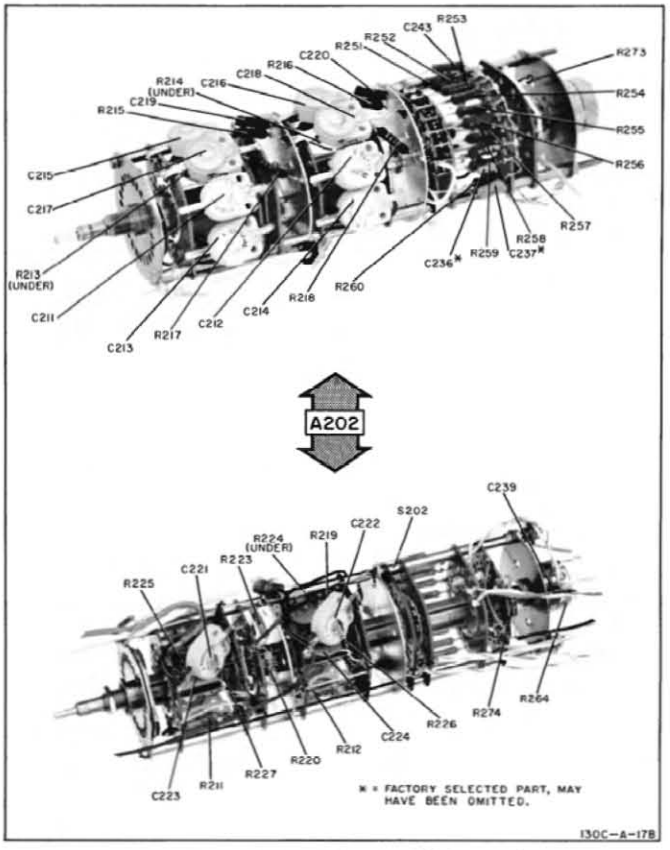


Figure 5-14. Horizontal Attenuator, A202, Component Location

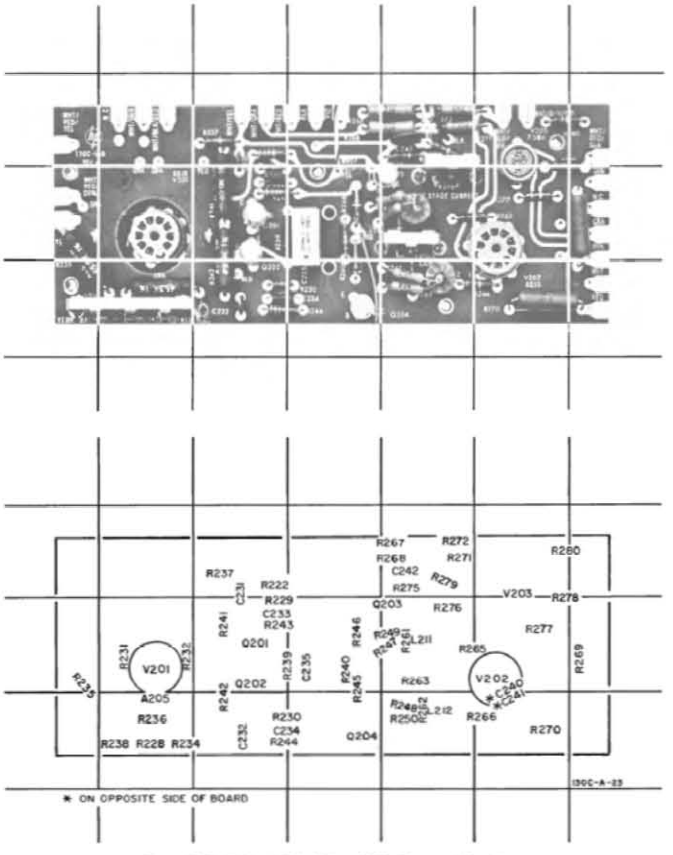


Figure 5-15. Horizontal Amplifier, A201, Component Location

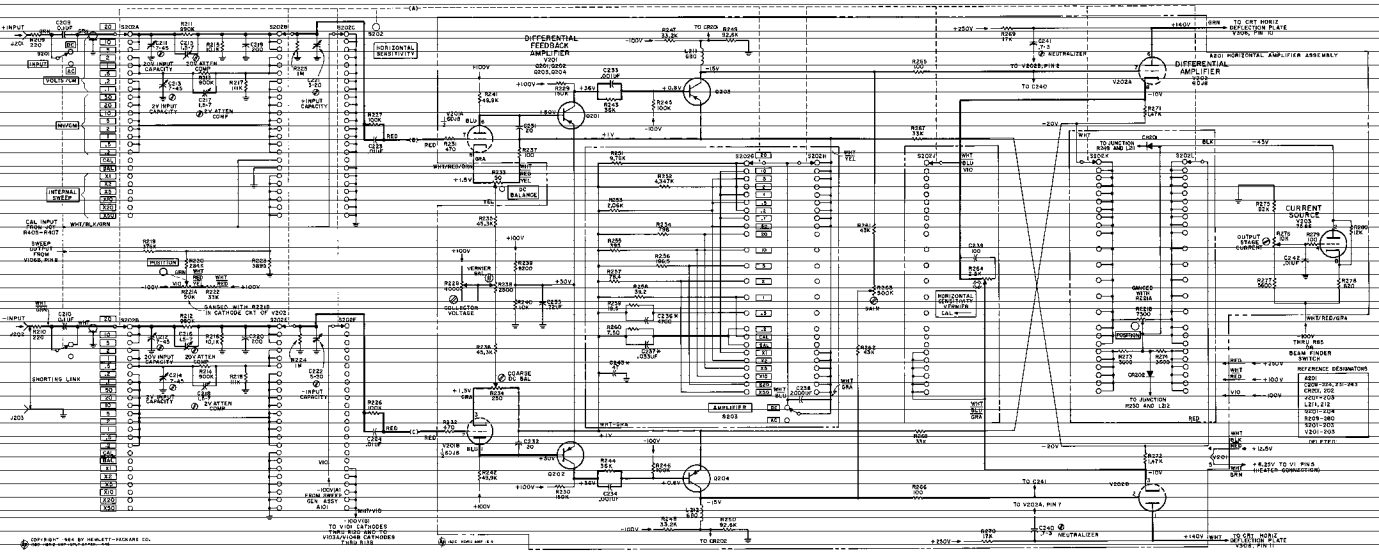


Figure 5-16. Horizontal Attenuator and Amplifier Schematic

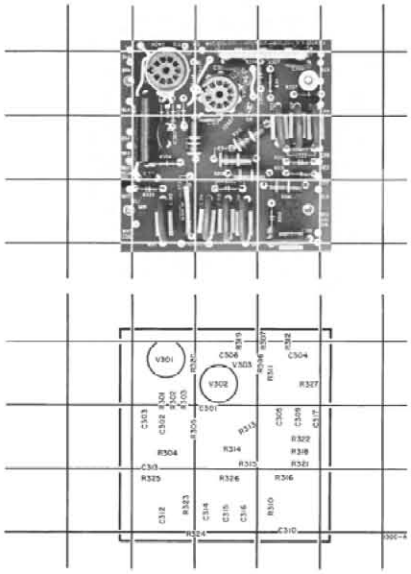


Figure 5-17. High Voltage Power Supply, A301, Component Location

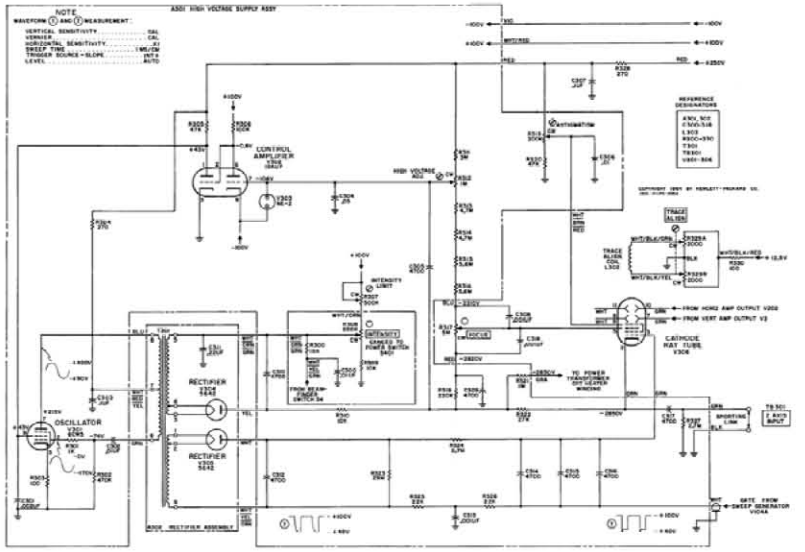


Figure 5-18. High Voltage Power Supply Schematic

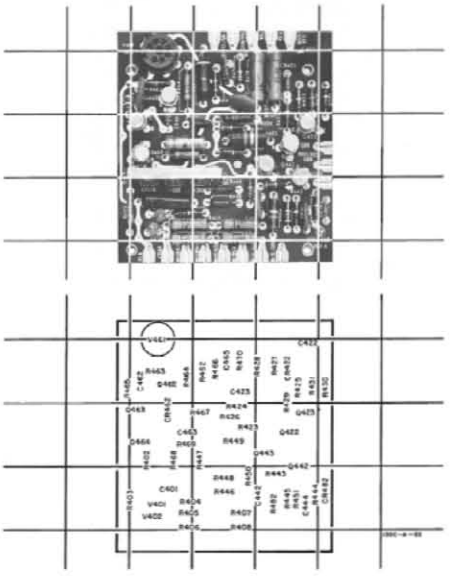


Figure 5-19. Low Voltage Power Supply, A401, Component Location

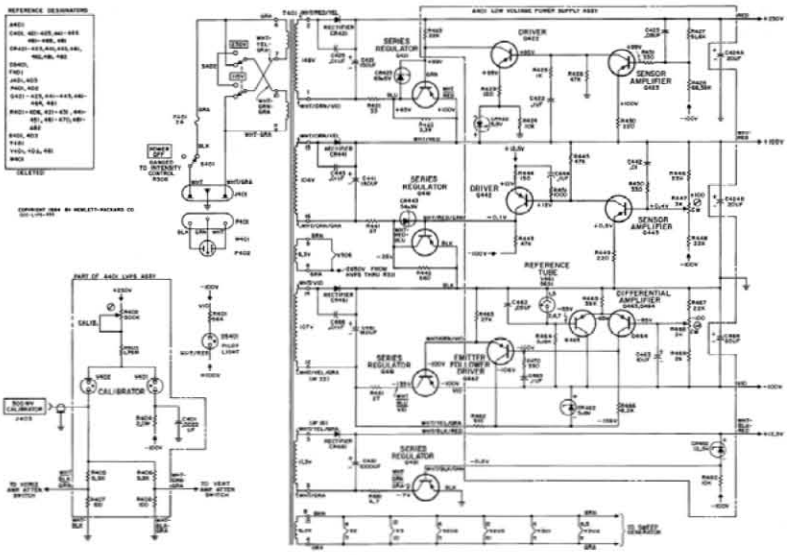
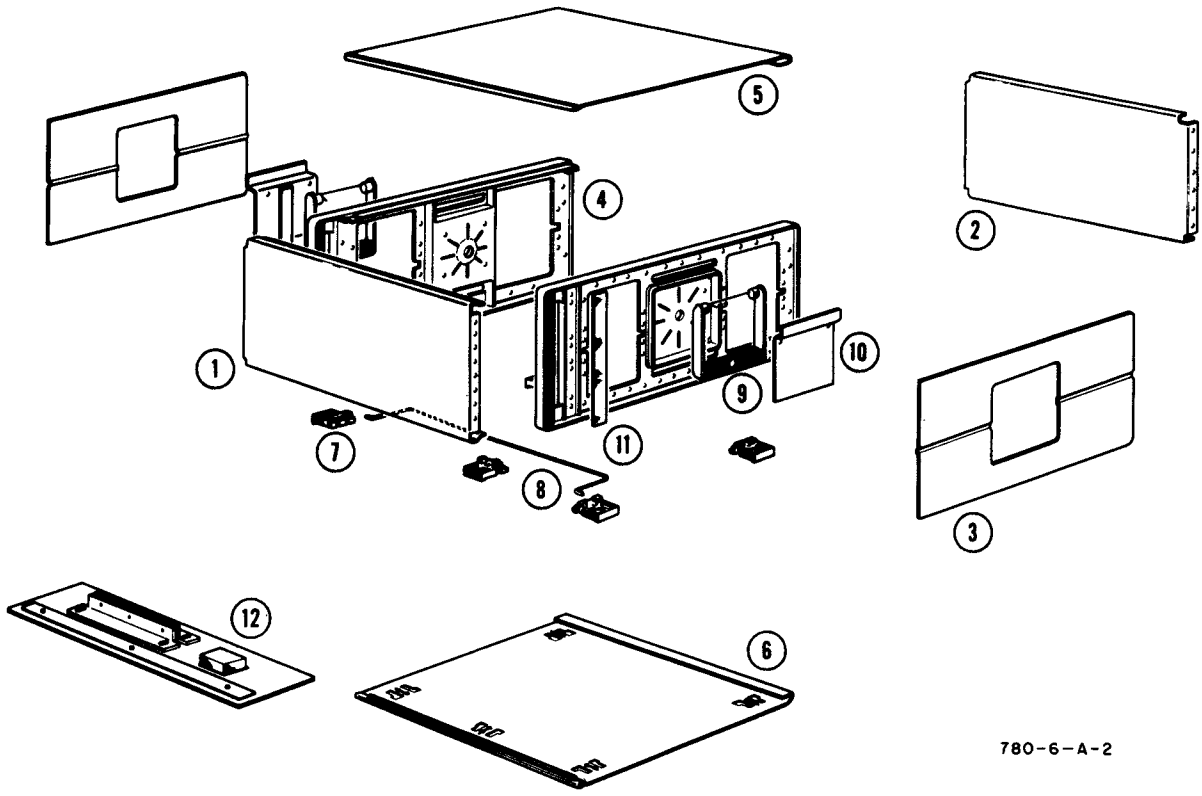


Figure 5-20. Low Voltage Power Supply Schematic



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

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

ABBREVIATIONS

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

01194-10

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 dpdt	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 - 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 dpdt	42190	6603JM SPEC
A104	2100-0347		1	A: r var comp 4 x 25k ohms 30% 1/4w	hp	
A105 - A174				Not assigned		
A175	130C-19G		1	A: sweep time switch	hp	
A176 - 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 dpdt	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 - 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 - 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 μf 20% 600 vdcw matched pair	hp	
C10				NSR: p/o C9		
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 μf 10% 200vdcw	hp	
C24	0180-0314		2	C: fxd elect 2000 μf 10vdcw	56289	D39330 6447
C25	0150-0084		4	C: fxd cer 0.1 μf -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 µf 20% 1000vdcw	56289	29C214A3
C42	0150-0012			C: fxd cer 0.01 µf 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 µf 20% 200vdcw	56289	224P22402
C48				NSR: p/o A6		
C49				NSR: p/o A6		
C50	0150-0012			C: fxd cer 0.01 µf 20% 1000vdcw	56289	29C214A3
C51	0150-0052		7	C: fxd cer 0.05 µf 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 ±0.25 pf 600vdcw	72982	301 000 COJO 229C
C54 - C109				Not assigned		
C110	0150-0012			C: fxd cer 0.01 µf 20% 1000vdcw	56289	29C214A3
C111	0150-0012			C: fxd cer 0.01 µf 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 µf 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 ±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 µf 20% 400vdcw	56289	33C17A
C120	0150-0052			C: fxd cer 0.05 µf 20% 400vdcw	56289	33C17A
C121	0150-0052			C: fxd cer 0.05 µf 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 µf 5% 200vdcw	84411	Type 621M 10552
C176	0170-0019		1	C: fxd my 0.1 µf 5% 200vdcw	hp	
C177	0160-0314		1	C: fxd my 0.01 µf 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 µf 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 μf 20% 1000vdcw	56289	29C214A3
C224	0150-0012			C: fxd cer 0.01 μf 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 μf 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 μf 10% 200vdcw	hp	
C238	0180-0314			C: fxd elect 2000 μf 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 μf 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 μf 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 μf 20% 1000vdcw	56289	29C214A3
C303	0160-0013		2	C: fxd my 0.1 μf 10% 400vdcw	56289	160P10494
C304	0150-0052			C: fxd cer 0.05 μf 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 μf 20% 1000vdcw	56289	29C214A3
C307	0160-0013			C: fxd my 0.1 μf 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 μf 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 150μf -10% +50% 250vdcw	00853	PLI
C422	0150-0084			C: fxd cer 0.1 μf -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 µf 20% 400vdcw	56289	33C17A
C424	0180-0012		1	C: fxd elect 2x20 µf 450vdcw	56289	D32440
C425	0150-0012			C: fxd cer 0.01 µf 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 µf 20% 1000vdcw	56289	29C214A3
C443	0150-0012			C: fxd cer 0.01 µf 20% 1000vdcw	56289	29C214A3
C444	0150-0084			C: fxd cer 0.1 µf -20% +80% 50vdcw	56289	33C41
C445-C460				Not assigned		
C461	0180-0398		1	C: fxd elect 150 µf -10% +50% 200vdcw	56289	D40728-DFP
C462	0150-0052			C: fxd cer 0.05 µf 20% 400vdcw	56289	33C17A
C463	0180-0059		1	C: fxd elect 10 µf -10% +100% 25vdcw	56289	30D106G025BB4
C464	0180-0132		1	C: fxd elect 60 µf -10% +100% 200vdcw	00853	PLI
C465	0150-0084			C: fxd cer 0.1 µf -20% +80% 50vdcw	56289	33C41
C466	0150-0012			C: fxd cer 0.01 µf 20% 1000vdcw	56289	29C214A3
C467-C480				Not assigned		
C481	0180-0056		1	C: fxd elect 1000 µf 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				Not assigned		
J201	1510-0010			J: red binding post	hp	
J202	1510-0010			J: red binding post	hp	
J203	5060-0627			J: black with shorting clip	hp	
J204 - J400				Not assigned		
J401	1251-0148		1	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 μh	hp	
L12	9140-0157			L: fxd rf 680 μh	hp	
L13 - L110				Not assigned		
L111	9140-0022		1	L: fxd rf 500 μh	hp	
L112 - L210				Not assigned		
L211	9140-0157			L: fxd rf 680 μh	hp	
L212	9140-0157			L: fxd rf 680 μh	hp	
L213 - L301				Not assigned		
L302	5060-0408		1	L: alignment	hp	
P401				NSR: p/o W401		
P402				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				Not assigned		
Q421	5080-0427		3	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				Not assigned		
Q441	5080-0427			Q: ge pnp (selected)	hp	
Q442	1850-0062			Q: ge pnp	hp	
Q443	1851-0017			Q: ge npn 2N1304	01295	2N1304
Q444 - Q460				Not assigned		
Q461	5080-0427			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 111k ohms 1% 1/2w	hp	
R18	0727-0210			R: fxd depc 111k 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						
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						
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				NSR: p/o A2		
S2				NSR: p/o A3		
S3				NSR: p/o A3		
S4	3101-0014		1	S: pushbutton spdt	82389	4S-1106
S5 - S100				Not assigned		
S101				NSR: p/o A102		
S102				NSR: p/o A102		
S103				NSR: p/o A103		
S104				NSR: p/o A103		
S105 - S174				Not assigned		
S175				NSR: p/o A175		
S176 - S200				Not assigned		
S201				NSR: p/o A203		
S202				NSR: p/o A202		
S203				NSR: p/o A203		
S204 - S400				Not assigned		
S401				NSR: p/o R308		
S402	3101-0033		1	S: slide dpdt	42190	4633
T301	130C-11A-1		1	T: high voltage	hp	
T302 - T400				Not assigned		
T401	9100-0241		1	T: power (low voltage)	hp	
TB301	0360-0104		1	TB: terminal (z axis input)	71785	321-11-02-036
V1	5080-0424		2	V: 6DJ8 dual triode (aged)	hp	
V2	1932-0035		2	V: 6DJ8 dual triode (special)	13396	6DJ8
V3	1921-0017		2	V: 7586 nuvistor	86684	7586
V4 - V100				Not assigned		
V101	1932-0022		3	V: 6DJ8 dual triode	73445	6DJ8/ECC88
V102	1932-0022			V: 6DJ8 dual triode	73445	6DJ8/ECC88
V103	1933-0008		2	V: 6BL8 triode pentode	73445	6BL8/ECF80
V104	1932-0022			V: 6DJ8 dual triode	73445	6DJ8/ECC88
V105	2140-0008		3	V: NE2 neon glow	24455	NE2
V106	1933-0008			V: 6BL8 triode pentode	73445	6BL8/ECF80
V107	2140-0084		1	V: glow lamp aged	74276	A092
V108	2140-0008			V: NE2 neon glow	24455	NE2
V109	1939-0002		1	V: 6BC7 triple diode	93332	6BC7
V110 - V200				Not assigned		
V201	5080-0424			V: 6DJ8 dual triode (aged)	hp	
V202	1932-0035			V: 6DJ8 dual triode (special)	13396	6DJ8
V203	1921-0017			V: 7586 nuvistor	86684	7586
V204 - V300				Not assigned		
V301	1923-0044		1	V: 6CW5 pentode	73445	6CW5/EL86
V302	1932-0029		1	V: 12AU7 dual triode	12859	12AU7
V303	2140-0008			V: NE2 neon glow	24455	NE2
V304	1920-0001		2	V: 5642 high voltage diode	93332	5642
V305	1920-0001			V: 5642 high voltage diode	93332	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		1	V: CRT P31 phosphor	hp	
	5083-0342			V: CRT P11 phosphor	hp	
	5083-0333			V: CRT P7 phosphor	hp	
	5083-0323			V: CRT P2 phosphor	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				Not assigned		
V461	1940-0001		1	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				Not assigned		
XQ441	1200-0044			XQ: 2 pin	97446	M7 PB
XQ442 - XQ460				Not assigned		
XQ461	1200-0044			XQ: 2 pin	97446	M7 PB
XQ462 - XQ480				Not assigned		
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				Not assigned		
XV306				XV: CRT consists of:		
	1200-0037		1	Socket body	72825	9709-4
	1200-0050		10	Pin	72825	9553
	1200-0192		1	Cover Plate	72825	9709-7
XV307 - XV460				Not assigned		
XV461	1200-0053		1	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.
				MISCELLANEOUS		
	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	
					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
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco Inc.	Denielson, Conn.
00334	Humidial	Colton, Calif.
00348	Microtron Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc., Electronics Products Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircreft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Celif.
00929	Microlab Inc.	Livingston, N.J.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lewndale, Celif.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01589	Pecific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Senta Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Voceline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Celif.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Mechine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03877	Transitron Electric Corp.	Wekefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div. Finderne Plant	Sumerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Chicago, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.
04713	Motorole, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Company	Westchester, Ill.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metro-Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., The	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Celif.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicego, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penecook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Semcor Div. Components Inc.	Phoenix, Ariz.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
06980	Varian Assoc. Eimac Div.	San Carlos, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07261	Avnet Corp.	Culver City, Calif.
07263	Fairchild Camere & Inst. Corp. Semiconductor Div.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp., The	Monterey Park, Calif.
07700	Technical Wire Products Inc.	Cranford, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.
07980	Hewlett-Packard Co., Boonton Redio Div.	Rockawey, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagera Falls, Ontario, Canade
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08792	CBS Electronics Semiconductor Operations, Div of C.B.S. Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texes
09145	Atohm Electronics	Sun Valley, Celif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Pelo Alto, Calif.
11534	Duncan Electronics Inc.	Costa Mesa, Celif.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12697	Clerostat Mfg. Co.	Dover, N.H.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beech, Celif.
12954	Dickson Electronics Corp.	Scottsdele, Arizooa
13103	Thermolloy	Dallas, Texas
13396	Telefunken (GmbH)	Haoover, Germany
13835	Midlend-Wright Div. of Pacific Industries, Inc.	Kansas City, Kensas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fle.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dublier Electric Corp.	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	So. Pasadena, Calif.
14960	Williams Mfg. Co.	San Jose, Celif.
15203	Webster Electronics Co.	New York, N.Y.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15558	Micron Electronics	Garden City, Long Island, N.Y.
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15818	Ametco Inc.	Mt. View, Calif.
15909	Daven Div. Thomas A. Edison Ind. McGraw-Edison Co.	Long Island City, N.Y.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N.J.
16688	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Inc.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Trenex Company	Mountain View, Calif.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Celif.
18042	Power Design Pacific Inc.	Palo Alto, Calif.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	Bendix Corp., The Eclipse-Poineer Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kenses
20183	General Atronics Corp.	Philedelphie, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23783	British Redio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Pelo Alto, Calif.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Cenada
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.

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

Code No.	Manufacturer	Address
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pn.
47904	Polaroid Corp.	Cnmbridge, Mnss.
48620	Precision Thermometer & Inst. Co.	Southnmpton, Pn.
49956	Micrownve & Power Tube Div.	Waltham, Mnss.
52090	Rowan Controller Co.	Westminster, Md.
52983	Snnborn Company	Wnlthnm, Mass.
54294	Shnllcross Mfg. Co.	Selmn, N.C.
55026	Simpson Electric Co.	Chicngo, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Rnytheon Co. Commercial Appnratus & Systems Div.	So. Norwnlk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonnwnndn, N.Y.
56289	Sprngun Electric Co.	North Adams, Mnss.
59446	Telex, Inc.	St. Pnul, Minn.
59730	Thomns & Betts Co.	Elizabeth, N.J.
60741	Triplett Electricnl Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pn.
62119	Universnl Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newnrk	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Revere Wollnnsnk Div. Minn. Mining & Mfg. Co.	St. Pnul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70318	Allmetnl Screw Product Co., Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicngo, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texns	Quincy, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71286	Camloc Fastener Corp.	Pnramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicngo, Ill.
71447	Cnlif. Spring Co., Inc.	Pico-Rivera, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71471	Cinema Plant, Hi-Q Div. Aerovox Corp.	Burbnnk, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centrnlnb Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicngo, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicngo Mininture Lamp Works	Chicngo, Ill.
71753	A.O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Co., Hownrd B. Jones Div.	Cbicngo, Ill.
71984	Dow Corning Corp.	Midlnnd, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72354	John E. Fast Co., Div. Victoreen Instr. Co.	Chicngo, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indinnn Genernl Corp., Electronics Div.	Kensby, N.J.
72699	General Instrument Corp., Cnp. Div.	Newark, N.J.
72765	Drake Mfg. Co.	Chicngo, Ill.
72825	Hugh H. Eby Inc.	Philndelphin, Pa.
72928	Gudeman Co.	Chicago, Ill.
72964	Robert M. Hadley Co.	Los Angeles, Cnlif.
72982	Erie Technologicnl Products, Inc.	Erie, Pa.
73061	Hnnsen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Hnrper Co.	Chicngo, Ill.
73138	Helipot Div. of Beckmnn Inst., Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North Americnn Phillips Co., Inc.	Hicksville, N.Y.
73506	Brndley Semiconductor Corp.	New Hnven, Conn.
73559	Carling Electric, Inc.	Hnrtford, Conn.
73682	George K. Garrett Co., Div. MSL Industries Inc.	Philndelphin, Pn.
73734	Federnl Screw Products Inc.	Chicngn, Ill.
73743	Fischer Specinl Mfg. Co.	Cincinnnti, Ohio
73793	Genernl Industries Co., The	Elyrin, Ohio
73846	Goshen Stnmping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Josn, Cnlif.
74276	Signnlite Inc.	Neptune, N.J.
74455	J.H. Winns, nnd Sons	Winchester, Mnss.
74861	Industrial Condenser Corp.	Chicngo, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Wasecn, Minn.
75042	Internntionnl Resistance Co.	Philndelphia, Pn.
75378	CTS Knights Inc.	Snndwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pn.
76210	C.W. Marwedel	San Francisco, Cnlif.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Cinch-Monndnock, Div. of United Carr Fastener Corp.	Snn Leandro, Calif.
76545	Mueller Electric Co.	Clevelnnd, Ohio
76703	Nntionnl Union	Newnrk, N.J.
76854	Oak Manufncturing Co.	Crystnl Lnke, Ill.
77068	Bendix Corp., The Bendix Pacific Div.	N. Hollywood, Cnlif.
77075	Pncific Mntals Co.	Snn Frnncisco, Cnlif.
77221	Phanostrnn Instrument and Electronic Co.	South Pnsndnna, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphin, Pn.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princetnn, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
77764	Resistance Products Co.	Hnrrisburg, Pa.
77969	Rubbercraft Corp. of Cnlif.	Torrnnce, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signnl Indicntor Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitmnn, N.J.
78452	Thompson-Bremer & Co.	Chicngo, Ill.
78471	Tilley Mfg. Co.	Snn Frnncisco, Calif.
78488	Stnckpole Cnrbon Co.	St. Mnrys, Pn.
78493	Stnndnrd Thomson Corp.	Wnlthnm, Mass.
78553	Tinnermnn Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Cnlif.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hnrtford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continentnl-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80130	Times Telephoto Equipment	New York, N.Y.
80131	Electronic Industries Associntion. Any brand Tube meeting EIA Standards-Wnshington, DC.	
80207	Unimnx Switch, Div. Mnxon Electronics Corp.	Wnllingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Stnr Products Inc.	Definnce, Ohio
80509	Avery Adhesive Label Corp.	Monrovin, Cnlif.
80583	Hammnrlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mnss.
81030	Internntional Instruments Inc.	Orange, Conn.
81073	Grnyhill Co.	LnGrange, Ill.
81095	Trind Trnnsformer Corp.	Venice, Calif.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	. . . . .
81483	Internntional Rectifier Corp.	El Segundo, Calif.
81541	Airpnx Electronics, Inc.	Cnmbridge, Mnss.
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mnss.
82042	Cnrter Precision Electric Co.	Skokie, Ill.
82047	Sperti Fnrnday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pn.
82170	Fairchild Cnmera & Inst. Corp., Defense Prod. Division	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvnnia Electric Prod. Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newnrk, Hnrrison, N.J.
82389	Switchcraft, Inc.	Chicngo, Ill.
82647	Metnls & Controls Inc. Spencer Products	Attleboro, Mnss.
82768	Phillips-Advnnce Control Co.	Joliet, Ill.
82866	Resenrch Products Corp.	Mndison, Wis.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendnle, Calif.
83053	Western Washer Mfg. Co.	Los Angeles, Cnlif.
83058	Cnrr Fastener Co.	Cnmbridge, Mnss.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Cnpacitor Div.	Dnrlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Cnlif.
83186	Victory Engineering Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bnnk, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83385	Central Screw Co.	Chicagn, Ill.
83501	Gavitt Wire and Cable Co. Div. of Amerace Corp.	Brookfield, Mnss.
83594	Burroughs Corp. Electronic Tube Div.	Plninfield, N.J.
83740	Union Carbide Corp. Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronnuticnl Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	Snn Frnncisco, Calif.
84411	TRW Capacitor Div.	Ogallnla, Neb.
84970	Sarkes Tnrzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.

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

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

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

0000F	Malco Tool and Die	Los Angeles, Calif.
0000M	Western Coil Div. of Autometic 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 1
MANUAL CHANGES

This appendix contains information on changes required to adapt this manual to an instrument with a serial prefix listed in the table below. Check for your instrument serial prefix and make 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 μf.
Table 6-2,
Change C23 to hp Part No. 0160-0159; C: fxd,my, 6800 pf, 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 μf,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 μf.
Figure 5-16,
Change value of C238 to 1000 μf.
Table 6-2,
Change C24 and C238 to C: fxd, elect, 1000 μf, +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 μf.
Figure 5-16,
Change C209 and C210 each to .022 μf.
Table 6-2,
Change C9, C10, C209, C210 to C: fxd, my, .002 μf, 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 μf.
Table 6-2,
Change C444 and C465 to C: fxd, cer, .01 μf, 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 replacement, 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 consequently 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, 1000μf.
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 fxdc, 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, .001μf, 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 μf, 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.

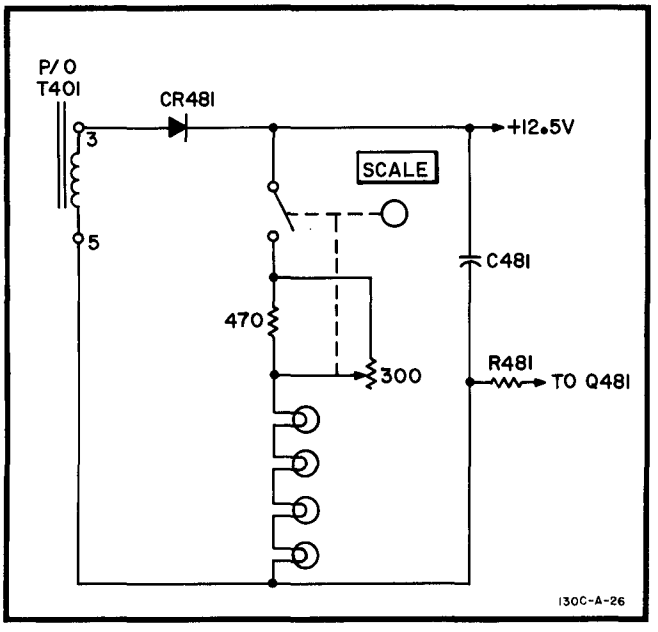


Figure II-1. Option 05 Schematic Diagram

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.

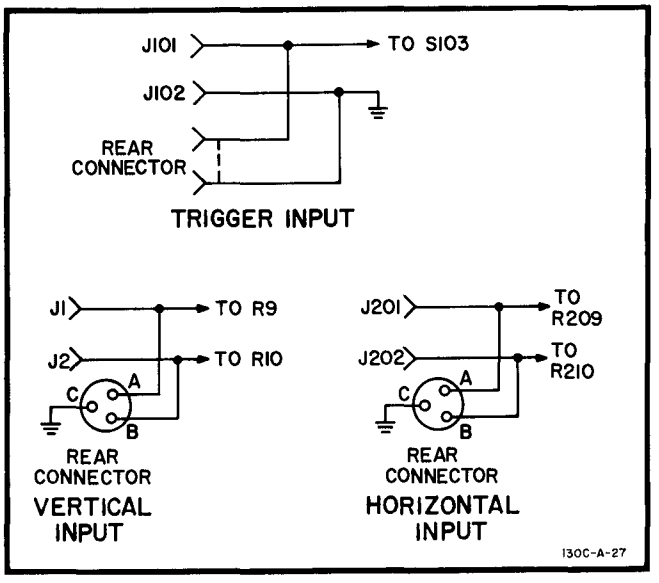


Figure II-2. Option 06 Schematic Diagram

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 ±3%. Automatically connected . . . to CAL."
Change General, Calibrator specification to read as follows:
"Line frequency square wave, 500 mv ±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.
Δ 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

Δ = Latest additions to this chenge 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, respsectively, 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.

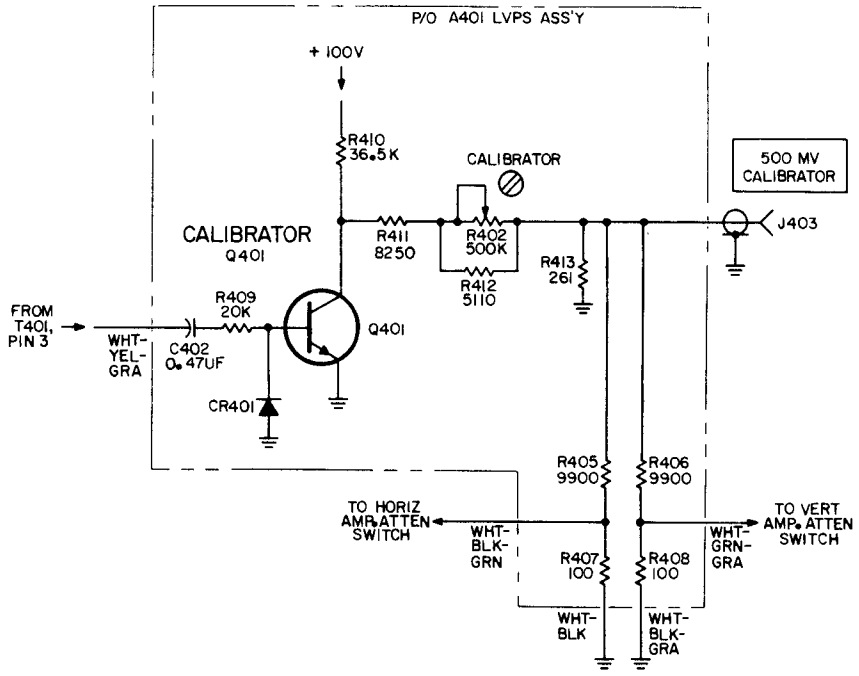
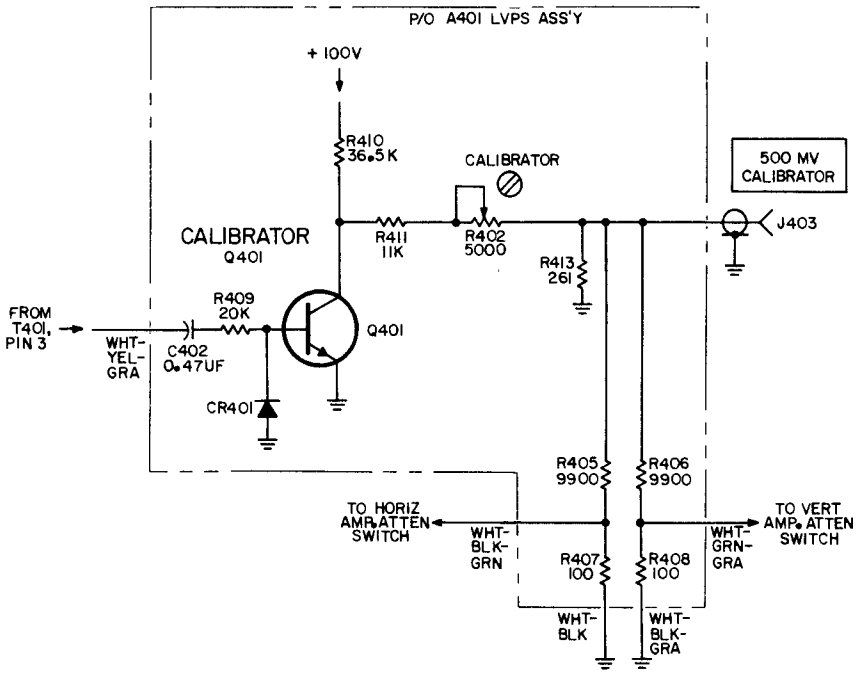


Figure 2.



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