ASSEMBLY MANUAL

FOR THE

BELL & HOWELL SCHOOLS

5-INCH TRIGGERED SWEEP OSCILLOSCOPE

9560-1

Bell & Howell Schools Inc.
4141 Belmont
Chicago, Illinois 60641


BELL & HOWELL SCHOOLS
POWER
CRT DISPLAY
BEAM POSITION
VERT.
HORIZ.
SOLID STATE
OSCILLOSCOPE
TRIGGERED SWEEP
5MHz BANDWIDTH
VERTICAL
VOLTS/CM
VARIABLE
CAL
MODE
DC
INPUT
OPERATE
INPUT
GND
HORIZONTAL
WIDTH
VARIABLE
CAL
µSEC/CM
EXT
AUTO
NORM
SLOPE
INT
EXT
IV P-P
HOR
GND
EXT TRIG

BEFORE OPENING
100-203-31 01526
100-203-31 01526

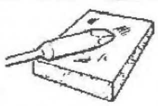
VERTICAL AMPLIFIER BOARD ASSEMBLY

STEP-BY-STEP ASSEMBLY

START

FOR GOOD SOLDERED CONNECTIONS, YOU MUST KEEP THE SOLDERING IRON TIP CLEAN...

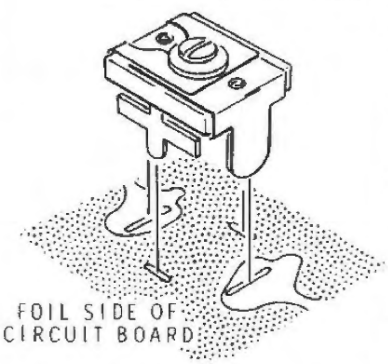
WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.



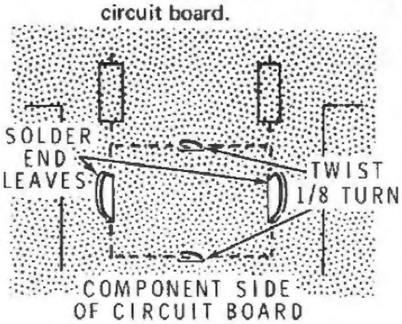
Position the vertical amplifier circuit board foil-side-up. Then complete each step on the Pictorial.

( ) Install a trimmer capacitor (#31-49) in the following manner.

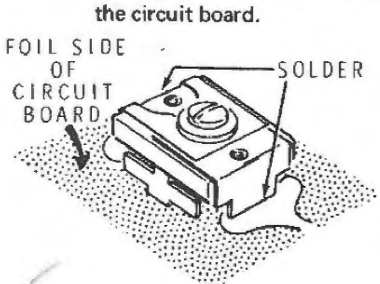
A. Install the capacitor on the foil side of the circuit board.



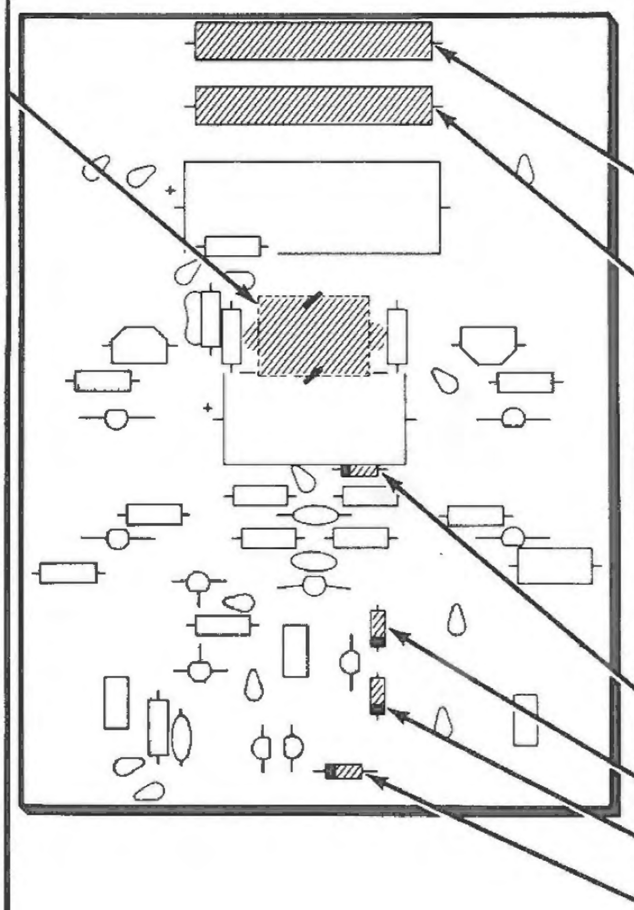
B. Use pliers to twist the two indicated side lugs (on the component side of the circuit board) slightly. Solder all of the small end leaves together on the component side of the circuit board.



C. Solder the indicated end lugs to the foil on the foil side of the circuit board.



( ) Turn the vertical amplifier circuit board lettered-side-up. Then complete the following steps.

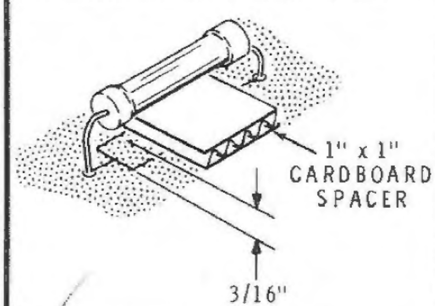


PICTORIAL 1-1

CONTINUE

NOTE: At times, resistors or capacitors will be supplied in various case lengths. Therefore, extra circuit board holes are provided. Use the holes that best accomodate the components you received.

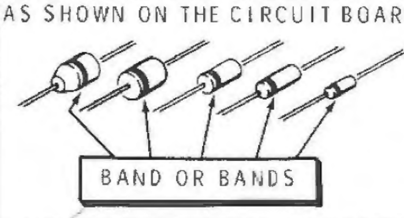
NOTE: When you are instructed to mount a power resistor 3/16" above the circuit board as shown, use a 1" x 1" piece of 3/16" cardboard (from shipping carton) for a spacer. Solder each resistor as it is installed, cut off the excess lead lengths, and then remove the cardboard spacer.



( ) 5600 Ω (5.6 k), 4-watt, wire-wound resistor. Mount this resistor 3/16" above the circuit board.

( ) 5600 Ω (5.6 k), 4-watt, wire-wound resistor. Mount this resistor 3/16" above the circuit board.

NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.



( ) VR-9.1 zener diode (#56-19) at ZD102.

( ) 1N4149 diode (#56-56) at D104.

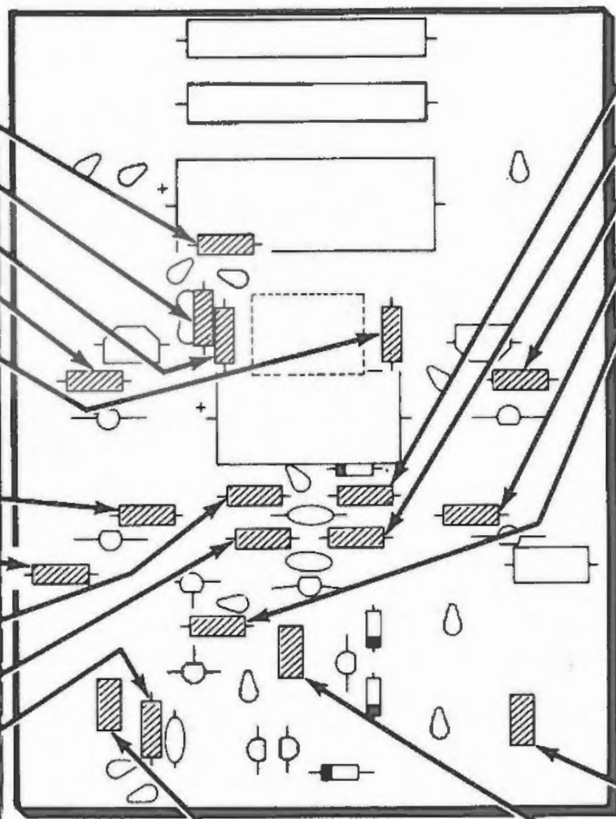
( ) 1N4149 diode (#56-56) at D103.

( ) VR-9.1 zener diode (#56-19) at ZD101.

( ) Solder the leads to the foil and cut off the excess lead lengths.

START

- ( ) 1000 Ω (brown-black-red).
- ( ) 3300 Ω (orange-orange-red).
- ( ) 330 Ω (orange-orange-brown).
- ( ) 1000 Ω (brown-black-red).
- ( ) 330 Ω (orange-orange-brown).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.
- ( ) 470 Ω (yellow-violet-brown).
- ( ) 1000 Ω (brown-black-red).
- ( ) 100 Ω (brown-black-brown).
- ( ) 56 Ω (green-blue-black).
- ( ) 1 MΩ (brown-black-green).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

- ( ) 100 Ω (brown-black-brown).
- ( ) 56 Ω (green-blue-black).
- ( ) 1000 Ω (brown-black-red).
- ( ) 470 Ω (yellow-violet-brown).
- ( ) 10 kΩ (brown-black-orange).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

NOTE: As you install each of the following controls, solder the leads to the foil.

- ( ) 500 Ω control (#10-918) at 100 V ADJUST.
- ( ) 5000 Ω (5 k) control (#10-904) at VERT CAL.
- ( ) 1000 Ω (1 k) control (#10-936) at DC BALANCE.

PICTORIAL 1-2

START

NOTE: When you install an electrolytic capacitor, always match the positive (+) marked end of the capacitor with the positive (+) mark on the circuit board.

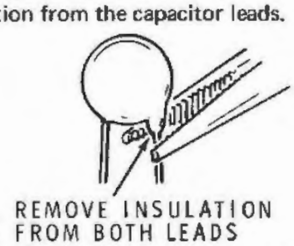
( ) 40 μF electrolytic.

( ) 10 μF electrolytic.

( ) 1000 μF electrolytic.

( ) 36 pF mica.

NOTE: Before you install disc capacitors, use long-nose pliers to remove the excess insulation from the capacitor leads.



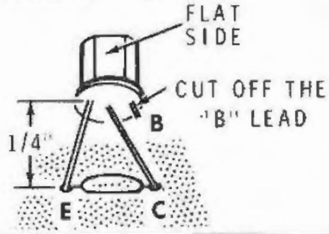
( ) 180 pF disc.

( ) 680 pF disc.

( ) .01 μF disc.

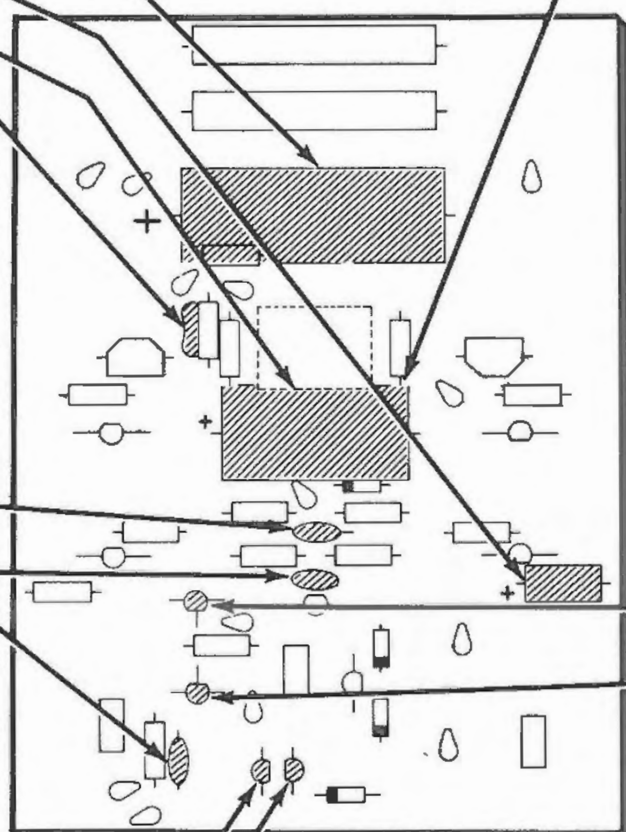
( ) Solder the leads to the foil and cut off the excess lead lengths.

NOTE: Install the next two transistors in the following manner: Cut off the "B" lead and then insert the other two leads into their correct holes in the circuit board. Solder each lead to the foil and cut off the excess lead lengths.



( ) 2N3393 transistor (#417-118) at D101.

( ) 2N3393 transistor (#417-118) at D102.



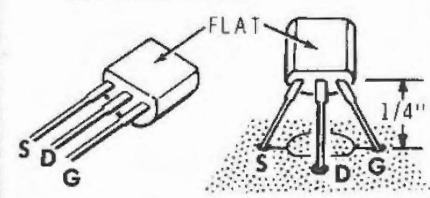
PICTORIAL 1-3

CONTINUE

CAUTION: Be sure this resistor lead does not touch the 1000 μF electrolytic capacitor case.

NOTE: In the following steps, install each of the transistors as follows:

1. Refer to the illustration below and identify the S, D, and G leads of the transistor.
2. Insert the transistor leads into the corresponding S, D, and G holes in the circuit board.
3. Position the transistor 1/4" above the circuit board.
4. Turn the circuit board over, solder the leads to the foil, and cut off the excess lead lengths.

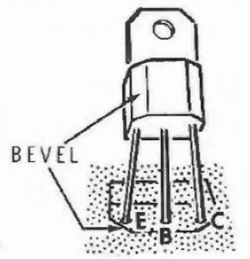


( ) EL131 transistor (#417-241) at Q103.

( ) EL131 transistor (#417-241) at Q101.

START

NOTE: Install the next two transistors as shown. Match the bevel on the transistor with the bevel outline on the circuit board. Solder the leads to the foil and cut off the excess lead lengths.

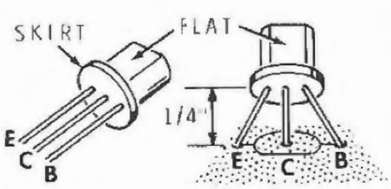


( ) MPSU10 (or MBF382) transistor (#417-834) at Q111.

( ) MPSU10 (or MBF382) transistor (#417-834) at Q109.

NOTE: In the following six steps, install each of the transistors as follows:

1. Refer to the illustration below and identify the E, C, and B leads of the transistor. The transistor supplied with your kit may not have a skirt as shown.
2. Insert the transistor leads into the corresponding E, C, and B holes in the circuit board.
3. Position the transistor 1/4" above the circuit board.
4. Turn the circuit board over, solder the leads to the foil, and cut off the excess lead lengths.



( ) L842 transistor (#417-83) at Q105.

( ) X29A829 transistor (#417-201) at Q107.

( ) 2N3393 transistor (#417-118) at Q104.

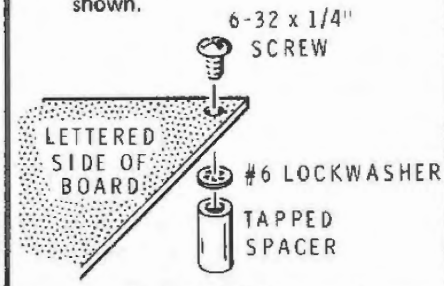
( ) 2N3393 transistor (#417-118) at Q102.

CONTINUE

( ) X29A829 transistor (#417-201) at Q108.

( ) L842 transistor (#417-83) at Q106.

( ) Note the locations marked ⊕ at each corner of the circuit board. Mount a tapped spacer at each of these four locations with a #6 lockwasher and a 6-32 x 1/4" screw. Place the lockwasher between the circuit board and the spacer as shown.



CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions.

( ) Unsoldered connections.

( ) "Cold" solder connections.

( ) Solder bridges between foil patterns.

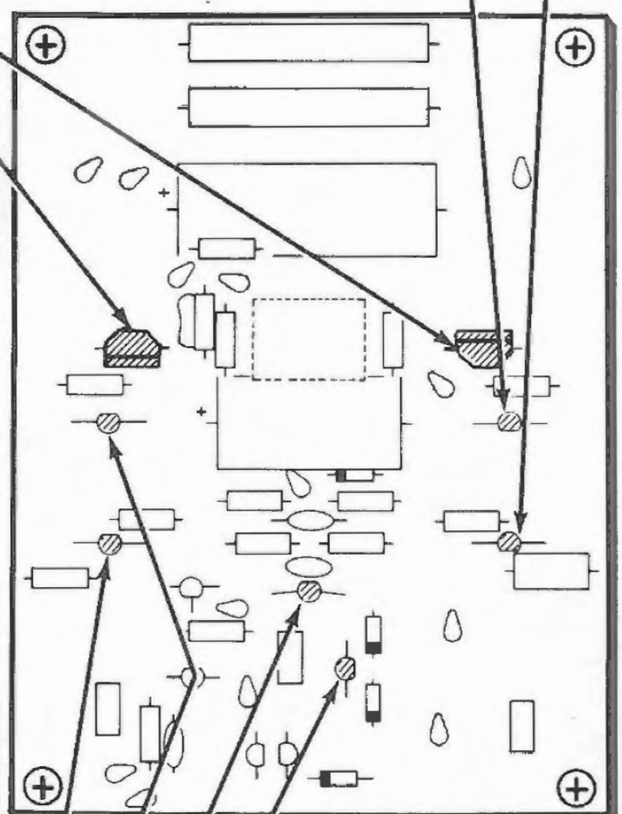
( ) Protruding leads which could touch together.

( ) Transistors for the proper type and installation.

( ) Electrolytic capacitors for the correct position of the positive (+) end.

( ) Diodes for the correct position of the banded end.

NOTE: At this point, there should be no remaining components. If any parts remain, carefully recheck your work to see if a step may have been overlooked.



PICTORIAL 1-4

POWER SUPPLY BOARD ASSEMBLY

KD50EI

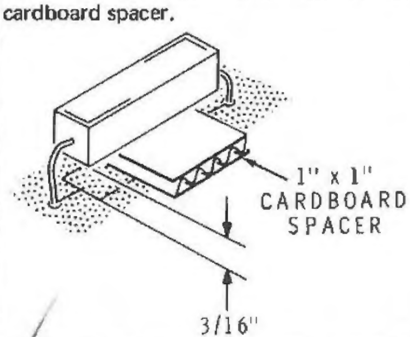
STEP-BY-STEP ASSEMBLY

START

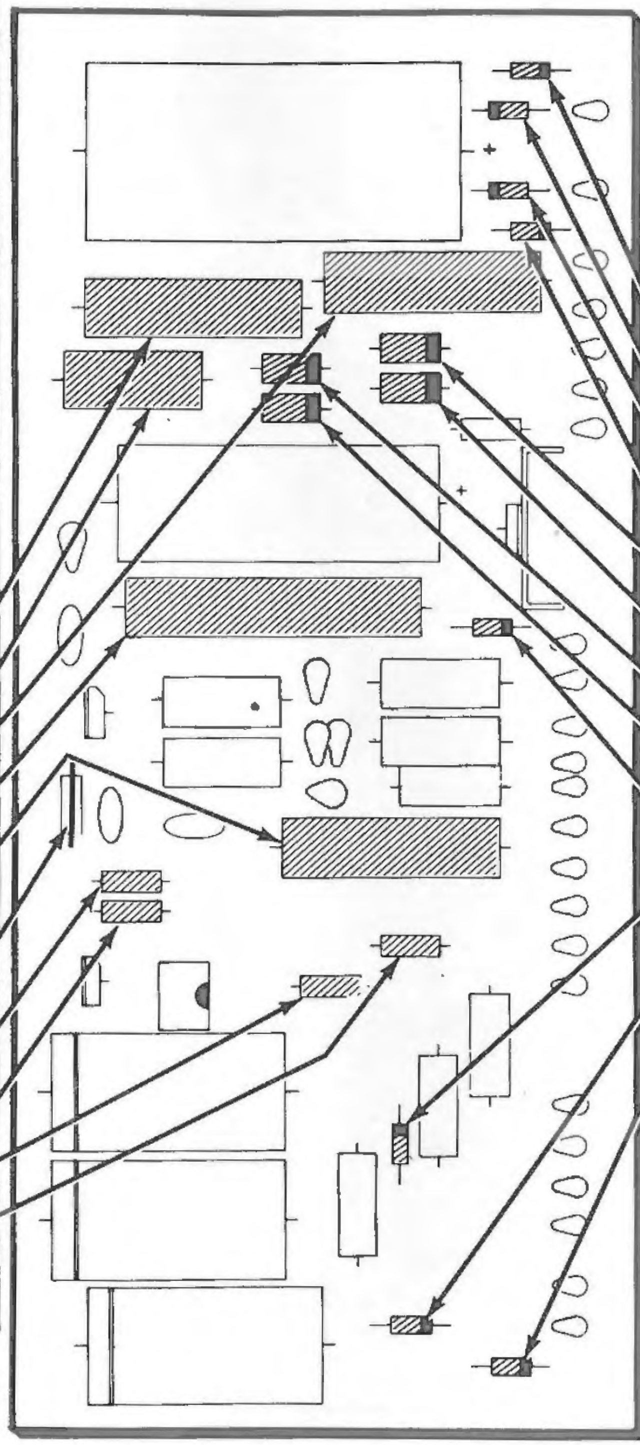
Position the power supply circuit board as shown. Then proceed with the following steps.

Resistors are 1/2-watt unless otherwise stated.

NOTE: Mount the following five resistors above the circuit board as shown. Use a 1" x 1" piece of 3/16" cardboard (from shipping carton), for a spacer. Solder each resistor as it is installed, cut off the excess lead lengths, and then remove the cardboard spacer.

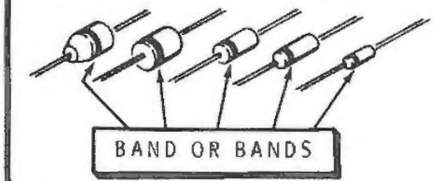


- ( ) 1000 Ω, (1 k), 7-watt, wire-wound.
- ( ) 330 Ω, 5-watt, wire-wound.
- ( ) 3750 Ω, 7-watt, wire-wound.
- ( ) 10 kΩ, 10-watt, wire-wound.
- ( ) 140 Ω, 5-watt, wire-wound. Save a cutoff lead for the next step.
- ( ) Wire. Use the cutoff lead from the previous step. Ignore the "220" and the resistor outline at this location.
- ( ) 220 kΩ (red-red-yellow).
- ( ) 220 kΩ (red-red-yellow).
- ( ) 33 kΩ (orange-orange-orange).
- ( ) 1000 Ω (brown-black-red).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.



- ( ) Locate eight 1N2071 silicon diodes (#57-27). They will be installed in the following steps.
- ( ) 1N2071 diode at D207.
- ( ) 1N2071 diode at D208.
- ( ) 1N2071 diode at D209.
- ( ) 1N2071 diode at D211.
- ( ) 1N2071 diode at D206.
- ( ) 1N2071 diode at D204.
- ( ) 1N2071 diode at D205.
- ( ) 1N2071 diode at D203.
- ( ) VR-36A zener diode (#56-55) at ZD201.
- ( ) VR-9.1 zener diode (#56-19) at ZD202.
- ( ) 5D20 silicon diode (#57-52) at D202.
- ( ) 5D20 silicon diode (#57-52) at D201.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 2-1

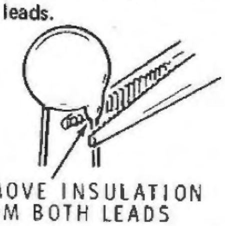
START

NOTE: When you install an electrolytic capacitor, always match the positive (+) marked end of the capacitor with the positive (+) mark on the circuit board.

( ) 70 μF electrolytic.

( ) 500 μF electrolytic.

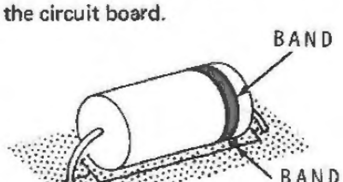
IMPORTANT NOTE: Before installing disc capacitors in this kit use long-nose pliers to remove the excess insulation from the capacitor leads.



( ) .005 μF disc. Position this capacitor 1/8" above the circuit board and solder the leads to the foil.

( ) .005 μF disc.

NOTE: When you install the following three capacitors, always match the banded end of each capacitor with the band mark on the circuit board.

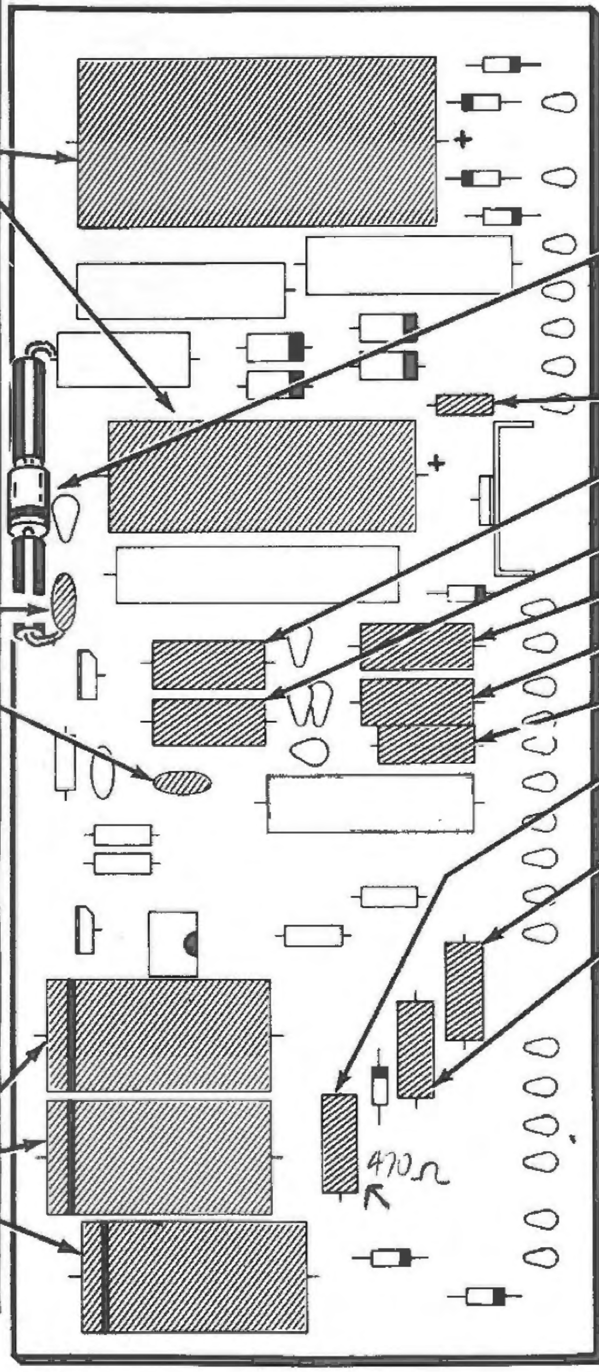


( ) .1 μF, 1600 V (1.6 kV) capacitor.

( ) .1 μF, 1600 V (1.6 kV) capacitor.

( ) .1 μF, 1600 V (1.6 kV) capacitor.

( ) Solder the leads to the foil and cut off the excess lead lengths.

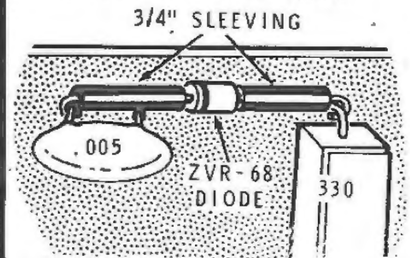


CONTINUE

( ) Cut two 3/4" lengths of sleeving. Place a length of sleeving on each lead of a ZVR-68 diode (#56-68).

( ) Connect the banded end of the ZVR-68 diode to the indicated lead of the .005 μF capacitor as shown (S-1).

( ) Connect the other end of this diode to the indicated lead of the 330 Ω, 5-watt resistor as shown (S-1).



( ) 1800 Ω (brown-gray-red).

( ) 330 Ω, 2-watt (orange-orange-brown).

( ) 220 Ω, 2-watt (red-red-brown).

( ) 270 Ω, 2-watt (red-violet-brown).

( ) 220 Ω, 2-watt (red-red-brown).

( ) 220 Ω, 1-watt (red-red-brown).

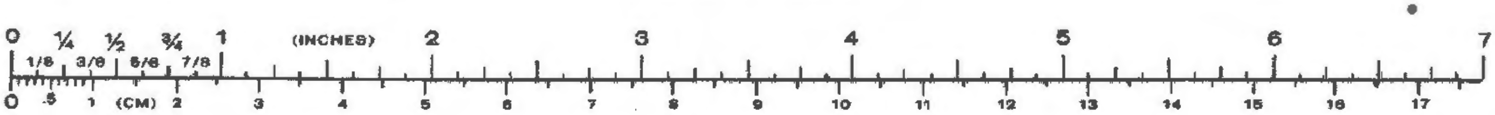
( ) 470 kΩ, 1-watt (yellow-violet-yellow).

( ) 470 kΩ, 1-watt (yellow-violet-yellow).

( ) 470 kΩ, 1-watt (yellow-violet-yellow).

( ) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 2-2

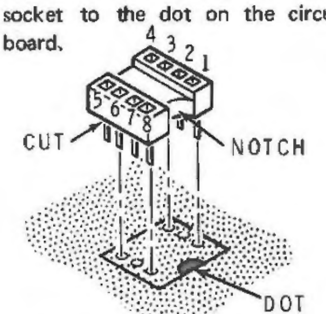


START

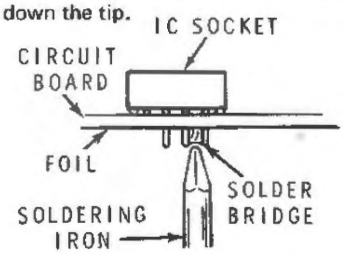
NOTE: Read the following information carefully before you install the IC (integrated circuit) socket in the following step.

( ) Mount the IC socket as follows:

1. Cut and remove pins 4 and 5 from the IC socket as shown.
2. Match the notch at the end of the IC socket to the dot on the circuit board.

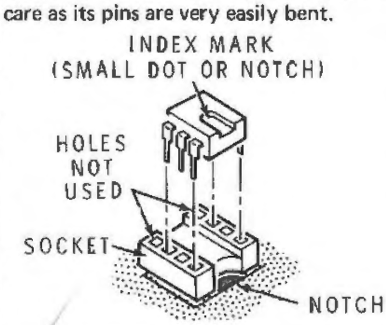


3. Insert the IC socket pins into their respective holes in the circuit board.
4. Push the IC socket firmly against the circuit board.
5. Solder the pins to the foil as each IC socket is installed. NOTE: It is easier to solder the pins to the foil if you use a small-tip soldering iron.
6. If a solder bridge occurs, clean the soldering iron tip and place it between the two points that are bridged until the excess solder flows down the tip.

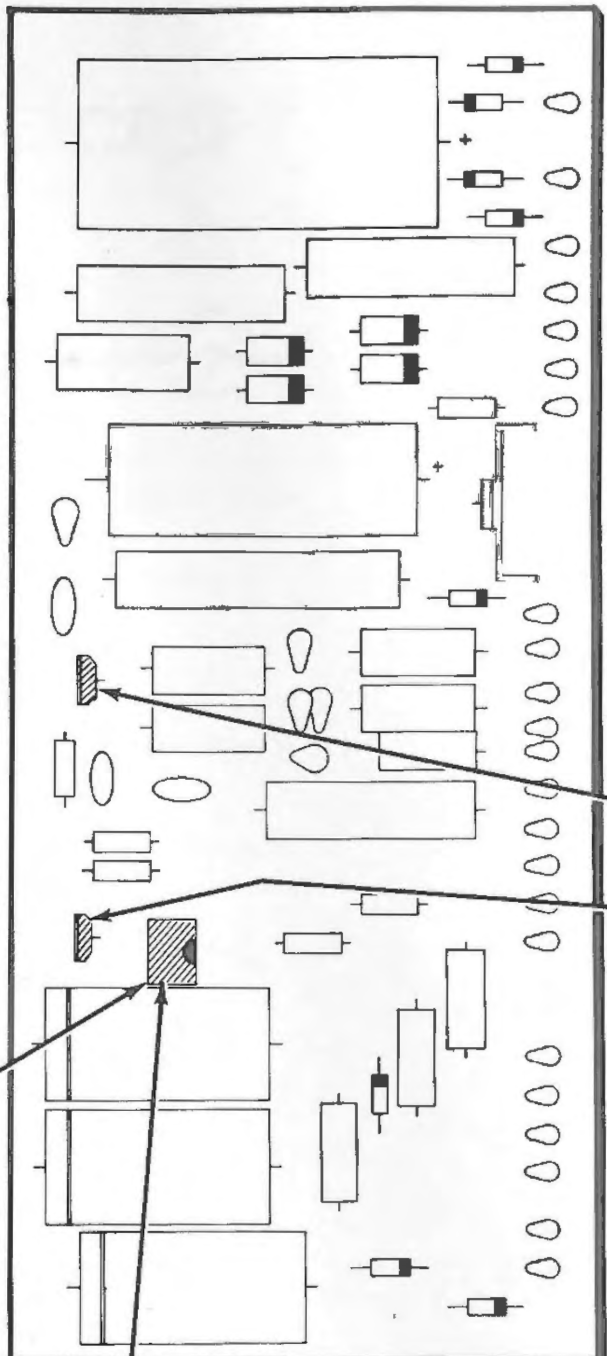


NOTE: In the following step, you must install a 6-pin IC in the 8-pin socket. Do not use the two socket holes nearest the edge of the circuit board.

Before applying downward pressure to the IC, make sure each IC pin is centered in its proper socket opening. Handle the IC with care as its pins are very easily bent.



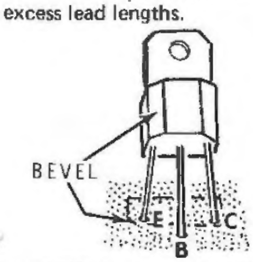
( ) Integrated circuit (IC) (#443-631) at IC201.



PICTORIAL 2-3

CONTINUE

1. Refer to the illustration below and identify the E, B, and C leads of the transistor.
2. Bend the base (B) lead of two MPSU10 transistors (#417-834) as shown.
3. Insert the transistor leads into the corresponding E, B, and C holes in the circuit board.
4. Turn the circuit board over, solder the leads to the foil, and cut off the excess lead lengths.



( ) MPSU10 (or MBF382) transistor (#417-834) at Q203.

( ) MPSU10 (or MBF382) transistor (#417-834) at Q202.

CIRCUIT BOARD CHECKOUT

This completes the assembly of your Bell and Howell DCS-1 shipment. Carefully inspect the power supply circuit board for the following conditions:

( ) Unsoldered connections.

( ) Solder bridges between foils.

( ) Protruding leads which could touch together.

( ) Transistors for proper type and installation.

( ) Electrolytic capacitors for the proper position of the positive (+) end.

( ) Diodes for the correct position of the banded end.

Save the unused sleeving and solder for later use. Transistor Q201 will be installed later. Set the circuit boards aside; they will be called for during the assembly portion of Manual 9560-3, Part 1. Proceed to the "Circuit Description" on the following pages; then complete the examination on Page 1-23 as instructed.

CIRCUIT DESCRIPTION

A complete Circuit Description of your Oscilloscope is contained in Book Three, Assembly Manual 9560-3, Part 1. The partial Circuit Description, which follows, applies only to those portions of your kit that you have completed in the first Assembly Manual, 9560-1.

VERTICAL AMPLIFIER

From the attenuator circuit, a portion of the input signal is coupled through resistor R101 and capacitor C101 to the gate of transistor Q101. Resistor R101 protects Q101 from being damaged in case a high potential is applied to the vertical Input connector while the Volts/Cm switch is in one of its lower ranges. Diodes D101 and D102 are transistors connected to provide a zener action. These diodes limit the input signal to approximately ±9 volts, to further protect Q101 from excess gate voltage. Capacitor C101 improves high frequency response by forming a high frequency path around R101.

Transistor Q101 is a field effect transistor (FET) connected as a source follower. This type of transistor provides the high impedance input necessary to prevent loading the circuit under test.

Transistor Q102 is a constant current source for input transistor Q101. Diodes D103 and D104 each provide a .6 volt drop (total 1.2 volts) and hold the base of Q102 at a constant voltage. Since the circuit of transistor Q102 is basically an emitter follower (common-collector), and the emitter voltage is dependent upon the base voltage, the emitter voltage will also remain constant. This constant emitter voltage is across DC Balance control R102; therefore, the current through R102 is constant. Control R102 is adjusted so the source voltage of Q101 is zero when an input signal is not present.

A signal applied to the gate of Q101 will cause only voltage changes at the source because the current through Q101 is constant. These voltage variations are applied across vertical Variable control R409, and a portion of this signal is applied to the gate of source follower Q103.

Transistor Q104 forms a constant current source for transistors Q105 and Q106. Since the emitter of each transistor is connected to this constant current source, the current source serves as a common emitter resistance and sets the operating point for the following stages.

The output from source follower transistor Q103 is amplified by Q105. A portion of the signal applied to the base of Q105 appears at its emitter. Because transistors Q105 and Q106 have a common emitter resistance, the signal present at the Q105 emitter is effectively coupled to the emitter of Q106.

Transistor Q106 functions as a common base amplifier whose base is held constant by the Vert. position control, R403. This control positions the trace by applying a DC voltage to the base of transistor Q106 and causes a DC unbalance in the vertical amplifier. When the collector output voltage of Q105 decreases, its emitter voltage will increase. An increased emitter voltage at Q106 reduces its forward bias and increases its collector output voltage. The signal at the collector of transistor Q106 is 180 degrees

CIRCUIT DESCRIPTION

A complete Circuit Description of your Oscilloscope is contained in Book Three, Assembly Manual 9560-3, Part 1. The partial Circuit Description, which follows, applies only to those portions of your kit that you have completed in the first Assembly Manual, 9560-1.

VERTICAL AMPLIFIER

From the attenuator circuit, a portion of the input signal is coupled through resistor R101 and capacitor C101 to the gate of transistor Q101. Resistor R101 protects Q101 from being damaged in case a high potential is applied to the vertical Input connector while the Volts/Cm switch is in one of its lower ranges. Diodes D101 and D102 are transistors connected to provide a zener action. These diodes limit the input signal to approximately ±9 volts, to further protect Q101 from excess gate voltage. Capacitor C101 improves high frequency response by forming a high frequency path around R101.

Transistor Q101 is a field effect transistor (FET) connected as a source follower. This type of transistor provides the high impedance input necessary to prevent loading the circuit under test.

Transistor Q102 is a constant current source for input transistor Q101. Diodes D103 and D104 each provide a .6 volt drop (total 1.2 volts) and hold the base of Q102 at a constant voltage. Since the circuit of transistor Q102 is basically an emitter follower (common-collector), and the emitter voltage is dependent upon the base voltage, the emitter voltage will also remain constant. This constant emitter voltage is across DC Balance control R102; therefore, the current through R102 is constant. Control R102 is adjusted so the source voltage of Q101 is zero when an input signal is not present.

A signal applied to the gate of Q101 will cause only voltage changes at the source because the current through Q101 is constant. These voltage variations are applied across vertical Variable control R409, and a portion of this signal is applied to the gate of source follower Q103.

Transistor Q104 forms a constant current source for transistors Q105 and Q106. Since the emitter of each transistor is connected to this constant current source, the current source serves as a common emitter resistance and sets the operating point for the following stages.

The output from source follower transistor Q103 is amplified by Q105. A portion of the signal applied to the base of Q105 appears at its emitter. Because transistors Q105 and Q106 have a common emitter resistance, the signal present at the Q105 emitter is effectively coupled to the emitter of Q106.

Transistor Q106 functions as a common base amplifier whose base is held constant by the Vert. position control, R403. This control positions the trace by applying a DC voltage to the base of transistor Q106 and causes a DC unbalance in the vertical amplifier. When the collector output voltage of Q105 decreases, its emitter voltage will increase. An increased emitter voltage at Q106 reduces its forward bias and increases its collector output voltage. The signal at the collector of transistor Q106 is 180 degrees out of phase with the signal at the collector of Q105 and forms a "push-pull" type of amplifier required to drive the CRT deflection plates. Capacitor C103 is an emitter bypass capacitor to boost the gain at high frequencies. Emitter resistors R108 and R109 establish the DC gain of the vertical amplifier.

Driver transistors Q107 and Q108 are common emitter amplifiers. In addition to providing gain, they also isolate transistors Q105 and Q106 from the output stages.

Output amplifiers Q109 and Q111 again amplify the differential signal and drive the vertical plates of the CRT.

POWER SUPPLY

Line voltage is connected through the slow-blow fuse and the power switch on the Intensity control to the primary windings of the power transformer. The dual-primary transformer windings may be connected in parallel for 120-volt operation or in series for 240-volt operation.

The high-voltage secondary winding of the power transformer is connected to the voltage doubler circuit consisting of D201, D202, C204, and C205. Resistor R208 and capacitor C203 filter this negative high voltage which is coupled through resistor R412 to the grid of the CRT. The intensity and focusing voltages are also supplied to the CRT from the voltage divider network consisting of resistors R206, R207, R209, Intensity control R403, and Focus control R411. A separate 6.3 volt winding supplies the CRT filament voltage.

A secondary winding supplies 1 volt peak-to-peak to the 1VP-P input and to the Input switch on the front panel.

The low voltage secondary winding is connected to full-wave rectifier diodes D203, D204, D205, and D206. Zener diode ZD204 and resistor R217 maintain a constant voltage to the base of pass transistor Q201. (Figure 1-1 shows a simplified schematic of this power supply.) The output from the series pass transistor is a regulated 31 volts. By connecting equal loads from each side of the supply to ground, shown as RL1 through RL6, six separate DC output voltages are obtained. These are: +9 volts (vert), +9 volts (horiz), +5 volts (sweep), −5 volts (sweep), −9 volts (vert), and −9 volts (horiz).

Deflection potentials are obtained from another secondary winding connected to full-wave bridge rectifier diodes D207, D208, D209, and D211. An unregulated 180 volts DC is obtained through resistor R219, and an unregulated 150 volts DC is obtained through resistor R221.

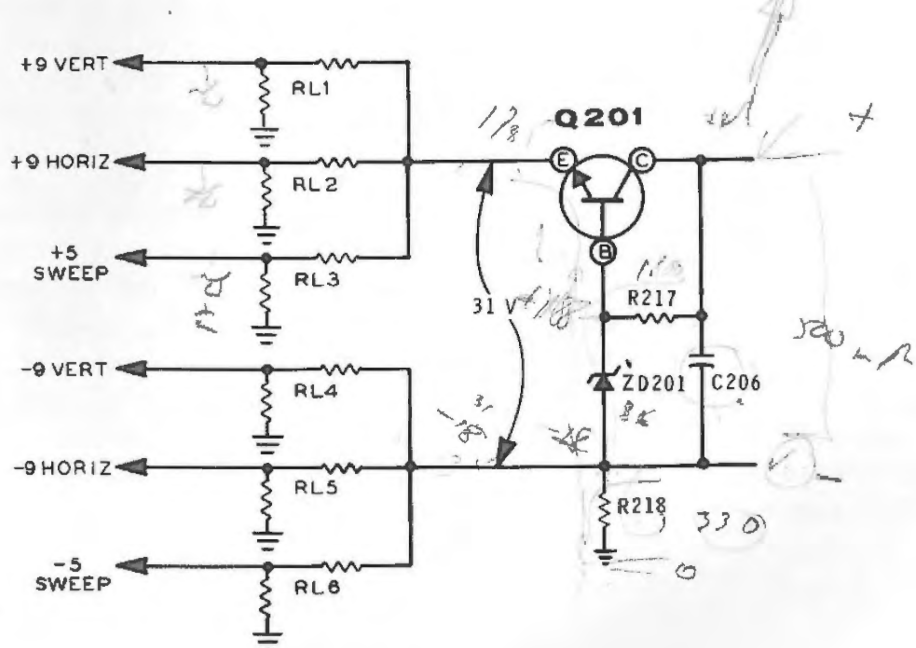
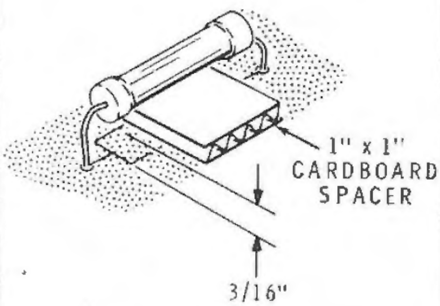


Figure 1-1

START

NOTE: Reposition the circuit board as shown in the identification drawing. Then proceed with the following steps.

NOTE: Mount the following two resistors above the circuit board as shown. Use a 1" x 1" piece of 3/16" cardboard (from shipping carton), for a spacer. Solder each resistor as it is installed, cut off the excess lead lengths, and then remove the cardboard spacer.



( ) 10 kΩ, 7-watt.

( ) 10 kΩ, 7-watt.

( ) 390 Ω (orange-white-brown).

( ) 1500 Ω (brown-green-red).

( ) 10 kΩ (brown-black-orange).

( ) 220 Ω (red-red-brown).

( ) 1000 Ω (brown-black-red).

( ) Solder the leads to the foil and cut off the excess lead lengths.

( ) 10 kΩ (brown-black-orange).

( ) 220 Ω (red-red-brown).

( ) 1000 Ω (brown-black-red).

( ) 3300 Ω (orange-orange-red).

( ) .01 μF disc capacitor.

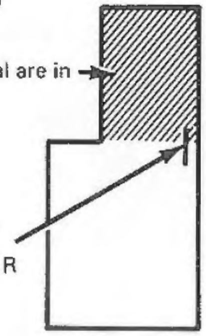
( ) 100 kΩ (brown-black-yellow).

( ) 390 Ω (orange-white-brown).

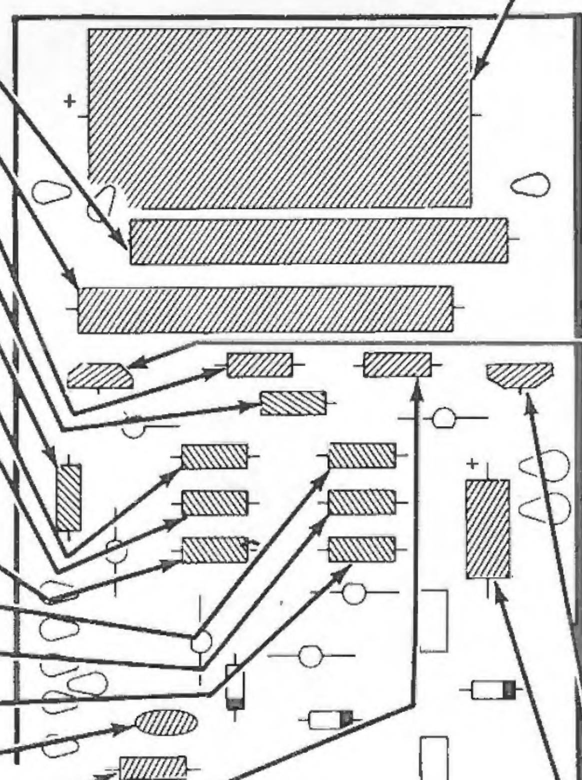
( ) Solder the leads to the foil and cut off the excess lead lengths.

IDENTIFICATION DRAWING

The steps performed in this Pictorial are in this area of the circuit board.



PART NUMBER

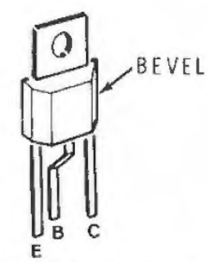


CONTINUE

NOTE: When you install an electrolytic capacitor, always match the positive (+) marked end of the capacitor with the positive (+) mark on the circuit board.

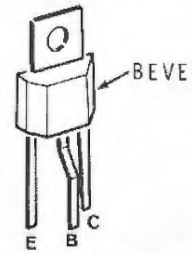
( ) 40 μF electrolytic.

( ) Bend the base (B) lead of one MPSU10 (or MBF382) transistor (#417-834) rearward as shown. NOTE: When you install this transistor in the next step, be sure to match the bevel on the transistor with the outline on the circuit board.



( ) MPSU10 transistor at Q323.

( ) Bend the base (B) lead of the remaining MPSU10 (or MBF382) transistor (#417-834) forward as shown. Note: Be sure to match the bevel on the transistor with the outline on the circuit board.



( ) MPSU10 transistor at Q324.

( ) 10 μF electrolytic. Be sure to match the positive (+) mark on the capacitor with the positive (+) mark on the circuit board.

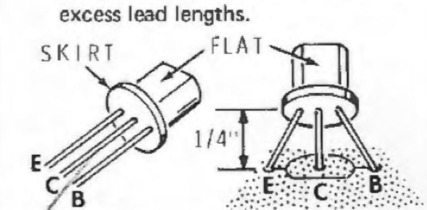
( ) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 3-6

START

NOTE: In the following steps, install each of the transistors as follows:

1. Refer to the illustration below and identify the E, C, and B leads of the transistor. The transistor supplied with your kit may not have a skirt as shown.
2. Insert the transistor leads into the corresponding E, C, and B holes in the circuit board.
3. Position the transistor 1/4" above the circuit board.
4. Turn the circuit board over, solder the leads to the foils, and cut off the excess lead lengths.

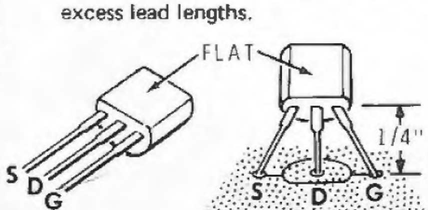


( ) 2N3393 transistor (#417-118) at Q322.

( ) 2N3393 transistor (#417-118) at Q321.

NOTE: In the following steps, install each of the transistors as follows:

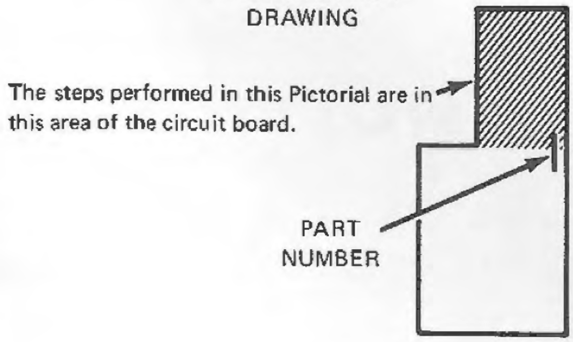
1. Refer to the illustration below and identify the S, D, and G leads of the transistor.
2. Insert the transistor leads into the corresponding S, D, and G holes in the circuit board.
3. Position the transistor 1/4" above the circuit board.
4. Turn the circuit board over, solder the leads to the foil, and cut off the excess lead lengths.

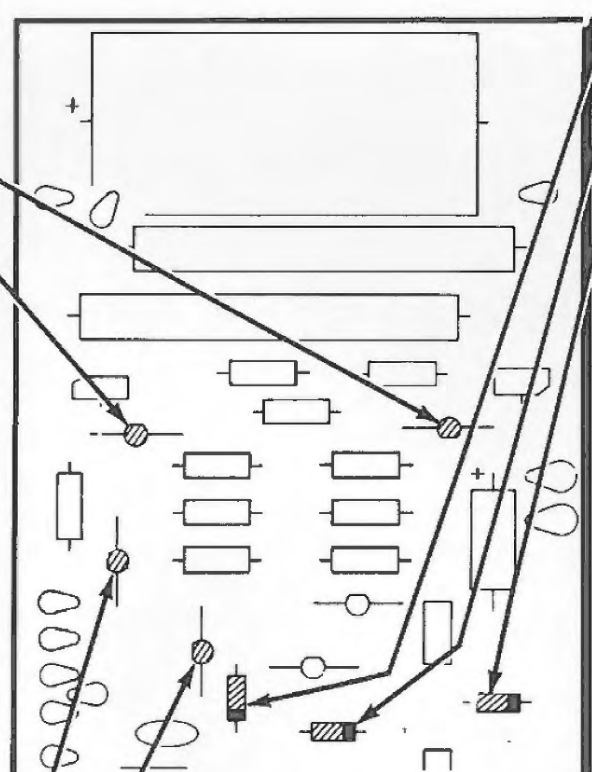


( ) EL131 transistor (#417-241) at Q319.

( ) EL131 transistor (#417-241) at Q317.

IDENTIFICATION DRAWING

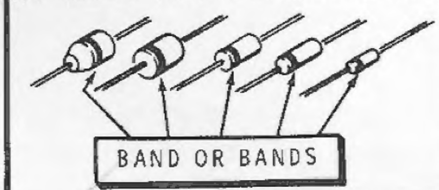




PICTORIAL 3-7

CONTINUE

NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.



( ) 1N4149 diode (#56-56) at D309.

( ) 1N4149 diode (#56-56) at D308.

( ) VR-9.1 zener diode (#56-19) at ZD303.

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions.

( ) Unsoldered connections.

( ) "Cold" solder connections.

( ) Solder bridges between foils.

( ) Protruding leads which could touch together.

( ) Transistors for the proper type and installation.

( ) Electrolytic capacitors for the correct position of the positive (+) end.

( ) Diodes for the correct position of the banded end.

This completes the assembly of the horizontal amplifier-sweep circuit board. There should be no remaining components.

Save any unused solder for use later. Set the circuit board aside; it will be called for during the assembly portion of Manual 9560-3, Part 1. Proceed to "Circuit Description" on the following pages; then complete Examination 9560-2 on Page 2-15 as instructed.

FINISH

CIRCUIT DESCRIPTION

HORIZONTAL AMPLIFIER

The horizontal amplifier is part of the circuitry on the sweep generator-horizontal amplifier circuit board.

Operation of the horizontal amplifier is similar to that of the vertical amplifier. The major difference is in the attenuator system. In the horizontal amplifier, the input is coupled from the HOR connector, through the μSec/Cm switch, to the input of transistor Q317. The source resistance of Q317 is provided by the action of constant current source transistor Q318.

The sawtooth voltage produced by the sweep generator is amplified by the horizontal amplifier and applied to the horizontal deflection plates of the CRT. This linearly increasing voltage causes the electron beam to sweep across the face of the CRT from left to right. The sweep speed of the electron beam is determined by the μSec/Cm switch on the front panel.

SWEEP AND TRIGGER CIRCUITS

The sweep and trigger circuits are part of the circuitry on the horizontal amplifier circuit board.

The Int-Ext trigger switch on the front panel determines whether the internal trigger signal or an external trigger source will be used to start the sweep action. In either case, the selected signal is routed through the selected trigger switch contacts, and is coupled to the gate of transistor Q301.

Level Set control R305 varies the voltage on the source of transistor Q301 by changing the current level through transistor Q302. The source voltage of Q301 is set at zero volts when the Auto-Norm switch is in the Auto position. When the Auto-Norm switch is in the Norm position, the Level control R407 on the front panel sets the current through transistor Q302; thus it controls the point at which the sweep generator will trigger.

Both gain and DC level controls are achieved as the signal is coupled through transistors Q304 and Q305. Note that inverted signals are developed in the emitter coupled circuits of transistors Q304 and Q305 and, after passing through transistors Q306 and Q307, may be selected as either positive or negative triggering signals by the SLOPE switch on the front panel. Capacitor C303 is a high-frequency AC coupler between the emitters of the differential amplifier. Transistor Q303 is a constant current source for transistors Q304 and Q305. Emitter follower transistors Q306 and Q307 provide a low impedance output to IC301A.

IC301 is a dual Schmitt trigger. The A section of the IC is used to shape the wave of the trigger signal, while the B section is used as a voltage sensor to turn the sweep off at the end of each sweep cycle.

Refer to Figure 2-1. The output of IC301B, at pin 8, is high most of the time. This positive voltage turns on transistor Q311 which, in turn, turns off Q312 and allows the selected sweep capacitor to charge. The high output from IC301B also turns on transistor Q308 which grounds one input (pin 4) of IC301A. This keeps other input pulses at pin 1 out of the circuit so that IC301B will not trigger before the sweep is completed.

Stability control R408 is set to bias the input of IC301B to a voltage level slightly below the trigger point. As the sweep capacitor charges, it overrides this voltage (after being coupled through source follower transistors Q314 and Q316) and continues to increase until the output of IC301B goes low. Then transistor Q311 turns off and transistor Q312 turns on and shorts out the sweep capacitor. Transistor Q308 is also turned off, which causes pin 4 of IC301A to go high.

The next positive-going pulse to pin 1 then drives the output low and turns off transistor Q310. A positive pulse is then coupled through capacitor C304 and sets the output of IC301B low. After the input pulse at IC301A is gone, pin 1 is again low and pin 6 then goes high and turns on transistor Q310. The negative pulse coupled through capacitor C304 causes the output of IC301B to go high. The output stays high because this input is biased between the turn-on and turn-off points of the Schmitt trigger. The process then repeats itself.

IC201 (on the power supply circuit board) is the unblanking amplifier. This amplifier receives signals from the sweep circuit to properly bias the CRT and turn the electron beam on and off as required. The sweep signal causes transistor Q309 to conduct which causes an LED (light-emitting-diode), located in the IC, to conduct. This conduction causes the LED to light which turns off a photo transistor in the IC. When the photo transistor turns off, high voltage is supplied to the CRT. When the sweep signal stops, the LED is cut off, the photo transistor turns on, and the high voltage is cut off.

The μSec/Cm switch determines the value of the sweep capacitor, and the amount of current flowing through transistor Q313. As the sweep capacitor charges, a positive-going ramp voltage (sawtooth) is generated. The speed of the horizontal sweep is determined by the particular timing capacitor chosen and by its charging current.

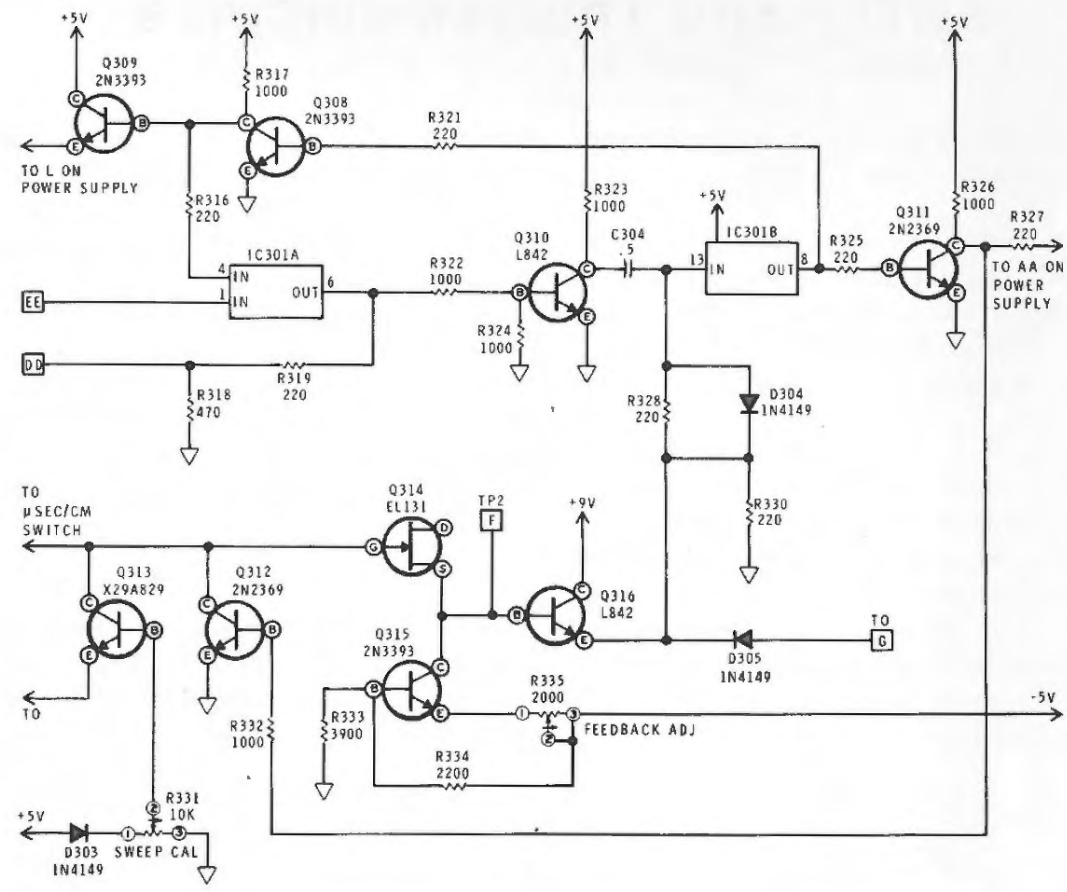
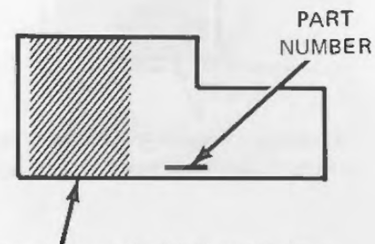


Figure 2-1

HORIZONTAL AMPLIFIER / SWEEP BOARD ASSEMBLY

STEP-BY-STEP ASSEMBLY

IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.

START

Each Pictorial in this Manual will have an Identification Drawing. The shaded area on each drawing will indicate the area of the circuit board in which the steps will be performed.

Position the horizontal amplifier-sweep circuit board as shown in the identification drawing. Then proceed with the following steps.

( ) 2200 Ω (red-red-red).

( ) 3900 Ω (orange-white-red).

( ) 2200 Ω (red-red-red).

( ) 3900 Ω (orange-white-red).

( ) 100 Ω (brown-black-brown).

( ) Solder the leads to the foil and cut off the excess lead lengths.

( ) 1" bare wire at J. Use a cutoff resistor lead.

( ) 3300 Ω (orange-orange-red).

( ) 100 kΩ (brown-black-yellow).

( ) 100 kΩ (brown-black-yellow).

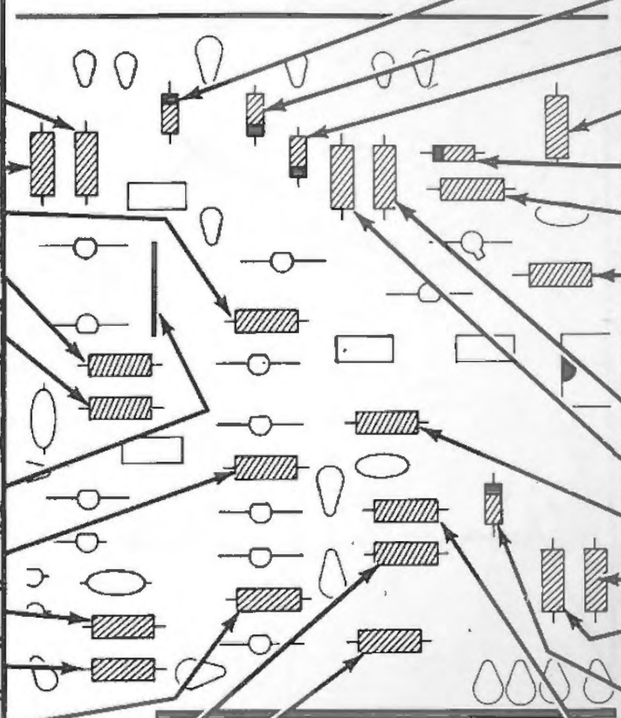
( ) 3300 Ω (orange-orange-red).

( ) 470 Ω (yellow-violet-brown).

( ) 22 Ω (red-red-black).

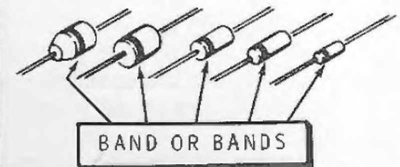
FOR GOOD SOLDER CONNECTIONS, YOU MUST **KEEP THE SOLDERING IRON TIP CLEAN.** WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.

( ) Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.



( ) 1N4653 diode (#56-44) at ZD302.

( ) 1N4653 diode (#56-44) at ZD301.

( ) 1N4149 diode (#56-56) at D305.

( ) 1000 Ω (brown-black-red).

( ) 1N4149 diode (#56-56) at D304.

( ) 220 Ω (red-red-brown).

( ) 1000 Ω (brown-black-red).

( ) Solder the leads to the foil and cut off the excess lead lengths.

( ) 10 kΩ (brown-black-orange).

( ) 220 Ω (red-red-brown).

( ) 22 Ω (red-red-black).

( ) 470 Ω (yellow-violet-brown).

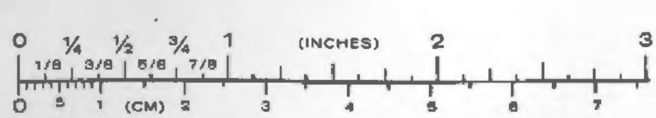
( ) 220 Ω (red-red-brown).

( ) 1N4149 diode (#56-56) at D303.

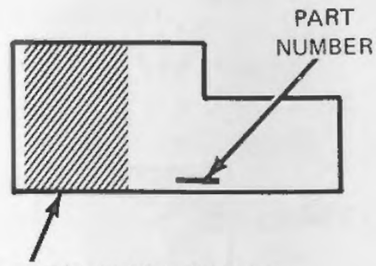
( ) 470 Ω (yellow-violet-brown).

( ) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 3-1



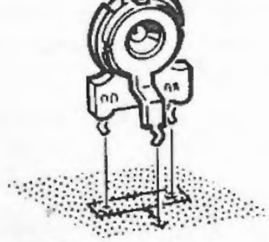
IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.

START

As you install each control in the following steps, solder all three lugs to the foil.



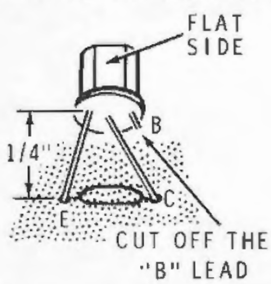
( ) 10 kΩ control (#10-386) at SWEEP CAL.

( ) 2000 Ω (2 k) control (#10-398) at TRIGGER BAL.

( ) 2000 Ω (2 k) control (#10-398) at FEEDBACK ADJ.

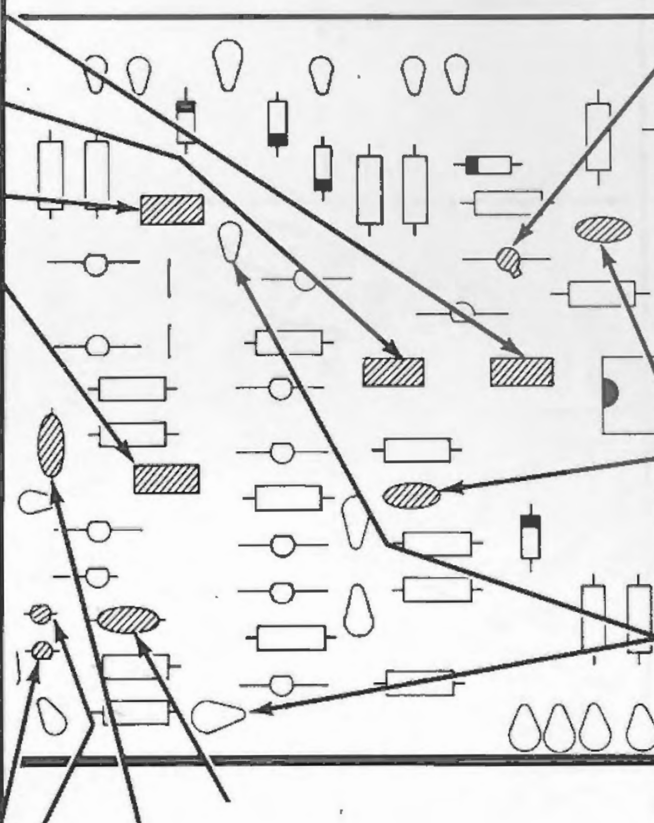
( ) 10 kΩ control (#10-386) at LEVEL SET.

NOTE: Install the next two transistors in the following manner as shown: Cut off the "B" lead and then insert the other two leads into their correct holes in the circuit board.



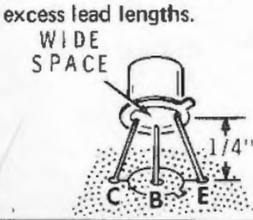
( ) 2N3393 transistor (#417-118) at D301.

( ) 2N3393 transistor (#417-118) at D302.



CONTINUE

NOTE: Install the following transistor as shown. Solder each lead to the foil and cut off the excess lead lengths.



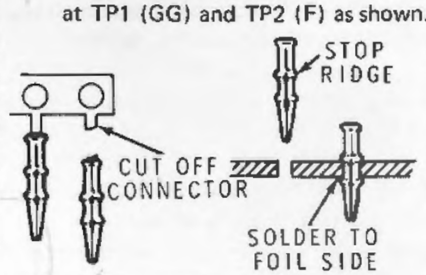
( ) 2N2369 transistor (#417-154) at Q312.

NOTE: Before installing disc capacitors in this kit, use long-nose pliers to remove the excess insulation from the capacitor leads.

( ) 5 pF disc.

( ) 470 pF disc.

( ) Install and solder circuit board pins at TP1 (GG) and TP2 (F) as shown.



( ) Cut the excess pin lengths from the foil side of the board.

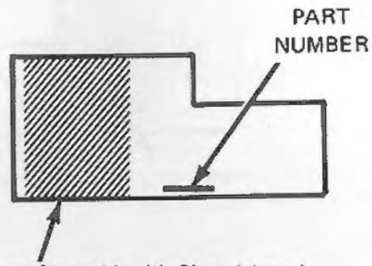
( ) .01 μF disc.

( ) .01 μF disc.

( ) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 3-2

IDENTIFICATION DRAWING

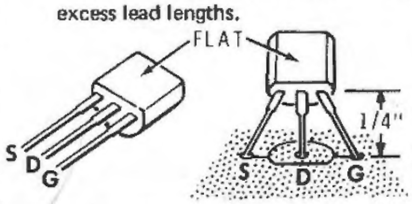


The steps performed in this Pictorial are in this area of the circuit board.

START

NOTE: In the following steps, install each of the transistors as follows:

1. Refer to the illustration below and identify the S, D, and G leads of the transistor.
2. Insert the transistor leads into the corresponding S, D, and G holes in the circuit board.
3. Position the transistor 1/4" above the circuit board.
4. Turn the circuit board over, solder the leads to the foil, and cut off the excess lead lengths.

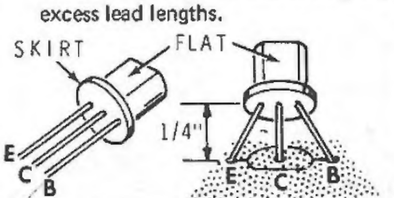


( ) EL131 transistor (#417-241) at Q314.

( ) EL131 transistor (#417-241) at Q301.

NOTE: In the following steps, install each of the transistors as follows:

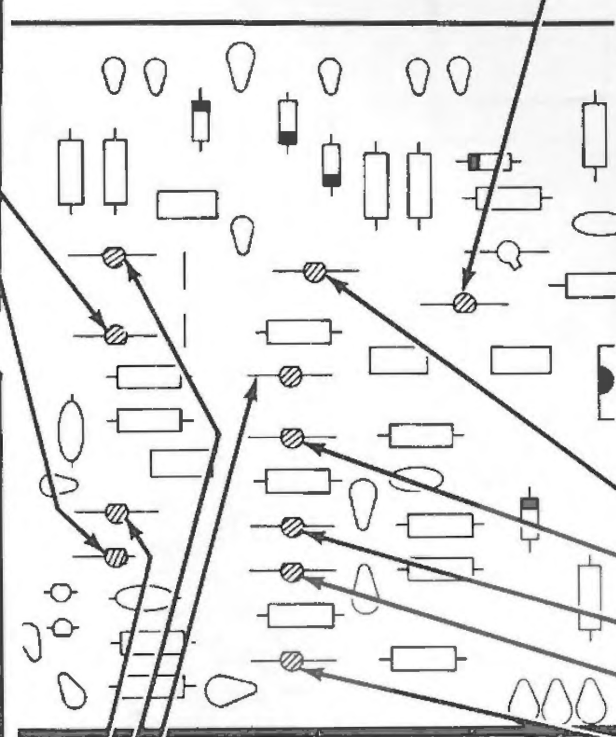
1. Refer to the illustration below and identify the E, C, and B leads of the transistor. The transistor supplied with your kit may not have a skirt as shown.
2. Insert the transistor leads into the corresponding E, C, and B holes in the circuit board.
3. Position the transistor 1/4" above the circuit board.
4. Turn the circuit board over, solder the leads to the foil, and cut off the excess lead lengths.



( ) 2N3393 transistor (#417-118) at Q302.

( ) 2N3393 transistor (#417-118) at Q315.

( ) 2N3393 transistor (#417-118) at Q303.

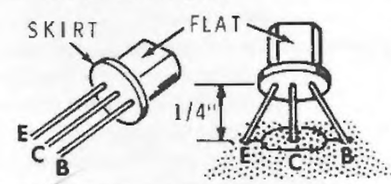


CONTINUE

( ) X29A829 transistor (#417-201) at Q313.

NOTE: In the following steps, install each of the transistors as follows:

1. Refer to the illustration below and identify the E, C, and B leads of the transistor. The transistor supplied with your kit may not have a skirt as shown.
2. Insert the transistor leads into the corresponding E, C, and B holes in the circuit board.
3. Position the transistor 1/4" above the circuit board.
4. Turn the circuit board over, solder the leads to the foil, and cut off the excess lead lengths.



( ) L842 transistor (#417-83) at Q316.

( ) L842 transistor (#417-83) at Q305.

( ) L842 transistor (#417-83) at Q307.

( ) L842 transistor (#417-83) at Q306.

( ) L842 transistor (#417-83) at Q304.

PICTORIAL 3-3

START

( ) Align the pins of an IC socket with the holes at IC301 in the circuit board. Position the notched end of the socket near the marked end (dot or half moon) of the IC location.

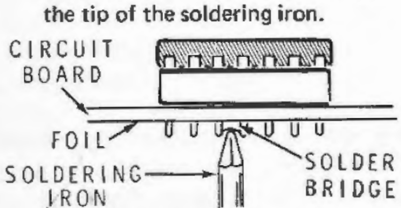
( ) Make sure all the IC socket pins penetrate the circuit board; press and hold the IC socket against the circuit board. Then turn the circuit board over and check to be sure a socket pin protrudes from each of the fourteen holes.

NOTE: Use a small-tip soldering iron to solder the pins on this IC socket. Since the pins are close together, do not place the soldering iron tip between them; this increases the possibility of a solder bridge.

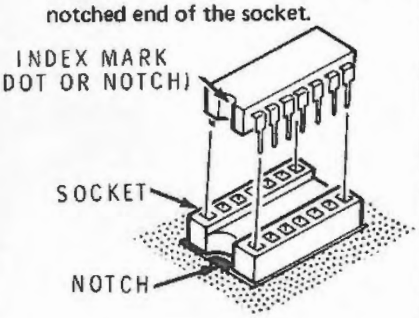
( ) Solder each of the fourteen socket pins to its foil in the following manner:

1. Apply more heat to the foil than the socket pins.
2. Solder the pins to the foil. Do not "flood" the connection with solder.

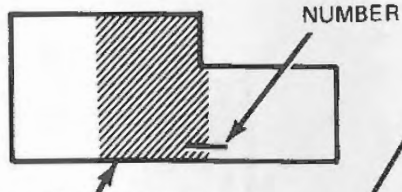
( ) Inspect each solder connection thoroughly. If you have a solder bridge, turn the circuit board foil-side-down and hold the soldering iron tip between the two points that are bridged. The solder will flow down the tip of the soldering iron.



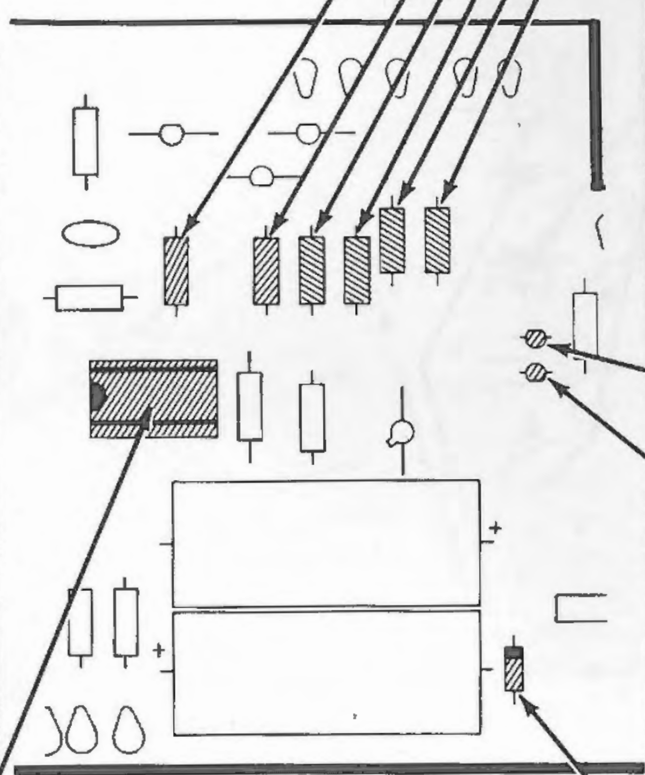
( ) Carefully install SN7413N integrated circuit (#443-44) in the IC socket. Be sure the dotted or notched end of the IC is at the notched end of the socket.



IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.



CONTINUE

( ) 1000 Ω (brown-black-red).

( ) 1000 Ω (brown-black-red).

( ) 220 Ω (red-red-brown).

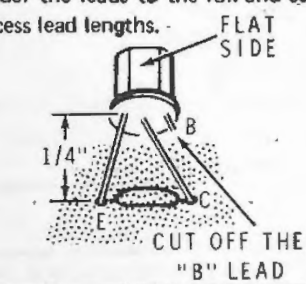
( ) 220 Ω (red-red-brown).

( ) 1000 Ω (brown-black-red).

( ) 220 Ω (red-red-brown).

( ) Solder the leads to the foil and cut off the excess lead lengths.

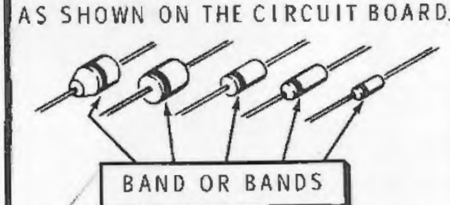
NOTE: Install the next two transistors in the following manner as shown: Cut off the "B" lead and then insert the other two leads into their correct holes in the circuit board. Solder the leads to the foil and cut off the excess lead lengths.



( ) 2N3393 transistor (#417-118) at D306.

( ) 2N3393 transistor (#417-118) at D307.

NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.

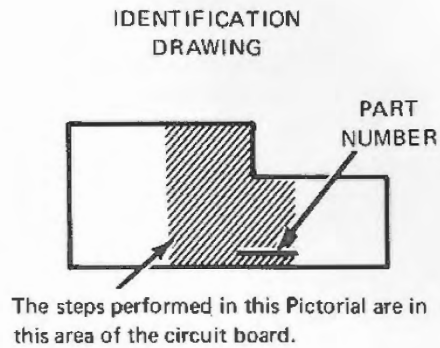


( ) VR-9.1 zener diode (#56-19) at ZD304.

FOR GOOD SOLDER CONNECTIONS, YOU MUST **KEEP THE SOLDERING IRON TIP CLEAN.** WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.

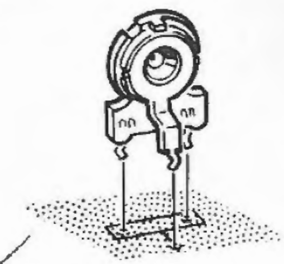
( ) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 3-4



START

As you install each control in the following steps, solder all three lugs to the foil.



( ) 200 Ω control (#10-917) at 100 V ADJ.

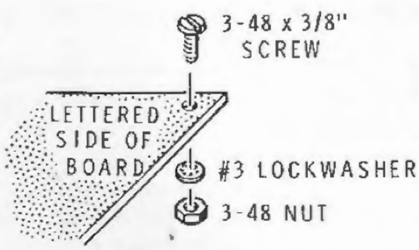
( ) 1000 Ω (1 k) control (#10-936) at DC BAL.

( ) 220 Ω (red-red-brown).

( ) 1000 Ω (brown-black-red).

( ) Solder the leads to the foil and cut off the excess lead lengths.

( ) Mount seven sets of 3-48 x 3/8" hardware at the locations marked ⊖ on the horizontal amplifier-sweep circuit board as shown in Detail 3-5A.



NOTE: When you install an electrolytic capacitor, always match the positive (+) marked end of the capacitor with the positive (+) mark on the circuit board.

( ) 2000 μF electrolytic.

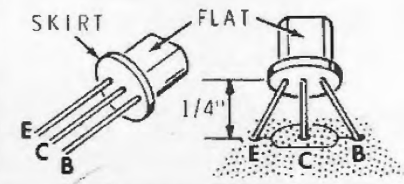
( ) 2000 μF electrolytic.

( ) Solder the leads to the foil and cut off the excess lead lengths.

CONTINUE

NOTE: In the following steps, install each of the transistors as follows:

1. Refer to the illustration below and identify the E, C, and B leads of the transistor. The transistor supplied with your kit may not have a skirt as shown.
2. Insert the transistor leads into the corresponding E, C, and B holes in the circuit board.
3. Position the transistor 1/4" above the circuit board.
4. Turn the circuit board over, solder the leads to the foil, and cut off the excess lead lengths.



( ) L842 transistor (#417-83) at Q310.

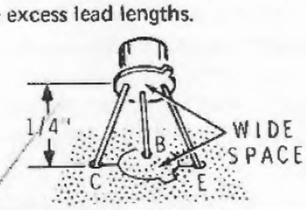
( ) 2N3393 transistor (#417-118) at Q309.

( ) 2N3393 transistor (#417-118) at Q308.

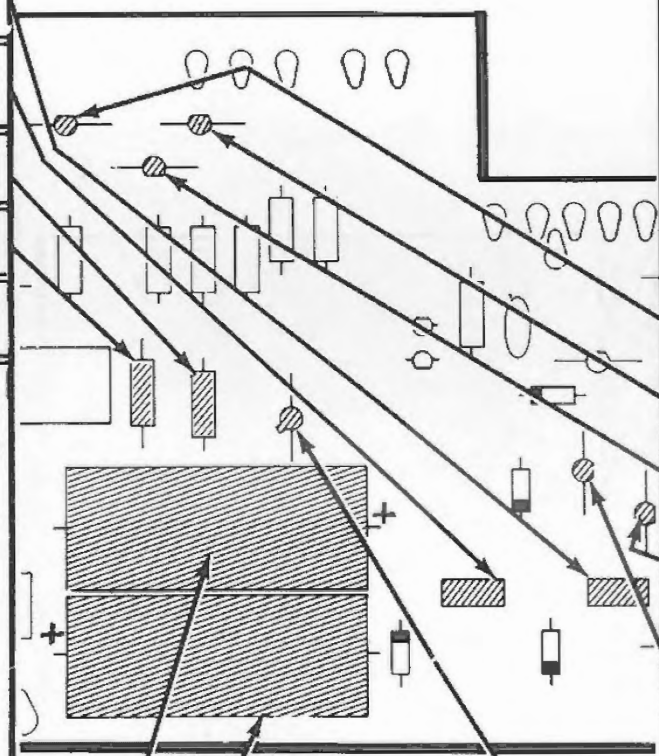
( ) 2N3393 transistor (#417-118) at Q320.

( ) 2N3393 transistor (#417-118) at Q318.

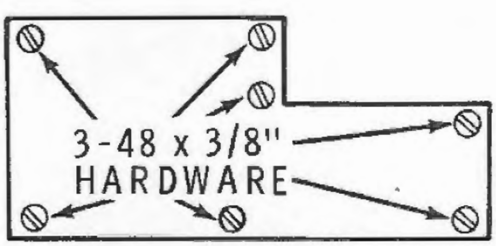
NOTE: Install the following transistor as shown. Solder each lead to the foil and cut off the excess lead lengths.



( ) 2N2369 transistor (#417-154) at Q311.



PICTORIAL 3-5



Detail 3-5A

INITIAL TESTS

CONTROL SETTINGS

CONTROLS THAT WORK TOGETHER
(SEE NUMBERED BOXES IN FIGURE 2-1)

FUNCTIONS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
TRACE	X	X													
VERTICAL DISPLAY			X	X	X										X
HORIZONTAL INPUT											X	X	X	X	
AUTOMATIC TRIGGER							X	X	X	X	X	X		X	
NORMAL TRIGGER						X	X	X	X	X	X	X		X	

Figure 2-2

FRONT PANEL

NOTE: Figure 2-1 (fold-out from Page 3-38) shows the front panel of the Oscilloscope. Study the Figure carefully, as well as the chart on Figure 2-2, to identify the function of each switch, control, jack, and connector. The chart shows which of the controls interact with each other.

Refer to Figure 2-1 and set the following groups of controls. All controls will be called out just as they appear on the front panel of the Oscilloscope.

NOTE: Do not plug the AC line cord into an outlet until you are instructed to do so.

CRT DISPLAY

( ) INTENSITY: Fully clockwise and pushed in

( ) FOCUS: Center of rotation

BEAM POSITION

NOTE: To make the following VERT (Coarse) control setting, remove the knob from the VERT control, insert a small screwdriver into the hollow shaft, and make the setting. Then reinstall the knob.

( ) VERT (Coarse): Center of rotation

( ) VERT (Fine): Center of rotation

( ) HORIZ: Center of rotation

VERTICAL

( ) VOLTS/CM: 0.3

( ) VARIABLE: Fully clockwise

( ) MODE: AC

( ) INPUT: Operate

HORIZONTAL

( ) WIDTH: Fully counterclockwise

( ) VARIABLE: Center of rotation

( ) μSEC/CM: EXT

SWEEP TRIGGER

( ) LEVEL: Center of rotation

( ) AUTO/NORM: Auto

( ) SLOPE: + (plus)

( ) INT/EXT: Ext

( ) STABILITY: Fully clockwise

INTERNAL

In the following steps you will preset the internal controls. These controls should be set when looking at the control from the position shown in a specific Figure.

Refer to Figure 3-1 (fold-out from Page 3-53) and set the following controls.

( ) 100 V ADJUST: Center of rotation

( ) VERT CAL: Center of rotation

( ) DC BALANCE: Center of rotation

Refer to Figure 3-2 (fold-out from Page 3-53) and set the following controls.

( ) FEEDBACK ADJ: Center of rotation

( ) LEVEL SET: Fully counterclockwise

( ) TRIGGER BAL: Center of rotation

( ) SWEEP CAL: Center of rotation

( ) DC BAL: Center of rotation

( ) 100 V ADJ: Center of rotation

ADJUSTMENTS

( ) Carefully remove IC201 from the power supply circuit board. It will be installed later.

If any trouble is encountered or the test results cannot be obtained in the following tests or adjustments, turn the power off and refer to the "In Case of Difficulty" section on Page 3-61.

Use your Bell and Howell Digital Voltmeter to make the following adjustments.

CAUTION: PROCEED WITH CARE DURING THE FOLLOWING STEPS UNTIL THE SIDE COVERS ARE INSTALLED. BOTH AC AND DC VOLTAGES IN SOME AREAS MAY EXCEED 1300 VOLTS. SEE PHOTOGRAPHS (BEGINNING ON PAGE 3-73).

( ) Plug the line cord into an AC outlet.

( ) Pull the INTENSITY control on the "On" position. The power lamp should come on. Allow the Oscilloscope to warm up for approximately 30 seconds. You may not see a trace at this time.

( ) Set the voltmeter to measure +200 VDC.

Refer to Figure 3-2 (fold-out from Page 3-53) for the following steps.

( ) Alternately measure the voltage at the collector tabs of Q323 and Q324. Adjust the HORIZ beam position control until these voltages are equal. NOTE: As the HORIZ beam position control is rotated in one direction, the voltage at one collector will increase while the voltage at the other collector will decrease.

( ) Adjust the 100 V ADJ control for a 100-volt meter indication at the collector of Q324.

( ) Repeat the two previous steps until the collector voltage at both Q323 and Q324 is 100 volts.

Refer to Figure 3-1 (fold-out from Page 3-53) for the following steps.

CAUTION: DO NOT PUT YOUR HAND ONTO ANY INTERNAL COMPONENTS AS YOU REPOSITION THE OSCILLOSCOPE.

( ) Set the voltmeter to measure +20 VDC.

( ) Measure the voltage at the positive end of capacitor C105. Your meter should indicate 9 volts (±10%). Turn the 100 V ADJUST control clockwise until the meter reading begins to drop. Return the control just enough (counterclockwise) for the meter to indicate the original reading.

( ) Remove the VERT beam position control knob.

( ) Measure the voltage on the base of Q107. Then measure the voltage on the base of Q108. Adjust the VERT beam position (Coarse) control with a small screwdriver to obtain equal voltages on the bases of Q107 and Q108.

( ) Set the voltmeter to read +200 VDC.

( ) Turn the 100 V ADJUST control slightly for a 100-volt meter indication at the collector of Q109.

( ) Alternately measure the voltage at the collector tabs of Q109 and Q111. With a small screwdriver, adjust the VERT beam position (Coarse) control slightly until the voltages are equal. NOTE: As the VERT beam position (Coarse) control is rotated in one direction, the voltage at one collector will increase while the voltage at the other collector decreases.

( ) Repeat the two previous steps until the collector voltage at both Q109 and Q111 is 100 volts. A spot should be approximately centered vertically on the CRT.

( ) Replace the VERT beam position control knob.

NOTE: Perform the following three steps once, and then perform them again before you proceed.

( ) 1. Set the voltmeter to measure +2 volts DC and connect it to lug 1 of the vertical VARIABLE control. Then adjust the DC BALANCE for an indication of zero volts. Reverse the voltmeter test leads to make sure the voltage has not gone negative.

( ) 2. Set the voltmeter to measure +200 volts and then alternately measure the voltage at the collectors of Q109 and Q111. Adjust the VERT beam position control until these voltages are equal.

( ) 3. Adjust the 100 V ADJUST control for a 100-volt meter indication at the collector of 109.

NOTE: Due to the high sensitivity of this scope, the following adjustment is also sensitive. Therefore, it may be necessary to repeat the following steps later. Be sure the Oscilloscope has warmed up for half an hour before you perform the step.

( ) Note the position of the spot on the CRT and rotate the vertical VARIABLE control from minimum to maximum. If the spot on the CRT moves vertically, adjust the DC BALANCE control until the spot remains stationary as the control is rotated back and forth.

( ) Rotate the horizontal WIDTH control from minimum to maximum. The spot should not move horizontally. If it does, perform the following three steps. It may be necessary to repeat these steps to obtain proper operation.

Refer to Figure 3-2 for the following steps.

NOTE: Perform the following three steps once, and then perform them again before proceeding.

( ) 1. Set the voltmeter to measure 2 volts DC and connect it to the source (S) of transistor Q317. (This voltage may either be positive or negative prior to its adjustment.) Then adjust the DC BAL for an indication of zero volts. Reverse the voltmeter leads to make sure the voltage has not gone negative.

( ) 2. Set the voltmeter to measure +200 volts and then alternately measure the voltage at the collector of Q323 and Q324. Adjust the HORIZ beam position control until these voltages are equal.

( ) 3. Adjust the 100 V ADJ control for a 100-volt meter indication at the collector of Q324.

( ) Note the position of the spot on the CRT and rotate the horizontal WIDTH control from minimum to maximum. If the spot moves horizontally, adjust the DC BAL control until the spot remains stationary as the control is rotated back and forth.

TRACE ADJUSTMENT

Refer to Figure 3-2 (fold-out from Page 3-53) for the following steps.

( ) Set the voltmeter to measure +200 volts DC.

( ) Connect the voltmeter test probe to the center lug of the ASTIGMATISM control, R413.

( ) Adjust the ASTIGMATISM control for a 100-volt meter indication.

( ) Set the horizontal VARIABLE control to the center of rotation.

( ) Set the μSEC/CM switch to the 1 mS position.

( ) Adjust the INTENSITY and FOCUS controls for the sharpest trace.

( ) Check to make sure the horizontal trace is parallel with the horizontal graticule (grid screen) lines. If the trace and graticule lines are parallel, proceed to the next check step. If they are not parallel, complete the following numbered steps.

1. Note the relative position of the horizontal line and unplug the line cord plug.
2. Loosen the CRT clamp nuts.
3. Rotate the CRT slightly.
4. Plug in the line cord and again check the position of the horizontal trace.
5. Repeat steps 1 through 4 as necessary to align the horizontal trace.
6. After the correct results have been obtained, unplug the line cord plug and tighten the CRT clamp nuts. Then again plug in the line cord.

( ) Turn the μSEC/CM switch to each of its positions. A horizontal trace should appear at all but the EXT position. Leave this switch at the EXT position.

( ) Connect a test lead from the 1 V P-P jack to the HORIZ jack.

( ) Make sure the horizontal WIDTH control is turned fully clockwise. A horizontal trace approximately 7 cm long should appear. Disconnect the test lead from the HORIZ jack.

( ) Turn the horizontal WIDTH control fully counterclockwise.

( ) Set the INPUT switch to the 1 V P-P CALIBRATE position.

( ) Set the VOLTS/CM switch to the 0.3 position.

( ) Turn the vertical VARIABLE fully clockwise. Then refer to Figure 3-1 and adjust the VERT CAL control for a vertical trace on the CRT that is approximately 3-1/2 cm long.

( ) Set the INPUT switch to the OPERATE position.

( ) Turn the VOLTS/CM switch to the GND position.

( ) Turn the VERT position control clockwise and counterclockwise. The spot should move up (clockwise) and down (counterclockwise).

( ) Turn the HORIZ position control clockwise and counterclockwise. The spot should move to the right (clockwise) and to the left (counterclockwise).

( ) Turn the Oscilloscope off by pushing in the INTENSITY control.

( ) Reinstall IC201 in its socket on the power supply circuit board. Be sure to match the dot or notch on one end with the notch in the socket.

Proceed to Experiment 1 of Manual 9560-3, Part 2, to complete the calibration of this instrument. If you have the square and sine wave generators described in the "Calibration" section of this Manual, you may perform the calibration steps on the following pages.

CALIBRATION

TRIGGER CIRCUITS

Refer to Figure 2-1 (fold-out from Page 3-38) and set the front panel controls as follows:

( ) μSEC/CM: 100

( ) WIDTH: Center of rotation.

Set the SWEEP TRIGGER switches as follows:

( ) STABILITY: Fully counterclockwise.

( ) LEVEL: Fully counterclockwise.

( ) AUTO-NORM: AUTO

( ) SLOPE: +

( ) INT-EXT: INT

( ) Refer to Figure 3-2 (fold-out from Page 3-53) and connect the common voltmeter lead to the Oscilloscope chassis and the positive lead to TP1 (base of transistor Q304). Set the voltmeter range to +20 volts. Then adjust the LEVEL SET control for zero volts. Reset the voltmeter range to +2 volts; then again adjust the LEVEL SET control for zero volts.

( ) Connect the positive lead of the voltmeter to TP2 (base of transistor Q316). Adjust the FEEDBACK ADJ control for 0.2 volts.

( ) Turn the STABILITY control clockwise until the trace appears on the face of the CRT.

( ) Adjust the INTENSITY and FOCUS controls for the sharpest trace.

( ) Adjust the HORIZ beam position control to center the display on the CRT.

NOTE: To properly perform the following calibration steps, you will need a signal generator capable of producing a sine wave of 10 kHz and square waves at 1000 Hz and 100 kHz.

( ) Set the output of the signal generator to produce a sine wave of approximately 10 kHz.

( ) Connect the output of the generator to the VERT input jack of the Oscilloscope.

( ) Set the VOLTS/CM switch to .3 and the vertical VARIABLE control fully clockwise.

( ) Set the MODE switch to AC.

( ) Set the amplitude control on the signal generator to display approximately 4 cm on the CRT screen.

( ) Center the CRT display by adjusting the VERT beam position control.

( ) Refer to Figure 3-2 and adjust the TRIGGER BAL control until the signal on the CRT is stabilized or "synchronized." This will be a condition where the sine wave displayed is steady and unshifting.

( ) Move the AUTO-NORM switch on the front panel to the NORM position. The CRT display should disappear. If it does not, return the switch to AUTO, turn the STABILITY control slightly counterclockwise and readjust the TRIGGER BAL control. After that is done, once again set the AUTO-NORM switch to the NORM position to cause the trace to disappear.

( ) Adjust the LEVEL control to lock in the signal display.

( ) Move the SLOPE switch to the "–" position. If the trace disappears from the CRT, carefully note the position of the LEVEL control. Turn the LEVEL control until the trace appears on the CRT. Note the position of the LEVEL control again.

( ) Set the LEVEL control to a position midway between the two noted settings.

( ) Adjust the TRIGGER BAL control (Figure 3-2) until the signal on the CRT locks in. Switch the SLOPE switch between the "+" position and the "–" position while you further adjust the TRIGGER BAL control until the trace starts at the same point in both switch positions.

( ) Place the AUTO-NORM switch in the AUTO position.

( ) Work the SLOPE switch up and down while observing the trace on the CRT. The trace should start an equal distance above and below the centerline of the graticule. If it does not, adjust the LEVEL SET control (Figure 3-2) until the traces for the switch positions are the same distance above and below the centerline.

( ) Set the SWEEP TRIGGER switches as follows:

AUTO-NORM: NORM

SLOPE: +

INT-EXT: INT

( ) Work the SLOPE switch up and down while you observe the trace on the CRT. Adjust the LEVEL control until the trace starts at the same point on the horizontal center line. Leave the SLOPE switch in the + position.

SWEEP CALIBRATION

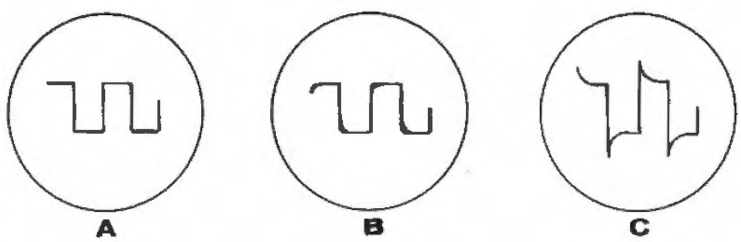


Figure 4-1

( ) Reset the STABILITY control for a steady trace on the CRT.

( ) Connect a 1000 Hz square wave signal to the vertical INPUT jack on the Oscilloscope.

( ) Set the horizontal WIDTH and horizontal VARIABLE controls fully clockwise.

( ) Set the μSEC/CM switch to the 100 position.

( ) Adjust the SWEEP CAL control (Figure 3-2) for a display of one cycle on the CRT. NOTE: The accuracy of the time base is directly related to the accuracy of the 1000 Hz input signal.

( ) Set the μSEC/CM switch to the 1 position.

( ) Adjust the output of the signal generator to provide a 100 kHz square wave signal to the vertical INPUT jack of the Oscilloscope. The signal on the CRT may resemble A, B, or C of Figure 4-1 at this time.

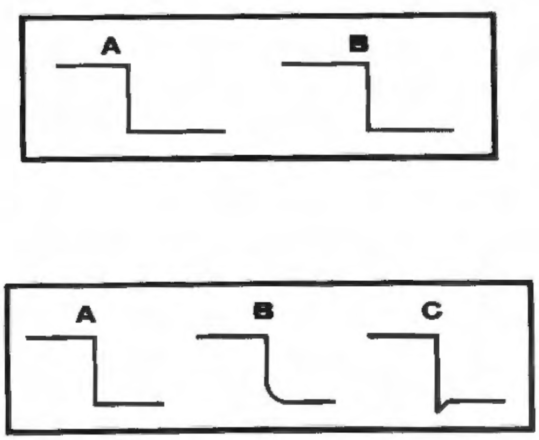


Figure 4-2

( ) Refer to Figure 4-2 and adjust trimmer capacitor C412 until one cycle produces a 10 cm display on the CRT. Use the Horiz position control to move the trace to the left so that you do not use the first 1/2 cycle of the square wave. If you cannot obtain one full cycle on the CRT, check the 1000 Hz calibration (3 steps prior to this one).

( ) Set the signal to approximately 4 cm of vertical deflection on the CRT.

( ) Turn the horizontal VARIABLE control counterclockwise to display several cycles.

VERTICAL COMPENSATION

Figure 4-1 shows the conditions of the correct amount of circuit compensation, too little, and too much. After you make the following adjustments, the waveform should appear as shown in Part A of Figure 4-1.

( ) Set the VOLTS/CM switch to the .03 volt position. Also be sure that your signal generator is adjusted to provide a 100 kHz signal.

( ) Adjust trimmer capacitor C106 (Figure 3-1, fold-out from Page 3-53) on the vertical amplifier circuit board until the waveform appears as shown in Part A of Figure 4-1.

( ) Set the μSEC/CM switch to the 100 position and the horizontal VARIABLE control to display several cycles on the CRT.

( ) Turn the VOLTS/CM switch to the 30 volt position.

( ) Set the signal generator to produce a 1000 Hz square wave.

( ) If possible, increase the signal generator output amplitude to display 4 cm of vertical signal on the CRT.

( ) Adjust trimmer capacitor C405 until the waveform appears as shown in Part A of Figure 4-1.

( ) Turn the VOLTS/CM switch to the 3 volt position.

( ) Decrease the signal generator output amplitude to display 4 cm of vertical signal on the CRT.

( ) Adjust trimmer capacitor C407 until the waveform appears as shown in Part A of Figure 4-1.

( ) Turn the VOLTS/CM switch to the 0.3 volt position.

( ) Decrease the signal generator output amplitude to display 4 cm of vertical signal on the CRT.

( ) Adjust trimmer capacitor C406 until the waveform appears as shown in Part A of Figure 4-1.

( ) Set the VOLTS/CM switch to the .03 position.

( ) Adjust the signal generator amplitude to produce a 4 cm vertical display on the CRT.

( ) Repeat all of the "Vertical Compensation" steps until no further improvement is noted.

NOTE: In the following steps, you will adjust the low capacity trimmer. If you do not have a low capacity probe, adjust trimmer C404 in the following step. If you do have a low capacity probe, proceed to "With Low Capacity Probe."

Without Low Capacity Probe

( ) Turn trimmer capacitor C404 clockwise until it is just snug, then turn it counterclockwise one-quarter turn. Proceed to "Vertical Calibration."

With Low Capacity Probe

( ) Set the signal generator to produce a 1000 Hz square wave signal.

( ) Turn the VOLTS/CM switch to the .03 volt position.

( ) Set the amplitude of the signal generator to produce a 4 cm vertical deflection on the CRT.

( ) Adjust the trimmer capacitor <u>on the low capacity probe</u> to produce a waveform as shown in Part A of Figure 4-1.

( ) Turn the VOLTS/CM switch to the .3 volt position.

( ) If possible, increase the amplitude of the CRT display to 4 cm.

( ) Adjust trimmer capacitor C404 to produce a waveform as shown in Part A of Figure 4-1.

VERTICAL CALIBRATION

( ) Set the µSEC/CM switch to the 1mS position.

( ) Set the VOLTS/CM switch to the .3 position.

( ) Set the INPUT switch to the 1 V P-P CALIBRATE position.

( ) Set the MODE switch to the AC position.

( ) Adjust horizontal VARIABLE to produce one cycle on the CRT.

( ) Refer to Figure 3-1 and adjust the VERT CAL control for 3.3 cm of vertical deflection.

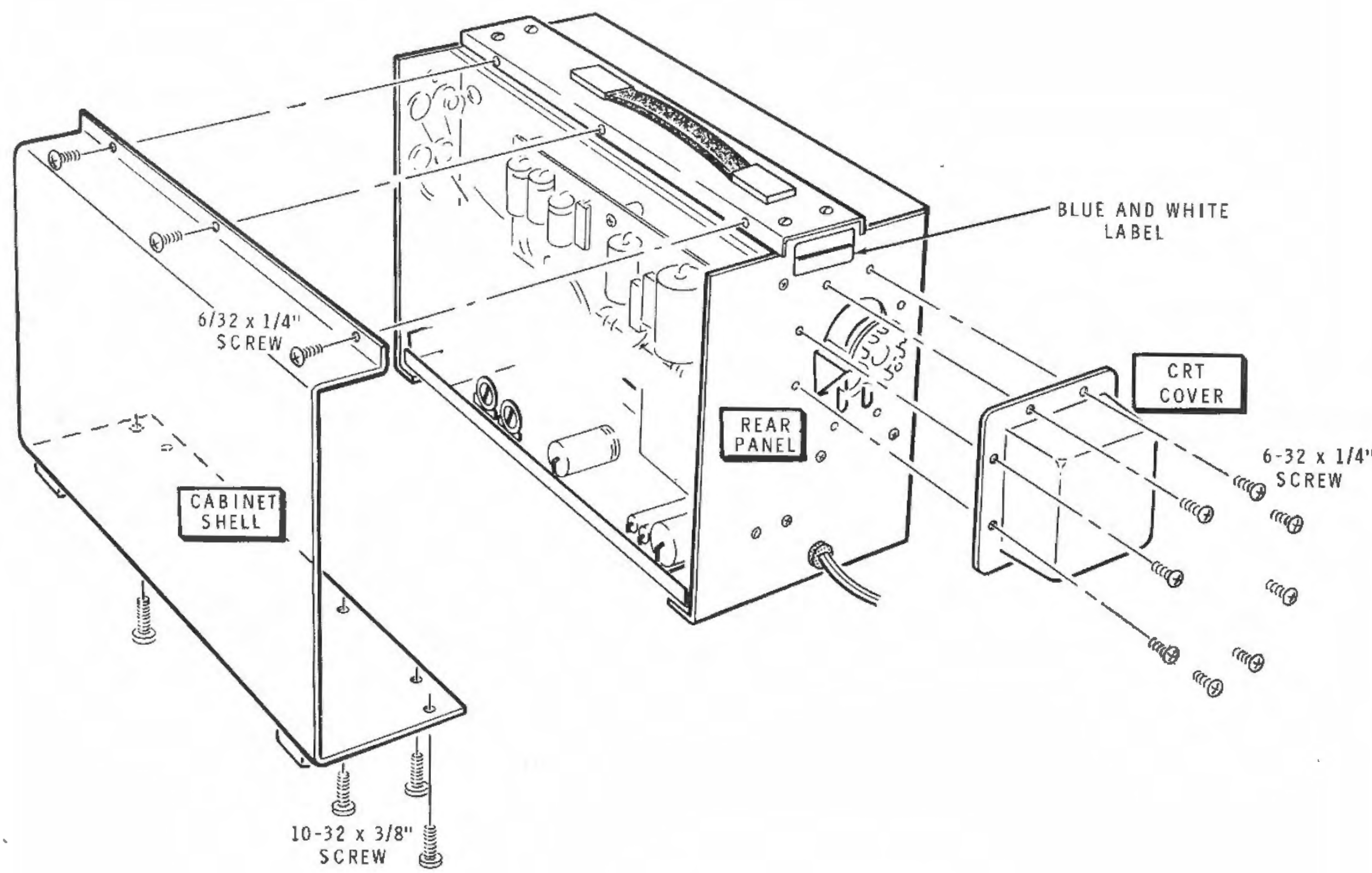
( ) Disconnect all cables from the Oscilloscope.

( ) Push in the INTENSITY knob on the front panel to turn the Oscilloscope off. Then remove the AC line cord plug from the wall outlet.

This completes the calibration of your Oscilloscope.

NOTE: It is suggested that you repeat the "Calibration" after your Oscilloscope has operated several hours, and periodically thereafter. Allow sufficient warm-up time (at least 30 minutes) before you start the calibration.

Proceed to "Final Assembly."



PICTORIAL 10-1

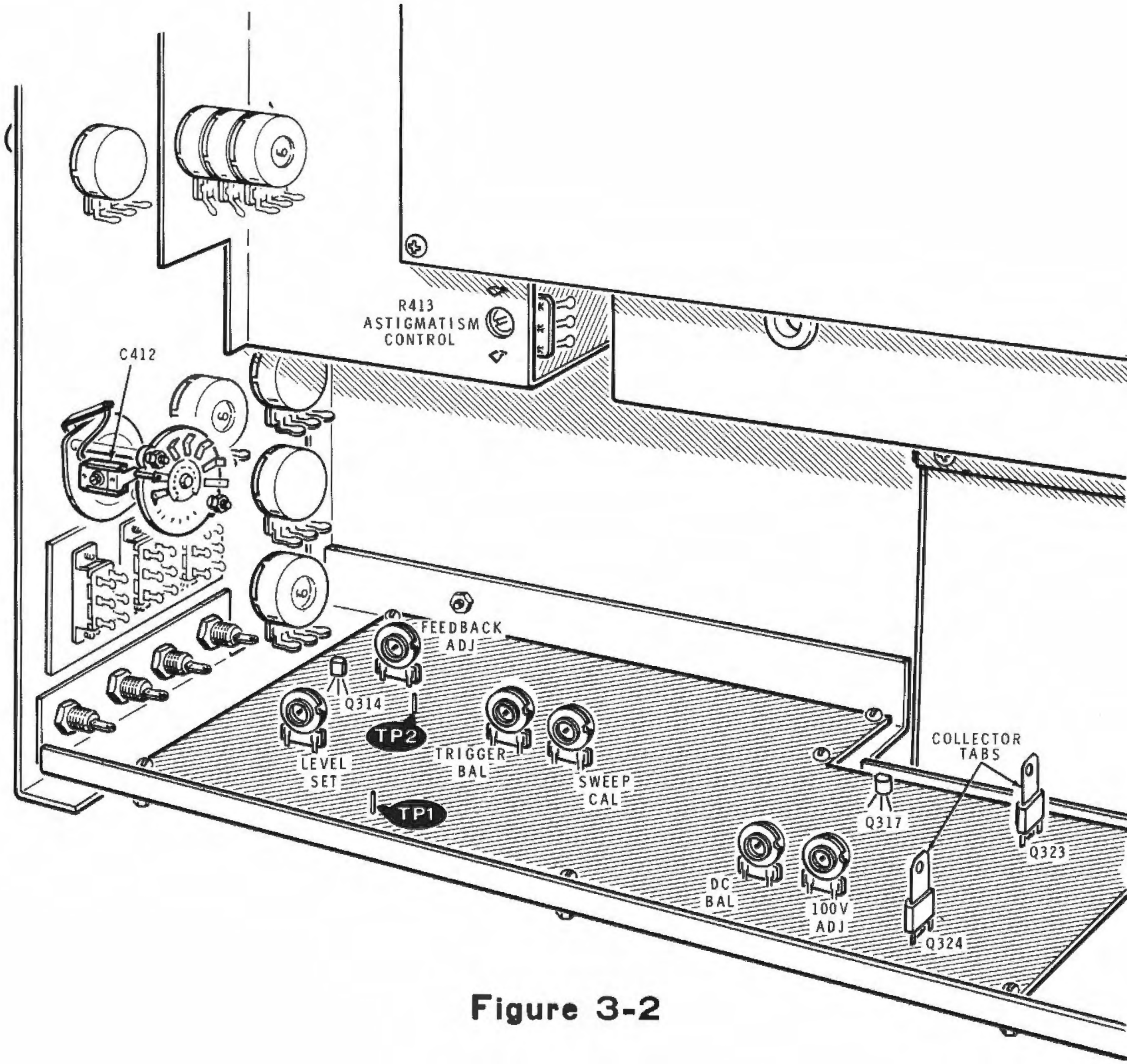
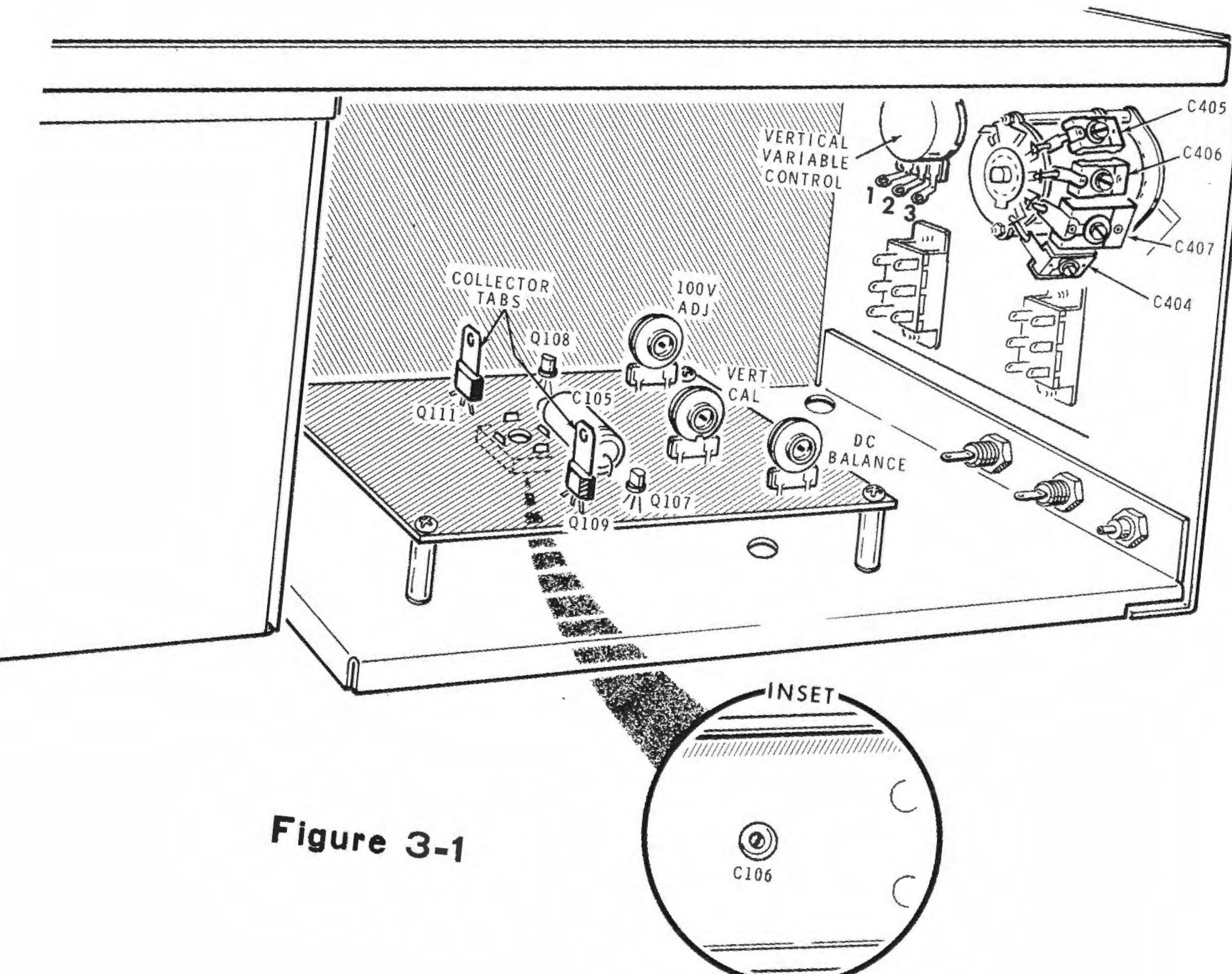

R413
ASTIGMATISM
CONTROL
C412
FEEDBACK
ADJ
Q314
TP2
LEVEL
SET
TRIGGER
BAL
SWEEP
CAL
TP1
COLLECTOR
TABS
Q317
Q323
DC
BAL
100V
ADJ
Q324

Figure 3-2



VERTICAL
VARIABLE
CONTROL
1
2
3
C405
C406
C407
C404
COLLECTOR
TABS
Q108
100V
ADJ
VERT
CAL
Q111
C105
DC
BALANCE
Q107
Q109
INSET
C106

Figure 3-1

SPECIFICATIONS

VERTICAL CHANNEL

Input Impedance	1 Megohm shunted by 30 pF.
Sensitivity	30 mV/centimeter.
Maximum Input Voltage	600 volts DC.
Frequency Response	DC to 5 MHz ±3 dB @ 3 cm deflection.
Rise Time	Less than 50 nanoseconds.
Attenuator	4-position, .03 to 30 volts/cm.

HORIZONTAL CHANNEL

Input Impedance	100 kΩ.
Sensitivity	0.25 volt/cm (uncalibrated).
Frequency Response	DC to 500 kHz.

TIME BASE

Sweep	4 decade steps, 100 milliseconds to 100 nanoseconds/cm, ±5%.
Trigger Modes (switch selected)	AUTO/NORMAL. +/– (plus or minus). INT/EXT.
Trigger Sensitivity	
(internal)	1 cm display.
(external)	0.5 volt peak-to-peak.

GENERAL

CRT	5DEP1F, 6 x 10 centimeter viewing area, green, medium persistance phosphor.
Graticule	Screened, 6 x 10 cm.
Power Supplies	All-solid-state rectifiers.
Power Requirements	110-130 or 220-260 VAC, 50/60 Hz, 35 watts.
Overall Dimensions	12-3/4" high, 9-1/4" wide, 16-1/4" long. These dimensions include all protruding surfaces: knobs, handle, feet, etc.
Net Weight	25 lbs. (11.34 kg.)

CIRCUIT DESCRIPTION

Refer to the Schematic Diagram (fold-out from Page 3-79) and the Block Diagram (fold-out from Page 3-66) while you read this "Circuit Description."

To help you locate specific parts in the Oscilloscope or on the Schematic, the resistors, capacitors, transistors, and diodes are numbered in the following groups.

100-199	Parts mounted on the vertical amplifier circuit board.
200-299	Parts mounted on the power supply circuit board.
300-399	Parts mounted on the horizontal amplifier-sweep generator circuit board.
400-499	Parts mounted on the chassis.

ATTENUATOR CIRCUIT

When the Mode switch is in the DC position, a signal applied to either vertical Input connector is coupled directly to the attenuator. When the Mode switch is in the AC position, the input signal is coupled through capacitor C403, which passes only AC signals, to the attenuator. This permits an AC signal superimposed on a DC potential to be seen without the DC component being displayed.

Because the vertical amplifier operates at a fixed level of gain, any signal applied to it must be within a usable range (approximately 0-180 millivolts). The primary purpose of the frequency-compensated attenuator (Volts/Cm switch) is to reduce the input signal, by a known factor, to this usable range. When the Volts/Cm switch is in the .03 volt position, the input signal passes directly to the vertical amplifier without attenuation. In the other positions, the Volts/Cm switch inserts an attenuator into the signal path and reduces the signal to a usable level before it reaches the vertical amplifier. The GND position of the Volts/Cm switch permits adjustment of the zero reference of the trace without disconnecting the test leads from the circuit under test.

VERTICAL AMPLIFIER

From the attenuator circuit, a portion of the input signal is coupled through resistor R101 and capacitor C101 to the gate of transistor Q101. Resistor R101 protects Q101 from being damaged in case a high potential is applied to the vertical Input connector while the Volts/Cm switch is in one of its lower ranges. Diodes D101 and D102 are transistors connected to provide a zener action. These diodes limit the input signal to approximately ±9 volts, to further protect Q101 from excess gate voltage. Capacitor C101 improves high frequency response by forming a high frequency path around R101.

Transistor Q101 is a field effect transistor (FET) connected as a source follower. This type of transistor provides the high impedance input necessary to prevent loading the circuit under test.

Transistor Q102 is a constant current source for input transistor Q101. Diodes D103 and D104 each provide a .6 volt drop (total 1.2 volts) and hold the base of Q102 at a constant voltage. Since the circuit of transistor Q102 is basically an emitter follower (common-collector), and the emitter voltage is dependent upon the base voltage, the emitter voltage will also remain constant. This constant emitter voltage is across DC Balance control R102; therefore, the current through R102 is constant. Control R102 is adjusted so the source voltage of Q101 is zero when an input signal is not present.

A signal applied to the gate of Q101 will cause only voltage changes at the source because the current through Q101 is constant. These voltage variations are applied across vertical Variable control R409, and a portion of this signal is applied to the gate of source follower Q103.

Transistor Q104 forms a constant current source for transistors Q105 and Q106. Since the emitter of each transistor is connected to this constant current source, the current source serves as a common emitter resistance and sets the operating point for the following stages.

The output from source follower transistor Q103 is amplified by Q105. A portion of the signal applied to the base of Q105 appears at its emitter. Because transistors Q105 and Q106 have a common emitter resistance, the signal present at the Q105 emitter is effectively coupled to the emitter of Q106.

Transistor Q106 functions as a common base amplifier whose base is held constant by the Vert. position control R403. This control positions the trace by applying a DC voltage to the base of transistor Q106 and causes a DC unbalance in the vertical amplifier. When the collector output voltage of Q105 decreases, its emitter voltage will increase. An increased emitter voltage at Q106 reduces its forward bias and increases its collector output voltage. The signal at the collector of transistor Q106 is 180 degrees out of phase with the signal at the collector of Q105 and forms a "push-pull" type of amplifier required to drive the CRT deflection plates. Capacitor C103 is an emitter bypass capacitor to boost the gain at high frequencies. Emitter resistors R108 and R109 establish the DC gain of the vertical amplifier.

Driver transistors Q107 and Q108 are common emitter amplifiers. In addition to providing gain, they also isolate transistors Q105 and Q106 from the output stages.

Output amplifiers Q109 and Q111 again amplify the differential signal and drive the vertical plates of the CRT.

HORIZONTAL AMPLIFIER

The horizontal amplifier is part of the circuitry on the sweep generator-horizontal amplifier circuit board.

Operation of the horizontal amplifier is similar to that of the vertical amplifier. The major difference is in the attenuator system. In the horizontal amplifier, the input is coupled from the HOR connector, through the μSec/Cm switch, to the input of transistor Q317. The source resistance of Q317 is provided by the action of constant current source transistor Q318.

The sawtooth voltage produced by the sweep generator is amplified by the horizontal amplifier and applied to the horizontal deflection plates of the CRT. This linearly increasing voltage causes the electron beam to sweep across the face of the CRT from left to right. The sweep speed of the electron beam is determined by the μSec/Cm switch on the front panel.

SWEEP AND TRIGGER CIRCUITS

The sweep and trigger circuits are part of the circuitry on the horizontal amplifier circuit board.

The Int-Ext trigger switch on the front panel determines whether the internal trigger signal or an external trigger source will be used to start the sweep action. In either case, the selected signal is routed through the selected trigger switch contacts, and is coupled to the gate of transistor Q301.

Level Set control R305 varies the voltage on the source of transistor Q301 by changing the current level through transistor Q302. The source voltage of Q301 is set at zero volts when the Auto-Norm switch is in the Auto position. When the Auto-Norm switch is in the Norm position, the Level control R407 on the front panel sets the current through transistor Q302; thus it controls the point at which the sweep generator will trigger.

Both gain and DC level controls are achieved as the signal is coupled through transistors Q304 and Q305. Note that inverted signals are developed in the emitter coupled circuits of transistors Q304 and Q305 and, after passing through transistors Q306 and Q307, may be selected as either positive or negative triggering signals by the SLOPE switch on the front panel. Capacitor C303 is a high-frequency AC coupler between the emitters of the differential amplifier. Transistor Q303 is a constant current source for transistors Q304 and Q305. Emitter follower transistors Q306 and Q307 provide a low impedance output to IC301A.

IC301 is a dual Schmitt trigger. The A section of the IC is used to shape the wave of the trigger signal, while the B section is used as a voltage sensor to turn the sweep off at the end of each sweep cycle.

Refer to Figure 6-1 (fold-out from Page 3-66). The output of IC301B, at pin 8, is high most of the time. This positive voltage turns on transistor Q311 which, in turn, turns off Q312 and allows the selected sweep capacitor to charge. The high output from IC301B also turns on transistor Q308 which grounds one input (pin 4) of IC301A. This keeps other input pulses at pin 1 out of the circuit so that IC301B will not trigger before the sweep is completed.

Stability control R408 is set to bias the input of IC301B to a voltage level slightly below the trigger point. As the sweep capacitor charges, it overrides this voltage (after being coupled through source follower transistors Q314 and Q316) and continues to increase until the output of IC301B goes low. Then transistor Q311 turns off and transistor Q312 turns on and shorts out the sweep capacitor. Transistor Q308 is also turned off, which causes pin 4 of IC301A to go high.

The next positive-going pulse to pin 1 then drives the output low and turns off transistor Q310. A positive pulse is then coupled through capacitor C304 and sets the output of IC301B low. After the input pulse at IC301A is gone, pin 1 is again low and pin 6 then goes high and turns on transistor Q310. The negative pulse coupled through capacitor C304 causes the output of IC301B to go high. The output stays high because this input is biased between the turn-on and turn-off points of the Schmitt trigger. The process then repeats itself.

IC201 (on the power supply circuit board) is the unblanking amplifier. This amplifier receives signals from the sweep circuit to properly bias the CRT and turn the electron beam on and off as required. The sweep signal causes transistor Q309 to conduct which causes an LED (light-emitting-diode), located in the IC, to conduct. This conduction causes the LED to light which turns off a photo transistor in the IC. When the photo transistor turns off, high voltage is supplied to the CRT. When the sweep signal stops, the LED is cut off, the photo transistor turns on, and the high voltage is cut off.

The μSec/Cm switch determines the value of the sweep capacitor, and the amount of current flowing through transistor Q313. As the sweep capacitor charges, a positive-going ramp voltage (sawtooth) is generated. The speed of the horizontal sweep is determined by the particular timing capacitor chosen and by its charging current.

POWER SUPPLY

Line voltage is connected through the slow-blow fuse and the power switch on the Intensity control to the primary windings of the power transformer. The dual-primary transformer windings may be connected in parallel for 120-volt operation or in series for 240-volt operation.

The high-voltage secondary winding of the power transformer is connected to the voltage doubler circuit consisting of D201, D202, C203, and C204. Resistor R208 and capacitor C202 filter this negative high voltage which is coupled through resistor R412 to the grid of the CRT. The intensity and focusing voltages are also supplied to the CRT from the voltage divider network consisting of resistors R206, R207, R209, Intensity control R403, and Focus control R411. A separate 6.3 volt winding supplies the CRT filament voltage.

A secondary winding supplies 1 volt peak-to-peak to the 1VP-P input and to the Input switch on the front panel.

The low voltage secondary winding is connected to full-wave rectifier diodes D203, D204, D205, and D206. Zener diode ZD201 and resistor R217 maintain a constant voltage to the base of pass transistor Q201. (Figure 6-2 shows a simplified schematic of this power supply.) The output from the series pass transistor is regulated 31 volts. By connecting equal loads from each side of the supply to ground, shown as RL1 through RL6, six separate DC output voltages are obtained. These are: +9 volts (vert), +9 volts (horiz), +5 volts (sweep), –5 volts (sweep), –9 volts (vert), and –9 volts (horiz).

Deflection potentials are obtained from another secondary winding connected to full-wave bridge rectifier diodes D207, D208, D209, and D211. An unregulated 180 volts DC is obtained through resistor R219, and an unregulated 150 volts DC is obtained through resistor R221.

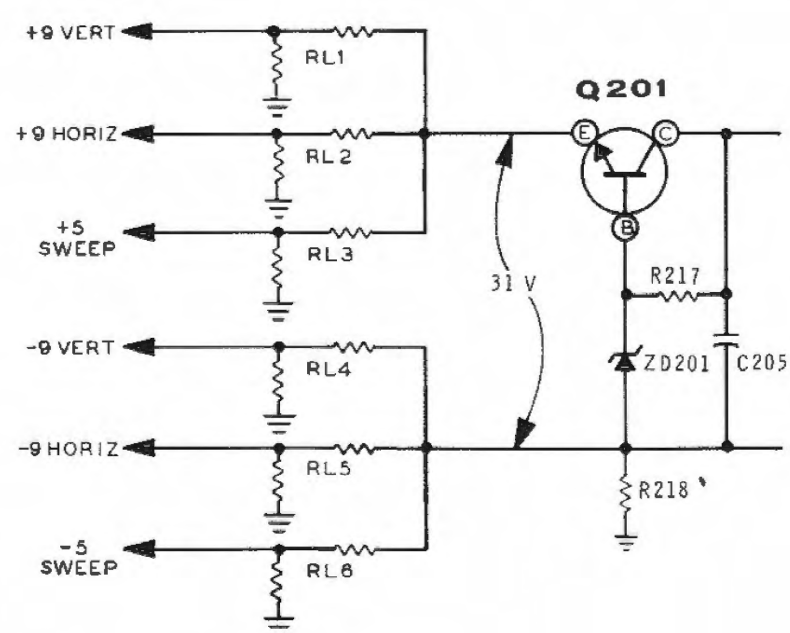


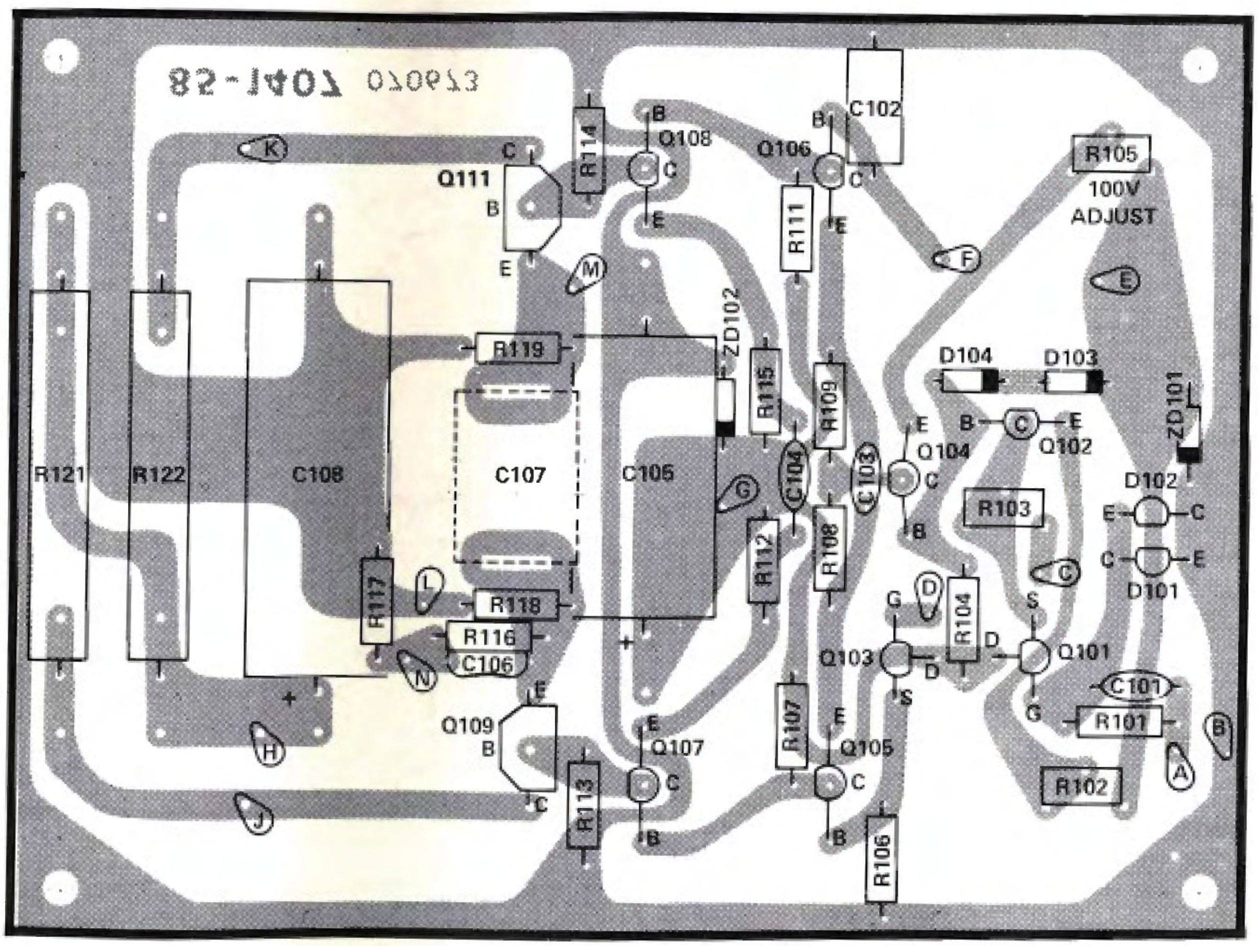
Figure 6-2

CIRCUIT BOARD X-RAY VIEWS

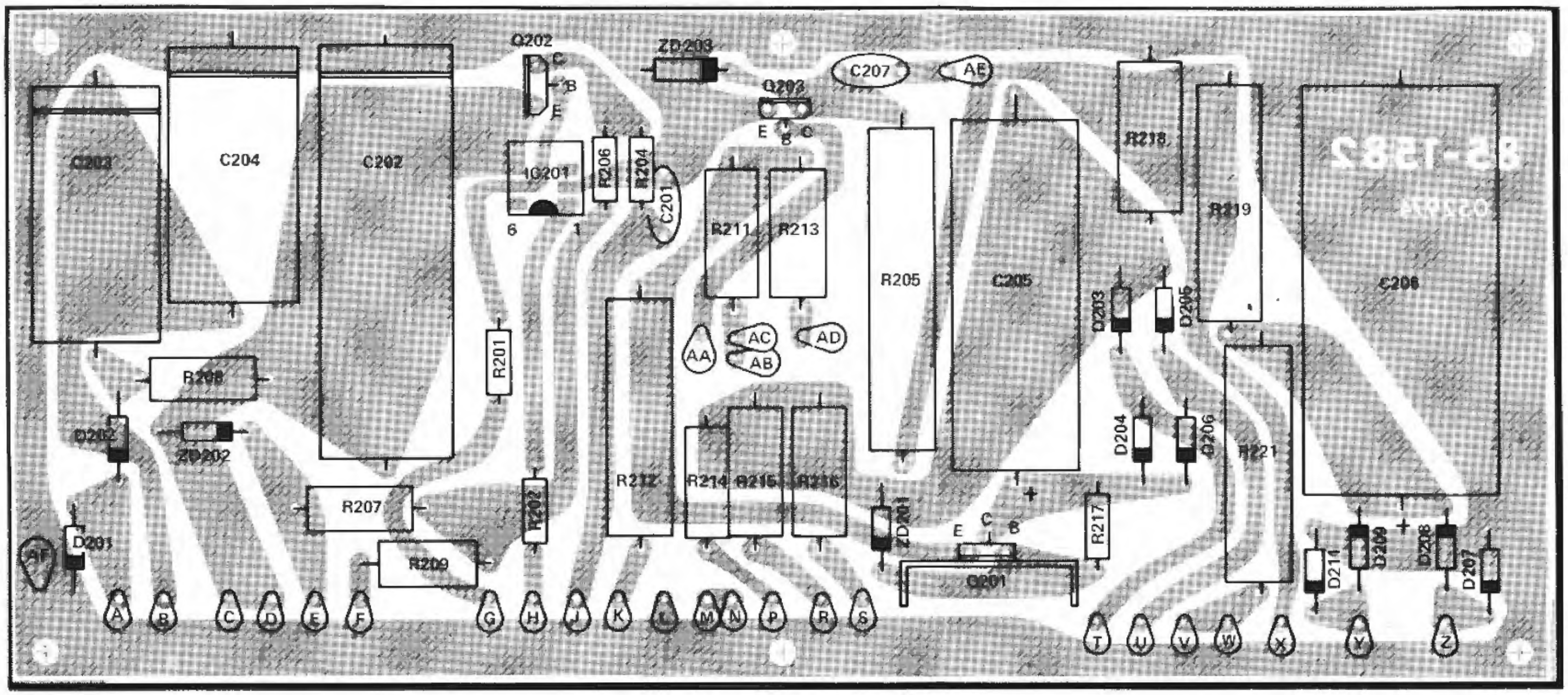
NOTE: To determine the value (22 kΩ, .05 μF, etc.) of one of these parts, you may proceed in either of the following ways.

1. Refer to the place where the part is installed in the Step-by-Step instructions.

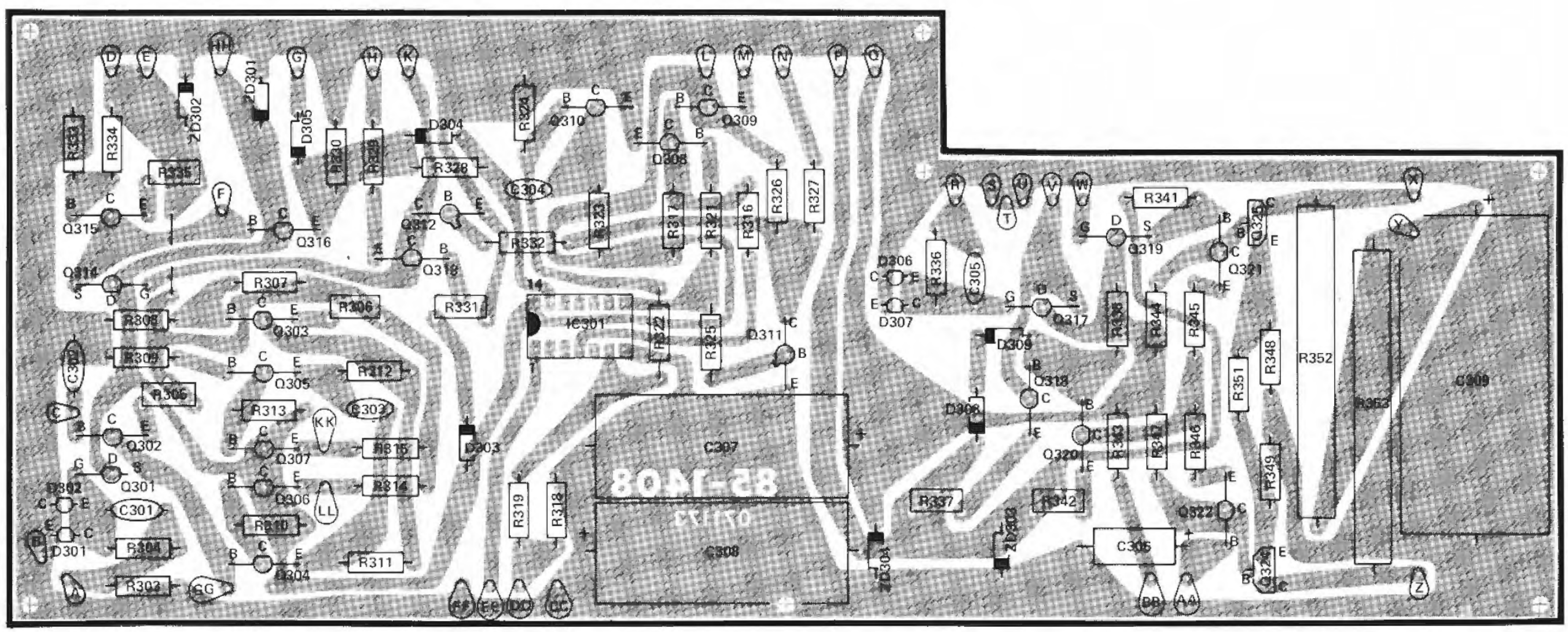
2. Note the identification number of the part (R-number, C-number, etc.). Then locate the same identification number next to the part on the Schematic. The value, or "Description", of most parts will be near this number. For diodes, integrated circuits, and transistors, refer to the transistor-diode identification chart.



VERTICAL CIRCUIT
(shown from component side)



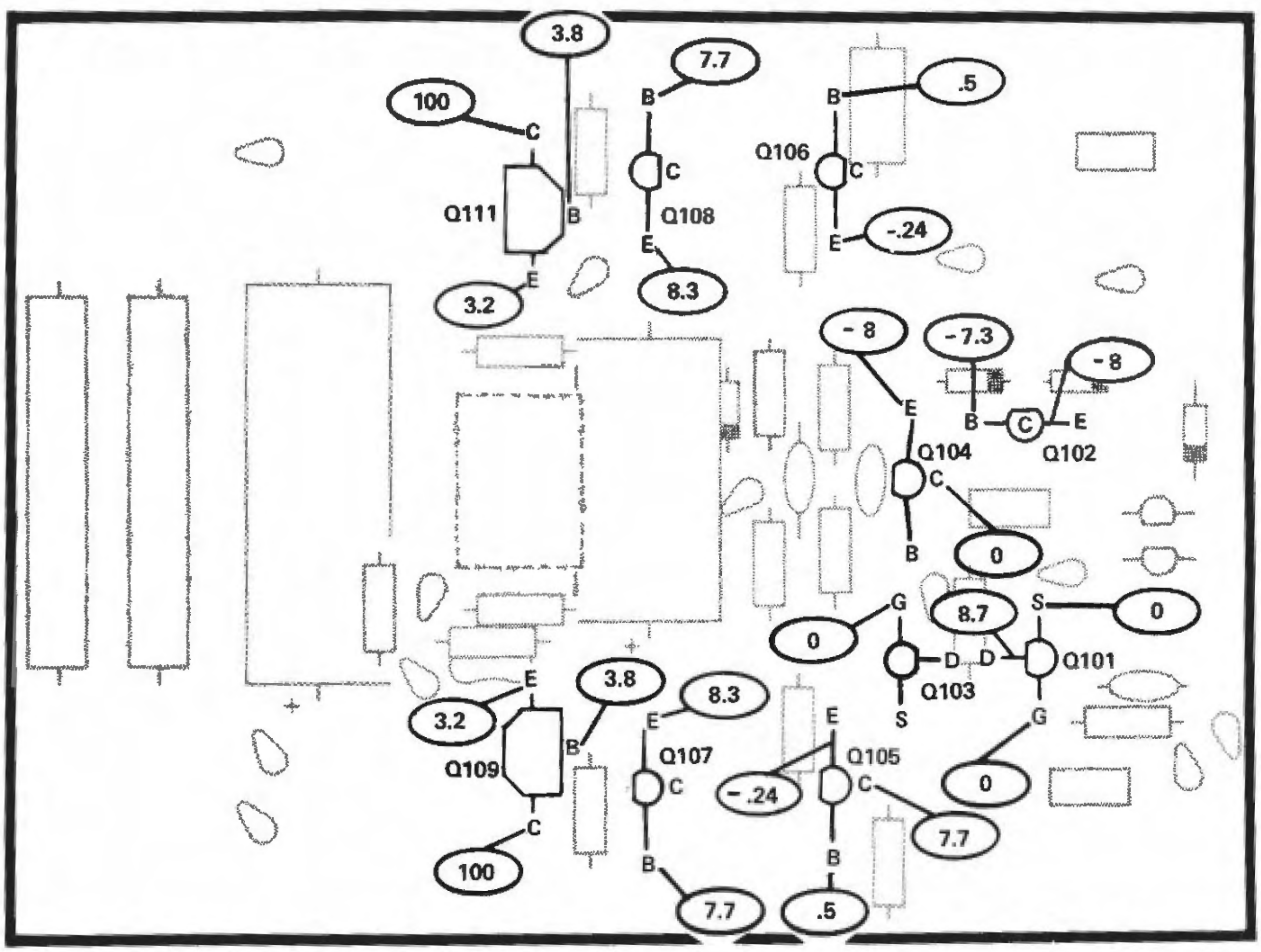
POWER SUPPLY CIRCUIT BOARD
(shown from component side)



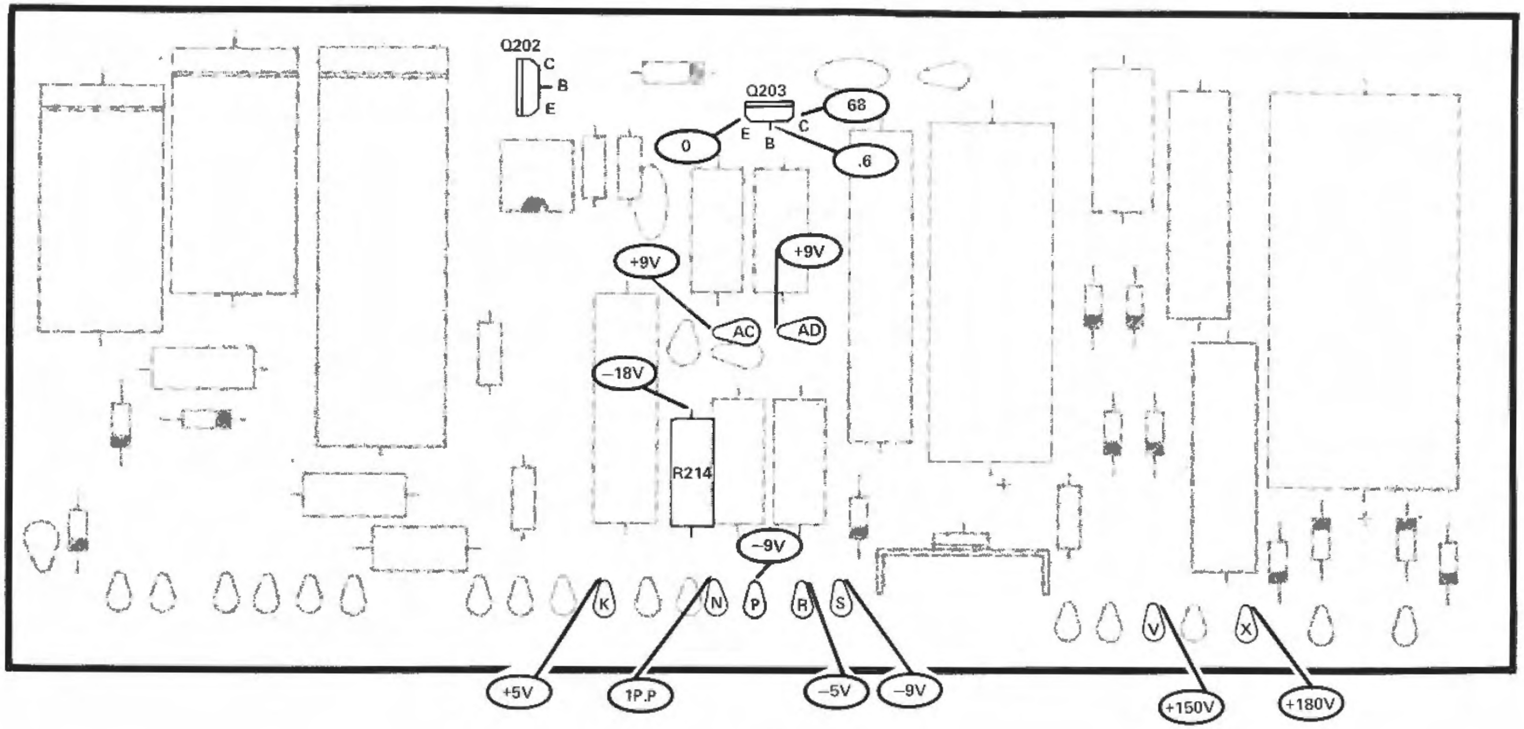
HORIZONTAL AMPLIFIER – SWEEP CIRCUIT BOARD
(shown from component side)

VOLTAGE CHARTS

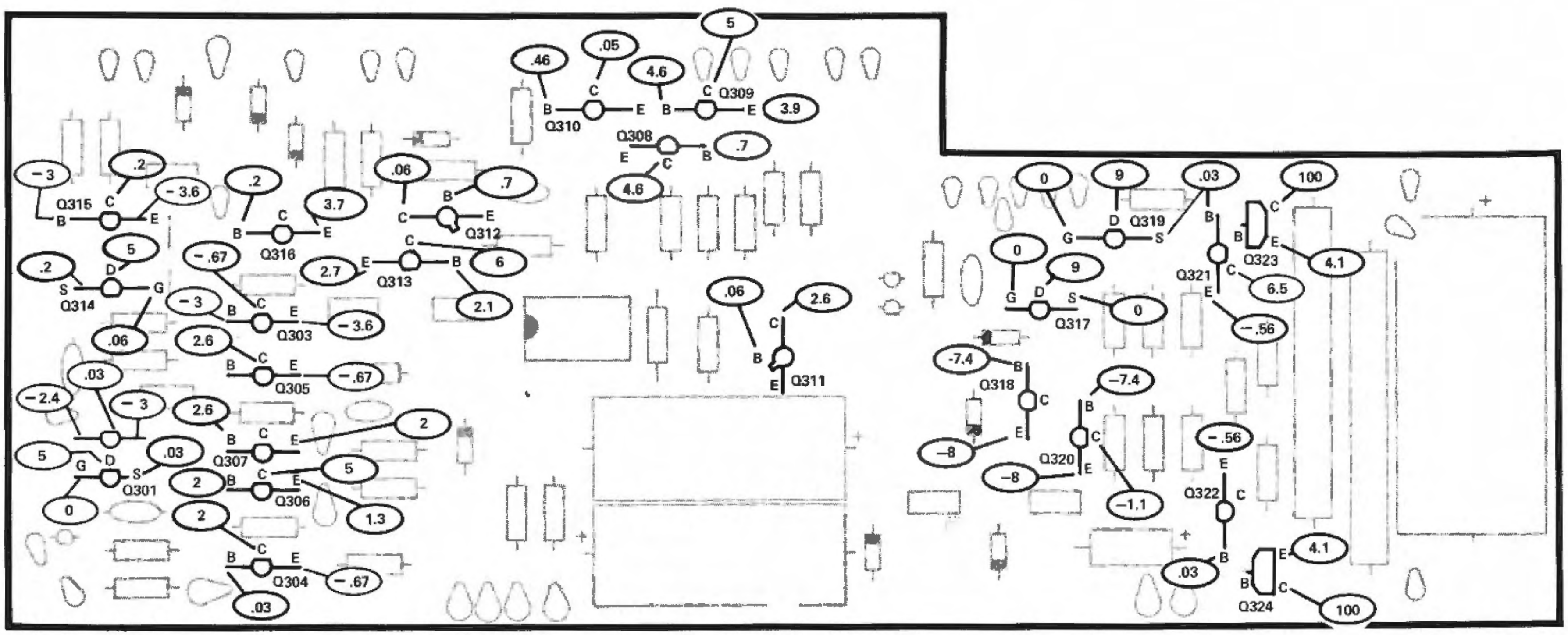
See the Schematic notes for voltage conditions.



VERTICAL CIRCUIT BOARD
(shown from component side)

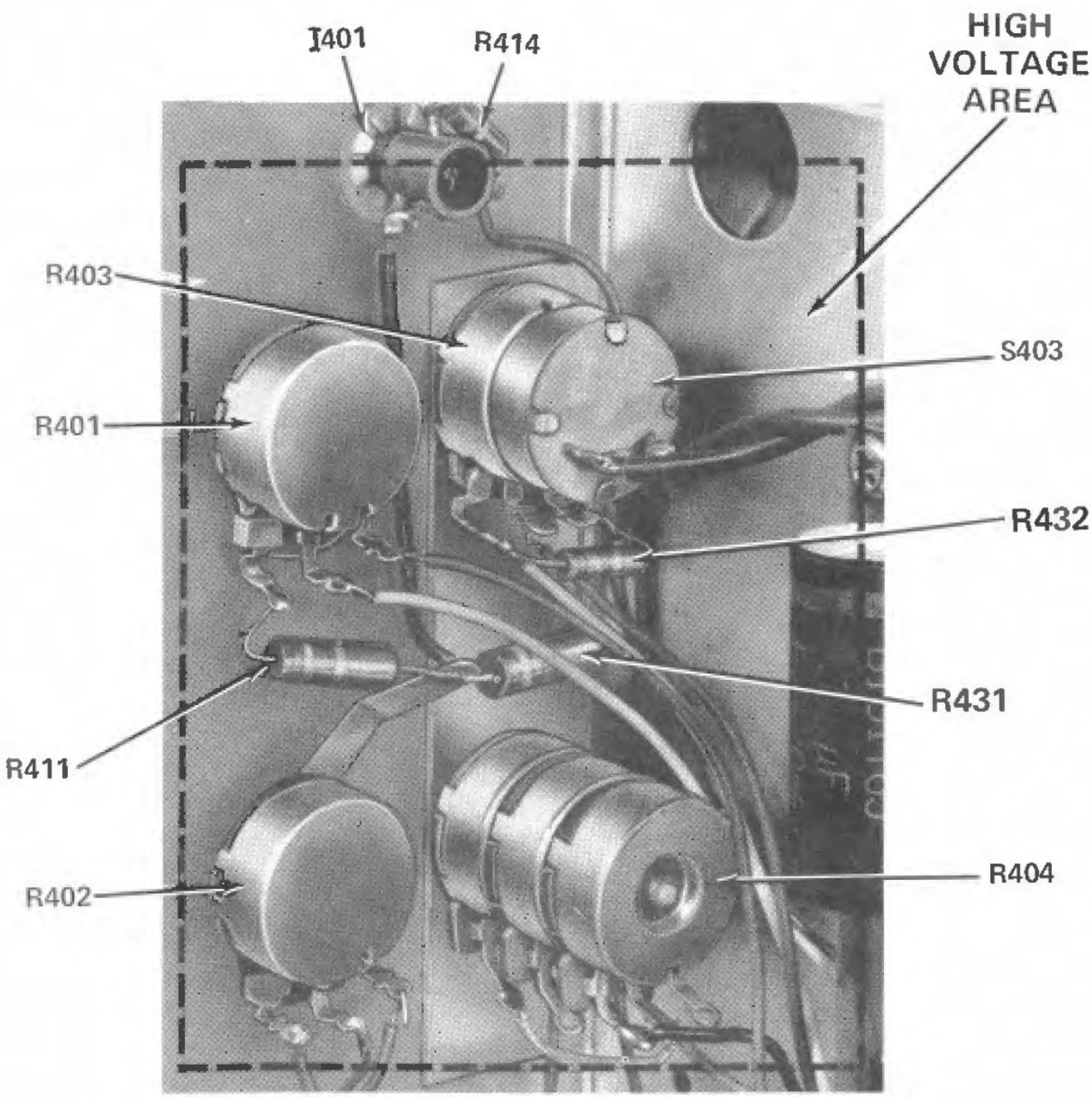


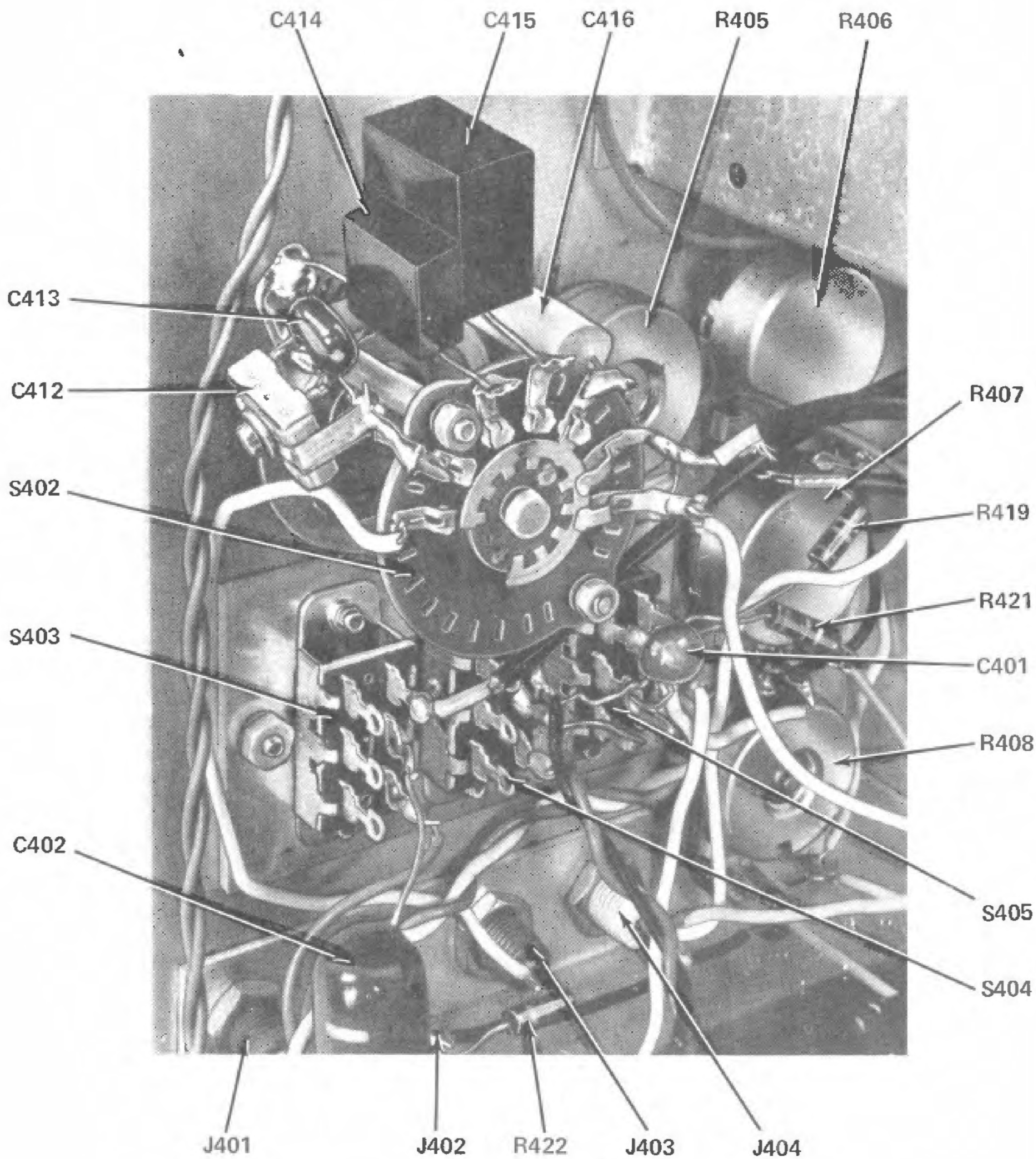
POWER SUPPLY CIRCUIT BOARD
(shown from component side)

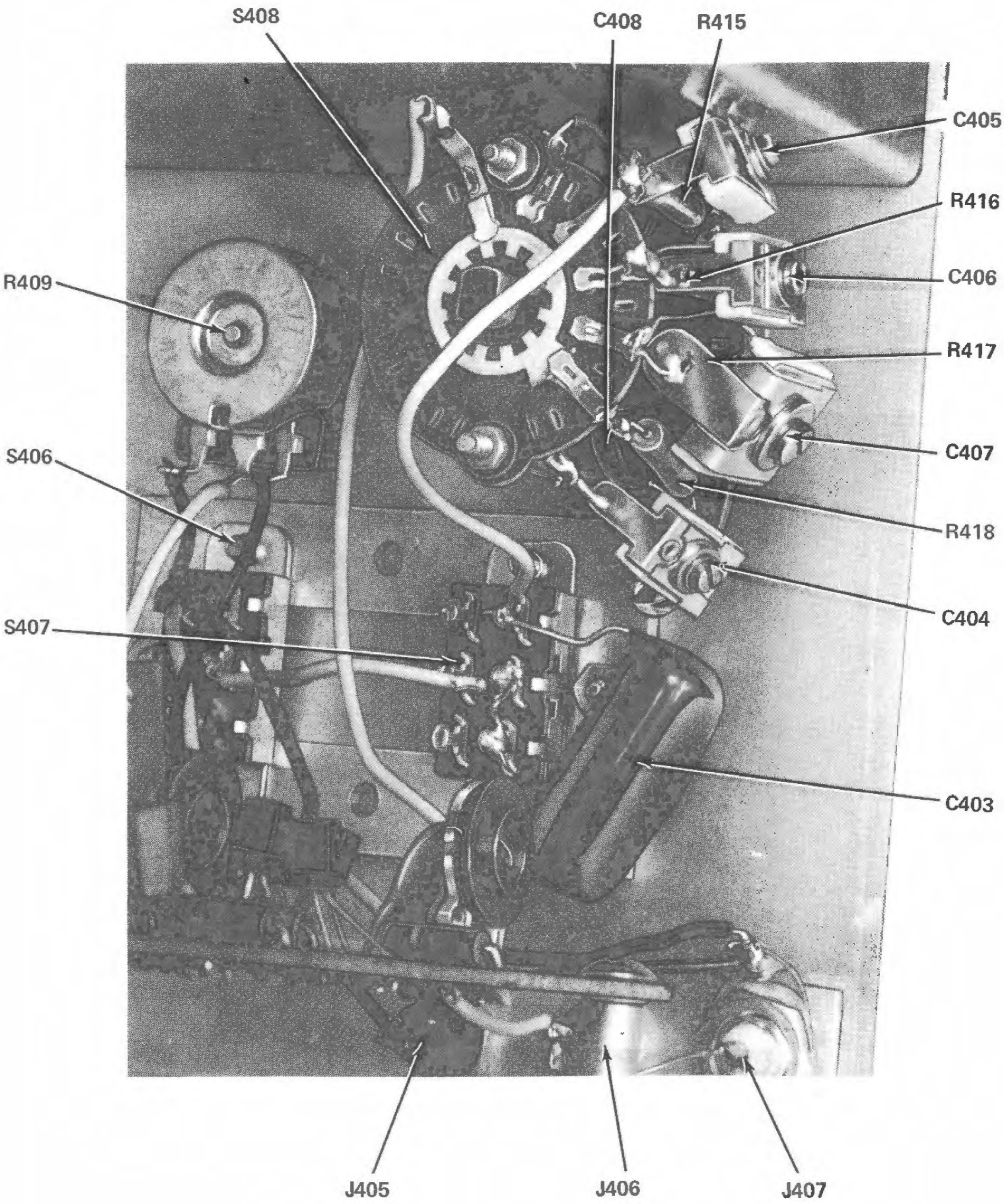


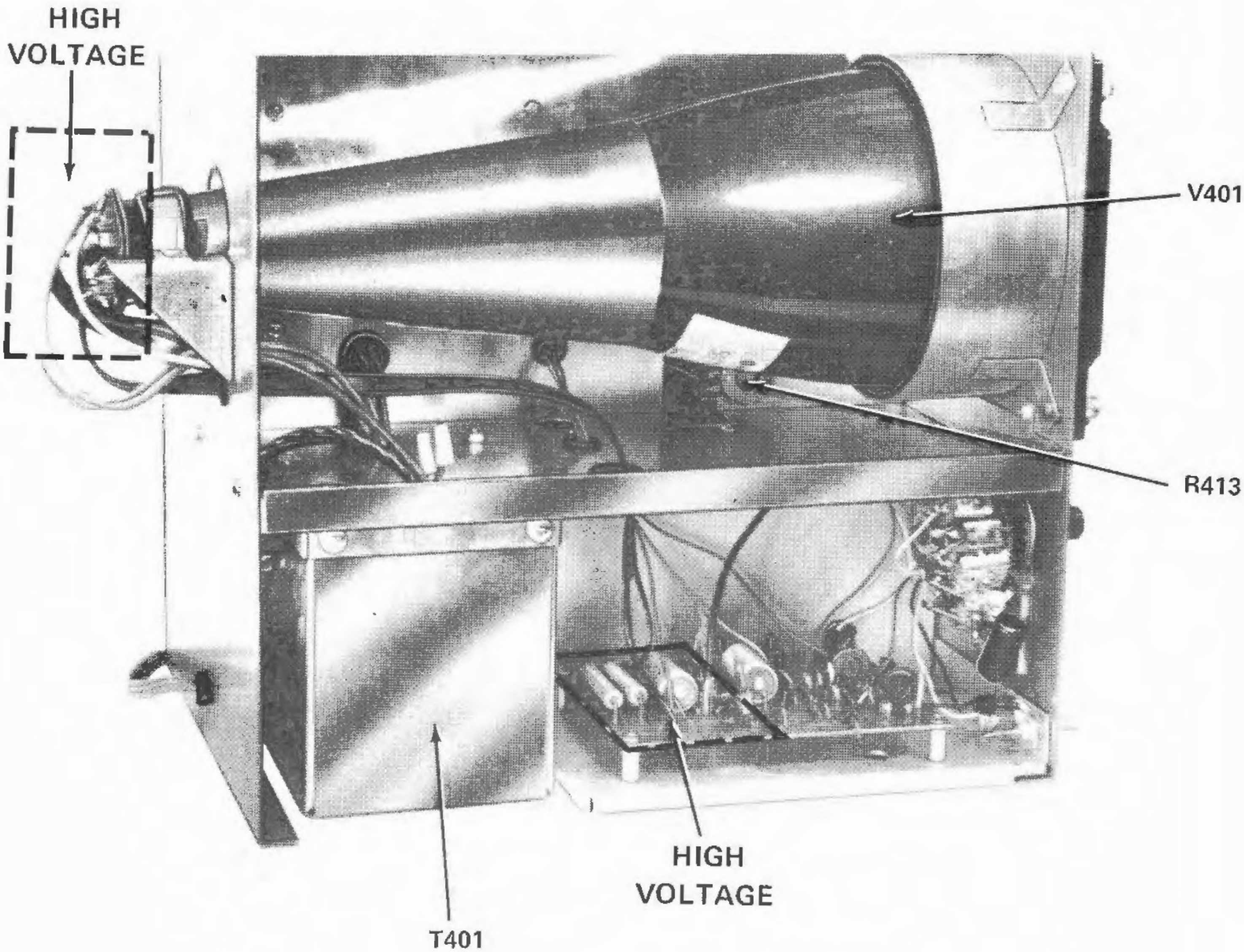
HORIZONTAL AMPLIFIER – SWEEP CIRCUIT BOARD
(shown from component side)

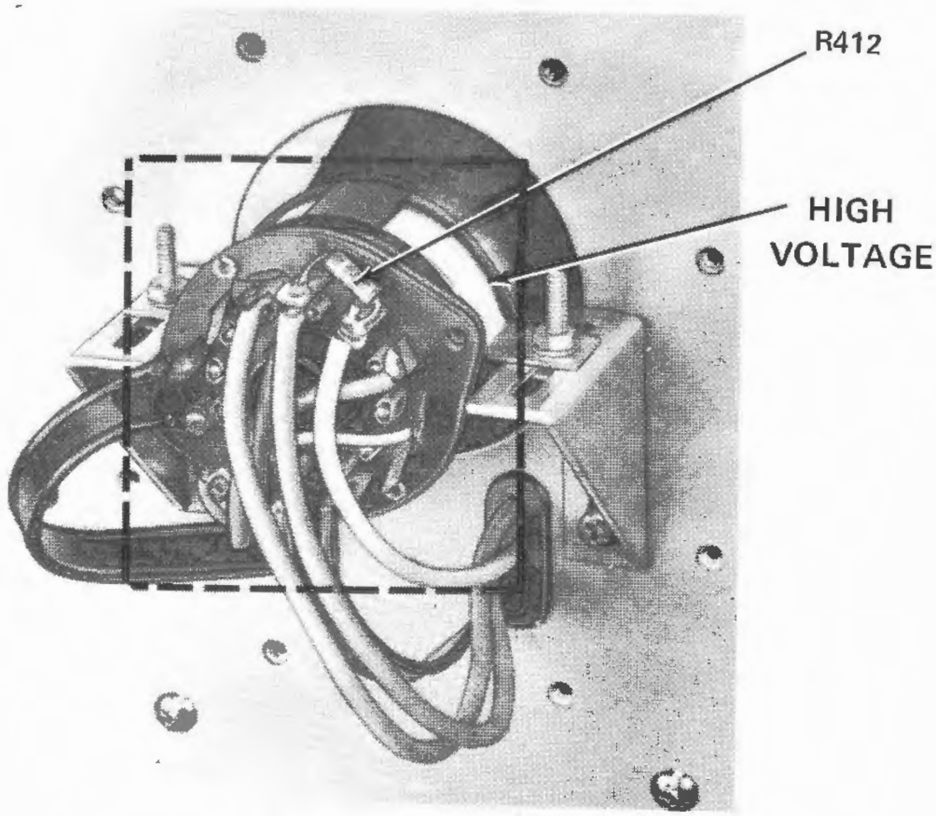
CHASSIS PHOTOGRAPHS

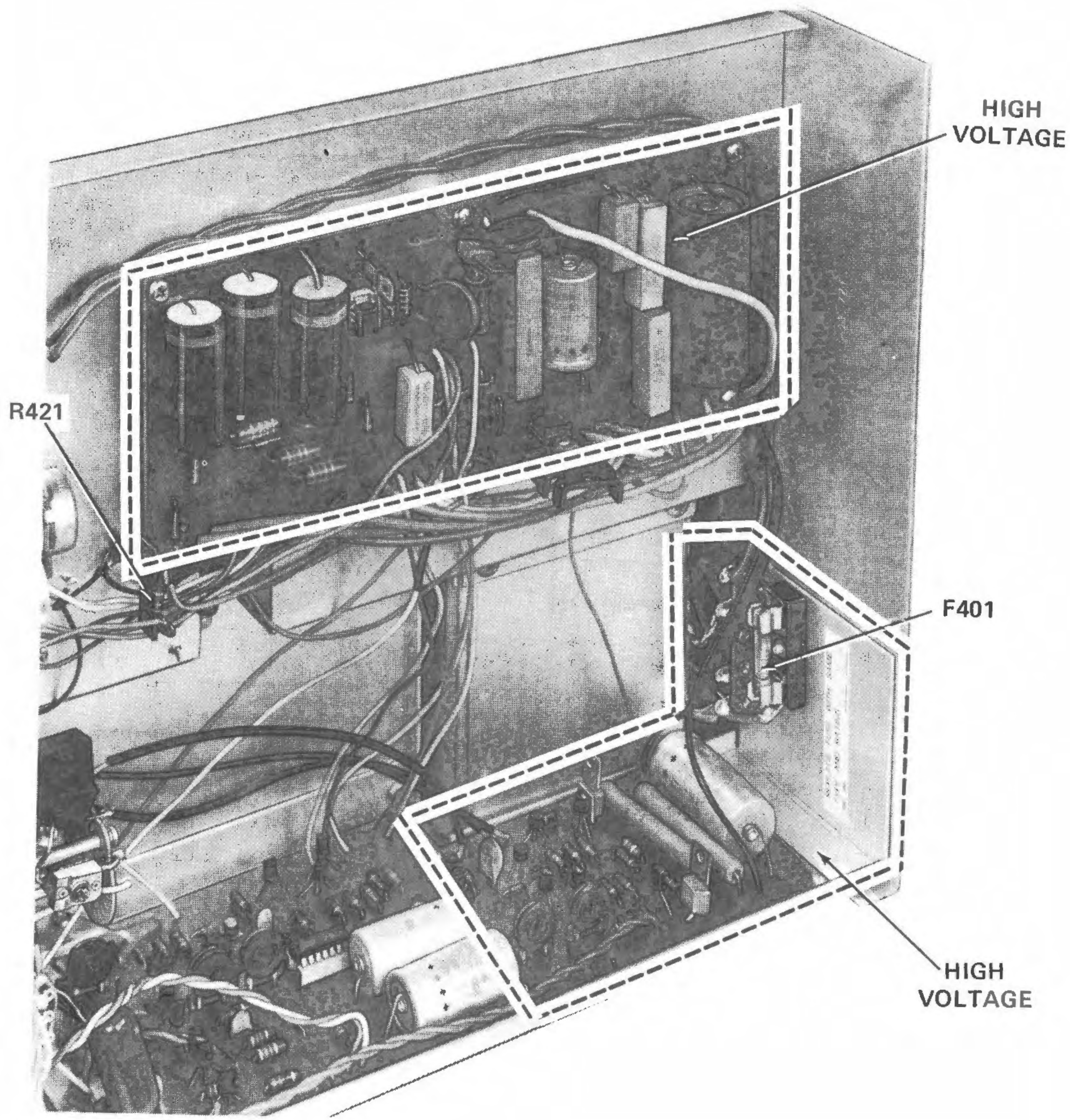



C414
C415
C416
R405
R406
C413
C412
R407
S402
R419
R421
S403
C401
R408
C402
S405
S404
J401
J402
R422
J403
J404


S408
C408
R415
C405
R416
R409
C406
R417
S406
C407
R418
C404
S407
C403
J405
J406
J407

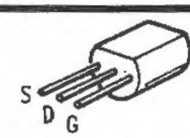
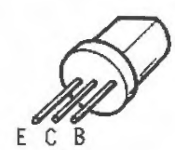
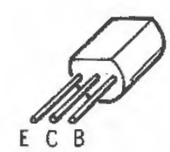
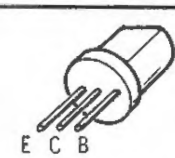
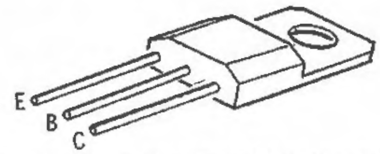
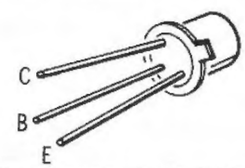
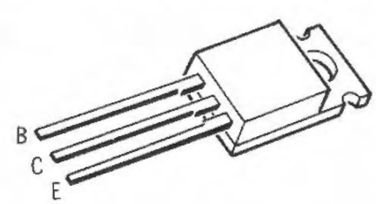

HIGH
VOLTAGE
V401
R413
HIGH
VOLTAGE
T401


R412
HIGH
VOLTAGE

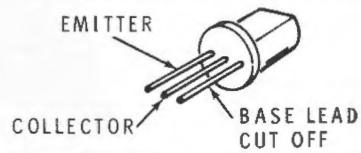
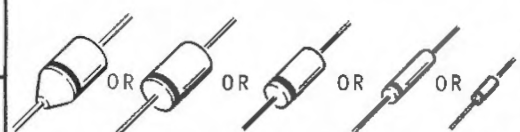

HIGH
VOLTAGE
R421
F401
HIGH
VOLTAGE

IDENTIFICATION CHARTS

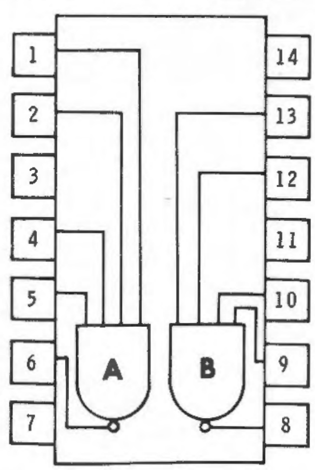
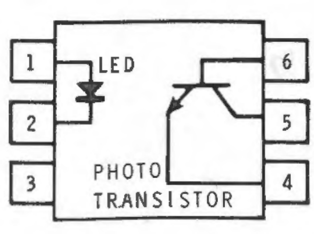
TRANSISTOR CROSS REFERENCE CHART

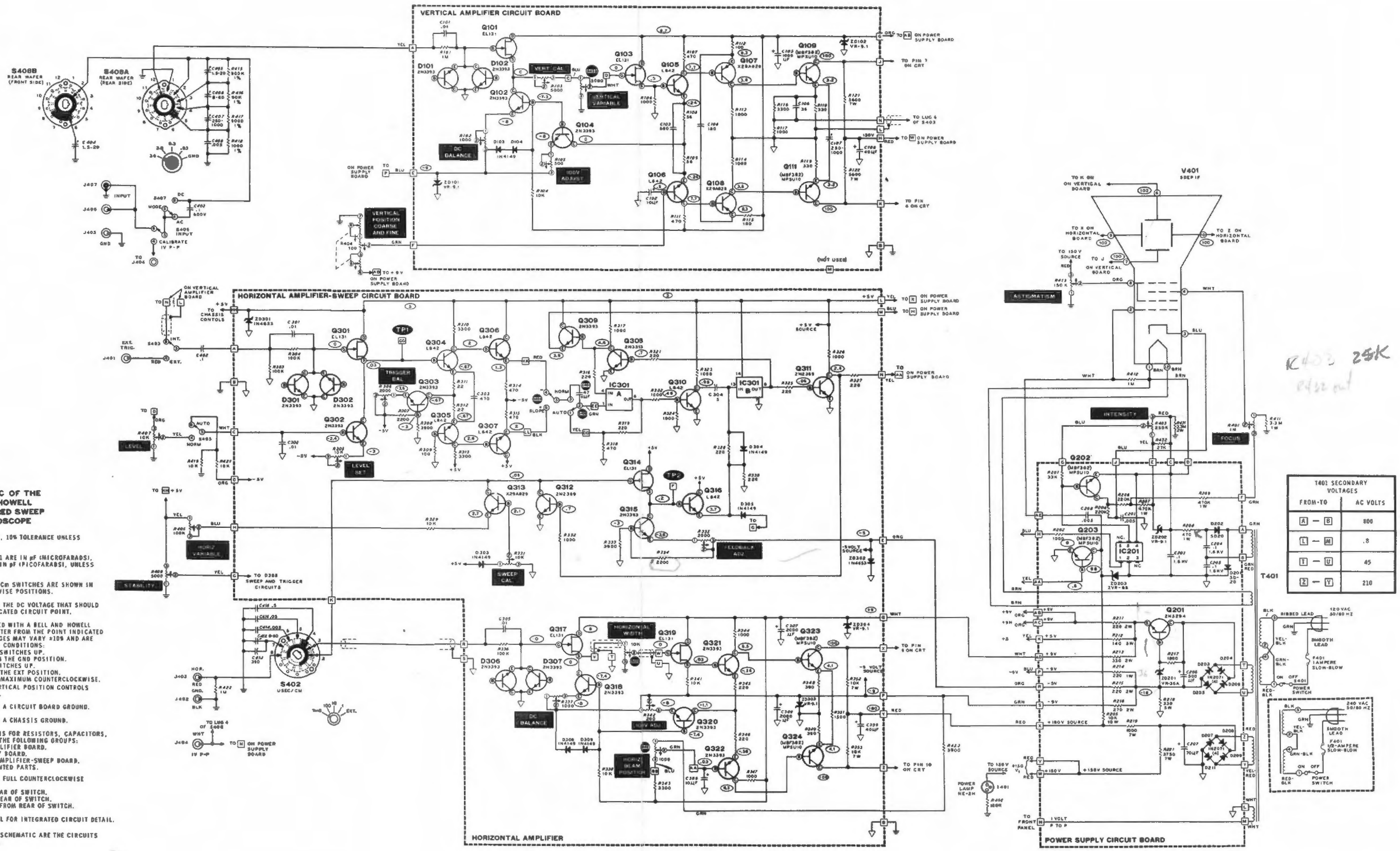
DESIGNATION	HEATH NUMBER	MANUFACTURER'S NUMBER	BASING DIAGRAM
Q101, Q103, Q301, Q314, Q317, Q319	417-241	EL131	
Q107, Q108, Q211, Q212, Q313, Q322	417-201	X29A829	 OR 
Q102, Q104, Q302, Q303, Q308, Q309, Q316, Q318, Q320, Q321, Q322	417-118	2N3393	
Q105, Q106, Q304, Q305, Q306, Q307, Q310, Q316	417-83	L842	
Q109, Q111, Q202, Q203, Q323, Q324	417-834	MPSU10 OR MBF382	
Q311, Q312	417-154	2N2369	
Q201	417-175	2N5294	

DIODE CROSS REFERENCE CHART

DESIGNATION	HEATH NUMBER	MANUFACTURER'S TYPE NUMBER	IDENTIFICATION
D101, D102, D301, D302, D306, D307	417-118	2N3393 (TRANSISTOR USED AS DIODE)	
D103, D104, D303, D304, D305, D308, D309	56-56	1N4149	
D201, D202	57-52	5D20	
D203, D204, D205, D206, D207, D208, D209, D211	57-27	1N2071	
ZD101, ZD102, ZD202, ZD303, ZD304	56-19	VR-9.1 (9.1VOLT, 25mA ZENER DIODE)	
ZD301, ZD302	56-44	1N4653 (4.6 VOLT, 53mA ZENER DIODE)	
ZD201	56-55	VR-36A (36VOLT, 4mA ZENER DIODE)	
ZD203	56-68	ZVR-68 (68 VOLT, 7 mA ZENER DIODE)	

IC CROSS REFERENCE CHART

DESIGNATION	PART NO.	MANUFACTURER'S TYPE NUMBER	CASE DIAGRAM
IC301	443-44	SN7413N	
IC201	443-631	TIL115	

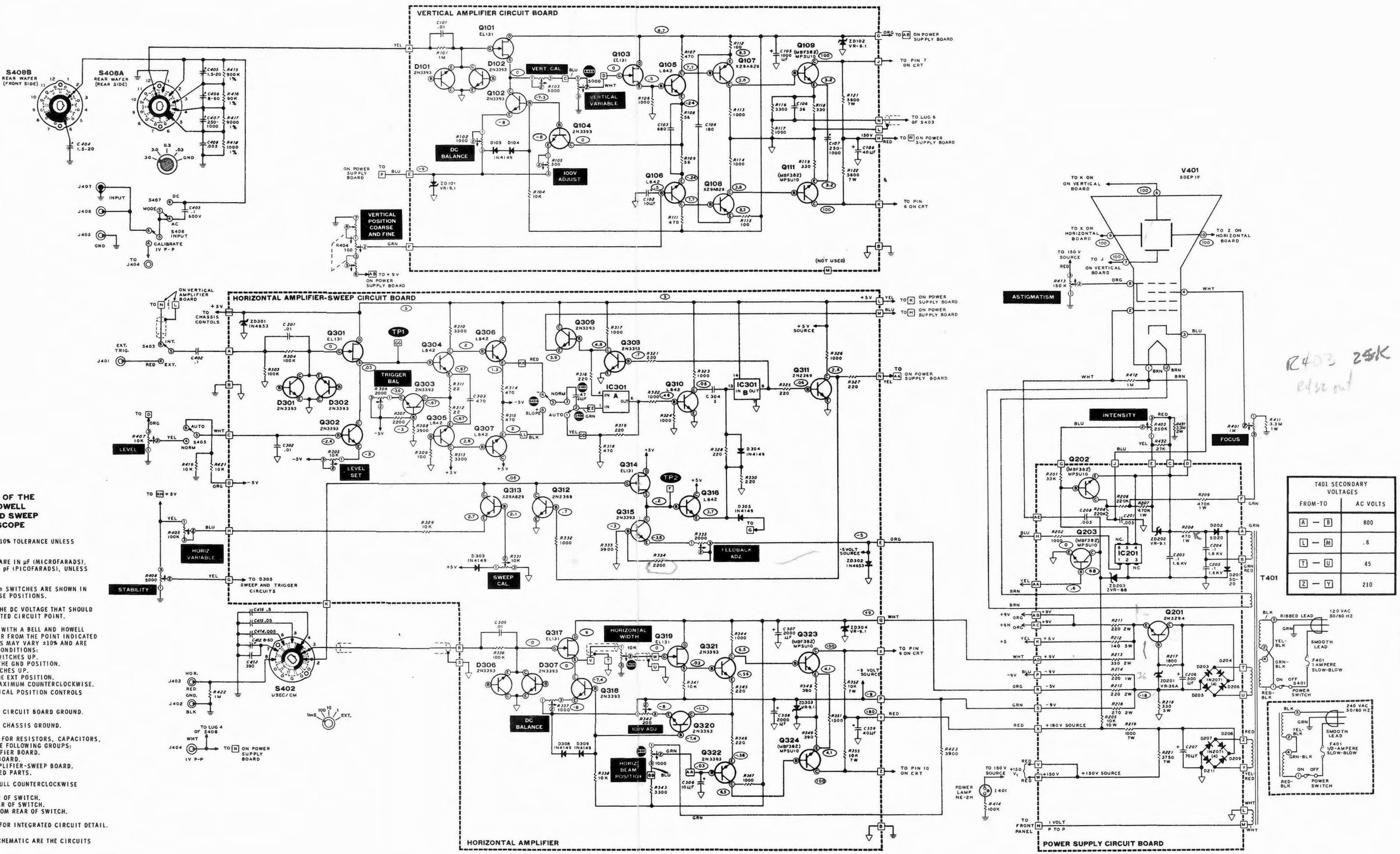


SCHEMATIC OF THE BELL & HOWELL 5" TRIGGERED SWEEP OSCILLOSCOPE

NOTES:

1. ALL RESISTORS ARE 1/2 WATT, 10% TOLERANCE UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS LESS THAN 1 ARE IN µF (MICROFARADS). ALL OTHER CAPACITORS ARE IN pF (PICOFARADS), UNLESS OTHERWISE NOTED.
3. THE VOLTS/Cm AND THE µSEC/Cm SWITCHES ARE SHOWN IN THEIR FULLY COUNTERCLOCKWISE POSITIONS.
4. ⬭ THIS SYMBOL INDICATES THE DC VOLTAGE THAT SHOULD BE PRESENT AT THE INDICATED CIRCUIT POINT.
5. ALL VOLTAGES WERE MEASURED WITH A BELL AND HOWELL DIGITAL MULTIMETER VOLTMETER FROM THE POINT INDICATED TO CHASSIS GROUND. VOLTAGES MAY VARY ±10% AND ARE TAKEN UNDER THE FOLLOWING CONDITIONS:
   A. ALL SWEEP TRIGGER SWITCHES UP.
   B. VOLTS/Cm SWITCH IN THE GND POSITION.
   C. MODE AND INPUT SWITCHES UP.
   D. µSEC/Cm SWITCH IN THE EXT POSITION.
   E. STABILITY CONTROL MAXIMUM COUNTERCLOCKWISE.
   F. HORIZONTAL AND VERTICAL POSITION CONTROLS CENTER OF ROTATION.
6. ▽ THIS SYMBOL INDICATES A CIRCUIT BOARD GROUND.
7. THIS SYMBOL INDICATES A CHASSIS GROUND.
8. LETTER-NUMBER DESIGNATIONS FOR RESISTORS, CAPACITORS, ETC., HAVE BEEN PLACED IN THE FOLLOWING GROUPS:
   100-199 VERTICAL AMPLIFIER BOARD.
   200-299 POWER SUPPLY BOARD.
   300-399 HORIZONTAL AMPLIFIER-SWEEP BOARD.
   400-499 CHASSIS MOUNTED PARTS.
9. ROTARY SWITCHES SHOWN IN FULL COUNTERCLOCKWISE POSITIONS.
   S402 WAFER VIEWED FROM REAR OF SWITCH.
   S408A WAFER VIEWED FROM REAR OF SWITCH.
   S408B WAFER X-RAY VIEWED FROM REAR OF SWITCH.
10. SEE PAGE 3-79 OF THE MANUAL FOR INTEGRATED CIRCUIT DETAIL.
11. UNSHADED PORTIONS OF THE SCHEMATIC ARE THE CIRCUITS ASSEMBLED IN THIS MANUAL.

T401 SECONDARY VOLTAGES	
FROM-TO	AC VOLTS
A — B	800
L — M	.8
T — U	45
Z — Y	210



T401 SECONDARY VOLTAGES	
FROM-TO	AC VOLTS
A — B	800
L — M	.8
T — U	45
Z — Y	210

SCHEMATIC OF THE BELL & HOWELL 5" TRIGGERED SWEEP OSCILLOSCOPE

NOTES:

1. ALL RESISTORS ARE 1/2 WATT, 10% TOLERANCE UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS LESS THAN 1 ARE IN µF (MICROFARADS), ALL OTHER CAPACITORS ARE IN pF (PICOFARADS), UNLESS OTHERWISE NOTED.
3. THE VOLTS/Cm AND THE µSEC/Cm SWITCHES ARE SHOWN IN THEIR FULLY COUNTERCLOCKWISE POSITIONS.
4. ⬭ THIS SYMBOL INDICATES THE DC VOLTAGE THAT SHOULD BE PRESENT AT THE INDICATED CIRCUIT POINT.
5. ALL VOLTAGES WERE MEASURED WITH A BELL AND HOWELL DIGITAL MULTIMETER VOLTMETER FROM THE POINT INDICATED TO CHASSIS GROUND. VOLTAGES MAY VARY ±10% AND ARE TAKEN UNDER THE FOLLOWING CONDITIONS:
   A. ALL SWEEP TRIGGER SWITCHES UP.
   B. VOLTS/Cm SWITCH IN THE GND POSITION.
   C. MODE AND INPUT SWITCHES UP.
   D. µSEC/Cm SWITCH IN THE EXT POSITION.
   E. STABILITY CONTROL MAXIMUM COUNTERCLOCKWISE.
   F. HORIZONTAL AND VERTICAL POSITION CONTROLS CENTER OF ROTATION.
6. ▽ THIS SYMBOL INDICATES A CIRCUIT BOARD GROUND.
7. ⏚ THIS SYMBOL INDICATES A CHASSIS GROUND.
8. LETTER-NUMBER DESIGNATIONS FOR RESISTORS, CAPACITORS, ETC., HAVE BEEN PLACED IN THE FOLLOWING GROUPS:
   100-199 VERTICAL AMPLIFIER BOARD.
   200-299 POWER SUPPLY BOARD.
   300-399 HORIZONTAL AMPLIFIER-SWEEP BOARD.
   400-499 CHASSIS MOUNTED PARTS.
9. ROTARY SWITCHES SHOWN IN FULL COUNTERCLOCKWISE POSITIONS.
   S402 WAFER VIEWED FROM REAR OF SWITCH.
   S408A WAFER VIEWED FROM REAR OF SWITCH.
   S408B WAFER X-RAY VIEWED FROM REAR OF SWITCH.
10. SEE PAGE 3-79 OF THE MANUAL FOR INTEGRATED CIRCUIT DETAIL.
11. UNSHADED PORTIONS OF THE SCHEMATIC ARE THE CIRCUITS ASSEMBLED IN THIS MANUAL.