OPERATING AND SERVICE MANUAL

OSCILLOSCOPE
130C

HEWLETT PACKARD

HP 130C

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.

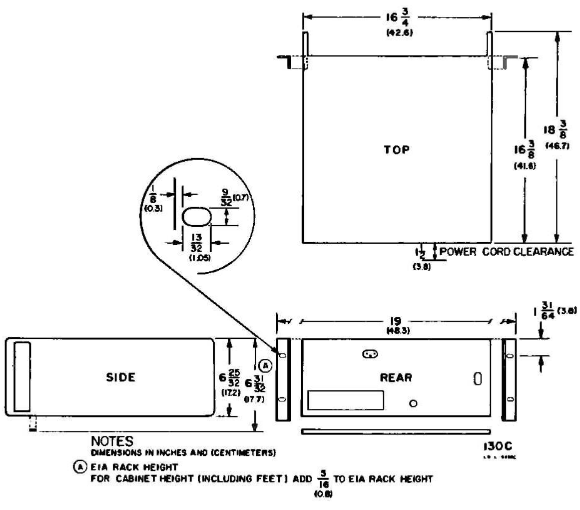
INTERNAL GRATICULE: Parallax-free 10 cm x 10 cm marked in cm squares. 2 mm subdivisions on major horizontal and vertical axis.

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.

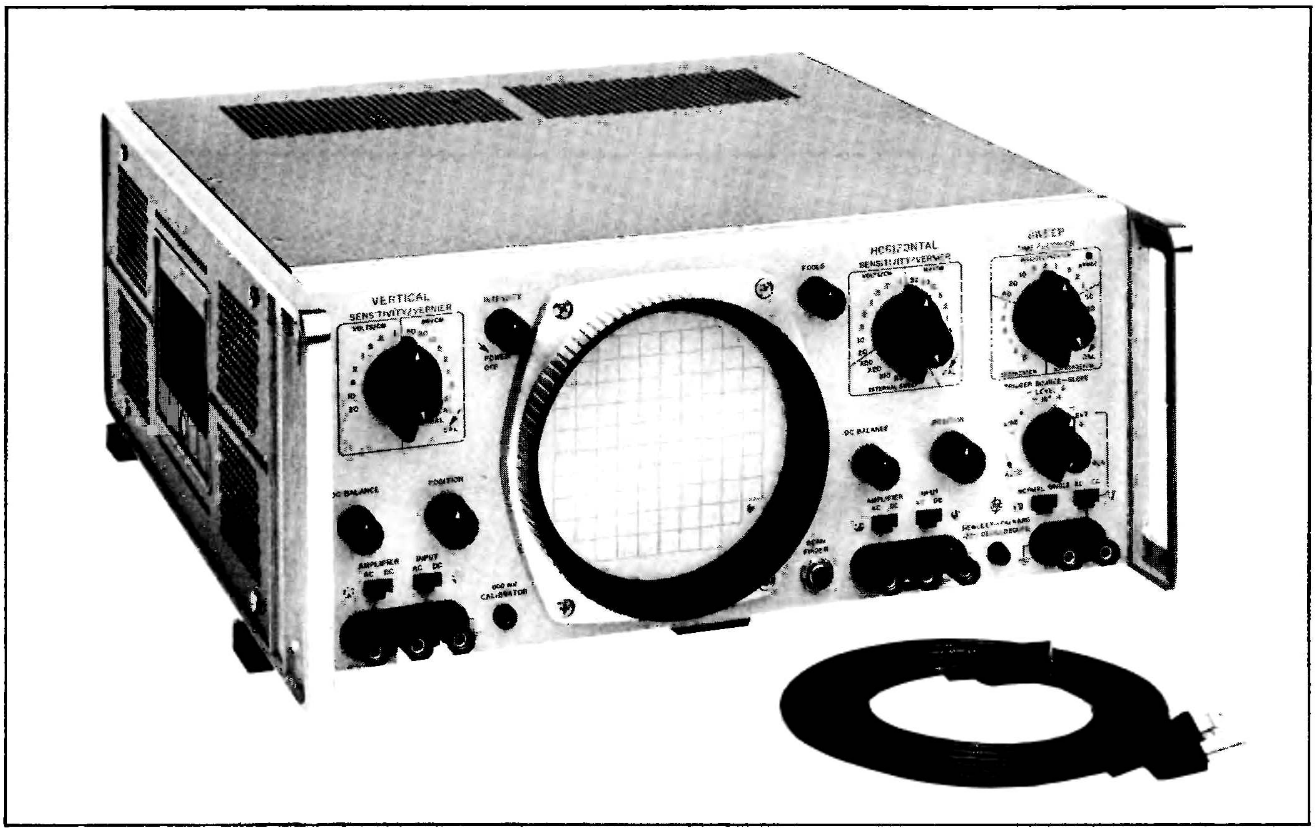


Figure 1-1. Model 130C Oscilloscope

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 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

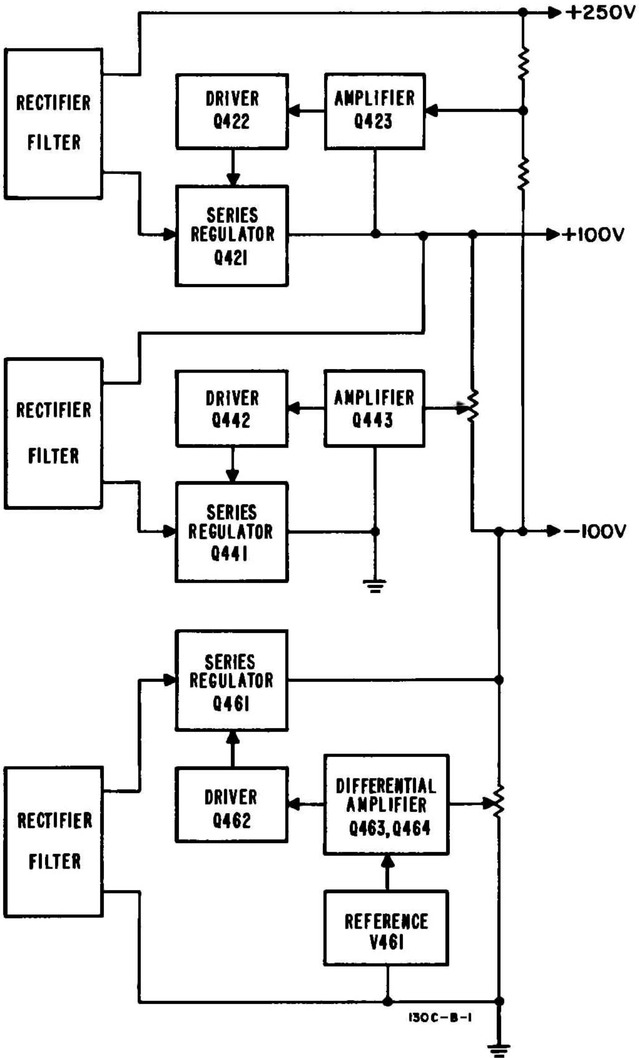


Figure 4-2. LV Power Supply Block Diagram

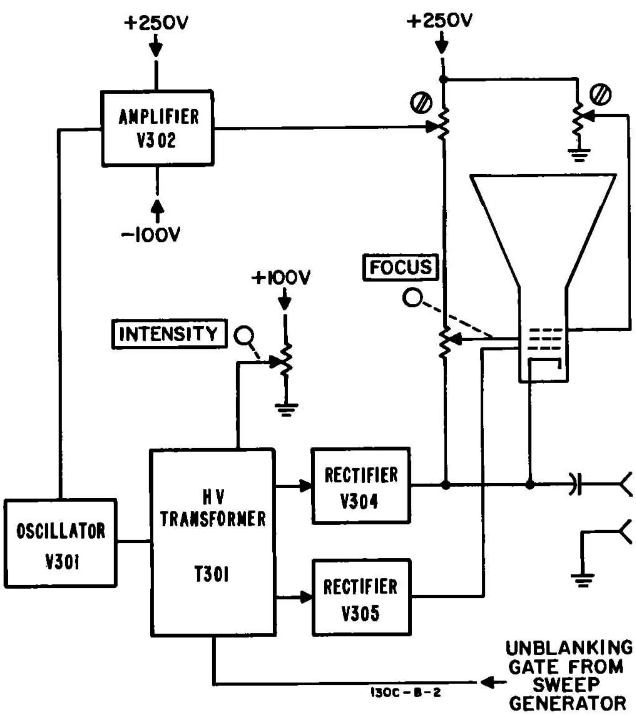


Figure 4-3. H V Power Supply Block Diagram

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

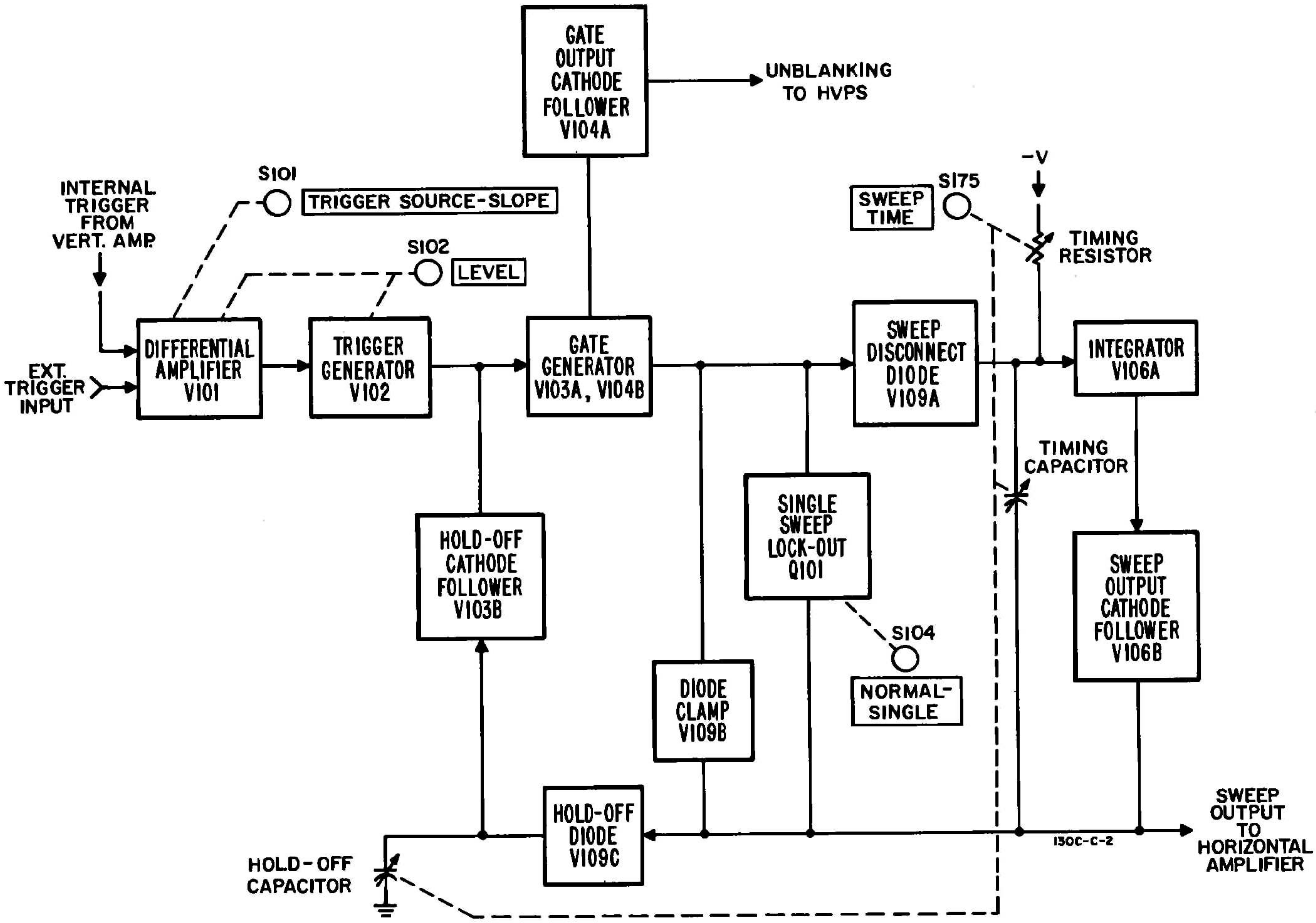


Figure 4-4. Sweep Generator Functional Block Diagram

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 MILLI-SECONDS/CM settings (and C177 becomes the hold-off capacitor).

4-26. FREE RUN CIRCUIT OPERATION.

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

4-28. SINGLE SWEEP CIRCUIT.

4-29. In single sweep operation the sweep is triggered on the first trigger received after manual arming, and further triggers are ineffective until the circuit is re-armed. This sequence is accomplished in the Model 130C by preventing the retrace from occurring. In NORMAL operation, switch S104A returns Q101 emitter to ground through R150 and the transistor is inoperative. In SINGLE operation, however, S104A connects R150 to -100 volts. This still biases Q101 off, but allows conduction when the base voltage becomes more positive during the sweep. In the SINGLE position, S104B connects +100v to neon indicator DS101. Because the sweep level is at zero volts before the sweep waveform begins, there is sufficient voltage across the neon to cause it to light (ARMED). Assuming that S104 has just been switched to SINGLE position, the first trigger to arrive at the gate generator starts a sweep in the usual way. As the sweep output voltage rises, the voltage across DS101 decreases until the light goes out. The positive-going sweep voltage is also applied by voltage divider R143 and R144 to the base of Q101, bringing the transistor into conduction and eventually driving it into saturation. As in NORMAL operation, the sweep voltage is fed back through the hold-off circuit to switch the gate generator back to its pre-sweep condition (V103A on, V104B off). With V104B cut off, the saturation current of Q101 flowing through R137 is still enough to keep diodes V109A and V109B biased off. Integrator V106A is thus allowed to continue integrating until it reaches saturation. The sweep output waveform rounds and levels off, remaining at this high positive level until the circuit is manually re-armed. Since this positive voltage is fed back through the hold-off circuit to the input of the gate generator, triggers generated by V102 are unable to overcome this voltage and operate the gate. To re-arm the circuit, S104 is switched back to NORMAL. This cuts off Q101, which allows V109A and V109B to conduct and return the integrator to its pre-sweep condition. Setting switch S104 back to SINGLE will repeat the single sweep operation.

4-30. VERTICAL AMPLIFIER.

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

4-32. INPUT ATTENUATOR.

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

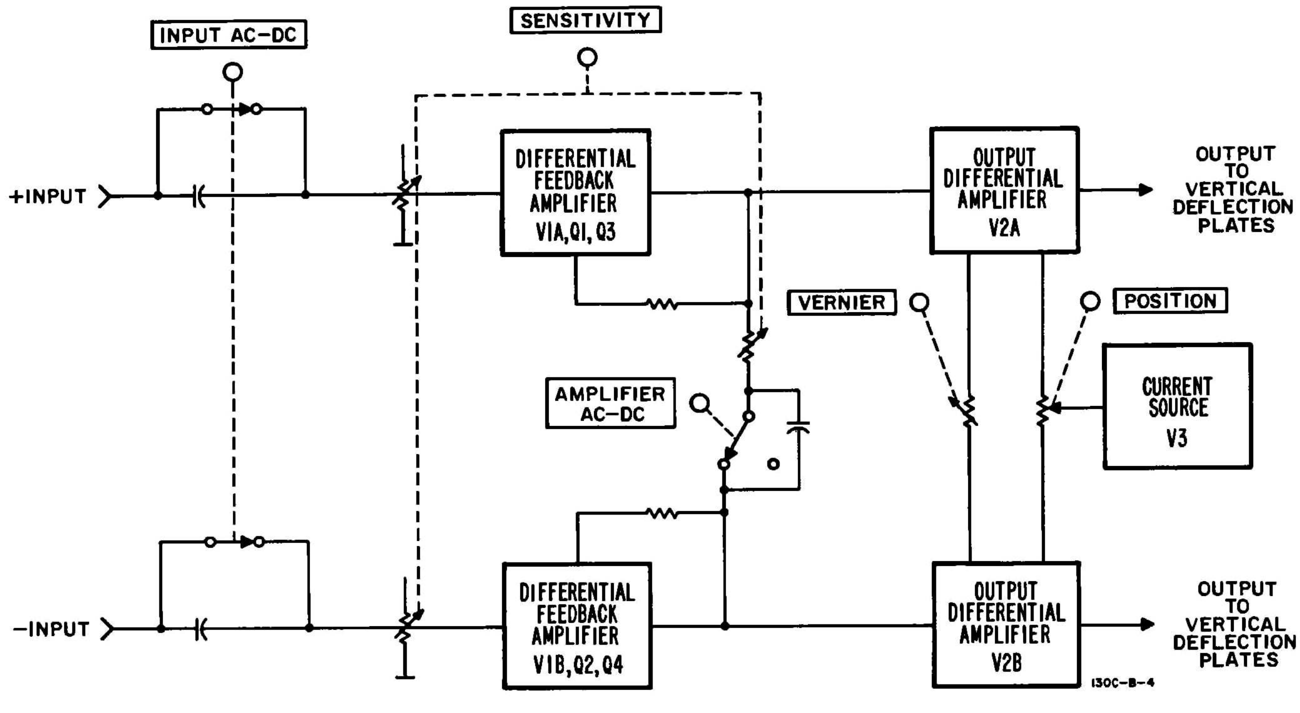


Figure 4-5. Vertical Amplifier Functional Block Diagram

ratio of 100:1 on the three least sensitive ranges (5 VOLTS/CM to 20 VOLTS/CM) is provided by R11/R13 and R12/R14 on the two inputs. Capacitors C11 and C12 maintain the ratio at high frequencies by capacitive division. Capacitors C13 and C14 are adjusted for 45 pf input capacitance on the three least sensitive ranges. A division ratio of 10:1 on the next three ranges (0.5 VOLTS/CM to 2 VOLTS/CM) is provided by R15/R17 and R16/R18 on the two inputs. Capacitors C17 and C18 maintain this ratio at high frequencies and C19 and C20 are adjusted to keep input capacitance at 45 pf on these three ranges. In the CAL. position of the SENSITIVITY switch, input terminals are opened and a 5 millivolt, ±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.

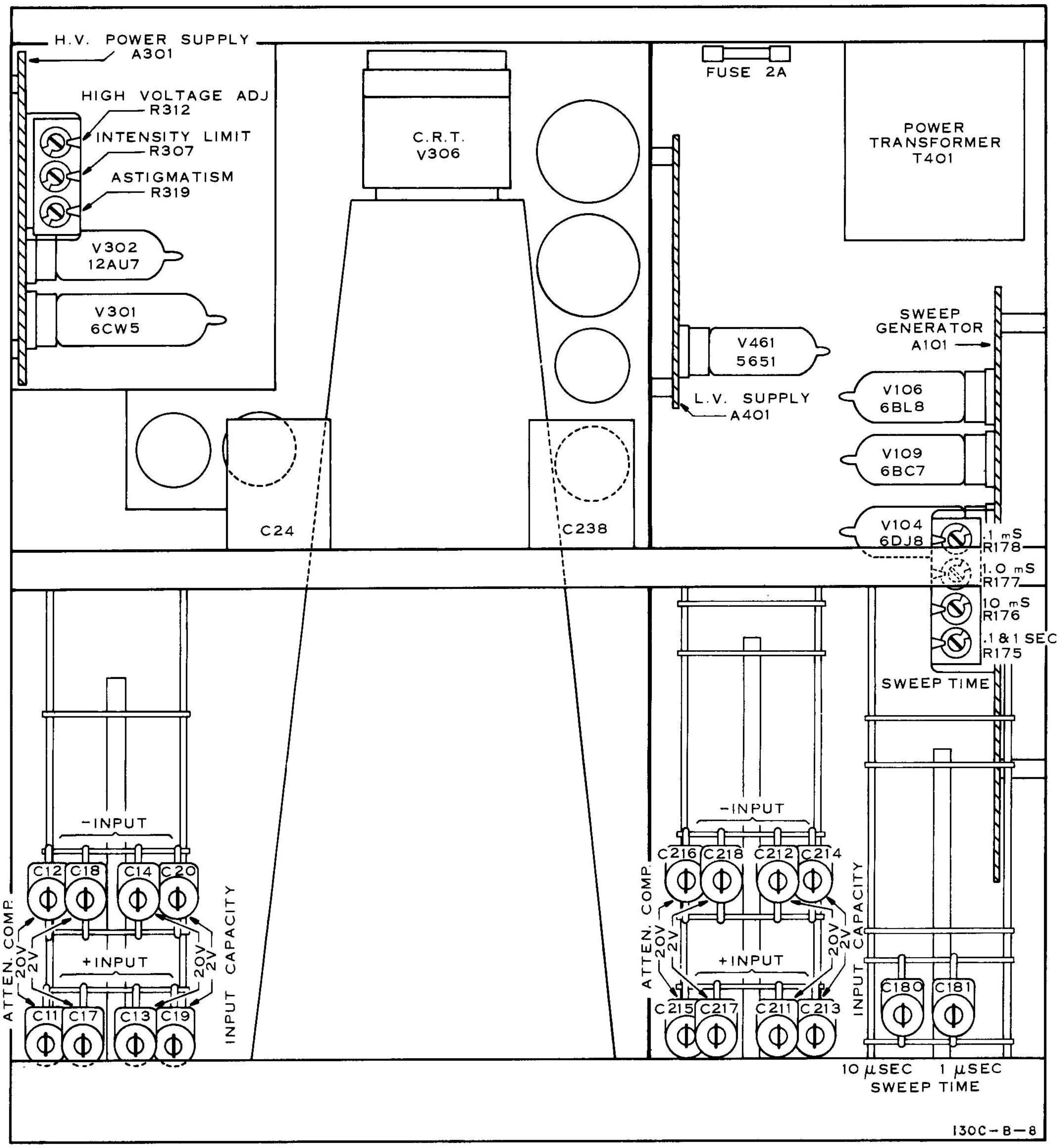


Figure 5-1. Model 130C Top View (Cover Removed)

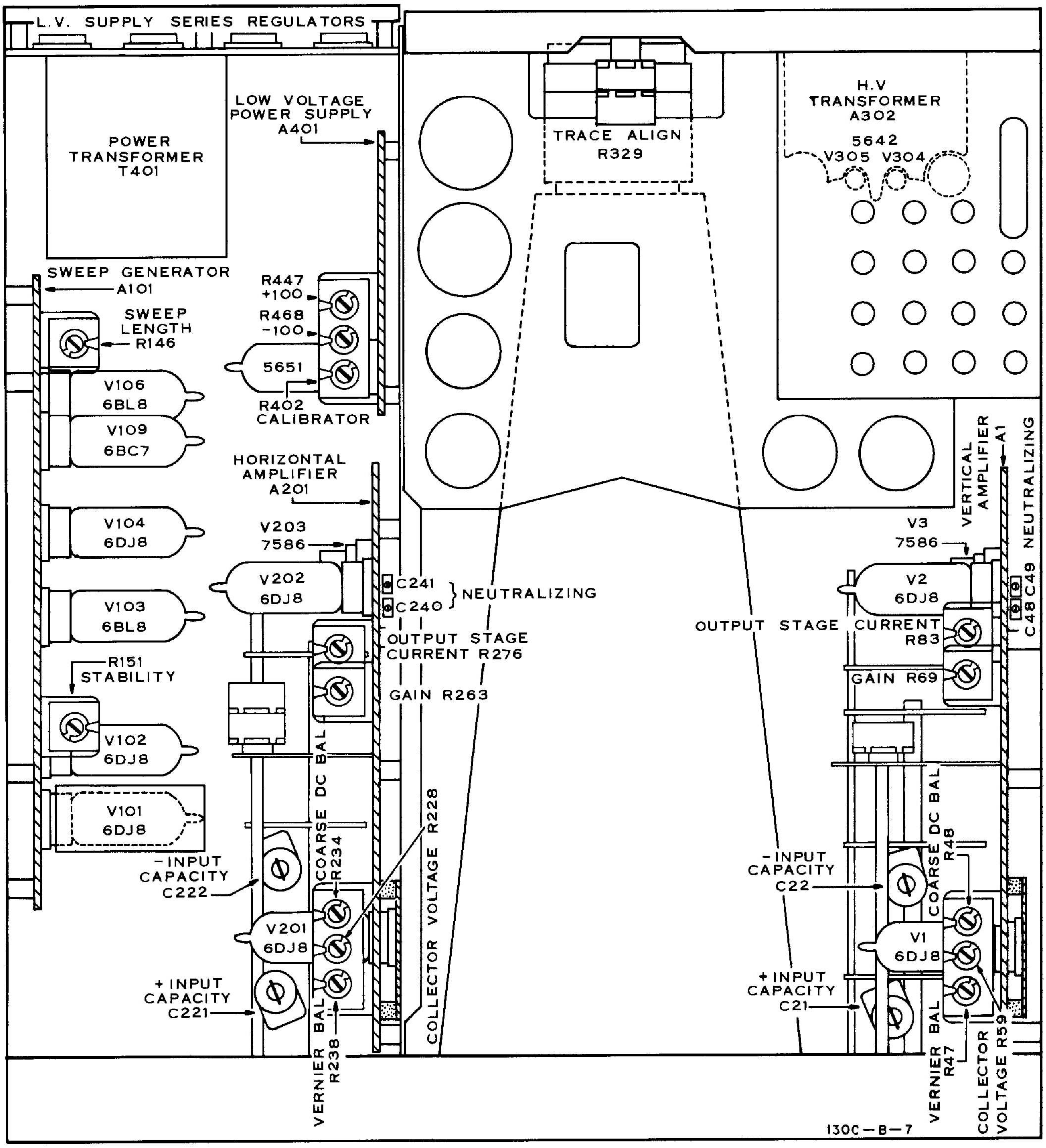


Figure 5-2. Model 130C Bottom View (Cover Removed)

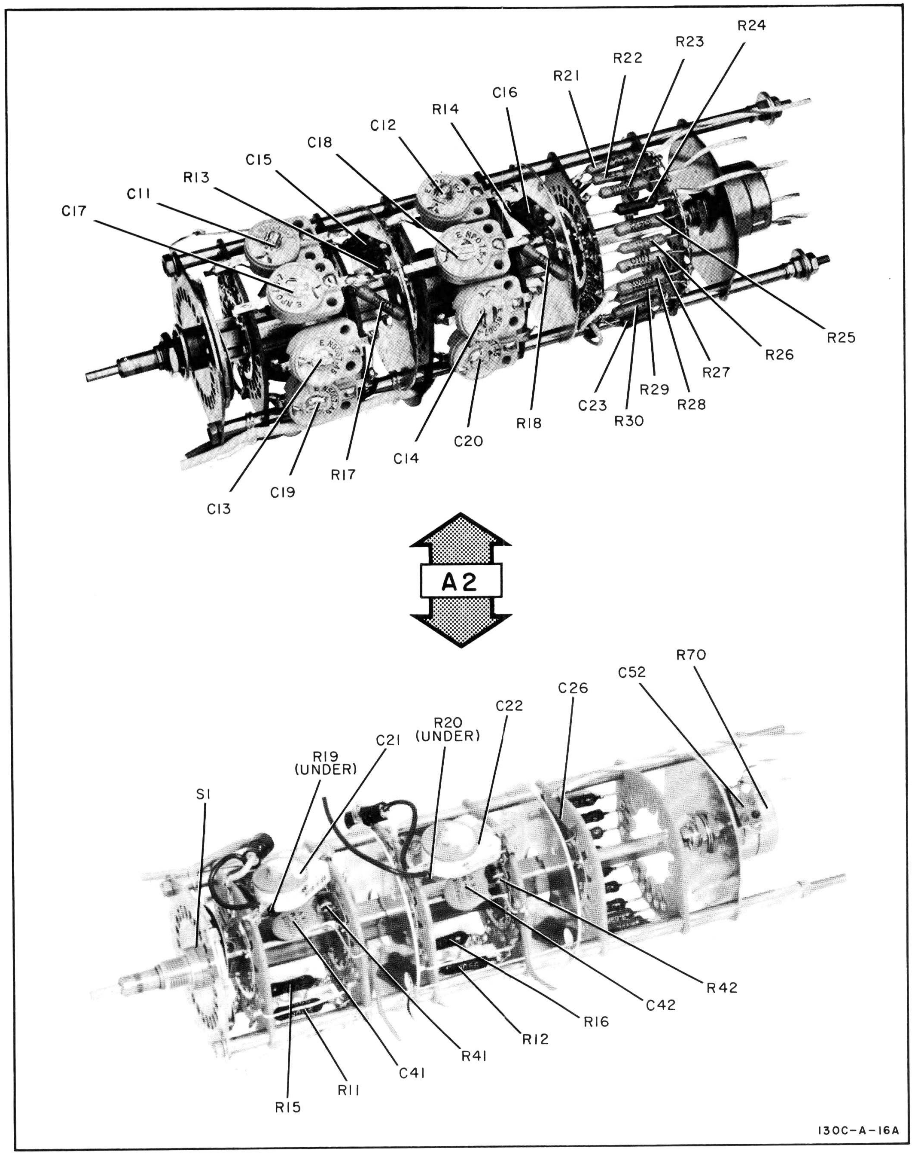


Figure 5-5. Vertical Attenuator, A2, Component Location

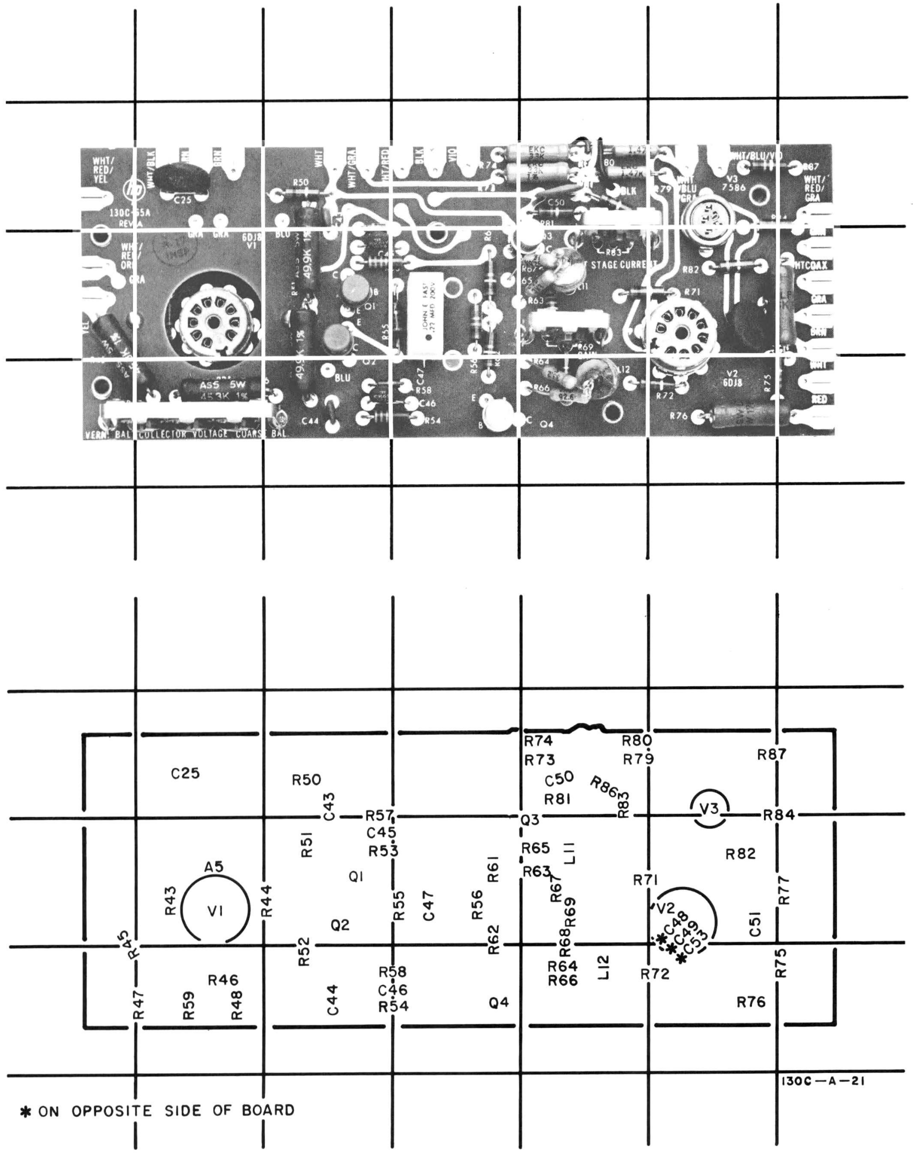


Figure 5-6. Vertical Amplifier, A1, Component Location

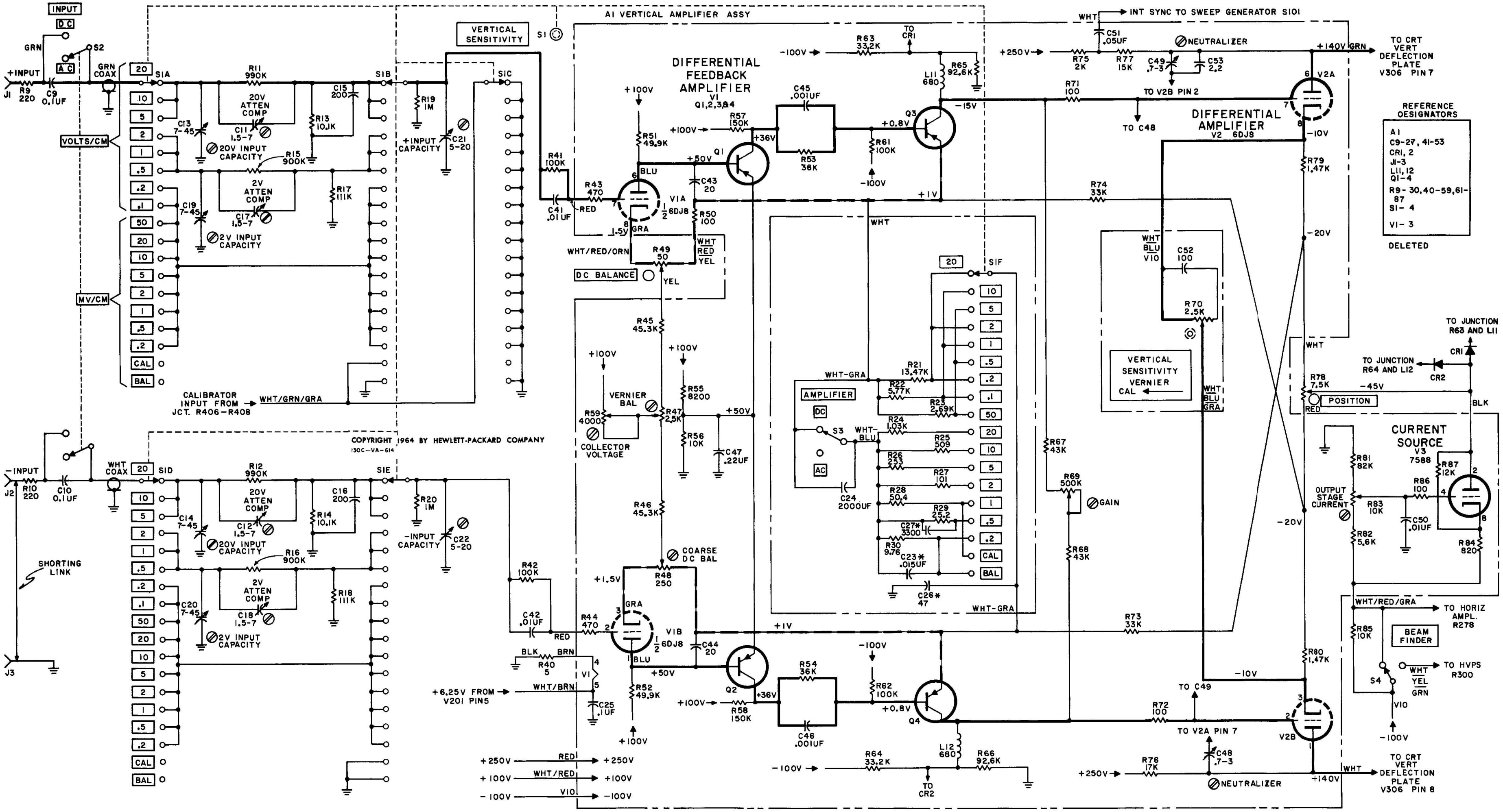
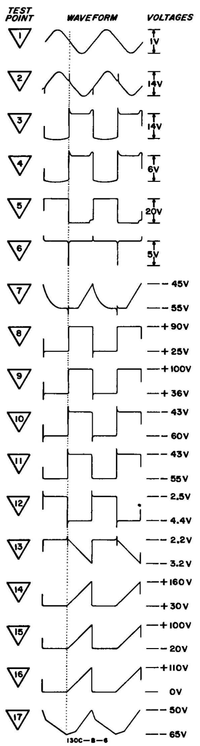


Figure 5-7. Vertical Attenuator and Amplifier Schematic



Note: Waveforms taken with a 2 kc, 1 volt peak-to-peak sine wave applied to the Trigger Input terminal (number 5 in Figure 3-2). 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

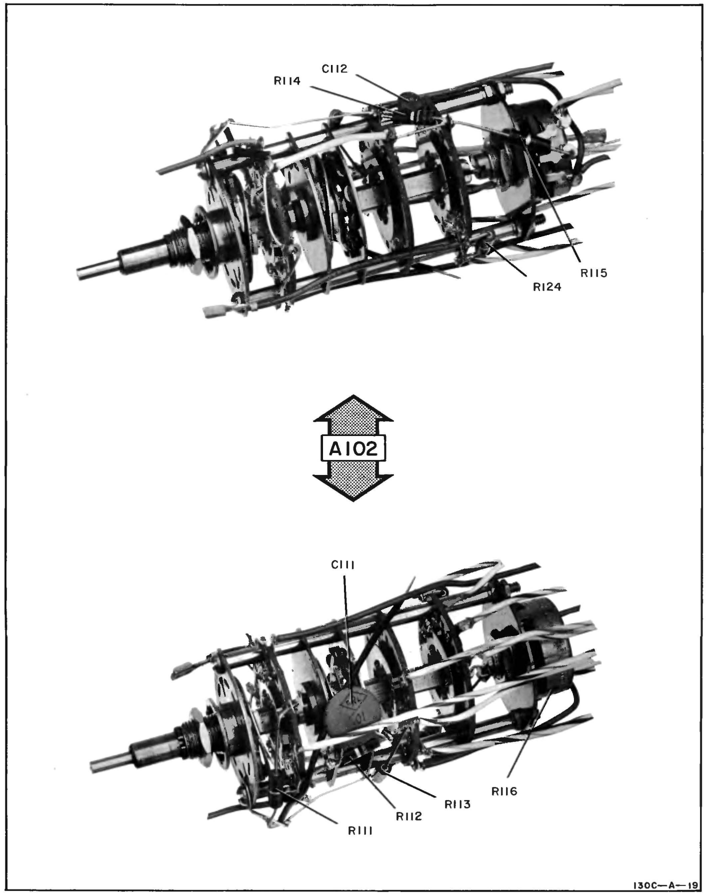


Figure 5-9. Trigger Source - Level Switch, A102, Component Location

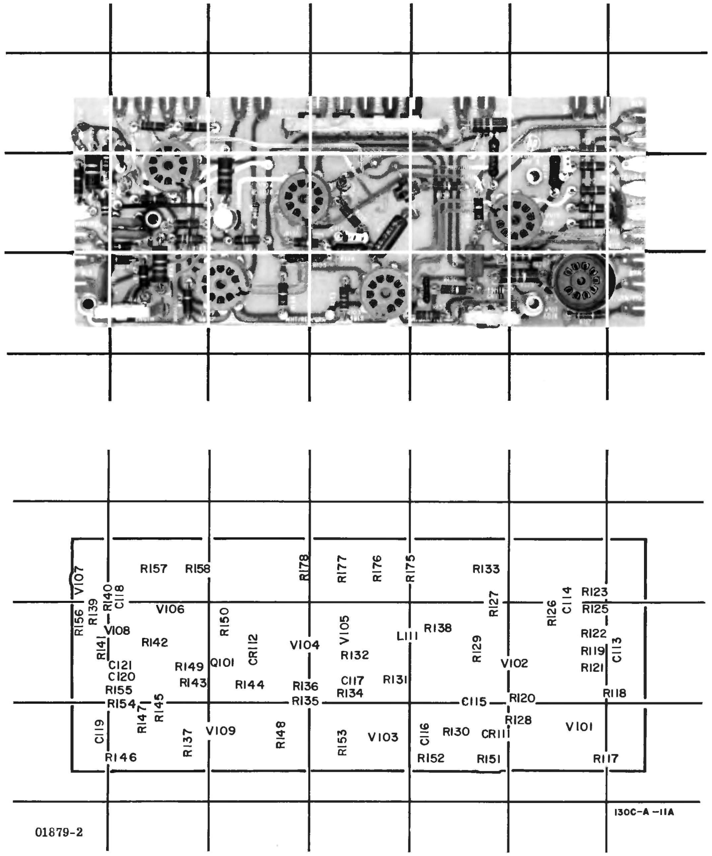


Figure 5-10. Sweep Generator, A101, Component Location

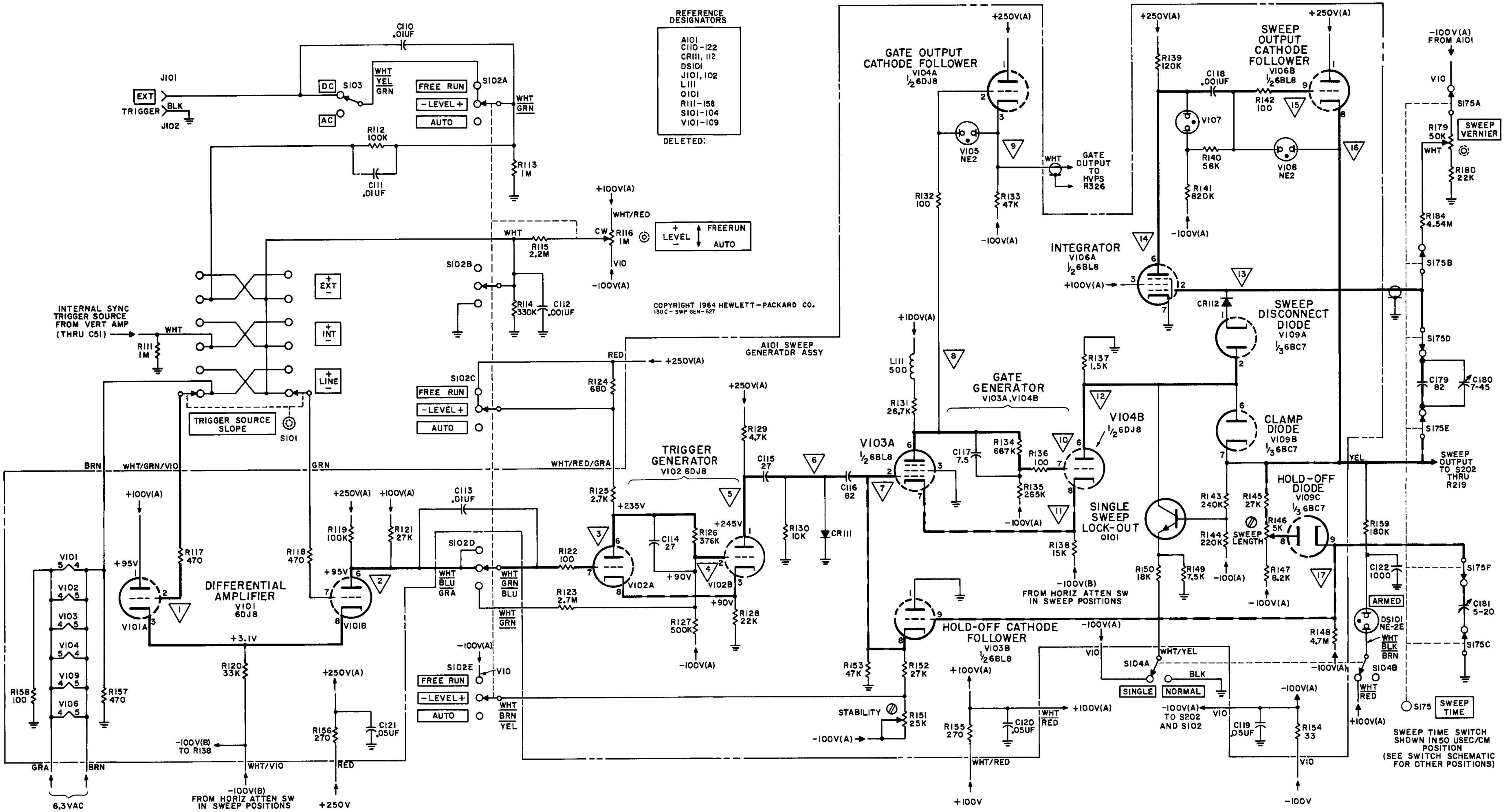


Figure 5-11. Sweep Generator Schematic

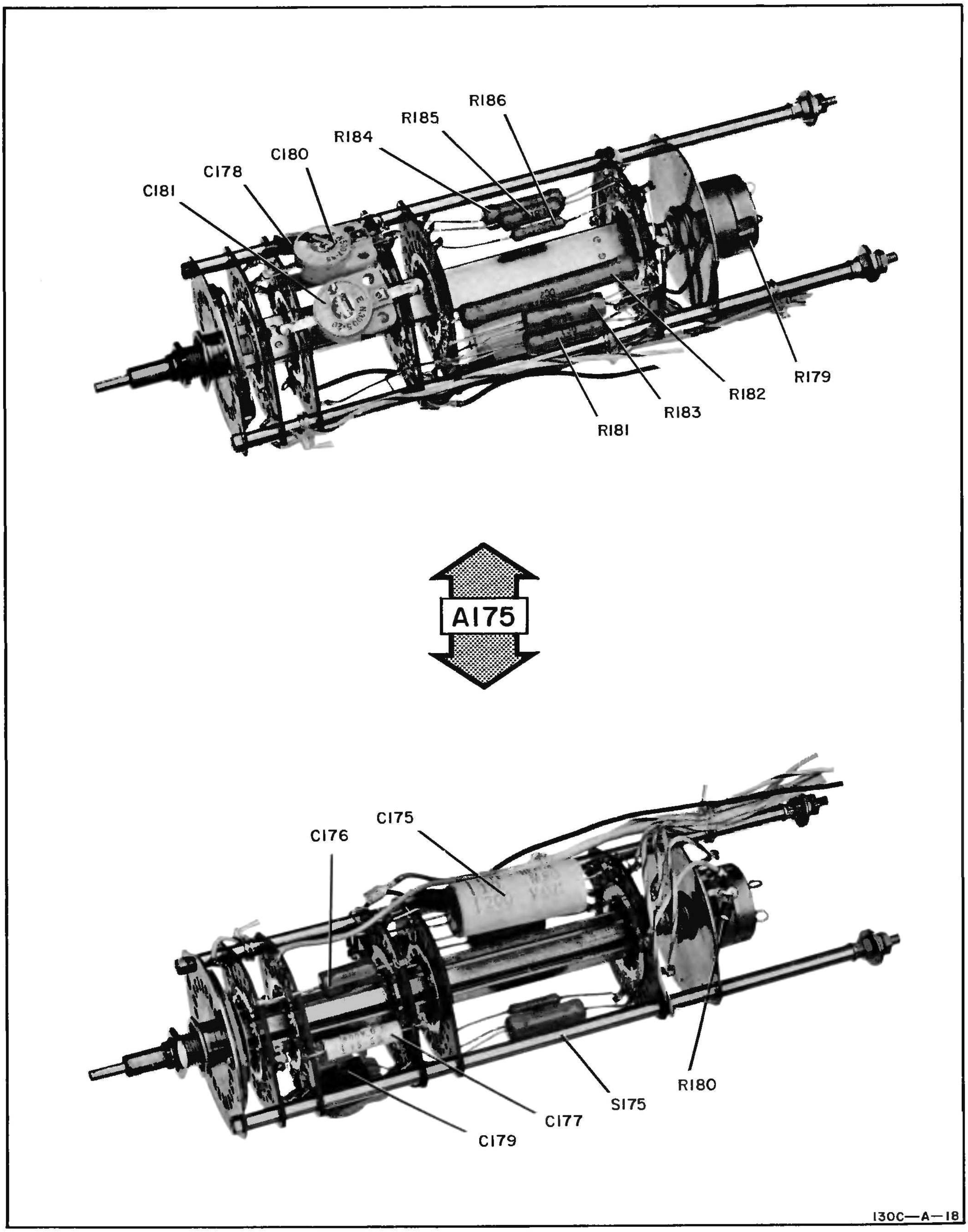


Figure 5-12. Sweep Time Switch, A175, Component Location

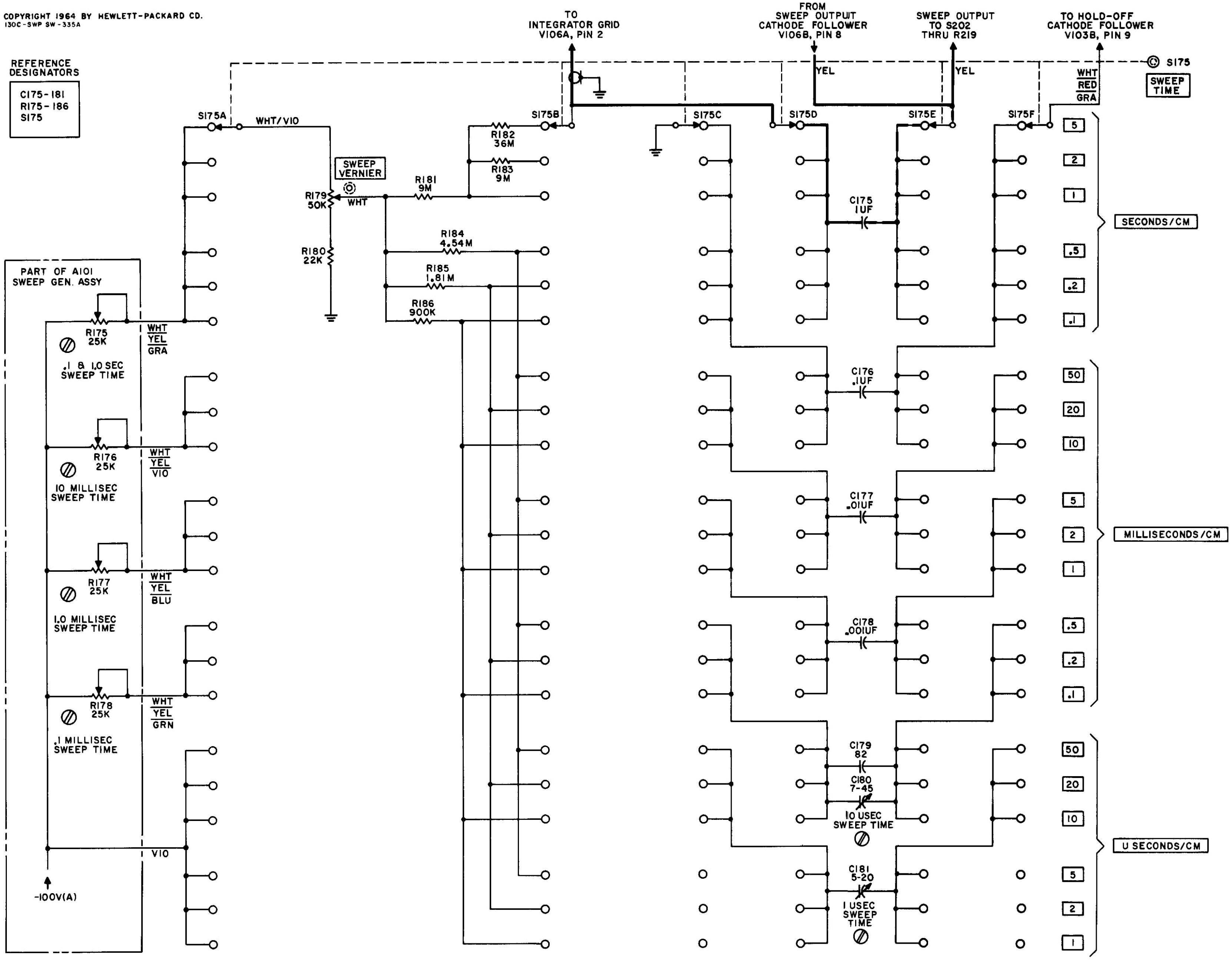


Figure 5-13. Sweep Time Schematic

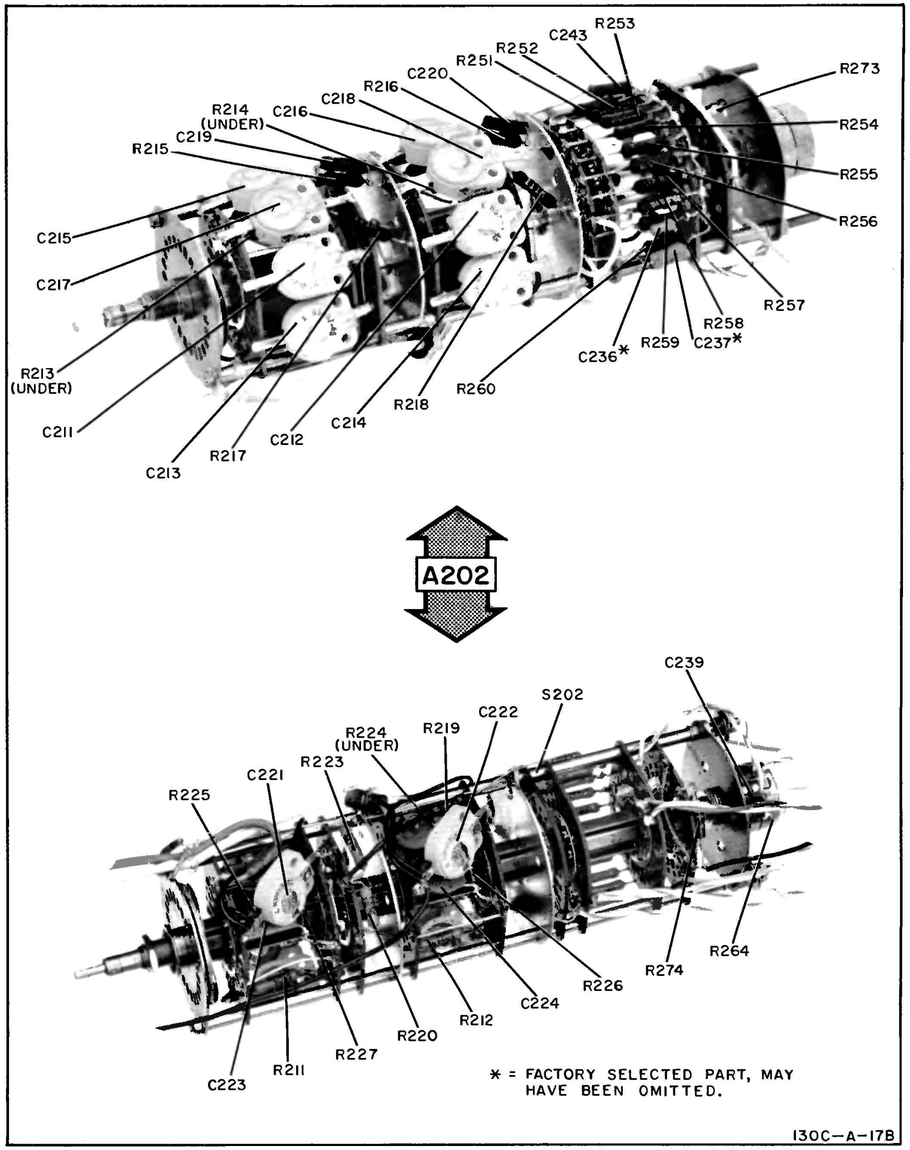


Figure 5-14. Horizontal Attenuator, A202, Component Location

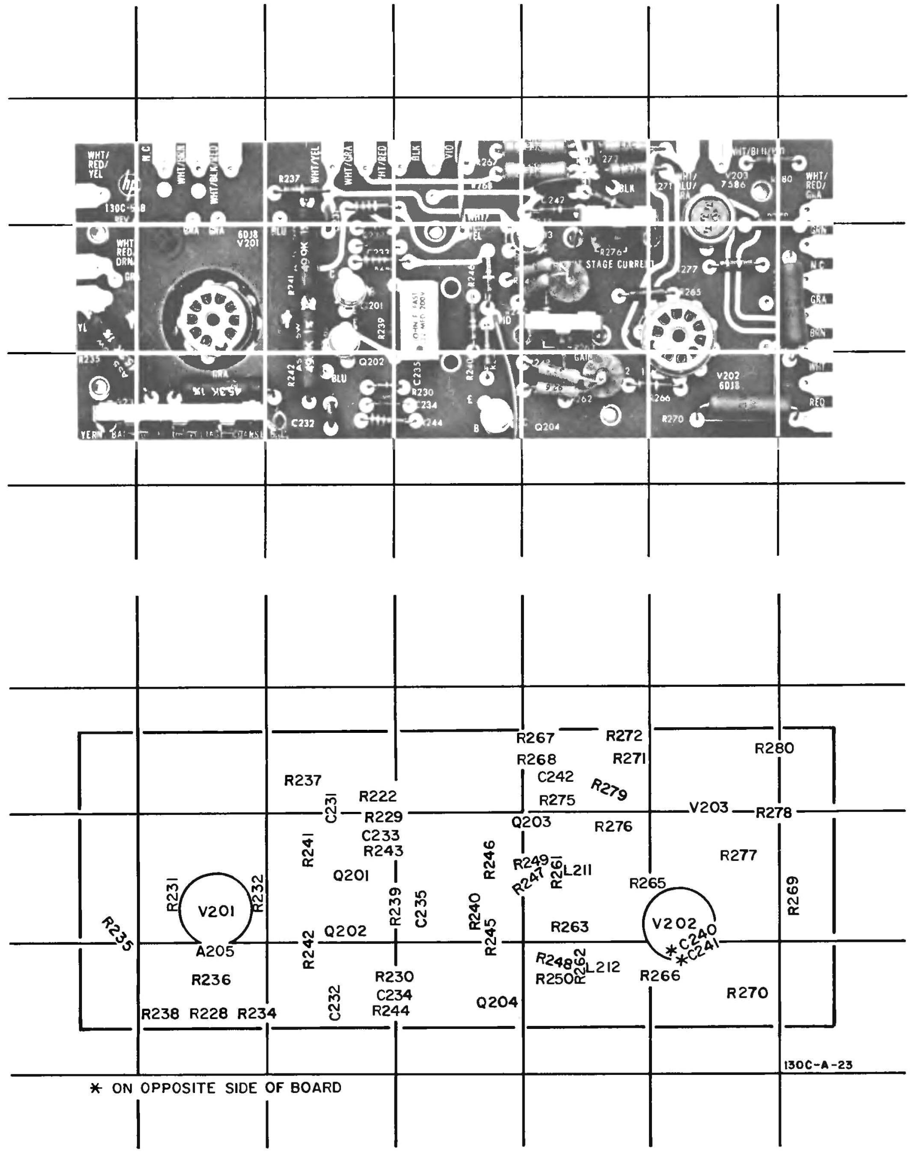


Figure 5-15. Horizontal Amplifier, A201, Component Location

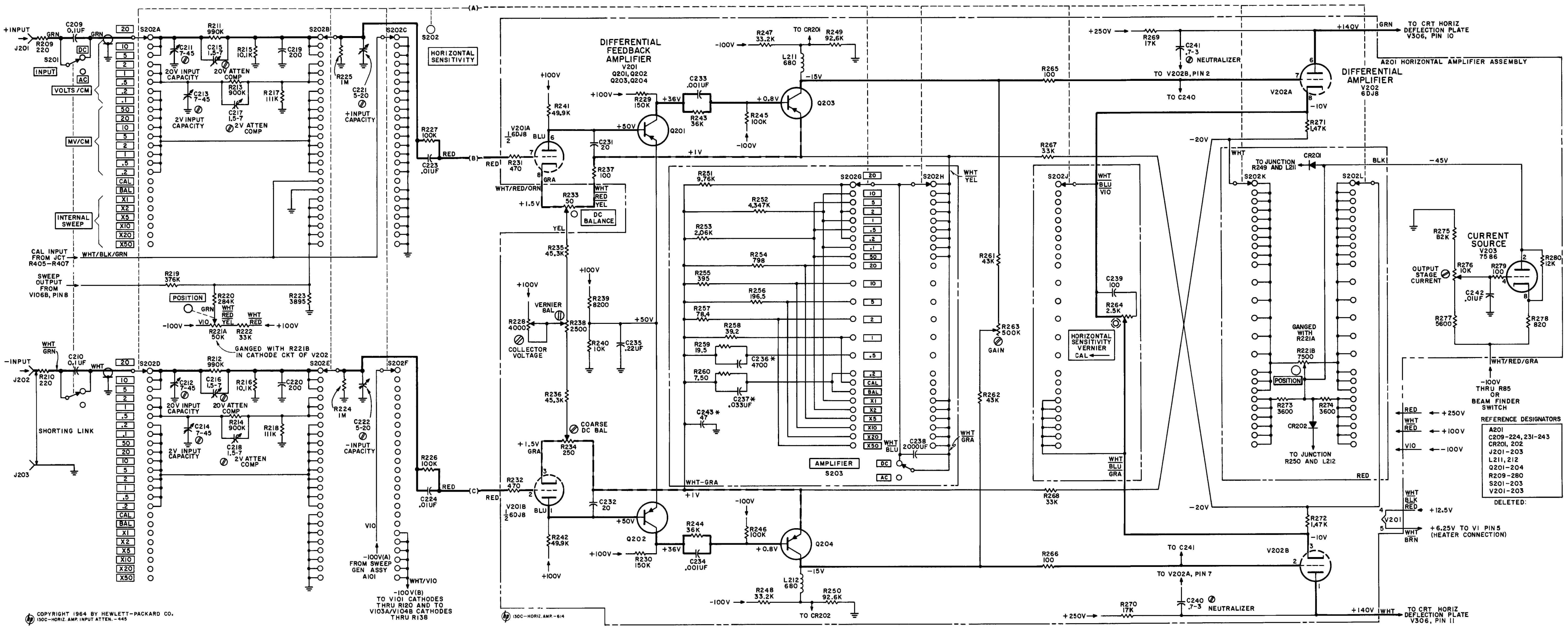


Figure 5-16. Horizontal Attenuator and Amplifier Schematic

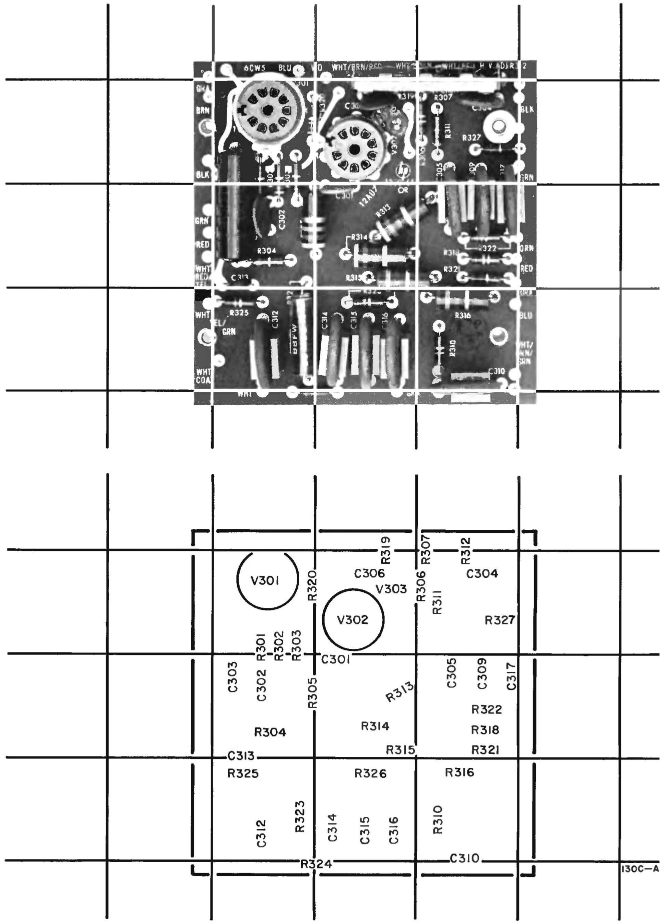


Figure 5-17. High Voltage Power Supply, A301, Component Location

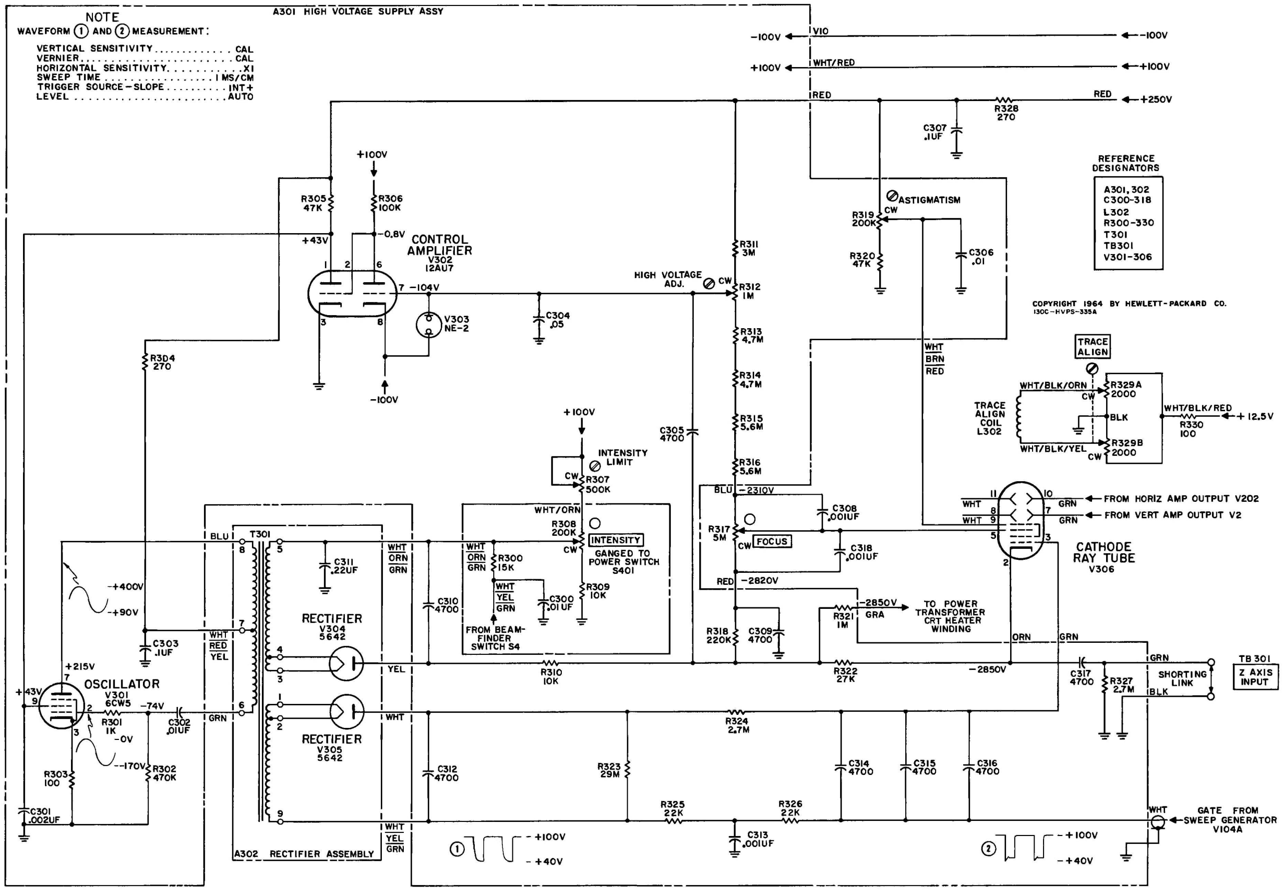


Figure 5-18. High Voltage Power Supply Schematic

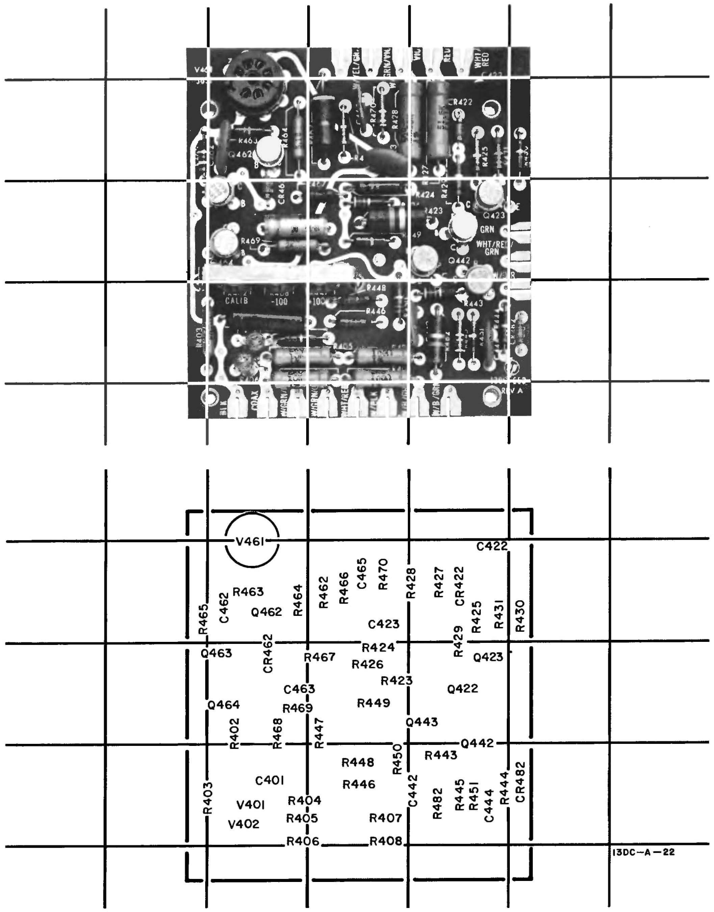


Figure 5-19. Low Voltage Power Supply, A401, Component Location

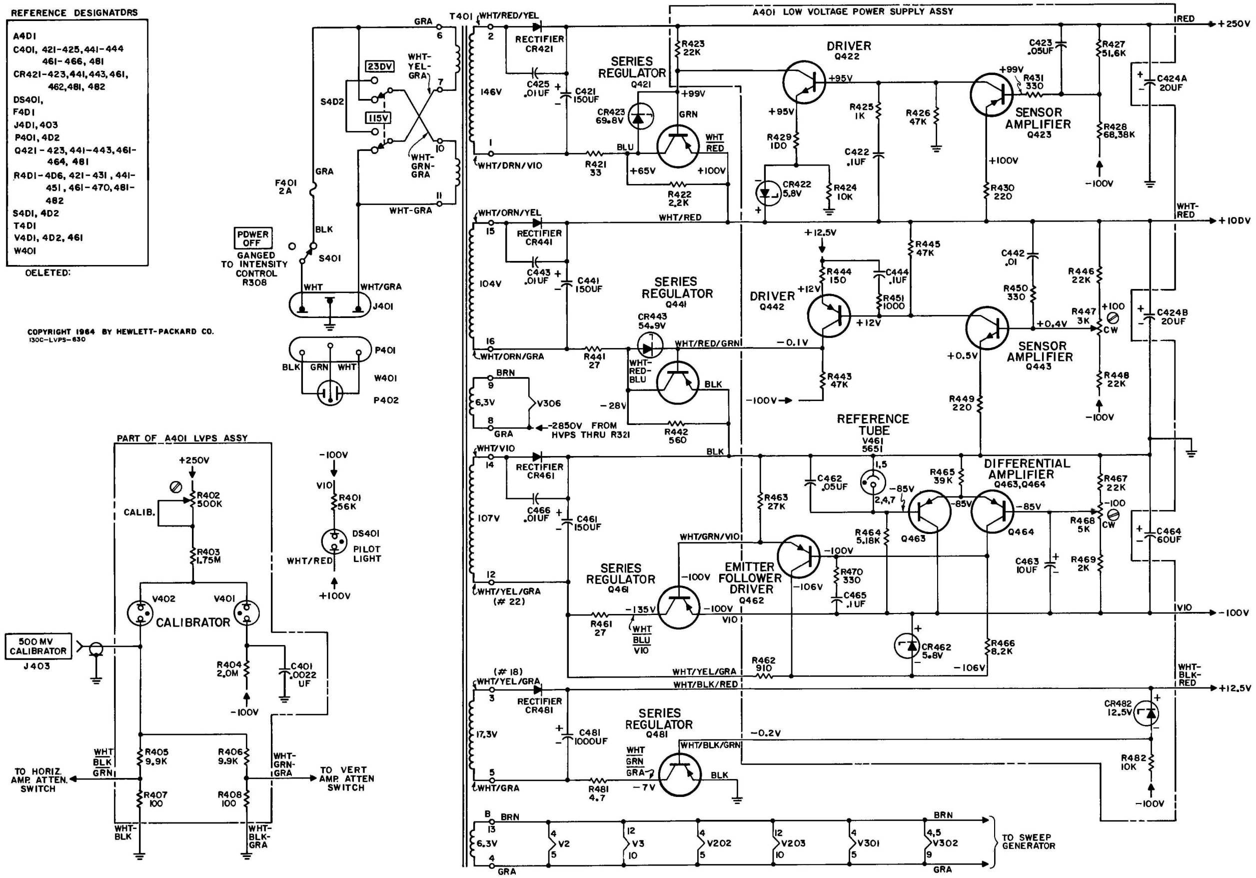


Figure 5-20. Low Voltage Power Supply Schematic

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.

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.

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, respspectively, 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.

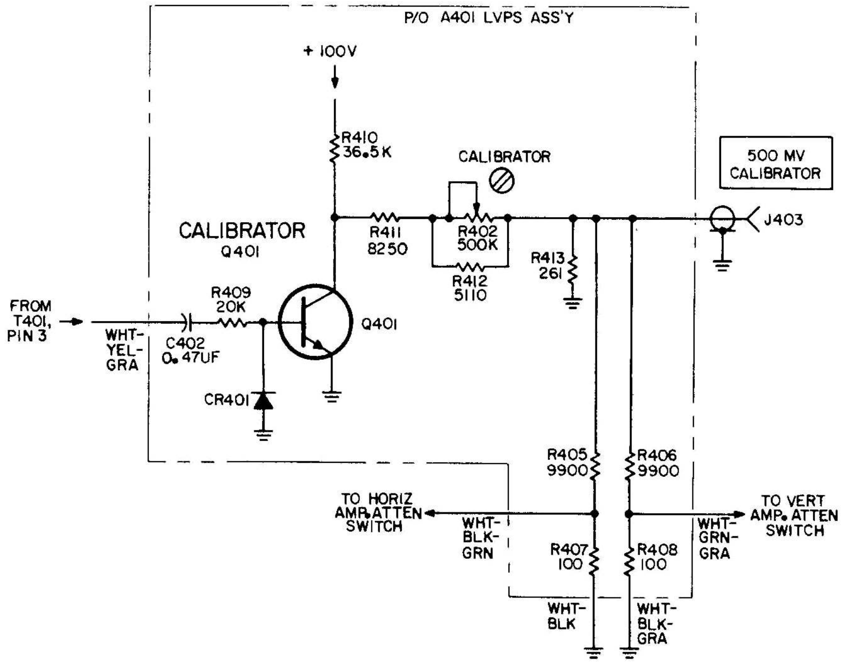
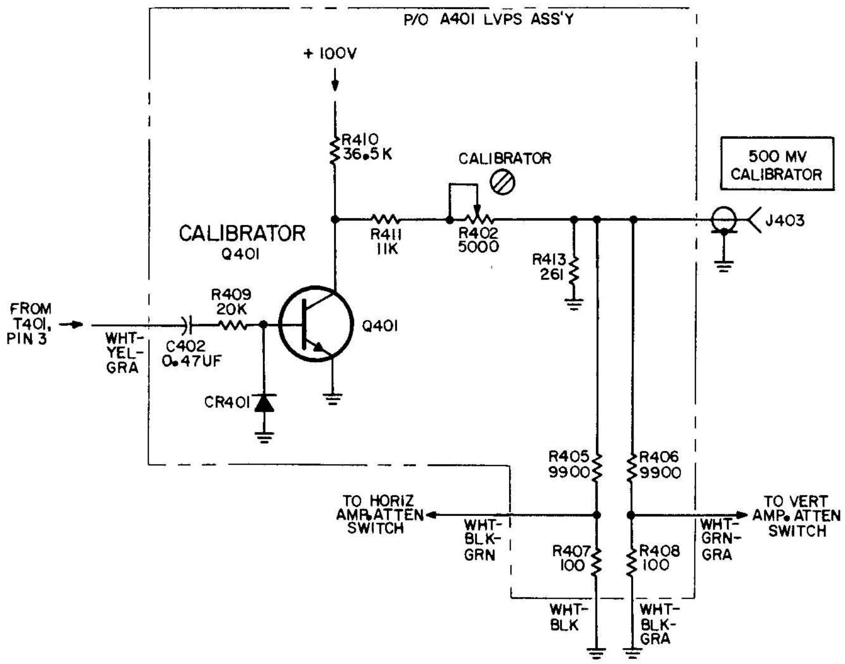


Figure 2.



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.

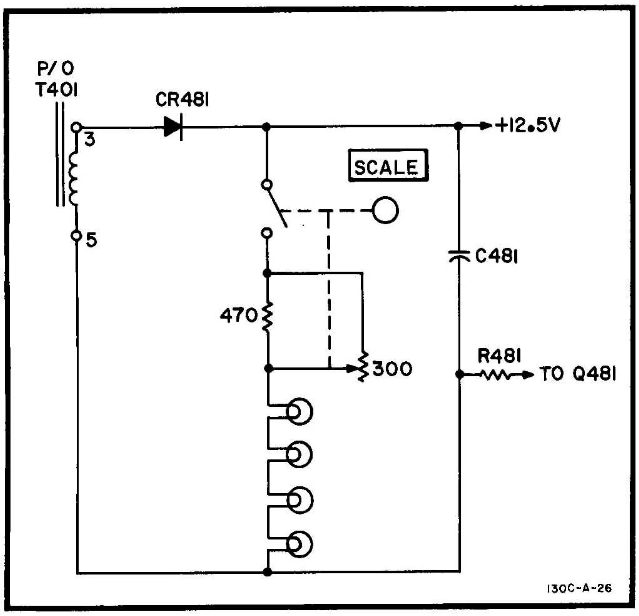


Figure II-1. Option 05 Schematic Diagram

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.

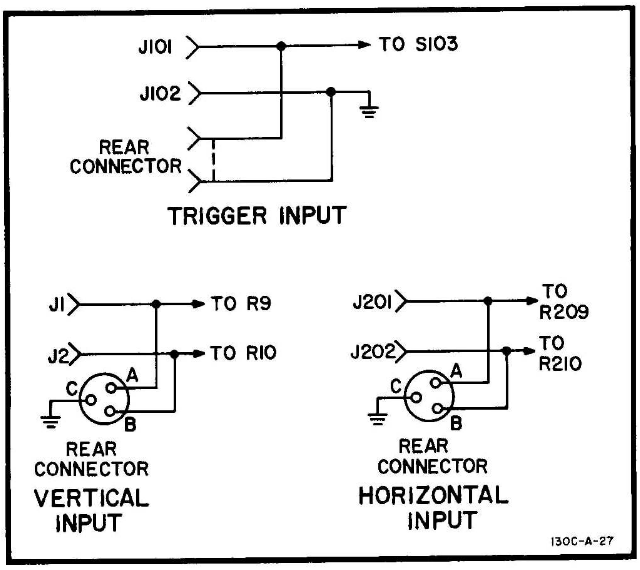


Figure II-2. Option 06 Schematic Diagram

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.