1782A

HEWLETT-PACKARD COMPANY / OPERATING AND SERVICE MANUAL

1782A

DISPLAY SCANNER

1782A

OPERATING AND SERVICE MANUAL

MODEL 1782A

SERIALS PREFIXED: 305-

DISPLAY SCANNER

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IMPORTANT

Some Model 175A Oscilloscopes with serial prefixes below 305- require modification in order to operate the Model 1782A Display Scanner. Please contact your nearest Hewlett-Packard representative for information regarding the changes.

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Figure 1-1. Model 1782A Display Scanner

SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Model 1782A Display Scanner provides outputs necessary to drive X-Y recorders so that the waveform displayed on the screen of Model 175A Oscilloscope may be reproduced. Automatic scan and pen control are provided, with manual reset. Horizontal and vertical amplitude may be adjusted independently of zero. The effective bandwidth of the scanner is 30 mc. Through the use of sampling techniques, the Model 1782A transforms high-speed phenomena to the bandwidth of conventional X-Y recorders such as the F. L. Moseley 3S or 2D. Sampling density is high enough to give a continuous presentation on the X-Y recorder.

1-3. PEN STABILIZER.

1-4. An electronic pen stabilizer circuit provides a nearly constant writing rate to the recorder so that fast pulses may be recorded faithfully in a minimum of time. The pen stabilizer slows the horizontal pen speed during vertical deflection so that fast rise and fall time may be recorded in detail. When there is no vertical deflection, the stabilizer increases horizontal pen speed to reduce scanning time.

1-5. MARKER.

1-6. With each sweep of the trace on the screen of the oscilloscope, the Model 1782A samples the amplitude of the waveform at a single point and intensifies the trace beyond that point. Therefore the start of the intensified trace forms a marker which indicates the point being sampled at any particular instant.

1-7. DIGITAL RECORDING.

1-8. The Model 1782A may be used with auxiliary equipment to digitize the CRT display. By applying the appropriate external scanning signal, the desired portion of the trace can be scanned either once or repeatedly, and the output reduced to digital form for recording or analysis. For example, an entire pulse train or a single pulse can be continuously monitored and the results permanently recorded in digital form.

1-9. SERIAL-NUMBER SYSTEM.

1-10. Hewlett-Packard instruments carry a two-section eight-digit serial number (000-00000). The first three digits are the serial prefix. If the serial prefix on your instrument does not agree with that shown on the title page of this manual, change sheets included with this manual will describe the difference between the manual and your instrument. If the serial prefix on your instrument is not mentioned in the change sheets, obtain correct information through your Hewlett-Packard representative.

Table 1-1. Specifications

VERTICAL OUTPUT:	200 mv/cm. Amplitude and dc level are independently adjustable.
HORIZONTAL OUTPUT:	Level: Adjustable to 0 v Amplitude: Adjustable from 0 to +15 v
BANDWIDTH:	Greater than 30 mc when installed in the Model 175A Oscilloscope with a 40-mc vertical plug-in.
SCANNING:	Manual, internal (with pen speed either stabilized or linear), or external (scan voltage approximately 0 to +15 volts).
SCANNING TIME:	Internal, linear: approximately 1-1/2 minutes. Internal, with pen speed stabilized: approximately 20 seconds when displaying time base only. Maximum external scan rate, 1 kc.
OSCILLOSCOPE SWEEP SPEED:	From fastest sweep time down to 5 msec/cm at signal repetition rates of 20 cps or greater.
REMOTE PEN LIFT:	Contact opening provided to lift X-Y recorder pen from paper when switching from RECORD to ARM RECORDER.
POWER:	Supplied by the Model 175A Oscilloscope.
WEIGHT:	Net 5 lb

SECTION II
PREPARATION FOR USE

2-1. INCOMING INSPECTION.

2-2. MECHANICAL INSPECTION.

2-3. Upon receipt of your Model 1782A, inspect the instrument for any obvious damage received in transit. If damage is evident, file claim with the carrier (see the Warranty Sheet at the rear of this manual).

2-4. PERFORMANCE CHECK.

2-5. Refer to section V of this manual for a series of checks which may be made to assure that the instrument is operating within specifications.

2-6. POWER REQUIREMENT.

2-7. All power for the Model 1782A is supplied automatically when the instrument is plugged into its compartment in the Model 175A Oscilloscope. Tighten the lock screw to assure firm electrical contact.

2-8. REPACKAGING FOR SHIPMENT.

2-9. To repack the Model 1782A for shipment, always use the best packing methods available. If the original container with its packing pads and fillers is not on hand, these materials may be obtained from the factory through your nearest Hewlett-Packard representative. The following steps are a general guide for proper packing:

a. Wrap the instrument in heavy paper or plastic.

b. Protect the panel with cardboard strips.

c. Use a strong cardboard or wooden box.

d. Use ample packing material around all sides, top and bottom of the instrument.

e. Seal with heavy tape or metal bands.

f. Mark packing box with "FRAGILE - DELICATE INSTRUMENT".

SECTION III
OPERATION

3-1. CONTROLS AND TERMINALS.

3-2. The Model 1782A Display Scanner fits into the horizontal plug-in compartment of the Model 175A Oscilloscope. The Display Scanner uses sampling techniques to scan the display on the CRT of the oscilloscope, and produce a low-frequency replica of the waveform suitable for driving a recorder. The horizontal output of the Scanner is proportional to the position of the sampled point on the waveform, and the vertical output is proportional to the amplitude at the sampled point. A marker (start of intensified trace) indicates the point being sampled at any instant. Figure 3-1 shows the controls of the Model 1782A. Operation of the Model 175A Oscilloscope and its vertical plug-in units is described in the manuals for those instruments.

3-3. FUNCTION SWITCH.

3-4. FUNCTION controls the output of the Model 1782A. It may be set to OFF, ARM RECORDER, or RECORD.

3-5. In the OFF position, internal circuits are disabled and no output is delivered to the VERT and HORIZ OUTPUT terminals.

3-6. The ARM RECORDER position returns the marker to the start of the trace (when scanning is in LINEAR or STABILIZED) and arms the internal ramp generator, preparing it to scan the CRT display.

3-7. The RECORD position lowers the pen on the X-Y chart and starts the linear or stabilized scan.

3-8. SCANNING SWITCH.

3-9. SCANNING selects the mode of operation of the Display Scanner. There are four positions: MANUAL, LINEAR, STABILIZED, and EXTERNAL. SCANNING and MANUAL SCAN are concentric controls, the inner knob being MANUAL SCAN.

a. In MANUAL the scan generator of the Model 1782A is disconnected and the sampling point may be selected by means of the MANUAL SCAN control.

b. In LINEAR the sampled point moves across the CRT at a constant horizontal rate, and horizontal output varies from 0 to approximately +15 volts at a constant rate. Although about 90 seconds is allowed for full scan in LINEAR the speed may be too fast to allow a recorder to follow sharp vertical deflections in the trace.

c. In STABILIZED, horizontal movement of the sampled point is decreased in proportion to the slope of the trace. Scan time for a straight-line trace is about 20 seconds. STABILIZED improves the fidelity of reproduction on an X-Y recorder by holding the pen speed almost constant.

d. EXTERNAL allows the use of an external scan voltage, connected to the EXTERNAL INPUT terminal.

3-10. RECORDER CHARACTERISTICS.

3-11. X-Y RECORDERS.

3-12. Almost any X-Y recorder will function with the Model 1782A Display Scanner. Maximum vertical output is at least 200 mv per centimeter of deflection on the CRT. Maximum horizontal output is from 0 to approximately +15 volts at full horizontal deflection on the CRT. Both are adjustable.

3-13. STRIP-CHART RECORDERS.

3-14. The Model 1782A may be used with strip-chart recorders. However, there are some limitations.

a. Only LINEAR, MANUAL, or EXTERNAL scan can be used. The recorder is motor-driven, therefore a linear scan is required.

b. Unless the recorder has a speed which will spread the display over a satisfactory length in 90 seconds, external scan should be used, obtaining the scan voltage from a sawtooth generator or from the recorder.

c. Horizontal calibration is not as convenient with the strip-chart recorder as with the X-Y recorder. Either the motor speed must be variable, or a variable external scan voltage must be used.

3-15. OPERATING INSTRUCTIONS.

3-16. As explained in paragraph 1-5, the Model 1782A Display Scanner samples the waveform on the screen of the CRT at one point on each sweep, then intensifies the remainder of that sweep. The start of the intensified portion is the marker that indicates the sampled point at any moment. Set oscilloscope INTENSITY for best contrast between the blanked part and the intensified part of the sweep.

3-17. With FUNCTION in LINEAR or STABILIZED, the sampled point advances along the display automatically, and the sampled voltage is retained by the Display Scanner until the next sample is taken. However, there is a practical limit to the length of time the sampled voltage can be retained. As the oscilloscope is switched to slower sweep speeds the time between samples increases. The slowest speed at which a smooth recording can be made is 5 msec/cm. The signal repetition rate (synchronizing the oscilloscope) must be at least 20 cps.

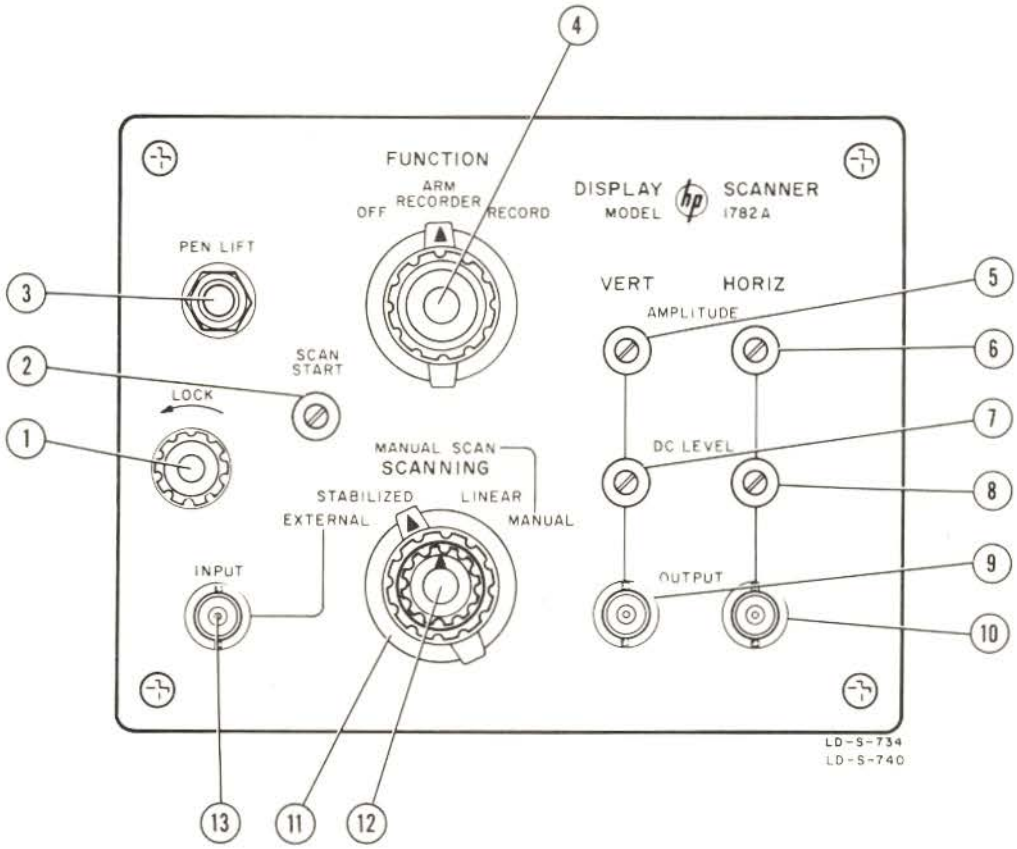
3-18. EXTERNAL SCAN. Scan times much faster than 90 seconds may be used, so long as the recording device is capable of following the vertical output voltage. The maximum external scan rate is 1 kc. The ratio of scan time to oscilloscope sweep time must be kept high enough to produce a smooth output.

3-19. PRELIMINARY ADJUSTMENTS.

3-20. There are five screwdriver adjustments on the front panel of the Model 1782A. These are VERT DC LEVEL, HORIZ DC LEVEL, VERT AMPLITUDE, HORIZ AMPLITUDE, and SCAN START. The procedure for setting these controls is given in figure 3-2.

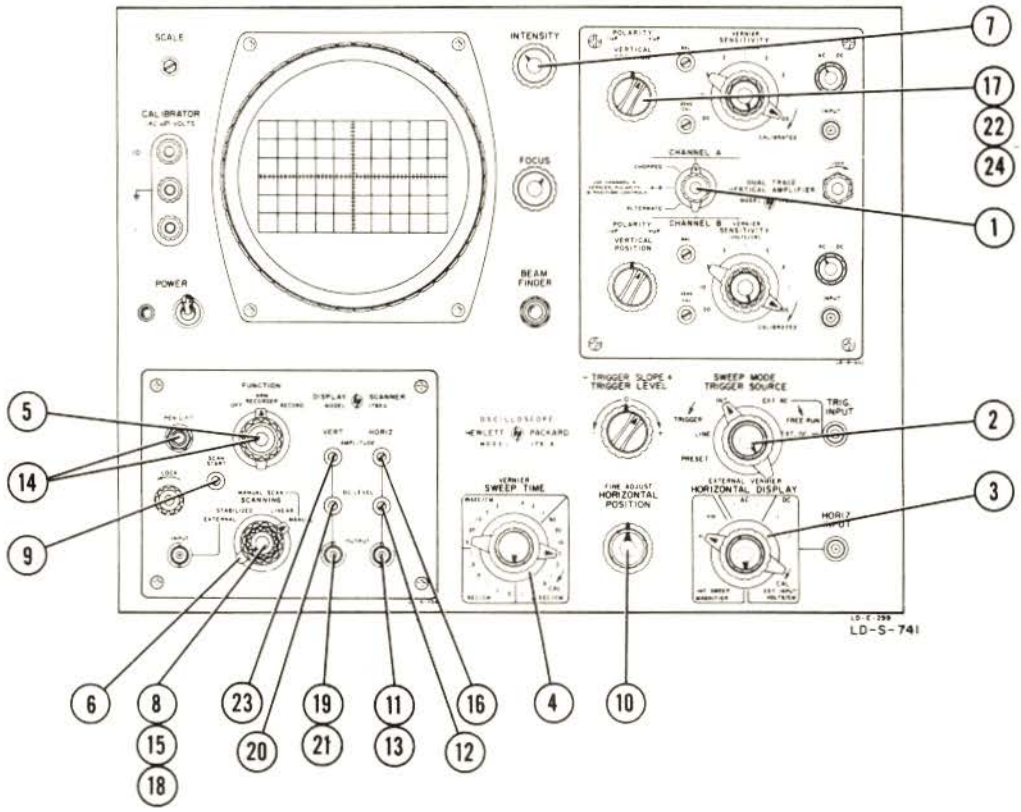
3-21. STEP-BY-STEP PROCEDURES.

3-22. Figures 3-2 through 3-5 give step-by-step instructions for operating the Model 1782A Display Scanner. The circled numbers refer to the text below each diagram.



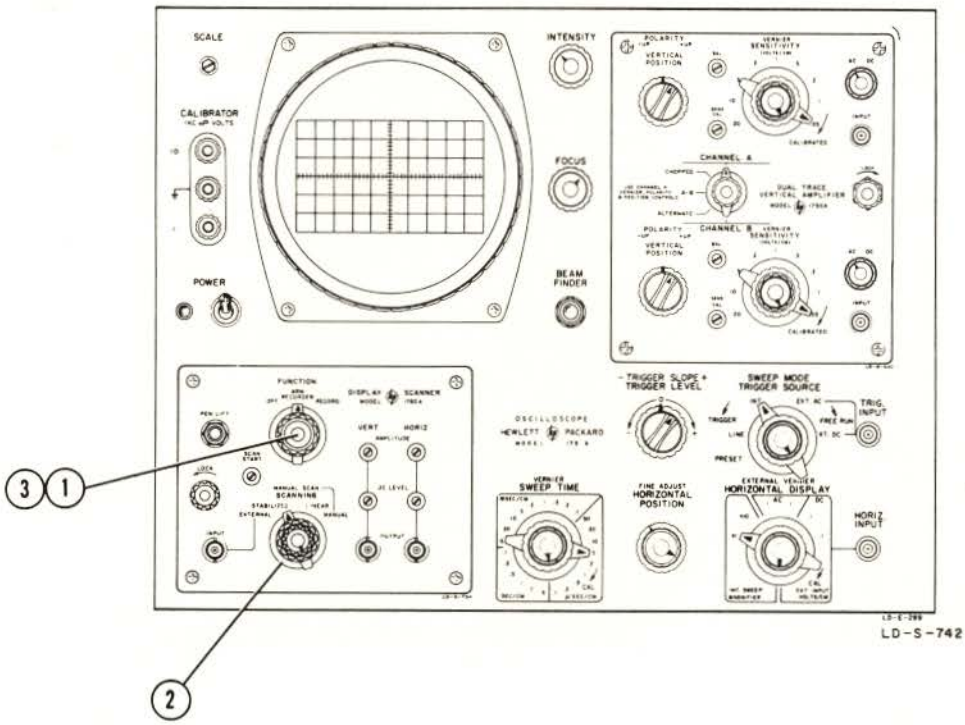
1. LOCK. Secures the instrument in its compartment.
2. SCAN START. On all internal positions of the SCANNING switch, SCAN START sets the point on the CRT trace at which the first sample is taken.
3. PEN LIFT. An insulated phone-jack terminal connected internally to the FUNCTION switch; the circuit closes when FUNCTION is in RECORD.
4. FUNCTION. Controls the scanning cycle. In OFF, no output is delivered to the recorder; ARM RECORDER returns the pen to the left-hand side of the X-Y chart; RECORD starts the pen moving across the chart.
5. VERT AMPLITUDE. Adjusts the vertical output between 0 and at least 200 mv/cm.
6. HORIZ AMPLITUDE. Adjusts horizontal output between 0 and approximately +15 volts for 10 cm of scan.
7. VERT DC LEVEL. Sets vertical zero to any point on the visible trace.
8. HORIZ DC LEVEL. On all internal positions of the SCANNING switch HORIZ DC LEVEL sets horizontal zero. It has no effect when SCANNING is in EXTERNAL.
9. VERT OUTPUT. Supplies output proportional to the amplitude of the scanned signal at the sampling point. Maximum output is at least 200 mv per centimeter of trace on the crt.
10. HORIZ OUTPUT. Supplies X-axis signal to X-Y recorder. Output can be set to zero volts for zero centimeters, approximately +15 volts for 10 centimeters.
11. SCANNING. Controls horizontal movement of the sampling point on the CRT. In MANUAL the point sampled is set by MANUAL SCAN. In LINEAR the sampling point moves from left to right across the CRT at a constant horizontal velocity regardless of vertical deflection. In STABILIZED horizontal velocity decreases as the slope of the trace increases (positive or negative). EXTERNAL allows the use of an external scan voltage.
12. MANUAL SCAN. Provides manual control when SCANNING is in MANUAL.
13. EXTERNAL INPUT. Connector for the external scan voltage. An input of 0 to +15 volts will result in a HORIZ OUTPUT of approximately +50 to -50 volts.

Figure 3-1. Model 1782A Controls and Terminals



1. Vertical Presentation to Channel A.
2. SWEEP MODE to FREE RUN.
3. HORIZONTAL DISPLAY to X1.
4. SWEEP TIME to 5 μSEC/CM.
5. FUNCTION to ARM RECORDER.
6. SCANNING to MANUAL.
7. Adjust INTENSITY for good contrast at marker (start of intensified trace).
8. Set MANUAL SCAN fully counterclockwise.
9. Adjust SCAN START so that marker is 2 mm from start of trace.
10. Set HORIZONTAL POSITION to place marker at left line of graticule.
11. Connect 1% voltmeter to HORIZ OUTPUT.
12. Adjust HORIZ DC LEVEL for a voltmeter reading of 0 volts.
13. Connect HORIZ OUTPUT to recorder X-input. Set recorder X sensitivity to 10 volts for full horizontal scan, and set X zero to place pen at left line of chart.
14. Connect PEN LIFT to recorder remote pen-lift connector. (To place a mark on the chart, switch FUNCTION to RECORD. To lift the pen, switch back to ARM RECORDER.)
15. Rotate MANUAL SCAN clockwise until marker coincides with right-hand line of graticule; the recorder pen will move to the right.
16. Adjust HORIZ AMPLITUDE to place pen at right-hand of chart.
17. Set VERTICAL POSITION to center trace.
18. Set MANUAL SCAN to place marker at center of graticule.
19. Connect 1% voltmeter to VERT OUTPUT.
20. Set VERT DC LEVEL for a voltmeter reading of 0 volts.
21. Connect VERT OUTPUT to Y input of recorder. Set recorder Y sensitivity to between 100 and 200 mv/major-division on the chart. Set recorder Y zero to place pen at third major division from bottom of chart.
22. Set VERTICAL POSITION to place marker on bottom line of graticule.
23. Adjust VERT AMPLITUDE to place pen on bottom line of chart.
24. Rotate VERTICAL POSITION clockwise until marker coincides with top line of graticule; the recorder pen will move upward to the sixth major division of the chart.

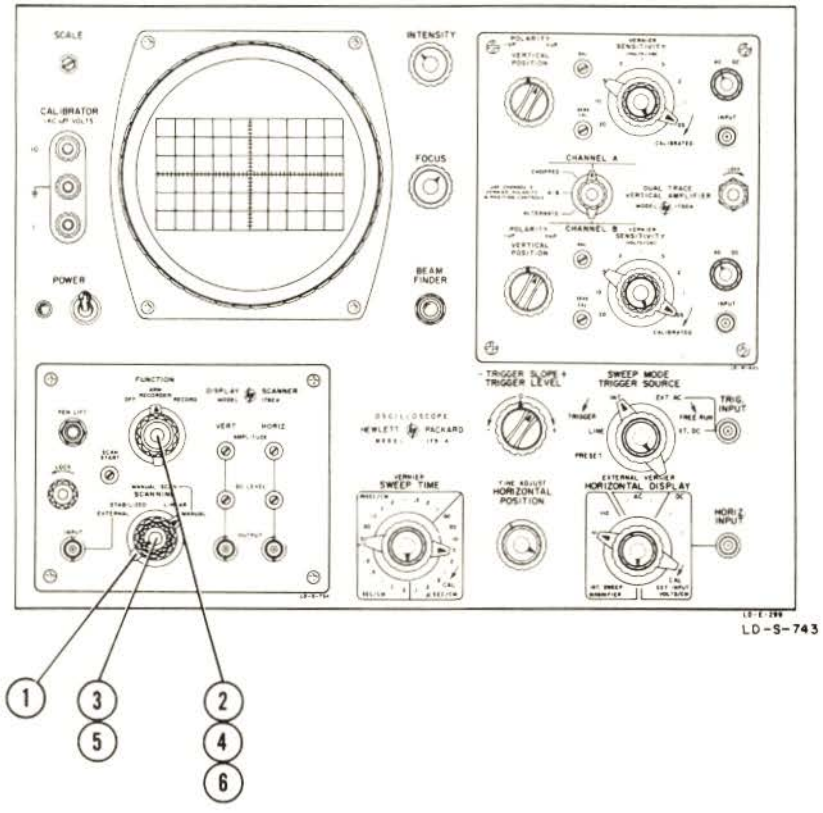
Figure 3-2. Recorder Calibration



Calibrate recorder. See figure 3-2.

1. Set FUNCTION to ARM RECORDER.
2. Set SCANNING to LINEAR or STABILIZED.
3. Set FUNCTION to RECORD.

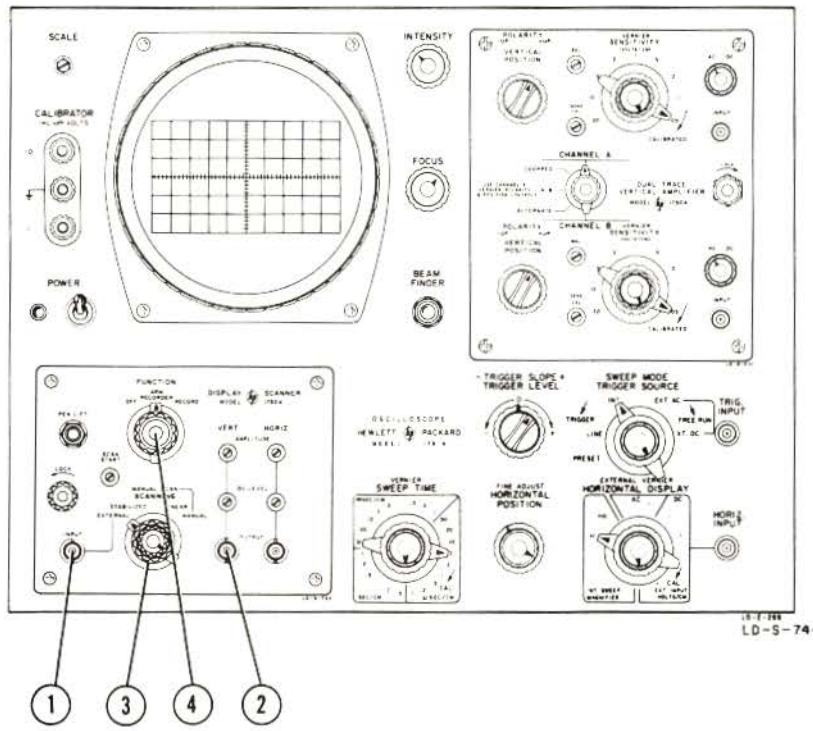
Figure 3-3. Automatic Scanning



Calibrate recorder. See figure 3-2.

1. Set SCANNING to MANUAL.
2. Set FUNCTION to ARM RECORDER to raise pen.
3. Rotate MANUAL SCAN to position pen at desired starting point.
4. Set FUNCTION to RECORD to lower pen.
5. Rotate MANUAL SCAN to record the display.
6. Set FUNCTION to ARM RECORDER to lift pen.

Figure 3-4. Manual Scanning



If an X-Y recording is to be made, calibrate recorder. See figure 3-2.

1. Connect external scan voltage to INPUT.
2. Connect VERT OUTPUT to input of recording device.
3. Set SCANNING to EXTERNAL.
4. Set FUNCTION to ARM RECORDER or RECORD. If an X-Y recording is to be made, select RECORD to lower pen.

Figure 3-5. External Scanning

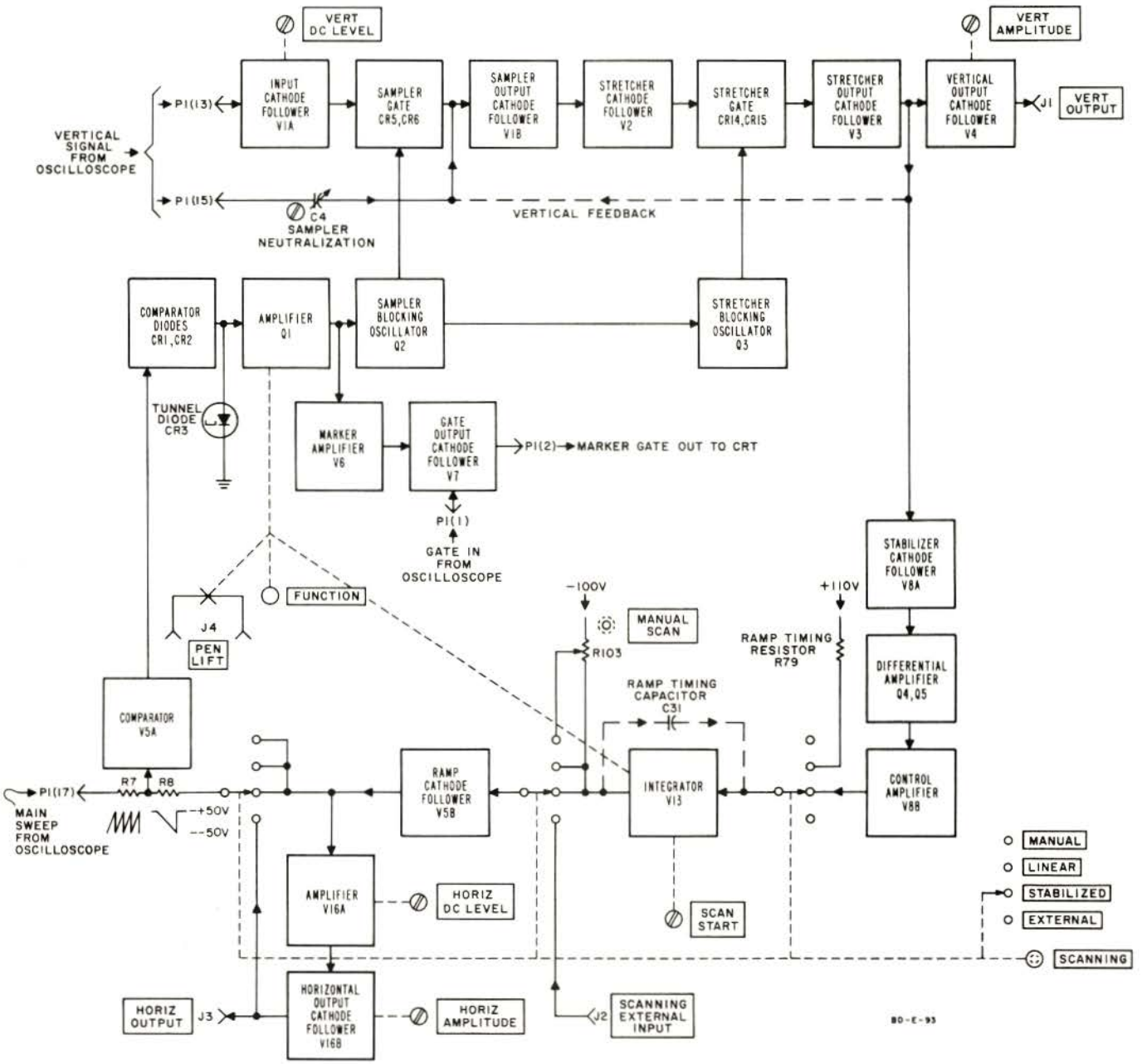


Figure 4-1. Model 1782A Overall Block Diagram

SECTION IV
PRINCIPLES OF OPERATION

4-1. OVER-ALL FUNCTIONAL DESCRIPTION.

4-2. The Model 1782A Display Scanner uses sampling techniques to reproduce the waveform seen on the screen of the Model 175A Oscilloscope. The vertical deflection voltage of the oscilloscope is sampled once during each sweep, the sampling point being determined by the scan voltage of Model 1782A. With the SCANNING switch set to LINEAR or STABILIZED, the sampling point moves progressively across the screen, each sample being taken slightly to the right of the previous one until the entire display has been scanned. The Scanner produces a vertical output voltage proportional to the amplitude of the waveform at the sampling point, and a horizontal output voltage proportional to the horizontal position of the sampling point.

4-3. Figure 4-1 shows a block diagram of the Model 1782A. A simplified diagram is shown in figure 4-2. The vertical signal from the oscilloscope is fed through input cathode-follower V1A to the sampler gate. The time at which the sampler gate opens is controlled by the ramp voltage from integrator V13. The integrator generates a slowly falling ramp voltage which is compared to the rising oscilloscope sweep voltage by comparator V5A. Each time these two voltages of opposite polarity approximately equal each other, the output of V5A passes through zero and sampler blocking oscillator Q2 generates a pulse which opens the sampler gate. At the same time, stretcher blocking oscillator Q3 opens the stretcher gate. The stretcher circuit adjusts to the signal and retains this level until the next sample is taken. The output of the stretcher circuit is fed to the vertical output terminal.

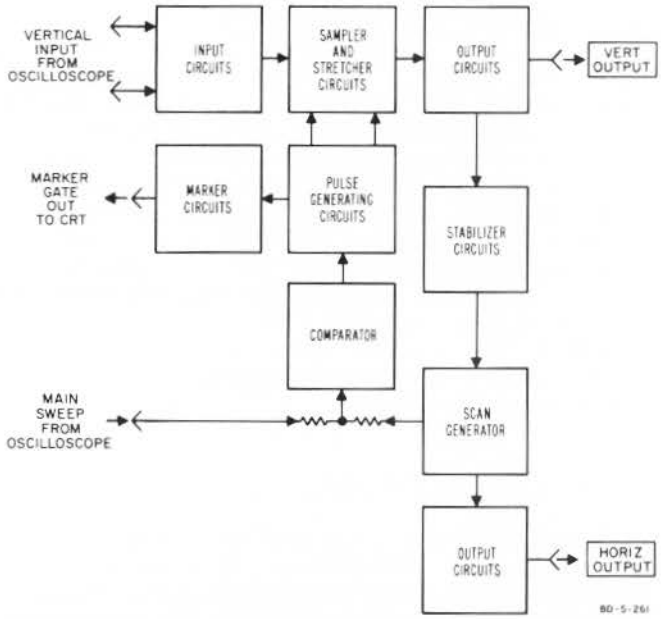


Figure 4-2. Model 1782A Simplified Block Diagram

4-4. Feedback through the stabilizer circuit controls the ramp speed when SCANNING is at STABILIZED. The ramp itself is attenuated, inverted, and fed to the horizontal output terminal. The gate which triggers the sampler blocking oscillator is also fed to marker amplifier V6 and cathode follower V7 where it is mixed with the main intensification gate from the oscilloscope to intensify the trace on the CRT after each sample is taken.

4-5. Figure 4-1 indicates the arrangement of the SCANNING switch.

a. In LINEAR, integrator V13 is controlled by voltage through ramp timing resistor R79, and the integrator drives ramp cathode follower V5B. The output of V5B is applied directly to comparator V5A.

b. In STABILIZED, vertical feedback through control amplifier V8B controls integrator V13, the integrator drives V5B, and the output of V5B is applied to comparator V5A.

c. In MANUAL and EXTERNAL, integrator V13 is disabled.

(1) In MANUAL, voltage through variable resistor R103 (adjusted by MANUAL SCAN) drives ramp cathode follower V5B, and the output of V5B is applied directly to comparator V5A.

(2) In EXTERNAL, voltage from an external source (applied through the SCANNING EXTERNAL INPUT connector) drives ramp cathode follower V5B, and the output of V5B is brought through amplifier V16A before being applied to comparator V5A.

4-6. CIRCUIT DESCRIPTION.

4-7. INTEGRATOR.

4-8. A simplified circuit of Miller integrator V13 is shown in figure 4-3. When SCANNING is in LINEAR, and FUNCTION is switched to RECORD, the grid of V13 is returned to a positive voltage through timing resistor R79 and C31 discharges, allowing the grid of V13 to move in a positive direction. However, the increasing plate current through V13 causes the plate side of C31 to move negative faster than the control-grid side moves positive. The result is that the grid voltage changes very little during the scan, so that the voltage drop across R79 and the current through it are practically constant. This current discharges C31 at a linear rate, producing the linear negative-going ramp voltage at the plate of V13.

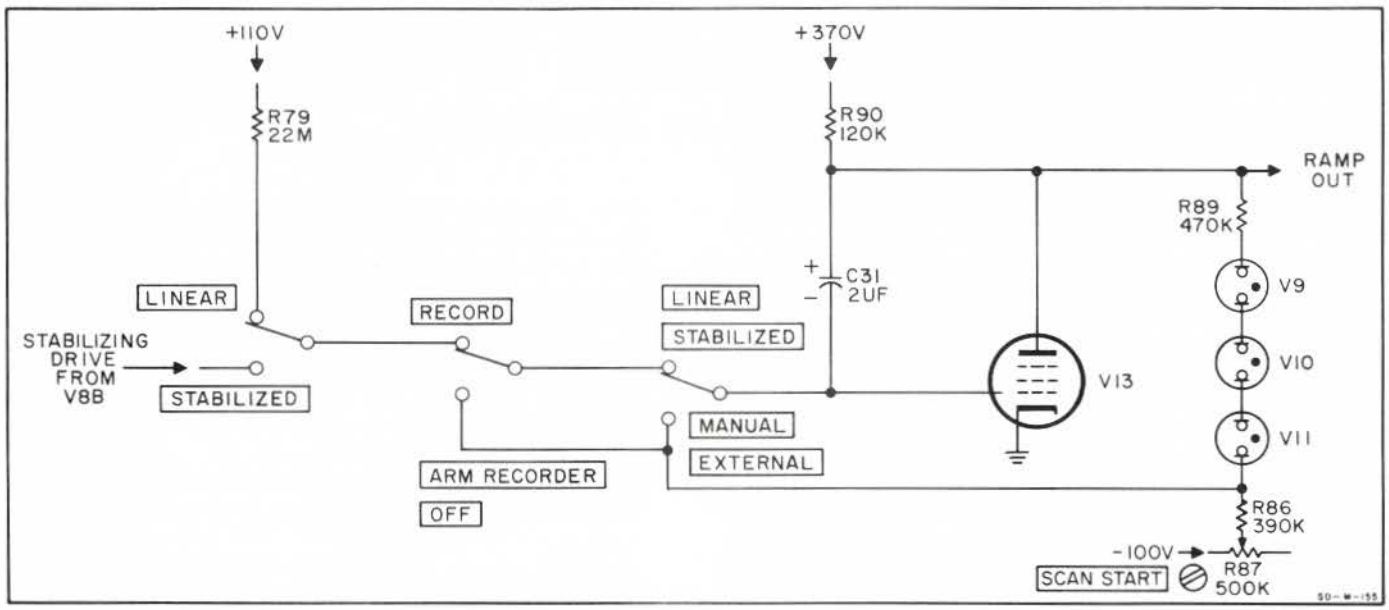


Figure 4-3. Miller Integrator Simplified Circuit

4-9. When FUNCTION is switched to ARM RECORDER, or SCANNING to MANUAL or EXTERNAL, the control grid of V13 is returned to a negative bias voltage through the SCAN START resistor. Timing capacitor C31 charges in the polarity shown until its voltage is great enough to ignite neon lamps V9, V10, and V11. The current through the neons and through SCAN START control R87 permits SCAN START to control the grid voltage of V13, adjusting the ramp output at the start of the scan, and thereby setting the first sampling point on the trace. The charge on capacitor C31 arms the integrator and a ramp starts when SCANNING is switched to LINEAR or STABILIZED.

4-10. Referring to figure 5-12, SCANNING switch S2 selects either the integrator output or MANUAL SCAN resistor R103 to drive ramp cathode follower V5B. Because R103 is referenced to the integrator output voltage, its output will be at the scan-start voltage when MANUAL SCAN is in the counterclockwise position. In the EXTERNAL position, SCANNING disconnects the integrator output and connects the SCANNING EXTERNAL INPUT jack to the grid of V5B.

4-11. Ramp cathode follower V5B (figure 5-12) drives both comparator V5A (figure 5-8) and the horizontal output amplifier. At the same time, SCANNING increases the gain of amplifier V16A and feeds the external scanning voltage through the amplifier to comparator V5A.

4-12. COMPARATOR.

4-13. The ramp voltage and sweep voltage fed to the grid of comparator V5A are equal in amplitude but opposite in polarity. The sweep time is much shorter than that of the ramp, and at some time during every sweep the grid of V5A passes through zero. As the ramp voltage moves slowly negative, the grid of V5A passes through zero at successively later times with respect to the start of the sweep. Thus on the screen of the CRT each sample is taken slightly to the right of the previous one. When the voltage across R9 passes zero going in the positive direction, comparator diode CR1 turns off and CR2 conducts, allowing tunnel diode CR3 to produce a fast-rising gate. The gate is amplified by Q1 and used to trigger sampler blocking oscillator Q2, and to intensify the trace through the marker output circuit.

4-14. MARKER OUTPUT CIRCUIT.

4-15. The circuit of gate cathode follower V7 is so designed that both V7 grids are at the same potential when the oscilloscope unblanking signal appears in the V7 grid circuit, and conducting marker amplifier V6 is drawing current through plate resistor R47 (figure 5-8). However, as soon as the marker gate (negative pulse from Q1) appears on the V6 grid, V6 turns off, allowing the voltage on the right-hand grid of V7 to rise. Resulting conduction through the right-hand section of V7 causes the V7 cathode to become less negative; this positive signal outgoing to the CRT control grid results in an intensification of the remaining portion of the trace.

4-16. SAMPLER CIRCUIT.

4-17. The negative-going gate from amplifier Q1 is also used, after differentiation by capacitor C11 and resistor R20, to produce a negative-going trigger, to actuate sampler blocking oscillator Q2. The negative-going output of blocking oscillator transformer T2 is

shaped by step-recovery diode CR8, differentiated into a 5-nanosecond pulse by C9, and applied to the primary of transformer T1 in the sampler circuit. The pulse output of transformer T1 exceeds the 7.5-volt bias maintained by CR4, and turns on sampler diodes CR5 and CR6 which couple the output of cathode follower V1A to Sampler Storage Capacitor C14 in the grid circuit of sampler output cathode follower V1B.

4-18. STRETCHER CIRCUIT.

4-19. A negative-going pulse is also developed across resistor R30 in the emitter circuit of sampler blocking oscillator Q2. This pulse is applied to the base of stretcher blocking oscillator Q3. The circuit of Q3 is similar to that of Q2, except that the feedback through transformer T4 is applied to the emitter of Q3 instead of the base. The output of blocking oscillator Q3, coupled by transformer T3, overcomes the bias developed across breakdown diode CR13, turning on stretcher diodes CR14 and CR15, which couple the voltage developed across V2 cathode resistor R29 to capacitor C21 which stores this voltage until the next sample is taken.

4-20. There is positive feedback around the stretcher circuit through Vertical Feedback adjust R39 that keeps Sampler Storage Capacitor C14 from completely discharging between samples. Out-of-phase vertical input voltage from the balanced output of the oscilloscope vertical amplifier is coupled through Sampler Neutralization capacitor C4 to neutralize sampler-diode capacitance. There are two cathode followers in cascade following the stretcher circuit. Stretcher output cathode follower V3 feeds drive voltage to the stabilizing circuit (V8A, Q4, Q5, and V8B, figure 5-12). Vertical output cathode follower V4 is coupled to the vertical output terminals through VERT AMPLI-tude control R43.

4-21. STABILIZER CIRCUIT.

4-22. Stretcher output cathode follower V3 delivers vertical signal to stabilizer cathode follower V8A through C28. Capacitor C28 differentiates the signal, applying to the grid of V8A a voltage which is proportional to the rate of change, $|de/dt|$, of the vertical signal. The single-ended output of V8A is converted to a balanced output by differential amplifier Q4-Q5. For any given signal at the base of Q4, one side of the differential output moves negative and the other positive. Diodes CR17 or CR18 conduct the positive-going signal, and drive the grid of control amplifier V8B. The resulting increase in plate current through V8B, when SCANNING is at STABILIZED, reduces the voltage drop across timing resistor R85. This, in turn, reduces the discharge rate of timing capacitor C31, and slows the ramp. Thus the slope of the ramp (and that of the scan voltage) is inversely proportional to the change in vertical signal fed to the input of the stabilizer circuit.

4-23. Pen Speed Stabilizer DC Balance control R63 applies negative feedback from the collector of Q4 to the grid of V8A to equalize the collector currents of Q4 and Q5 when there is no change in vertical signal to V8A. Under these conditions the voltages at CR17, CR18 will be equal, and a change in either direction will slow the ramp; therefore the fastest ramp (and scan) speed will occur when there is no change in vertical signal.

Table 5-1. Test Equipment for Check and Adjustment

Item	Instrument Type	Required Characteristics	Required to Test	Reference Paragraph	Recommended Instrument
1	Watch	With second hand	Scan Time	5-9	
2	Signal Generator	Frequency 3 mc, 30 mc Amplitude: 300 mv p-p	Vertical Output	5-11	hp 606A
3	Voltmeter	Range: 0 to + 15 v Accuracy: ±1% of full scale	Horizontal Output Vertical Output Horizontal DC Level Stabilizer DC Balance Vertical DC Level	5-7 5-11 5-22 5-26 5-24	hp 412A
4	Test Oscilloscope	Sweep Output: 1 μsec/cm to 5 msec/cm Rise Time: 0.1 μsec	Vertical Bandwidth Stretcher Gate Width Comparator Compensation Input Attenuator Compensation Sampling Efficiency Vertical Feedback Sampling Gate Neutralization	5-13 5-19 5-20 5-23 5-24 5-24 5-25	 hp 160B hp 170A hp 175A w/08*
5	Special Attenuator	See Paragraph 5-4	Vertical Bandwidth Sampling Efficiency Vertical Feedback Sampling Gate Neutralization	5-13 5-24 5-24 5-25	To be constructed (see para 5-4)
6	Square-Wave Generator	Frequency: 8 kc to 200 kc Amplitude: 1 volt Rise Time: 0.1 μsec	Comparator Compensation Input Attenuator Compensation Sampling Efficiency Vertical Feedback Sampling Gate Neutralization	5-20 5-23 5-24 5-24 5-25	hp 211A

* Model 175A Oscilloscope with option 08 Sweep Output

SECTION V
MAINTENANCE

5-1. PERFORMANCE CHECK.

5-2. The performance check is intended only to reveal whether or not the instrument is operating within its specifications. Should adjustment be required, refer to paragraph 5-14.

5-3. TEST EQUIPMENT.

5-4. Test equipment required to complete a performance check is listed in table 5-1, items 1 through 5. Similar equipment having the listed characteristics may be substituted. To construct the Special Attenuator, refer to figure 5-1 and proceed as follows:

a. Obtain the following parts (hp stock numbers are in parentheses):

1. Resistor, 36k ±5% 1/2W (0686-3635).

2. Resistor, 15k ±10% 1/2W (0687-1531).

3. Male BNC connector, type UG-88/U (1250-0061).

4. Female BNC connector, type UG-1094/U (1250-0083).

5. Feed-thru body (AC67A-1) (10100A-20101).

b. Assemble the attenuator as follows (numbered steps refer to figure 5-1):

1. Cut and bend the 36k resistor as shown.

2. Cut and bend the 15k resistor as shown.

3. Wrap one end of the 15k resistor around the short lead of the 36k resistor. Solder.

4. Place the lockwasher over the threaded end of the female connector. Do not use the hex nut which is supplied with the connector.

5. Solder the resistors to the connector as indicated.

6. Insert the long lead of the 36k resistor in the connector center pin, and solder.

7. Slide the body over the assembly and thread tightly against lockwasher.

8. Solder lead of 15k resistor to inside of body as indicated.

9. Insert pin in center hole of male connector and thread tightly to body.

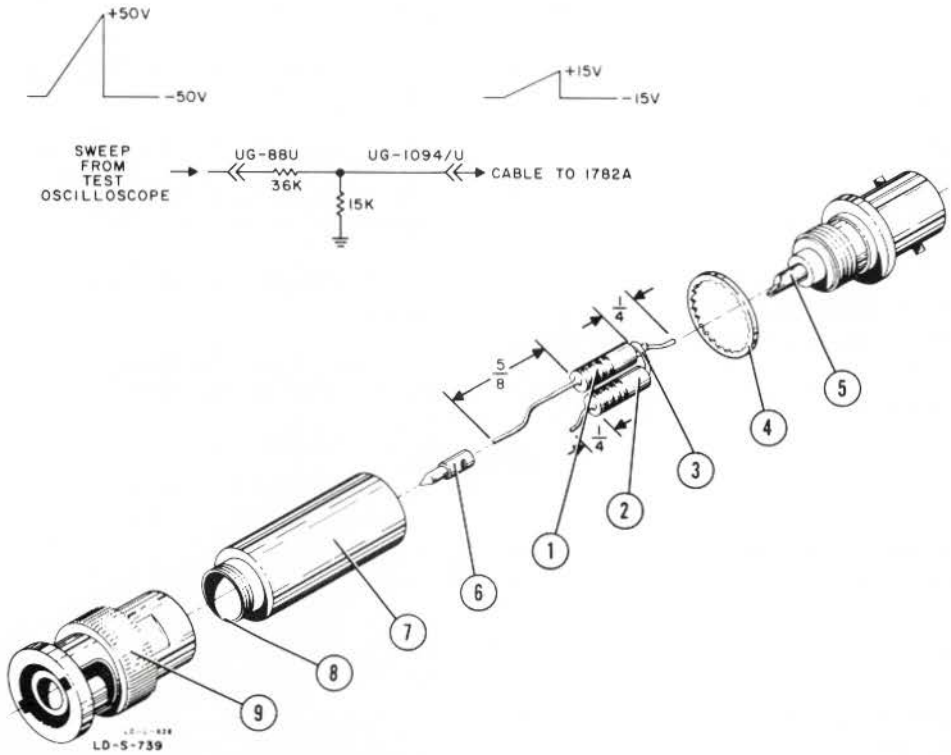


Figure 5-1. Special Attenuator

5-5. PRELIMINARY SETTINGS.

5-6. A vertical plug-in unit must be in place to make the performance check.

a. If the vertical plug-in has more than one channel, select CHANNEL A and use channel A controls. Make the following settings on the front panel of the vertical plug-in unit:

AC-DC . . . . . AC
VERNIER . . . . . CAL

b. Set Model 175A controls as follows:

POWER . . . . . ON
INTENSITY MODULATION . . . . . INTERNAL
SWEEP TIME . . . . . 1 MSEC/CM
Sweep VERNIER . . . . . CAL
HORIZONTAL DISPLAY X1
TRIGGER SOURCE . . . . . INT
SWEEP MODE . . . . . FREE RUN

c. Center trace on CRT.

d. Set: FUNCTION . . . . . ARM RECORDER

e. Rotate MANUAL SCAN to locate marker (start of intensified trace) and adjust INTENSITY for best contrast at marker.

5-7. HORIZONTAL OUTPUT.

5-8. DC LEVEL AND AMPLITUDE.

a. Set: SCANNING . . . . . MANUAL
HORIZ AMPLITUDE . . . . fully clockwise

b. Connect Voltmeter to HORIZ OUTPUT.

c. Rotate MANUAL SCAN fully counterclockwise.

d. Adjust SCAN START so that marker is 2 mm from start of trace.

e. Set HORIZONTAL POSITION to place marker at left line of graticule.

f. Adjust HORIZ DC LEVEL for a voltmeter reading of 0 volts.

g. Rotate MANUAL SCAN clockwise until marker is at right line of graticule. Voltmeter reading should be between 15 and 18 volts.

h. Disconnect voltmeter.

5-9. SCAN TIME.

a. Set: SCANNING . . . . . LINEAR

b. Switch FUNCTION to RECORD and time the scan. The marker should reach the right line of the graticule in 70 to 100 seconds.

c. Set: SCANNING . . . . . STABILIZED

d. Switch FUNCTION to ARM RECORDER and back to RECORD. The marker should reach the right line of the graticule in 15 to 24 seconds.

e. Return FUNCTION to ARM RECORDER.

5-10. EXTERNAL SCANNING.

a. Set: SENSITIVITY . . . . . 20 VOLTS/CM
SCANNING . . . . . EXTERNAL
SWEEP TIME . . . . . 10 MSEC/CM
SWEEP MODE . . . . . PRESET

b. Connect 10 VOLT CALIBRATOR output to EXTERNAL INPUT.

c. Connect HORIZ OUTPUT to vertical INPUT.

d. Set HORIZONTAL POSITION to start trace at left graticule edge.

e. The lower intensified portion of trace should start between the 7 and 8 cm lines.

f. Disconnect 10 VOLT CALIBRATOR and HORIZ OUTPUT from vertical INPUT. Return SWEEP MODE to FREE RUN, and SWEEP TIME to 1MSEC/CM.

5-11. VERTICAL OUTPUT.

5-12. DC LEVEL AND AMPLITUDE.

a. Set: SENSITIVITY . . . . . 0.05 VOLTS/CM
SCANNING . . . . . MANUAL
VERT AMPLITUDE . . . . fully clockwise

b. Connect Voltmeter to VERT OUTPUT.

c. Set VERTICAL POSITION to center trace.

d. Set MANUAL SCAN to place marker toward center of graticule.

e. Adjust VERT DC LEVEL, for a Voltmeter reading of 0 volts.

f. Position trace on top line of graticule with VERTICAL POSITION.

g. Voltmeter should read at least +0.6 volts.

h. Position trace on bottom line of graticule with VERTICAL POSITION.

i. Voltmeter should read -0.6 volts or more negative.

j. Disconnect Voltmeter and return VERTICAL POSITION to center trace.

5-13. BANDWIDTH.

a. Set: SWEEP TIME . . . . . 1 μSEC/CM
SWEEP MODE . . . . . PRESET
SENSITIVITY . . . . . 0.05 VOLTS/CM
SCANNING . . . . . EXTERNAL

b. Connect the sweep output from the Test Oscilloscope through the Special Attenuator (para 5-4) to EXTERNAL INPUT.

c. Trigger the Test Oscilloscope with the gate output of the Model 175A (pin 1 of the horizontal plug-in connector J105, available on rear panel instruments with option 08).

d. Set the Test Oscilloscope sweep time to 5 msec/cm.

e. Connect the Signal Generator to Model 175A vertical INPUT. Set frequency to 1 mc, amplitude for about 6 cm deflection on the Model 175A.

f. Connect Model 1782A VERT OUTPUT to Test Oscilloscope vertical input.

g. Observe the signal on the Test Oscilloscope. Set to exactly 4 cm of vertical deflection.

h. Set: Model 175A SWEEP TIME to 0.1 μSEC/CM, and set TRIGGER LEVEL for a stable display.

i. Set Oscillator frequency to 30 mc.

j. Observe the signal on the Test Oscilloscope. Vertical deflection with a 40-mc vertical plug-in in the Model 175A, should be greater than 2.8 cm.

5-14. ADJUSTMENTS.

5-15. Adjustment of the Model 1782A Display Scanner requires that the Model 175A Oscilloscope and its vertical plug-in unit be operating properly. Proper operation may be confirmed by following the performance check given in the manuals for each instrument.

5-16. TEST EQUIPMENT.

5-17. Test equipment recommended for adjustment of the Model 1782A is listed in table 5-1, items 3 through 6. Similar equipment having the required characteristics may be substituted.

5-18. PRELIMINARY SETTINGS.

a. If the vertical plug-in unit has more than one channel, select CHANNEL A and set the controls as follows:

AC-DC . . . . . AC
Vertical SENSITIVITY . . . . . 0.05 VOLTS/CM
Sensitivity VERNIER . . . . . CAL

b. Set the Model 175A controls as follows:

POWER . . . . . ON
INTENSITY MODULATION . . . . . INTERNAL
Sweep VERNIER . . . . . CAL
HORIZONTAL DISPLAY X1
TRIGGER SOURCE . . . . . INT
TRIGGER SLOPE . . . . . +

c. Set the Model 1782A controls as follows:

FUNCTION . . . . . ARM RECORDER
SCANNING . . . . . MANUAL

5-19. STRETCHER GATE WIDTH.

a. Set: SWEEP TIME . . . . . 1 μSEC/CM
SWEEP MODE . . . . . FREE RUN
MANUAL SCAN place marker on screen

b. Connect Test Oscilloscope through a compensated probe to the collector of stretcher blocking oscillator Q3 (TP1, figure 5-2).

c. Adjust Stretcher Gate Width (R36, figure 5-2) so that the positive-going portion of the waveform is 1.2 μsec wide at the half-amplitude point.

d. Disconnect Test Oscilloscope.

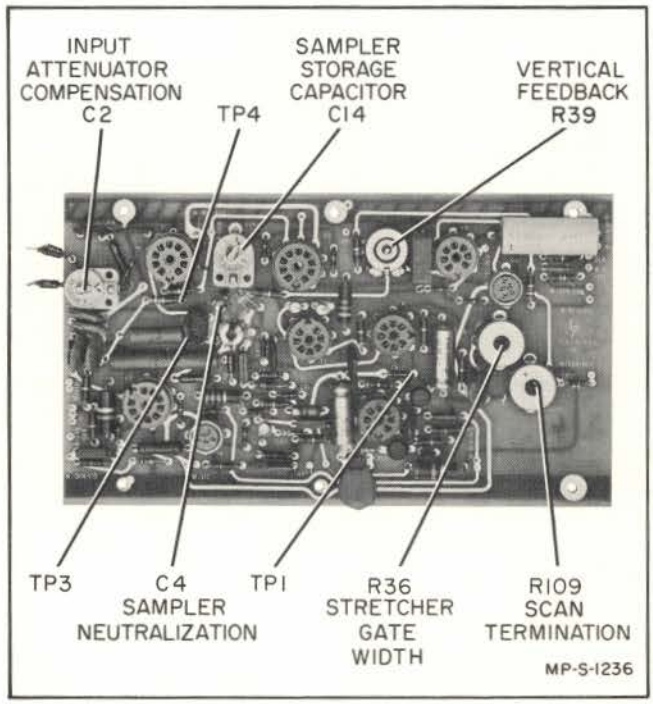


Figure 5-2. A1 Sampler Assembly, Location of Adjustments and Test Points

5-20. COMPARATOR COMPENSATION.

a. Set: SWEEP TIME . . . . . 10 μSEC/CM
SWEEP MODE . . . . . PRESET
MANUAL SCAN . . . . . fully clockwise

b. Disconnect the foam-covered wire which runs from the sweep generator board to the horizontal plug-in connector in the Model 175A Oscilloscope. This wire is located adjacent to adjustment C125 on the sweep generator printed circuit board. Refer to the Model 175A Operating and Service Manual if necessary.

c. Connect the Square-Wave Generator 75-ohm output to the foam covered wire and set Generator frequency to 8 kc; set amplitude to maximum.

d. Connect the Test Oscilloscope through a compensated Probe to pin 3 of V5 (TP2, figure 5-3).

e. Adjust Comparator Compensation (C1, figure 5-3) for the best square wave as viewed on the test oscilloscope.

f. Disconnect the Square-Wave Generator and Test Oscilloscope. Reconnect the foam-covered wire to the sweep-generator board.

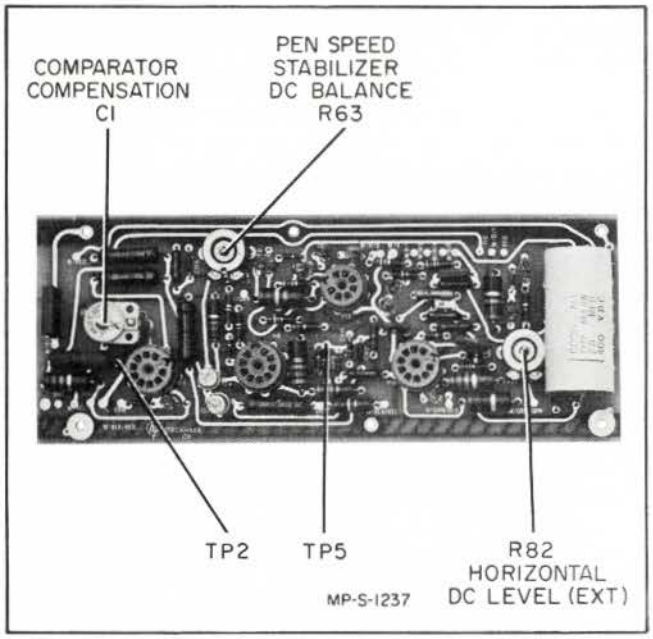


Figure 5-3. A2 Scan Generator Assembly, Location of Adjustments and Test Points

5-21. SCAN START AND TERMINATION.

a. Set: SWEEP TIME . . . . . 10 μSEC/CM
SWEEP MODE . . . . . FREE RUN
MANUAL SCAN . . fully counterclockwise

b. Adjust SCAN START (front panel) so that the marker appears 2 mm after the start of the sweep.

c. Set: MANUAL SCAN fully clockwise.

d. Adjust Scan Termination (R109, figure 5-2) so that the marker appears 11 cm after the start of the sweep.

5-22. HORIZONTAL DC LEVEL.

a. Set: SWEEP TIME . . . . . 20 μSEC/CM
SWEEP MODE . . . . . FREE RUN
MANUAL SCAN. . . fully counterclockwise

b. Connect the Voltmeter to HORIZ OUTPUT.

c. Adjust HORIZ DC LEVEL (front panel) for a Voltmeter reading of zero volts.

d. Disconnect Voltmeter.

e. Set: SCANNING . . . . . EXTERNAL

f. Short the EXTERNAL INPUT to ground.

g. Adjust Horizontal Level (Ext) (R82, figure 5-3) so that the marker appears 2 mm after the start of the trace.

h. Remove short from EXTERNAL INPUT.

5-23. INPUT ATTENUATOR COMPENSATION.

a. Connect the Square-Wave Generator 75-Ohm output to vertical INPUT and set the frequency to 8 kc.

b. Connect the Test Oscilloscope through a compensated Probe to pin 8 of V1 (TP3, figure 5-2).

c. Set the Square-Wave Generator output for approximately 6 cm vertical deflection.

d. Adjust Input Attenuator Compensation (C2, figure 5-2) for the best square wave as viewed on the Test Oscilloscope.

5-24. SAMPLING EFFICIENCY AND VERTICAL FEEDBACK.

a. Set: SWEEP TIME . . . . . 50 μSEC/CM
SWEEP MODE . . . . . PRESET
SCANNING . . . . . EXTERNAL

b. Connect the sweep output from the Test Oscilloscope through the Special Attenuator (para 5-4) to the Model 1782A EXTERNAL INPUT.

c. Connect the Square-Wave Generator 75-ohm output to vertical INPUT. Set the frequency to 10 kc and set amplitude for 6 cm vertical deflection.

d. Connect the Test Oscilloscope through a compensated probe to pin 3 of V1 (TP4, figure 5-2). Set the Test Oscilloscope sweep time to 5 msec/cm and select dc coupling.

e. Adjust Vertical Feedback (R39, figure 5-2) so that the decay between samples is toward the center of the graticule from both sides of the square wave (see figure 5-4) as viewed on the Test Oscilloscope.

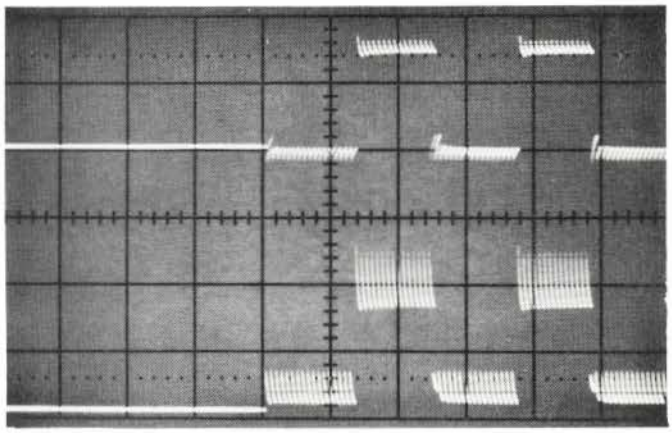


Figure 5-4. Vertical Feedback Adjustment
Top: Correct
Bottom: Incorrect

f. Adjust Sampler Storage Capacitor (C14, figure 5-2) so that the amplitude of the first sample of each half cycle of the square wave is the same as that of the succeeding samples (see figure 5-5).

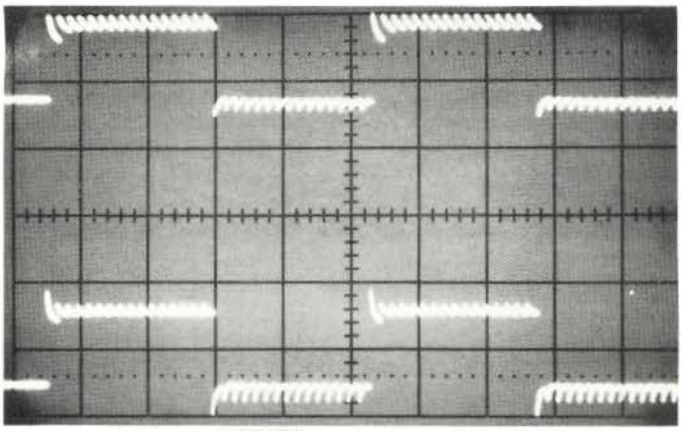


Figure 5-5. Sampler Storage Capacitor Adjustment
Top: Correct
Bottom: Incorrect

g. Disconnect the Square-Wave Generator.

h. Set: SWEEP MODE . . . . . FREE RUN
VERTICAL POSITION . . . . center trace

i. Connect the Voltmeter to VERT OUTPUT.

j. Adjust VERT DC LEVEL for zero volts as read on the Voltmeter.

k. Observe the trace on the Test Oscilloscope and adjust Vertical Feedback (R39, figure 5-2) for no decay between samples.

m. Disconnect Voltmeter.

5-25. SAMPLING GATE NEUTRALIZATION.

a. Set: SWEEP TIME . . . . . 2 μSEC/CM
SWEEP MODE . . . . . PRESET
SCANNING . . . . . EXTERNAL

b. Connect the Test Oscilloscope sweep output as in paragraph 5-24 and the vertical input to Model 1782A VERT OUTPUT.

c. Connect Square-Wave Generator 75-ohm output to vertical INPUT. Set the frequency to 200 kc, and the amplitude for 6 cm vertical deflection.

d. Observe the waveform on the Test Oscilloscope and adjust Sampler Neutralization (C4, figure 5-2) for the best square wave.

e. Recheck sampling efficiency (paragraph 5-24).

f. Disconnect Test Oscilloscope and Square-Wave Generator.

5-26. STABILIZER DC BALANCE.

a. Set: SWEEP TIME . . . . . 50 μSEC/CM
SWEEP MODE . . . . . FREE RUN
SCANNING . . . . . STABILIZED

b. Center the trace with VERTICAL POSITION.

c. Connect the Voltmeter to pin 7 of V8 (TP5, figure 5-3).

d. Adjust Pen Speed Stabilizer DC Balance (R63, figure 5-3) for a maximum negative reading on the Voltmeter.

e. Disconnect Voltmeter.

5-27. REPAIRS.

5-28. The Model 1782A uses edge-on connectors for most connections to the boards. When removing or replacing edge-on connectors be careful to align the connector properly with its guide slot. Applying force with the connector improperly aligned may spring the contacts and result in a poor connection.

5-29. EQUIPMENT REQUIRED.

5-30. In general, miniaturized equipment calls for miniature tools. The following are particularly important:

a. Low-heat soldering iron (25 to 50 watts). Idling temperature must be no more than 800°F.

b. Small soldering iron tip (1/16 to 3/32 inch).

c. Small-diameter rosin-core solder.

d. Wooden toothpick.

5-31. The low-heat iron is required in order to protect solid-state devices from too high a temperature, and to avoid causing conductors to lift from the printed circuit boards. The small tip will transfer less heat to the component, yet will be adequate to melt the solder. Small-diameter solder melts more quickly, reducing the length of time that heat must be applied. The toothpick is essential for cleaning out mounting holes after removing a component. Do not attempt repairs on the Model 175A unless the above equipment is on hand.

5-32. PROCEDURE.

5-33. The Model 175A has plated-through circuit boards. Each component mounting hole is plated through in order to provide electrical conduction from one side of the board to the other and to provide a better solder bond between the circuit and the component. The plating is easily damaged by reaming the hole with a metal tool, or by forcing component leads into the hole. The use of the wooden toothpick for cleaning out solder, and ordinary care in replacing the component, will result in a satisfactory job. Solid-state diodes and transistors require special handling, in that they are sensitive to both heat and electrical overload. Use long-nose pliers between the iron and the device as a heat sink. Hold the pliers for a moment after the iron is removed to allow the joint to cool. Be sure there is no electrical leakage from iron to work. Such leakage can damage transistors.

5-34. TROUBLESHOOTING.

5-35. ISOLATING TROUBLES TO A MAJOR SECTION.

5-36. The following check may be performed whenever an instrument malfunction is suspected.

a. Set: HORIZONTAL DISPLAY X1
TRIGGER SOURCE . . . . . INT
TRIGGER SLOPE . . . . . +
TRIGGER LEVEL 0
SWEEP MODE . . . . . PRESET
SWEEP TIME . . . . . 1 MSEC/CM
Sweep VERNIER . . . . . CAL
Vertical SENSITIVITY . . 2 VOLTS/CM
Vertical Sensitivity VERNIER . . . CAL
Vertical Polarity . . . . . +UP
SCANNING . . . . . EXTERNAL

b. Connect the CALIBRATOR 10 volt output to the vertical INPUT and the 1782A EXTERNAL INPUT.

c. Center the display on the CRT with the vertical POSITION controls.

d. The top of the square wave display should be intensified starting between 7 to 8 cm from the start of the sweep.

e. If the proper display is obtained, it is likely that V5, V16, Q1, V6, and V7 are operating properly.

f. Set: SCANNING . . . . . LINEAR
FUNCTION . . . . . ARM RECORDER

g. Set the FUNCTION to RECORD and note the time it takes for the marker to travel 10 cm.

h. The scanning time should be between 70 and 100 seconds.

i. Return the FUNCTION to ARM RECORDER.

j. The marker should be at the start of the sweep.

k. If the proper time and display are obtained, it is likely that V13 and its associated circuitry is operating properly.

m. Set: SCANNING . . . . . STABILIZED
FUNCTION . . . . . RECORD

n. It should take approximately 20 seconds for the marker to travel 10 cm.

p. If the proper time is obtained, it is likely CR14, CR15, V3, C28, V8, Q4, and Q5 are operating properly.

q. Set: SCANNING . . . . . STABILIZED
FUNCTION . . . . . ARM RECORDER
VERT AMPLITUDE . . fully clockwise

r. Connect a direct coupled test oscilloscope to the VERT OUTPUT.

s. Set: FUNCTION . . . . . RECORD

t. A sampled square wave should be obtained with a frequency of approximately 1/4 cps and an amplitude of approximately 1 volt.

u. If the proper display is obtained, it is likely that Q2, Q3, CR8, V1, V2, CR5, and CR6 are operating properly.

5-37. CIRCUIT TROUBLESHOOTING.

5-38. A series of test conditions is given on the schematic, along with waveforms and dc voltages to be expected in a typical properly operating unit. If tests given in paragraph 5-35 indicate a problem area, set up the test conditions given on the schematic and check the waveforms and dc voltages at specific points in the circuit in question. Some possible problems and cures are given in table 5-2.

Table 5-2. Circuit Troubleshooting

Condition	Cause
Unable to set sampling efficiency	CR8, CR5, CR6, V1
Uneven recording on slow sweep times	CR14, CR15
Slow scanning times with FUNCTION set to STABILIZED	CR14, CR15
Nonlinear horizontal scan	C1, V5, CR1, CR2
Unable to set Pen Speed Stabilizer D.C. Balance	C28, V8, Q4, Q5, CR16, CR17, CR18

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alpha-numerical order of their reference designators and indicates the description and ⓗⓟ stock number of each part, together with any applicable notes. Table 6-2 lists parts in alpha-numerical order of their ⓗⓟ stock numbers and provides the following information on each part:

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

b. Typical manufacturer of the part in a five-digit code; see list of manufacturers in appendix.

c. Manufacturer's stock number.

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

e. Recommended spare part quantity for complete maintenance during one year of isolated service (RS column).

6-3. Miscellaneous parts not indexed in table 6-1 are listed at the end of table 6-2.

6-4. ORDERING INFORMATION.

6-5. To order a replacement part, address order or inquiry either to your authorized Hewlett-Packard sales representative or to

CUSTOMER SERVICE
Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California

or, in Western Europe, to

Hewlett-Packard S.A.
54-54bis Route des Acacias
Geneva, Switzerland

6-6. Specify the following information for each part:

a. Model and complete serial number of instrument.

b. Hewlett-Packard stock number.

c. Circuit reference designator.

d. Description.

6-7. To order a part not listed in tables 6-1 and 6-2, give a complete description of the part and include its function and location.

REFERENCE DESIGNATORS

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

ABBREVIATIONS

A = amperes
BP = bandpass
BWO = backward wave oscillator
CER = ceramic
CMO = cabinet mount only
COEF = coefficient
COM = common
COMP = composition
CONN = connection
CRT = cathode-ray tube
DEPC = deposited carbon
EIA = Tubes or transistors meeting Electronic Industires' Association standards will normally result in instrument operating within specifications; tubes and transistors selected for best performance will be supplied if ordered by ⓗⓟ stock numbers.
ELECT = electrolytic
ENCAP = encapsulated
F = farads
FXD = fixed
GE = germanium
GL = glass
GRD = ground(ed)
H = henries
HG = mercury
HR = hour(s)
IMPG = impregnated
INCD = incandescent
INS = insulation(ed)
K = kilo = 1000
LIN = linear taper
LOG = logarithmic taper
MEG = meg $=10^6$
M = milli $=10^{-3}$
MINAT = minature
METFLM = metal film
MFR = manufacturer
MOM = momentary
MTG = mounting
MY = mylar
NC = normally closed
NE = neon
NO = normally open
NPO = negative positive zero (zero temperature coefficient)
NSR = not separately replaceable
OBD = order by description
OX = oxide
P = peak
PC = printed circuit board
PF = picofarads = 10^{-12} farads
PP = peak-to-peak
PIV = peak inverse voltage
POR = porcelain
POS = position(s)
POLY = polystyrene
POT = potentiometer
RECT = rectifier
ROT = rotary
RMS = root-mean-square
RMO = rack mount only
S-B = slow-blow
SE = selenium
SECT = section(s)
SI = silicon
SIL = silver
SL = slide
SPL = special
TA = tantalum
TD = time delay
TI = titanium dioxide
TOG = toggle
TOL = tolerance
TRIM = trimmer
TWT = traveling wave tube
U = micro $=10^{-6}$
VAC = vacuum
VAR = variable
W/ = with
W = watts
WW = wirewound
W/O = without
* = optimum value selected at factory, average value shown (part may be omitted)

01194-6

Table 6-1. Reference Designation Index

Circuit Reference	Stock No.	Description	Note
A1	1782A-65A	ASSY:SAMPLER	
A2	1782A-65B	ASSY:SCAN GENERATOR	
		COMPARATOR COMPENSATION	
C1	0130-0006	C:VAR 5-20 PF 500VDCW	
		INPUT ATTENUATOR COMPENSATION	
C2	0130-0001	C:VAR 7-45PF 500VDCW	
C3	0150-0081	C:FXD .01UF -20% +80% 500VDCW	
		SAMPLER NEUTRALIZATION	
C4	0132-0004	C:VAR 7-13PF 350VDCW	
C5	0150-0081	C:FXD .01UF -20% +80% 500VDCW	
C6	0150-0081	C:FXD .01UF -20% +80% 500VDCW	
C7		NOT ASSIGNED	
C8	0150-0121	C:FXD CER 0.1UF +80%-20% 50VDCW	
C9	0140-0039	C:FXD MICA 47 PF 5% 500 VDCW	
C10	0180-0058	C:FXD ELECT 50UF -10%+100% 25VDCW	
C11	0140-0090	C:FXD MICA 200 PF 5% 500 VDCW	
C12	0150-0081	C:FXD .01UF -20% +80% 500VDCW	
C13	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
		SAMPLER STORAGE CAPACITOR	
C14	0130-0006	C:VAR 5-20 PF 500VDCW	
C15	0150-0050	C:FXD CER 100 PF 600 VDCW	
C16	0150-0081	C:FXD .01UF -20% +80% 500VDCW	
C17		NOT ASSIGNED	
C18	0150-0081	C:FXD .01UF -20% +80% 500VDCW	
C19	0180-0058	C:FXD ELECT 50UF -10%+100% 25VDCW	
C20	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
C21	0140-0009	C:FXD MICA 0.01 UF 5% 500VDCW	
C22	0140-0036	C:FXD MICA 110 PF 5% 500 VDCW	
C23	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
C24	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
C25	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
C26	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
C27		NOT ASSIGNED	
C28	0170-0057	C:FXD MY 5 UF 10% 100VDCW	
C29	0140-0054	C:FXD MICA 100 PF 10% 500 VDCW	
C30	0160-0127	C:FXD 1UF OHM 20% 25VDCW	
C31	0170-0002	C:FXD MY 2 UF 20% 400VDCW	
C32	0140-0039	C:FXD MICA 47PF 5% 300VDCW	
C33	0150-0052	C:FXD 0.05 UF 20% 400 VDCW	
C34	0150-0091	C:FXD 1.5PF 500VDCW	
C35		NOT ASSIGNED	
C36	0170-0018	C:FXD MY 1UF 5% 200VDCW	
C37	0150-0081	C:FXD .01UF -20% +80% 500VDCW	
CR1	1901-0034	SEMICON DEVICE DIODE JUNCTION	
CR2	1901-0034	SEMICON DEVICE DIODE JUNCTION	
CR3	1912-0007	SEMICON DEVICE:DIODE GERMANIUM	
CR4	1902-0064	DIODE:ZENER 7.5V 5% 400MW	
CR5	G-29L-49	DIODE	
CR6	G-29L-49	DIODE	
CR7		NOT ASSIGNED	

See introduction to this section

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

Circuit Reference	Stock No.	Description	Note
CR8	G-290-38	SEMICON DEVICE:DIODE STEP RECOVERY	
CR9	G-29E-12	SEMICON DEVICE:DIODE SILICON	
CR10	1902-0031	SEMICON DEVICE DIODE	
CR11	1901-0040	DIODE:SILICON	
CR12	1902-0031	SEMICON DEVICE DIODE	
CR13	1902-0064	DIODE:ZENER 7.5V 5% 400MW	
CR14	G-29M-9	SEMICON DEVICE:DIODE	
CR15	G-29M-9	SEMICON DEVICE:DIODE	
CR16	1902-0031	SEMICON DEVICE DIODE	
CR17	1901-0025	DIODE:SILICON 50 MA	
CR18	1901-0025	DIODE:SILICON 50 MA	
CR19	1901-0033	SEMICON DEVICE DIODE 1N485B	
CR20	1901-0033	SEMICON DEVICE DIODE 1N485B	
J1	1250-0083	CONNECTOR:BNC	
J2	1250-0083	CONNECTOR:BNC	
J3	1250-0083	CONNECTOR:BNC	
J4	1251-0070	JACK:PHONE PEN LIFT	
L1	9140-0018	COIL:FXD 1UH	
L2	9140-0018	COIL:FXD 1UH	
L3	9140-0077	COIL FXD RF: 2.2UHY	
L4	9140-0024	COIL:FXD 0.68 UH	
L5	9140-0146	COIL FXD RF 10.0 UHY	
P1	1251-0136	CONNECTOR:32 PIN MALE	
Q1	1854-0005	TRANSISTOR 2N708NPNSILICONPLANAR	
Q2	1850-0091	TRANSISTOR GERMANIUM 2N2048 PNP	
Q3	1850-0091	TRANSISTOR GERMANIUM 2N2048 PNP	
Q4	1850-0062	TRANSISTOR:SPL2N404A	
Q5	1850-0062	TRANSISTOR:SPL2N404A	
R1	0683-3315	R:FXD COMP 330 OHMS 5% 1/4W	
R2	0727-0201	R:FXD DEPC 71.56K OHMS 1% 1/2W	
R3	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R4	0727-0244	R:FXD DEPC 500K OHM 1% 1/2W VERTICAL DC LEVEL	
R5	2100-0422	R:VAR WW LIN 10K OHM 20% 5W	
R6	0683-3315	R:FXD COMP 330 OHMS 5% 1/4W	
R7	0727-0274	R:FXD DEPC 1M OHM 1% 1/2W	
R8	0727-0274	R:FXD DEPC 1M OHM 1% 1/2W	
R9	0767-0006	R:FXD MET FLM 10K OHMS 5% 3W	
R10	0690-3331	R:FXD COMP 33K OHMS 10% 1W	
R11 THRU R13		NOT ASSIGNED	
R14	0767-0006	R:FXD 6.5K 5% 3W	
R15	0687-4711	R:FXD COMP 470 OHMS 10% 1/2W	
R16	0686-1115	R:FXD COMP 110 OHMS 5%1/2W	
R17	0686-1005	R:FXD COMP 10 OHMS 5%1/2W	
R18	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R19	0693-1031	R:FXD COMP 10K OHMS 10% 2W	
R20	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R21	0687-4701	R:FXD 47 OHMS 10% 1/2W	
R22	0689-2435	R:FXD COMP 24K OHMS 5% 1W	

See introduction to this section

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

Circuit Reference	Stock No.	Description	Note
R23	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R24 THRU			
R25		NOT ASSIGNED	
R26	0687-3931	R:FXD COMP 39K OHMS 10% 1/2W	
R27	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R28	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R29	0774-0001	R:FXD MET FLM 4000 OHMS 10M 5W	
R30	0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	
R31	0686-2225	R:FXD COMP 2200 OHMS 5% 1/2W	
R32	0686-1215	R:FXD COMP 120 OHMS 5%1/2W	
R33	0687-1061	R:FXD COMP 10M OHMS 10% 1/2W	
R34	0687-1001	R:FXD COMP 10 OHMS 10% 1/2W	
R35	0687-2221	R:FXD COMP 2200 OHMS 10% 1/2W	
		STRETCHER GATE WIDTH	
R36	2100-0419	R:VAR WW 50 OHM LIN 10% 2W	
R37	0687-4701	R:FXD 47 OHMS 10% 1/2W	
R38	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
		VERTICAL FEEDBACK	
R39	2100-0092	R:VAR COMP 10K OHMS 20% LIN 1/5W	
R40	0687-8231	R:FXD COMP 82K OHMS 10% 1/2W	
R41	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R42	0687-3931	R:FXD COMP 39K OHMS 10% 1/2W	
R43	2100-0421	R:VAR COMP LIN 5K OHM 20% 1/5W	
R44 THRU			
R45		NOT ASSIGNED	
R46	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R47	0727-0111	R:FXD DEPC 1650 OHMS 1% 1/2W	
R48	0727-0100	R:FXD DEPC 1000 OHMS 1% 1/2W	
R49	0683-2015	R:FXD COMP 200 OHMS 5% 1/4W	
R50	0686-7525	R:FXD COMP 7500 OHMS 5% 1/2W	
R51	0686-1145	R:FXD COMP 110K OHMS 5%1/2W	
R52	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R53	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R54	0693-2231	R:FXD COMP 22K OHMS 10% 2W	
R55	0687-2201	R:FXD COMP 22 OHMS 10% 1/2W	
R56	0687-2201	R:FXD COMP 22 OHMS 10% 1/2W	
R57 THRU			
R58		NOT ASSIGNED	
R59	0687-2261	R:FXD COMP 22M OHMS 10% 1/2W	
R60	0687-1541	R:FXD COMP 150K OHMS 10% 1/2W	
R61	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R62	0690-1831	R:FXD COMP 18K OHMS 10% 1W	
		PEN SPEED STABILIZER DC BALANCE	
R63	2100-0096	R:VAR COMP 1M OHMS 30% LIN 1/5W	
R64	0730-0037	R:FXD DEPC 19K OHMS 1% 1W	
R65	0730-0037	R:FXD DEPC 19K OHMS 1% 1W	
R66	0730-0044	R:FXD DEPC 27.5K OHMS 1% 1W	
R67	0730-0044	R:FXD DEPC 27.5K OHMS 1% 1W	
R68	0727-0145	R:FXD DEPC 6960 OHMS 1% 1/2W	
R69	0727-0145	R:FXD DEPC 6960 OHMS 1% 1/2W	
R70 THRU			
R71		NOT ASSIGNED	

See introduction to this section

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

Circuit Reference	Stock No.	Description	Note
R72	0687-1061	R:FXD COMP 10M OHMS 10% 1/2W	
R73	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R74	0692-6835	R:FXD COMP 68K OHMS 5% 2W	
R75	0689-6835	R:FXD COMP 68K OHMS 5% 1W	
R76	0689-1245	R:FXD COMP 120K OHM 5% 1W	
R77	0687-6801	R:FXD COMP 68 OHMS 10% 1/2W	
R78	0687-2701	R:FXD COMP 27 OHMS 10% 1/2W	
R79	0687-2261	R:FXD COMP 22M OHMS 10% 1/2W	
R80	0686-2035	R:FXD COMP 20K OHMS 5% 1/2W	
R81	0687-5621	R:FXD COMP 5600 OHMS 10% 1/2W HORIZONAL DC LEVEL (EXT.)	
R82	2100-0092	R:VAR 10K OHM 20% LIN.	
R83	2100-0421	R:VAR COMP LIN 5K OHM 20% 1/5W	
R84	0687-3931	R:FXD 39K OHM 1% 1/2W	
R85	0687-4751	R:FXD COMP 4.7M OHMS 10% 1/2W	
R86	0687-3941	R:FXD COMP 390K OHMS 10% 1/2W SCAN START	
R87	2100-0423	R:VAR COMP LIN 500K OHM 20% 1/5W	
R88	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R89	0687-4741	R:FXD COMP 470K OHMS 10% 1/2W	
R90	0692-1245	R:FXD COMP 120K OHMS 5% 2W	
R91	0687-3931	R:FXD 39K OHM 1% 1/2W	
R92 THRU			
R93		NOT ASSIGNED	
R94	0727-0208	R:FXD 100K 1% 1/2W	
R95	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R96	0727-0274	R:FXD DEPC 1M OHM 1% 1/2W	
R97	0727-0170	R:FXD DEPC 18K OHMS 1% 1/2W	
R98	0693-8231	R:FXD COMP 82K OHMS 10% 2W	
R99	0687-1031	R:FXD COMP 10K OHMS 10% 1/2W	
R100	0687-3341	R:FXD COMP 330K OHMS 10% 1/2W	
R101	0686-2245	R:FXD COMP 220K OHMS 5% 1/2W	
R102	0686-4745	R:FXD COMP 470K OHMS 5% 1/2W	
R103	2100-0310	R:VAR 1 MEGOHM MANUAL SCAN	
R104	0687-1241	R:FXD COMP 120K OHMS 10% 1/2W	
R105	0727-0222	R:FXD DEPC 214K OHM 1% 1/2W	
R106	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R107	0693-1521	R:FXD COMP 1500 OHMS 10% 2W	
R108	0693-1831	R:FXD COMP 18K OHMS 10% 2W SWEEP TERMINATION	
R109	2100-0420	R:VAR WW 15K OHM LIN 10% 2W	
R110	0687-1041	R:FXD COMP 100K OHM 10% 1/2W	
R111	0687-1051	R:FXD COMP 1M OHMS 10% 1/2W	
R112	0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	
R113	0693-1831	R:FXD COMP 18K OHMS 10% 2W	
R114		NOT ASSIGNED	
R115	2100-0426	R:VAR 20K HORIZONAL AMPLITUDE	
S1	3100-0402	SWITCH ROT 1-SECT 3-POS FUNCTION	
S2	3100-0401	SWITCH ROT 2-SECT 4-POS SCANNING	
T1	1660-60A	TRANSFORMER:SAMPLING	

See introduction to this section

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

Circuit Reference	Stock No.	Description	Note
T2	166C-60B	TRANSFORMER	
T3	166C-60C	TRANSFORMER	
T4	166C-60D	TRANSFORMER	
V1	1932-0022	ELECTRON TUBE: DUAL TRIODE	
V2	1932-0022	ELECTRON TUBE: DUAL TRIODE	
V3	1923-0001	ELECTRON TUBE: 5654 PENTODE	
V4	1921-0013	TUBE:ELECTRON6CW4	
V5	1932-0022	ELECTRON TUBE: DUAL TRIODE	
V6	1921-0013	TUBE:ELECTRON6CW4	
V7	1932-0022	ELECTRON TUBE: DUAL TRIODE	
V8	1932-0022	ELECTRON TUBE: DUAL TRIODE	
V9	G-84B	LAMP:NEON SELECTED BLUE TIP	
V10	G-84B	LAMP:NEON SELECTED BLUE TIP	
V11	G-84B	LAMP:NEON SELECTED BLUE TIP	
V12	2140-0008	LAMP:NEON NE2	
V13	1923-0021	ELECTRON TUBE: 6AU6 MIN 7 PIN PENTODE	
V14	G-84D	LAMP:NEON SELECTED GREEN TIP	
V15	G-84D	LAMP:NEON SELECTED GREEN TIP	
V16	1932-0022	ELECTRON TUBE: DUAL TRIODE	
V17	G-84D	LAMP:NEON SELECTED GREEN TIP	
V18	G-84D	LAMP:NEON SELECTED GREEN TIP	
V19	G-84D	LAMP:NEON SELECTED GREEN TIP	
V20	2140-0008	LAMP:NEON NE2	
V21	2140-0008	LAMP:NEON NE2	
XT2	1200-0053	SOCKET:TUBE 7 PIN MINAT	
XT3	1200-0053	SOCKET:TUBE 7 PIN MINAT	
XT4	1200-0053	SOCKET:TUBE 7 PIN MINAT	
XV1	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV2	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV3	1200-0053	SOCKET:TUBE 7 PIN MINAT	
XV4	1200-0086	SOCKET:NUVISTOR 5-PIN	
XV5	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV6	1200-0086	SOCKET:NUVISTOR 5-PIN	
XV7	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV8	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
XV9 THRU XV12		NOT ASSIGNED	
XV13	1200-0053	SOCKET:TUBE 7 PIN MINAT	
XV14 THRU XV15		NOT ASSIGNED	
XV16	1200-0062	SOCKET:TUBE 9 PIN MINIATURE	
	G-74DK	KNOB:MANUAL SCAN	
	G-74DJ	KNOB:SCANNING	
	G-74DH	KNOB:FUNCTION	
	G-74CE	KNOB:LOCK	

See introduction to this section

Table 6-2. Replaceable Parts

Stock No.	Description	Mfr.	Mfr. Part No.	TQ	RS		
G-29E-12	SEMICON DEVICE:DIODE SILICON	28480	G29E12	1	1		
G-29J-38	SEMICON DEVICE:DIODE STEP RECOVERY	28480	G29J38	1	1		
G-29L-49	DIODE	28480	G-29L-49	2	2		
G-29M-9	SEMICON DEVICE:DIODE	28480	G29M9	2	2		
G-74CE	KNOB:LOCK	28480	G-74CE	1	1		
G-74DH	KNOB:FUNCTION	28480	G-74DH	1	1		
G-74DJ	KNOB:SCANNING	28480	G-74DJ	1	1		
G-74DK	KNOB:MANUAL SCAN	28480	G-74DK	1	1		
G-84B	LAMP:NEON SELECTED BLUE TIP	28480	G-84B	3	3		
G-84D	LAMP:NEON SELECTED GREEN TIP	28480	G-84D	5	5		
166C-60A	TRANSFORMER:SAMPLING	28480	166C-60A	1	1		
166C-60B	TRANSFORMER	28480	166C-60B	1	1		
166C-60C	TRANSFORMER	28480	166C-60C	1	1		
166C-60D	TRANSFORMER	28480	166C-60D	1	1		
1782A-65A	ASSY:SAMPLER	28480	1782A-65A	1	1		
1782A-65B	ASSY:SCAN GENERATOR	28480	1782A-65B	1	1		
0130-0001	C:VAR 7-45PF 500VDCW	72982	5030U002P0	1	1		
0130-0006	C:VAR 5-20 PF 500VDCW	72982	B2PC28R	2	1		
0132-0004	C:VAR 7-13PF 350VDCW	72982	535-0009-4R	1	1		
0140-0009	C:FXD MICA 0.01 UF 5% 500VDCW	00853	TYPE C C1110 B5	1	1		
0140-0036	C:FXD MICA 110 PF 5% 500 VDCW	04062	CM15E111J	1	1		
0140-0039	C:FXD MICA 47 PF 5% 500 VDCW	14655	CM15E470J	2	1		
0140-0054	C:FXD MICA 100 PF 10% 500 VDCW	00853	TYPE K K1310 B10	1	1		
0140-0090	C:FXD MICA 200 PF 5% 500 VDCW	00853	TYPE DR DR1320 E5	1	1		
0150-0050	C:FXD CER 100 PF 600 VDCW	00RRR	TYPE E	1	1		
0150-0052	C:FXD 0.05 UF 20% 400 VDCW	05729	20X503MC4	7	2		
0150-0081	C:FXD .01UF -20% +80% 500VDCW	72982	CK63AW103X	7	2		
0150-0091	C:FXD 1.5PF 500VDCW	72982	301-011-C0K0159C	1	1		
0150-0121	C:FXD CER 0.1UF +80%-20% 50VDCW	56289	56289	1	1		
0160-0127	C:FXD 1UF OHM 20% 25VDCW	56289	5C13	1	1		
0170-0002	C:FXD MY 2 UF 20% 400VDCW	72928	343E205M 355 SERIES	1	1		
0170-0018	C:FXD MY 1UF 5% 200VDCW	84411	HEW 4	1	1		
0170-0057	C:FXD MY 5 UF 10% 100VDCW	56289	148P133A1	1	1		
0180-0058	C:FXD ELECT 500F -10%+100% 25VDCW	56289	TYPE 30D186A1	2	1		
0683-2015	R:FXD COMP 200 OHMS 5% 1/4W	01121	CB 2015	1	1		
0683-3315	R:FXD COMP 330 OHMS 5% 1/4W	01121	CB 3315	2	1		
0684-1011	R:FXD COMP 100 OHMS 10% 1/4W	01121	CB 1011	16	4		
0686-1005	R:FXD COMP 10 OHMS 5%1/2W	01121	EB-1005	1	1		
0686-1115	R:FXD COMP 110 OHMS 5%1/2W	01121	EB 1115	1	1		
0686-1145	R:FXD COMP 110K OHMS 5%1/2W	01121	EB 1145	1	1		
0686-1215	R:FXD COMP 120 OHMS 5%1/2W	01121	EB1215	1	1		
0686-2035	R:FXD COMP 20K OHMS 5% 1/2W	01121	EB2035	1	1		
0686-2225	R:FXD COMP 2200 OHMS 5% 1/2W	51121	EB2225	1	1		
0686-2245	R:FXD COMP 220K OHMS 5% 1/2W	51121	EB2245	1	1		
0686-4745	R:FXD COMP 470K OHMS 5% 1/2W	01121	EB 4745	1	1		
0686-7525	R:FXD COMP 7500 OHMS 5% 1/2W	01121	EB 7525	1	1		
0687-1001	R:FXD COMP 10 OHMS 10% 1/2W	01121	EB 1001	1	1		
0687-1011	R:FXD COMP 100 OHMS 10% 1/2W	01121	EB 1011	2	1		
0687-1031	R:FXD COMP 10K OHMS 10% 1/2W	01121	EB 1031	1	1		
0687-1041	R:FXD COMP 100K OHM 10% 1/2W	01121	EB1041	1	1		

See introduction to this section

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

Stock No.	Description	Mfr.	Mfr. Part No.	TQ	RS		
0687-1051	R:FXD COMP 1M OHMS 10% 1/2W	01121	EB 1051	1	1		
0687-1061	R:FXD COMP 10M OHMS 10% 1/2W	01121	EB 1061	2	1		
0687-1241	R:FXD COMP 120K OHMS 10% 1/2W	01121	EB 1241	1	1		
0687-1541	R:FXD COMP 150K OHMS 10% 1/2W	01121	EB 1541	1	1		
0687-2201	R:FXD COMP 22 OHMS 10% 1/2W	01121	EB 2201	2	1		
0687-2221	R:FXD COMP 2200 OHMS 10% 1/2W	01121	EB 2221	1	1		
0687-2261	R:FXD COMP 22M OHMS 10% 1/2W	01121	EB 2261	2	1		
0687-2701	R:FXD COMP 27 OHMS 10% 1/2W	01121	EB 2701	1	1		
0687-3341	R:FXD COMP 330K OHMS 10% 1/2W	01121	EB 3341	1	1		
0687-3931	R:FXD COMP 39K OHMS 10% 1/2W	01121	EB 3931	4	1		
0687-3941	R:FXD COMP 390K OHMS 10% 1/2W	01121	EB 3941	1	1		
0687-4701	R:FXD 47 OHMS 10% 1/2W	01121	EB4701	2	1		
0687-4711	R:FXD COMP 470 OHMS 10% 1/2W	01121	EB 4711	1	1		
0687-4741	R:FXD COMP 470K OHMS 10% 1/2W	01121	EB 4741	1	1		
0687-4751	R:FXD COMP 4.7M OHMS 10% 1/2W	01121	EB 4751	1	1		
0687-5621	R:FXD COMP 5600 OHMS 10% 1/2W	01121	EB 5621	1	1		
0687-6801	R:FXD COMP 68 OHMS 10% 1/2W	01121	EB 6801	1	1		
0687-8231	R:FXD COMP 82K OHMS 10% 1/2W	01121	EB 8231	1	1		
0689-1245	R:FXD COMP 120K OHM 5% 1W	01121	GB 1245	1	1		
0689-2435	R:FXD COMP 24K OHMS 5% 1W	01121	GB 2435	1	1		
0689-6835	R:FXD COMP 68K OHMS 5% 1W	01121	GB 6835	1	1		
0690-1831	R:FXD COMP 18K OHMS 10% 1W	01121	GB 1831	1	1		
0690-3331	R:FXD COMP 33K OHMS 10% 1W	01121	GB 3331	1	1		
0692-1245	R:FXD COMP 120K OHMS 5% 2W	01121	HB 1245	1	1		
0692-6835	R:FXD COMP 68K OHMS 5% 2W	01121	HB 6835	1	1		
0693-1031	R:FXD COMP 10K OHMS 10% 2W	01121	HB 1031	1	1		
0693-1521	R:FXD COMP 1500 OHMS 10% 2W	01121	HB 1521	1	1		
0693-1831	R:FXD COMP 18K OHMS 10% 2W	01121	HB 1831	2	1		
0693-2231	R:FXD COMP 22K OHMS 10% 2W	01121	HB 2231	1	1		
0693-8231	R:FXD COMP 82K OHMS 10% 2W	01121	HB 8231	1	1		
0727-0100	R:FXD DEPC 1000 OHMS 1% 1/2W	19701	CD 1/2CR5	1	1		
0727-0111	R:FXD DEPC 1650 OHMS 1% 1/2W	19701	DC 1/2CR5	1	1		
0727-0145	R:FXD DEPC 6960 OHMS 1% 1/2W	19701	DC 1/2CR5	2	1		
0727-0170	R:FXD DEPC 18K OHMS 1% 1/2W	19701	DC 1/2CR5	1	1		
0727-0201	R:FXD DEPC 71.56K OHMS 1% 1/2W	19701	DC1/2CR571561 F	1	1		
0727-0208	R:FXD 100K 1% 1/2W	19701	DC1/2CR5	1	1		
0727-0222	R:FXD DEPC 214K OHM 1% 1/2W	19701	DC 1/2C R5	1	1		
0727-0244	R:FXD DEPC 500K OHM 1% 1/2W	19701	DC 1/2A R5	1	1		
0727-0274	R:FXD DEPC 1M OHM 1% 1/2W	19701	DC 1/2 R5	3	1		
0730-0037	R:FXD DEPC 19K OHMS 1% 1W	19701	DC 1	2	1		
0730-0044	R:FXD DEPC 27.5K OHMS 1% 1W	19701	DC1 R5	2	1		
0767-0006	R:FXD 6.5K 5% 3W	07115	LPI-3	1	1		
0767-0008	R:FXD MET FLM 10K OHMS 5% 3W	07115	LPI 3	1	1		
0774-0001	R:FXD MET FLM 4000 OHMS 10M 5W	07115	LPI 5	1	1		
1200-0053	SOCKET:TUBE 7 PIN MINAT	71785	11151-11	5	1		
1200-0062	SOCKET:TUBE 9 PIN MINIATURE	71785	1215111060	6	2		
1200-0086	SOCKET:NUVISTOR 5-PIN	71785	1336510009	2	1		
1250-0083	CONNECTOR:BNC	91737	UG-1094/U	3	1		
1251-0070	JACK:PHONE PEN LIFT	82389	2J-1581	1	1		
1251-0136	CONNECTOR:32 PIN MALE	02660	26410032P	1	1		

See introduction to this section

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

Stock No.	Description	Mfr.	Mfr. Part No.	TQ	RS		
1850-0062	TRANSISTOR:SPL2N404A	28480	1850-0062	2	2		
1850-0091	TRANSISTOR GERMANIUM 2N2048 PNP	87216	2N2048	2	2		
1854-0005	TRANSISTOR 2N708NPNSILICONPLANAR	07263	2N708	1	1		
1901-0025	DIODE:SILICON 50 MA	98925	CSD2693	2	2		
1901-0033	SEMICON DEVICE DIODE 1N485B	07910	1N485B	2	2		
1901-0034	SEMICON DEVICE DIODE JUNCTION	28480	1901 0034	2	2		
1901-0040	DIODE:SILICON	28480	1901-0040	1	1		
1902-0031	SEMICON DEVICE DIODE	28480	1902 0031	3	3		
1902-0064	DIODE:ZENER 7.5V 5% 400MW	01281	1902-0064	2	2		
1912-0007	SEMICON DEVICE:DIODE GERMANIUM	03508	TD2	1	1		
1921-0013	TUBE:ELECTRON6CW4	86684	6CW4	2	2		
1923-0001	ELECTRON TUBE: 5654 PENTODE	33173	5654	1	1		
1923-0021	ELECTRON TUBE: 6AU6 MIN 7 PIN	33173	6AU6	1	1		
1932-0022	ELECTRON TUBE: DUAL TRIODE	73445	6DJ8/ECC 88	6	6		
2100-0092	R:VAR COMP 10K OHMS 20% LIN 1/5W	28480	2100 0092	2	1		
2100-0096	R:VAR COMP 1M OHMS 30% LIN 1/5W	28480	2100 0096	1	1		
2100-0310	R:VAR 1 MEGOHM MANUAL SCAN	01121	TYPEJ	1	1		
2100-0419	R:VAR WW 50 OHM LIN 10% 2W	28480	2100 0419	1	1		
2100-0420	R:VAR WW 15K OHM LIN 10% 2W	28480	2100-0420	1	1		
2100-0421	R:VAR COMP LIN 5K OHM 20% 1/5W	28480	2100-0421	2	1		
2100-0422	R:VAR WW LIN 10K OHM 20% 5W	28480	2100-0422	1	1		
2100-0423	R:VAR COMP LIN 500K OHM 20% 1/5W	28480	2100-0423	1	1		
2100-0426	R:VAR 20K HORIZONAL AMPLITUDE	11237	70	1	1		
2140-0008	LAMP:NEON NE2	24455	NE2	3	3		
3100-0401	SWITCH ROT 2-SECT 4-POS SCANNING	28480	3100-0401	1	1		
3100-0402	SWITCH ROT 1-SECT 3-POS FUNCTION	28480	3100-0402	1	1		
9140-0018	COIL:FXD 10H	28480	9140-0018	2	1		
9140-0024	COIL:FXD 0.68 UH	28480	9140-0024	1	1		
9140-0077	COIL FXD RF: 2.2UHY	28480	9140 0077	1	1		
9140-0146	COIL FXD RF 10.0 UHY	28480	9140 0146	1	1		

See introduction to this section

APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 1 of 2)

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

CODE NO.	MANUFACTURER	ADDRESS
00136	McCoy Electronics	Mount Holly Springs, Pa.
00334	Humidial Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Products Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Company, Ordill Division (Capacitors)	Marion, Ill.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	Pacific Semiconductors, Inc.	Culver City, Calif.
01295	Texas Instruments, Inc. Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Ind.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co., Electronics Division	Burbank, Calif.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prods., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Division	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire & Cable Company	Redwood City, Calif.
04870	P. M. Motor Co.	Chicago 44, Ill.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp., Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05624	Barber Colman Co.	Rockford, Ill.
05729	Metropolitan Telecommunications Corp., Matro Cap. Div.	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
06004	The Bassick Co.	Bridgeport, Conn.
06136	Ward Leonard Electric	Los Angeles, Calif.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06751	U.S. Semcor Div. of Nuclear Corp. of Am.	Phoenix, Ariz.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
07115	Corning Glass Works Electronic Components Dept.	Bradford, Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08717	Sloan Company	Burbank, Calif.
08718	Cannon Electric Co. Phoenix Div.	Phoenix, Ariz.
08792	CBS Electronics Semiconductor Operations, Div. of C.B.S. Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09250	Electro Assemblies, Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11312	Microwave Electronics Corp.	Palo Alto, Calif.
11534	Duncan Electronics, Inc.	Santa Ana, Calif.
11711	General Instrument Corporation Semiconductor Division	Newark, N.J.
11717	Imperial Electronics, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
14298	American Components, Inc.	Conshocken, Pa.
14655	Cornell Dubilier Elec. Corp.	So. Plainfield, N.J.
15909	The Daven Co.	Livingston, N.J.
16688	De Jur-Amsco Corporation	Long Island City 1, N.Y.
16758	Delco Radio Div. of G. M. Corp.	Kokomo, Ind.
18873	E. I. DuPont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E., Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
37942	P. R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C. A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer and Inst. Co.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson & Co., Inc.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Owosso, Mich.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Div. of Daystrom, Inc.	Newark, N.J.
66295	Wittek Manufacturing Co.	Chicago 23, Ill.
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Electronic Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C. P. Clare & Co.	Chicago, Ill.
71528	Standard-Thomson Corp., Clifford Mfg. Co. Div.	Waltham, Mass.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71753	A. O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72354	John E. Fast & Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72758	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73138	Helipot Div. of Beckman Instruments, Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North American Phillips Co., Inc.	Hicksville, N.Y.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.

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H4-1 Dated: December 1962
H4-2 Dated: April 1962

APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 2 of 2)

CODE NO.	MANUFACTURER	ADDRESS
73734	Federal Screw Products Co.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74455	J. H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E. F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Division of Cinch Mfg. Corp.	Chicago, Ill.
75378	James Knights Co.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littelfuse Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C. W. Marwedel	San Francisco, Calif.
76433	Micamold Electronic Mfg. Corp.	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J. W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	Bendix Pacific Division of Bendix Corp.	No. Hollywood, Calif.
77221	Phaostron Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine and Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signal Indicator Corp.	New York, N.Y.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products	Elizabeth, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Association Any brand tube meeting EIA standards	Washington, D.C.
80207	Unimax Switch, Div. of W. L. Maxson Corp.	Wallingford, Conn.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Fulton Controls Co.	Columbus 16, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80583	Hammerlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81312	Winchester Electronics Co., Inc.	Norwalk, Conn.
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div., Industr. Tube Operations	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Ill.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Allen B. DuMont Labs., Inc.	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc., Electronic Tube Div.	Emporium, Pa.
82376	Astron Co.	East Newark, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods.	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Manufacturing Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Union, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronics, Inc.	New York, N.Y.
84396	A. J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A. B. Boyd Co.	San Francisco, Calif.
85474	R. M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86197	Clifton Precision Products	Clifton Heights, Pa.
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corp. (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baler Co.	Chicago, Ill.
89665	United Transformer Co.	Chicago, Ill.
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Brothers, Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Philadelphia, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91921	Minneapolis-Honeywell Regulator Co., Micro-Switch Division	Freeport, Ill.
92196	Universal Metal Products, Inc.	Bassett Puente, Calif.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94144	Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div., California Street Plant	Newton, Mass.
94148	Scientific Radio Products, Inc.	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Paterson, N.J.
94310	Tru Ohm Prod. Div. of Model Engineering and Mfg. Co.	Chicago, Ill.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94928	Telefunken	Berlin, W. Germany
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95354	Methode Mfg. Co.	Chicago, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Division of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner Div. of Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic and Precision Mfg. Co.	Yonkers, N.Y.
97966	CBS Electronics, Div. of C.B.S., Inc.	Danvers, Mass.
97979	Reon Resistor Corp.	Yonkers, N.Y.
98141	Axel Brothers Inc.	Jamaica, N.Y.
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Carad Corp.	Redwood City, Calif.
98734	Palo Alto Engineering Co., Inc.	Palo Alto, Calif.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. of Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Ill.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

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

0000F	Malco Tool and Die	Los Angeles, Calif.
0000I	Telefunken (c/o American Elite)	New York, N.Y.
0000M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
0000N	Nahm-Bros. Spring Co.	San Leandro, Calif.
0000P	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
0000T	Texas Instruments, Inc. Metals and Controls Div.	Versailles, Ky.
0000U	Tower Mfg. Corp.	Providence, R.I.
0000W	Webster Electronics Co. Inc.	New York, N.Y.
0000X	Spruce Pine Mica Co.	Spruce Pine, N.C.
0000Y	Midland Mfg. Co. Inc.	Kansas City, Kans.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AA	British Radio Electronics Ltd.	Washington, D.C.
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CC	Computer Diode Corp.	Lodi, N.J.
000EE	A. Williams Manufacturing Co.	San Jose, Calif.
000FF	Carmichael Corrugated Specialties	Richmond, Calif.
000GG	Goshen Die Cutting Service	Goshen, Ind.
000HH	Rubbercraft Corp.	Torrance, Calif.
000II	Birtcher Corporation, Industrial Division	Monterey Park, Calif.
000KK	Amatom	New Rochelle, N.Y.
000LL	Avery Label	Monrovia, Calif.
000MM	Rubber Eng. & Development	Hayward, Calif.
000NNA	"N" D Manufacturing Co.	San Jose 27, Calif.
000PP	Atohm Electronics,	Sun Valley, Calif.
000QQ	Cooltron	Oakland, Calif.
000RR	Radio Industries	Des Plaines, Ill.
000SS	Control of Elgin Watch Co.	Burbank, Calif.
000TT	Thomas & Betts Co., The	Elizabeth 1, N.J.
000WW	California Eastern Lab.	Burlingame, Calif.
000XX	Methode Electronics, Inc.	Chicago 31, Ill.
000YY	S. K. Smith Co.	Los Angeles 45, Calif.

From: F.S.C. Handbook Supplements
H4-1 Dated: December 1962
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00015-29
Revised: 20 December 1962

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MANUAL CHANGES

MODEL 1782A

DISPLAY SCANNER

Manual Serial Prefixed: 305-
Manual Printed: 2/63

To adapt this manual to instruments with other serial prefixes check for errata below, and make changes shown in tables.

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
ALL SERIALS	ERRATA		

ERRATA: Paragraph 5-28 applies to the Model 175A Oscilloscope, but not to the Model 1782A Display Scanner.

Page 5-6,
Add Table 5-3, see attached sheet.

C4: Change to Stock No. 0132-0002, C: var .7 to 3.0 pf 350 vdcw.
C11: Change to hp Stock No. 0140-0040, C: fxd, mica 75 pf ±5%, 500 vdcw.
CR14 and CR15: Change to hp Stock No. 1901-0085, semicon device: diode.
J4: Change to hp Stock No. 1251-0205, Jack Phone PEN LIFT.
L1 and L2: Change to hp Stock No. 9140-0046, Coil: fxd, 1.2 uh.
R1 and R6: Change to hp Stock No. 0683-2215, R: fxd, comp 220 ohms ±5%, 1/4W.
R32: Change to hp Stock No. 0686-1515, R: fxd, 150 ohms ±5%, 1/2W.
R36: Change to hp Stock No. 2100-0388, R: var, ww 20 ohms, lin ±20%, 2W.

Table 5-3. Condensed Adjustment Procedure

Test	Ext. Equip. Required	Procedure	Adjust
1. Stretcher Gate Width	Test Oscilloscope	a. SWEEP TIME .... 1 μSEC/CM SWEEP MODE .... FREE RUN TRIGGER SOURCE ..... INT TRIGGER SLOPE ..... (+) FUNCTION... ARM RECORDER SCANNING ..... MANUAL MANUAL SCAN..... ..... place marker on screen b. Connect probe from Test Oscilloscope to collector of Q3 (TP1).	Stretcher Gate Width for 1.2 μsec width at 1/2-amplitube point (positive-going portion).
2. Comparator Compensation	Test Oscilloscope; Square Wave Generator	a. SWEEP TIME ... 10 μSEC/CM MANUAL SCAN..... fully cw b. Disconnect foam-covered wire from 175A sweep board. c. Apply 8 kc square wave (about 7v peak) to the disconnected wire. d. Connect Test Oscilloscope to pin 3 of V5 (TP2).	Comparator Compensation C1 for best square wave. (Reconnect wire to sweep board.)
3. Scan Start and Termination	None	MANUAL SCAN ..... fully ccw	a. SCAN START to position marker 2 mm after start of sweep. b. MANUAL SCAN: fully cw. c. Scan Termination R109 to position marker 11.0 cm after start of sweep.
4. Horizontal DC Level	DC Voltmeter	a. SWEEP TIME ... 20 μSEC/CM MANUAL SCAN..... fully ccw b. Connect Voltmeter to HORIZ OUTPUT.	a. HORIZ DC LEVEL for zero volts. b. Disconnect Voltmeter. c. SCANNING: EXTERNAL d. Short EXTERNAL INPUT. e. Horizontal Level (Ext) R82 to position marker 2 mm after start of trace.
5. Input Attenuator Compensation	Test Oscilloscope; Square Wave Generator	a. Apply 8 kc square wave to vertical INPUT, amplitude 6 cm. b. Connect Test Oscilloscope to pin 8 of V1 (TP3).	Input Attenuator Compensation C2 for best square wave.
6. Sampling Efficiency and Vertical Feedback	Test Oscilloscope; DC Voltmeter	a. SWEEP TIME ... 50 μSEC/CM SCANNING ..... EXTERNAL b. Connect sweep output (15v peak max) from Test Oscilloscope to EXTERNAL INPUT. c. Apply 10 kc square wave to vertical INPUT, amplitude 6 cm. d. Connect Test Oscilloscope (dc-coupled) to pin 3 of V1 (TP4); sweep time: 5 msec/cm	a. Vertical Feedback R39 for decay toward center from both sides of square wave. b. Sampler Storage Capacitor C14 to make first sample same amplitude as succeeding samples. c. Disconnect Square Wave Generator. d. (See over)

Table 5-3. Condensed Adjustment Procedure (Cont'd)

Test	Ext. Equip. Required	Procedure	Adjust
6. Sampling Effeciency and Vertical Feedback (Cont'd)			d. SWEEP MODE . . . . . FREE RUN VERTICAL POSITION. . . . . center trace e. Connect Voltmeter to VERT OUTPUT. f. VERT DC LEVEL for zero volts. g. Readjust R39 for no decay between samples.
7. Sampling Gate Neutralization	Test Oscilloscope; Square Wave Generator	a. SWEEP TIME . . . . 2 μSEC/CM SWEEP MODE . . . . . PRESET b. Connect sweep output from Test Oscilloscope to EXTERNAL INPUT, and vertical input to VERT OUTPUT. c. Apply 200 kc square wave to vertical INPUT, amplitude 6 cm.	a. Sampler Neutralization C4 for best square wave. b. Recheck sampling efficiency, step 6.
8. Stabilizer DC Balance	DC Voltmeter	a. SWEEP TIME . . . 50 μSEC/CM SWEEP MODE . . . . FREE RUN SCANNING . . . . . STABILIZED b. Center trace vertically. c. Connect Voltmeter to pin 7 of V8 (TP5).	Pen Speed Stabilizer DC Balance R63 for maximum negative voltage.

SCHEMATIC DIAGRAM NOTES

1. Resistance in ohms, capacitance in pf, inductance in μh unless otherwise noted.

2. Signal lines weighted. Feedback lines weighted with dashes.

3. Conditions of waveform and dc voltage measurements:

SWEEP TIME	1 μSEC/CM
SWEEP MODE	FREE RUN
HORIZONTAL DISPLAY	X1
HORIZONTAL POSITION	to place start of sweep at left graticule edge
VERTICAL POSITION	to position trace on bottom graticule line
SCANNING	MANUAL
MANUAL SCAN	to place marker at center of bottom graticule line
FUNCTION	RECORD

Note

Waveforms marked with a star (★) were taken by switching the function from ARM RECORDER to RECORD with SCANNING in LINEAR and STABILIZED.

Length of sweep time:

LINEAR	80 seconds
STABILIZED	20 seconds

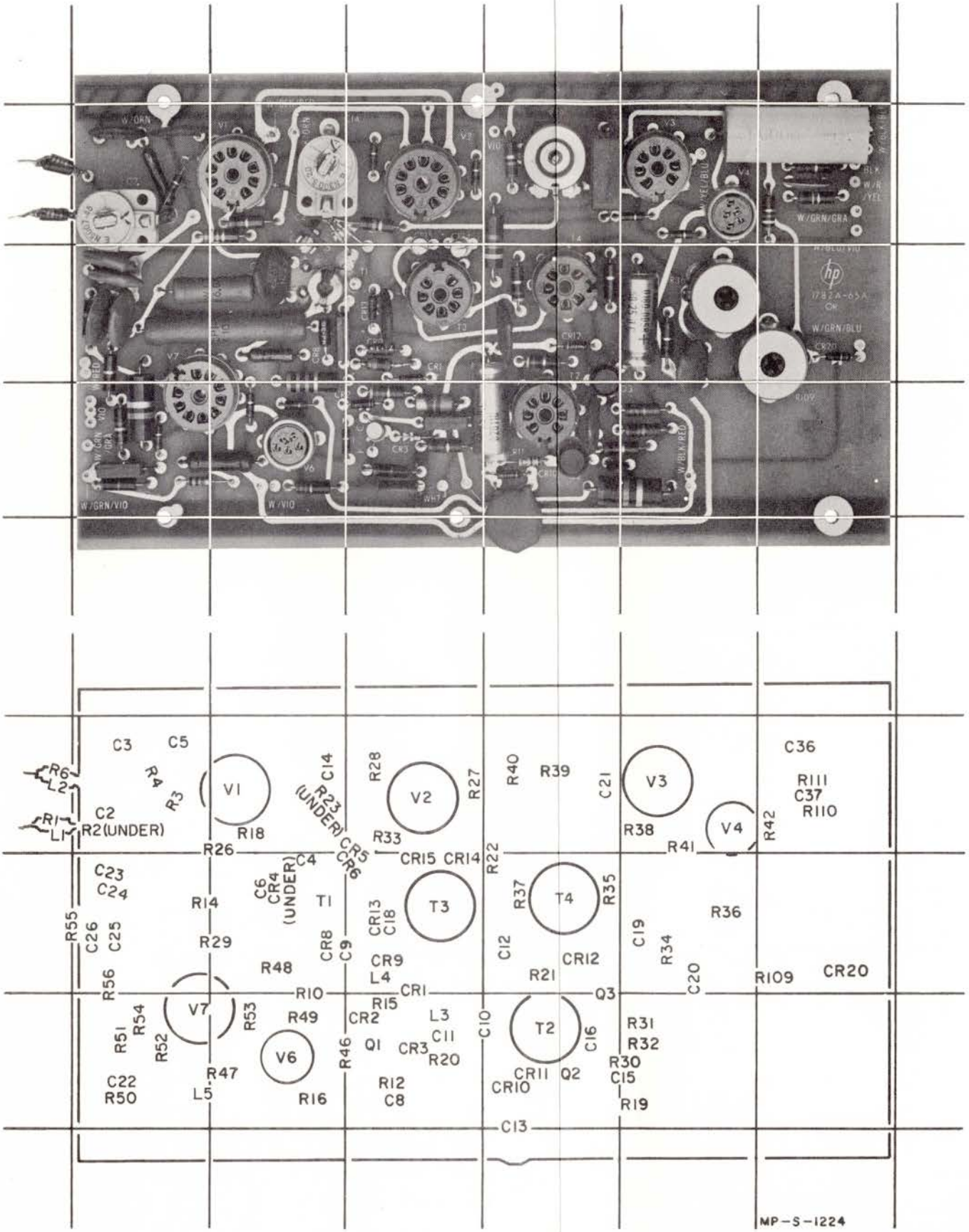


Figure 5-6. Component Locations, A1 Sampler Assembly

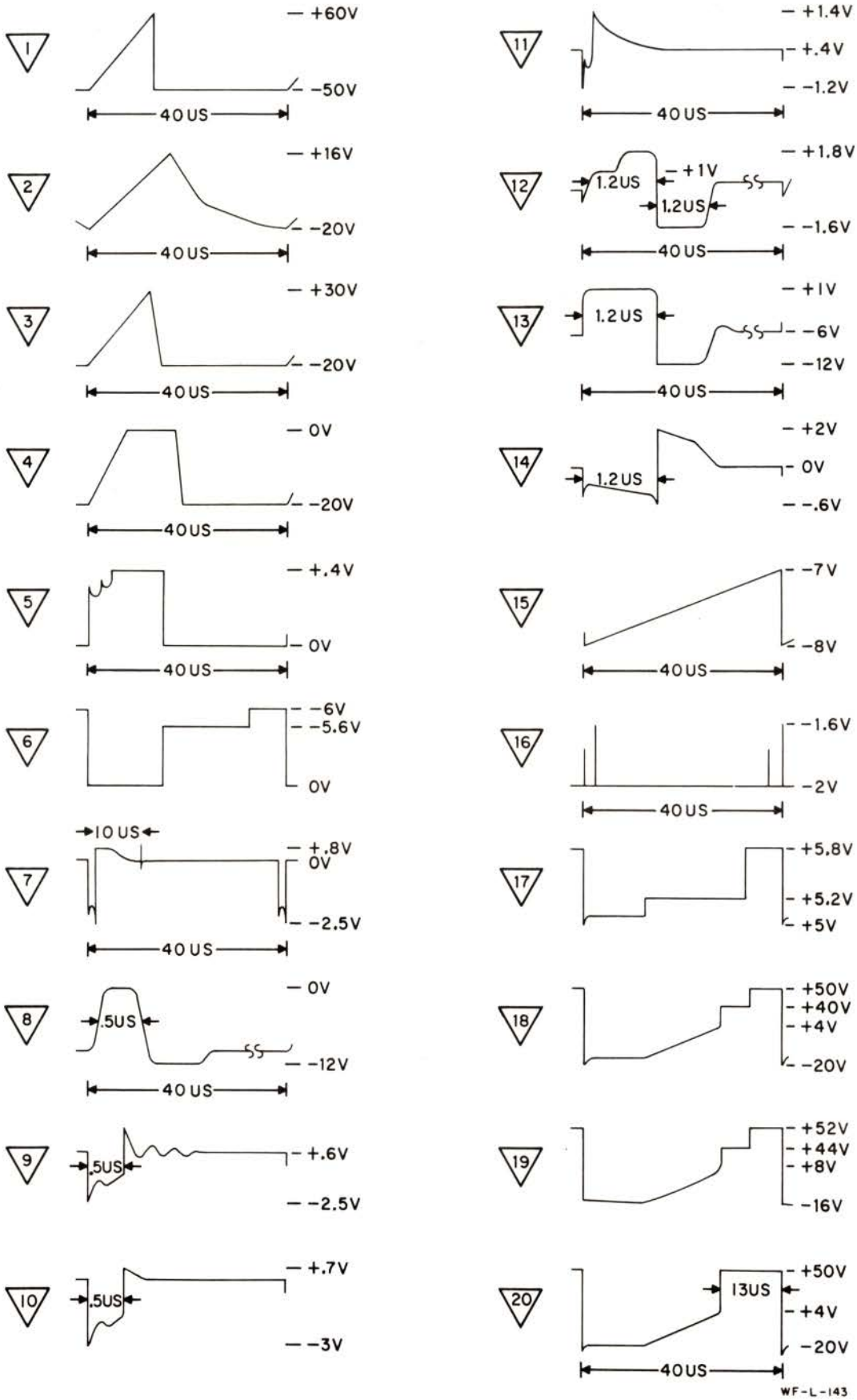
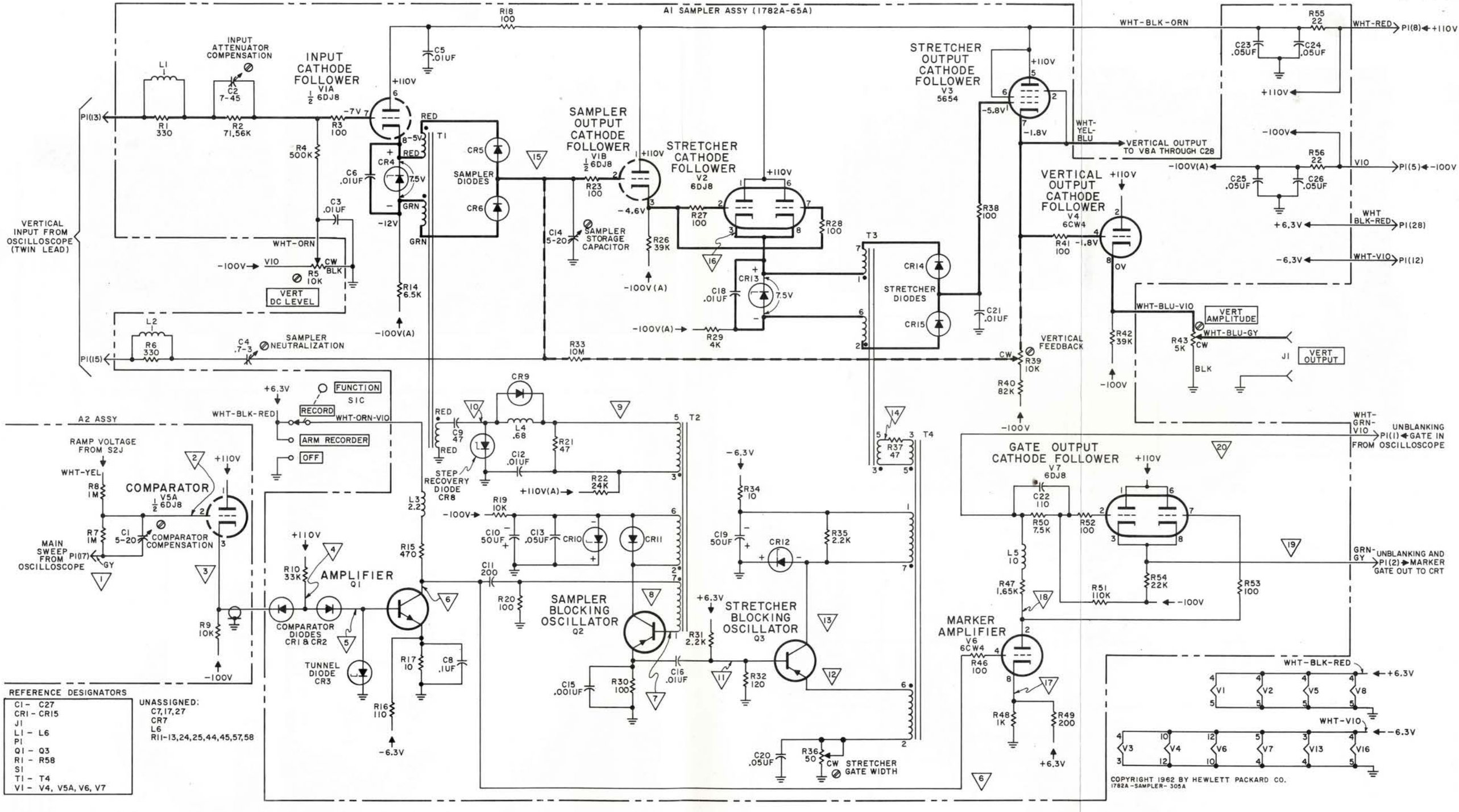
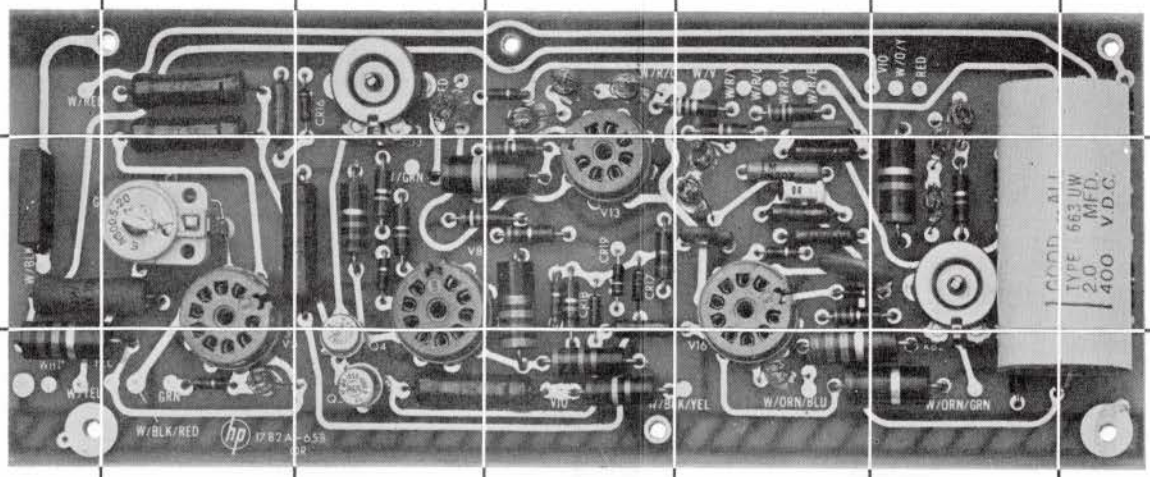


Figure 5-7. Sampler Waveforms (See schematic diagram notes, page 5-7)



01550-1

Figure 5-8. Sampler Schematic



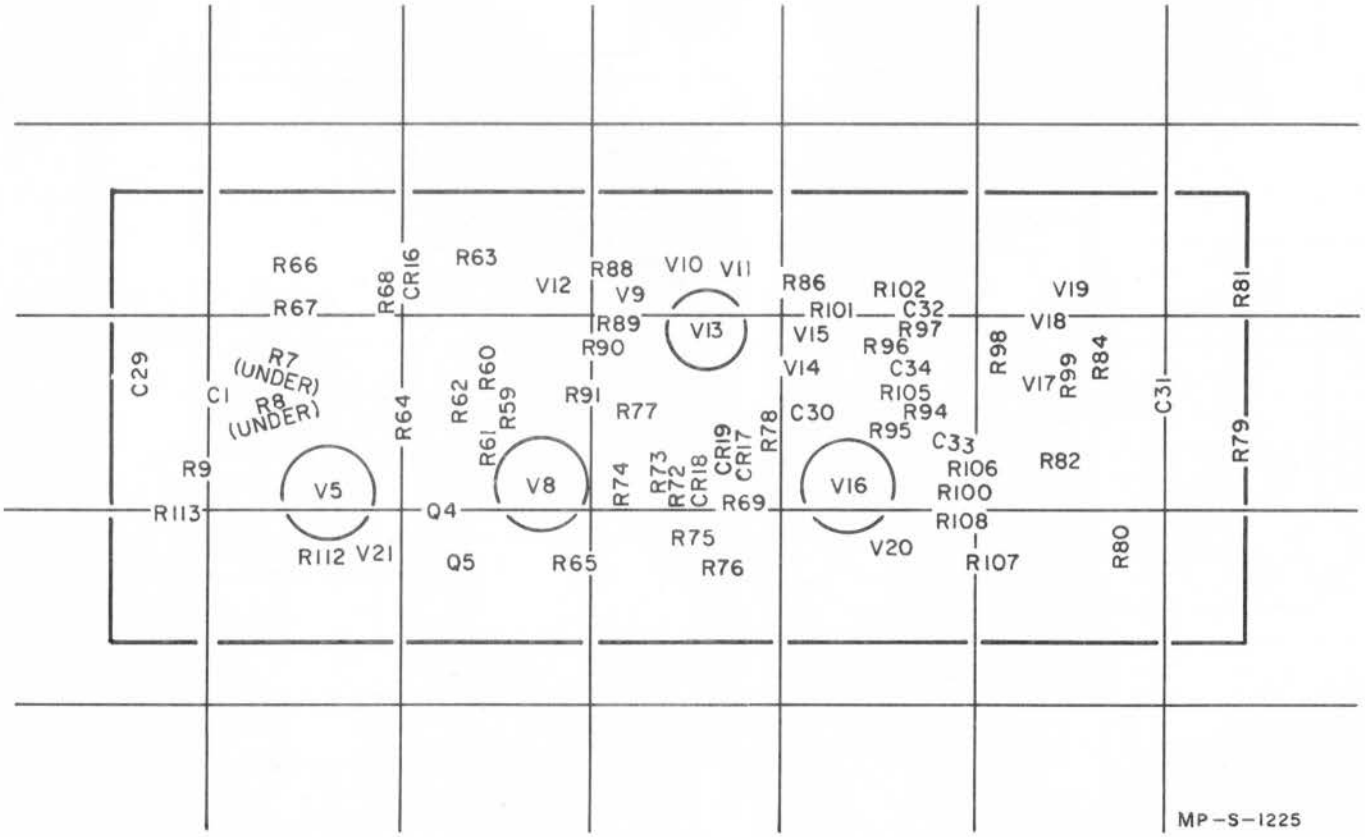


Figure 5-9. Component Locations, A2 Scan Generator Assembly

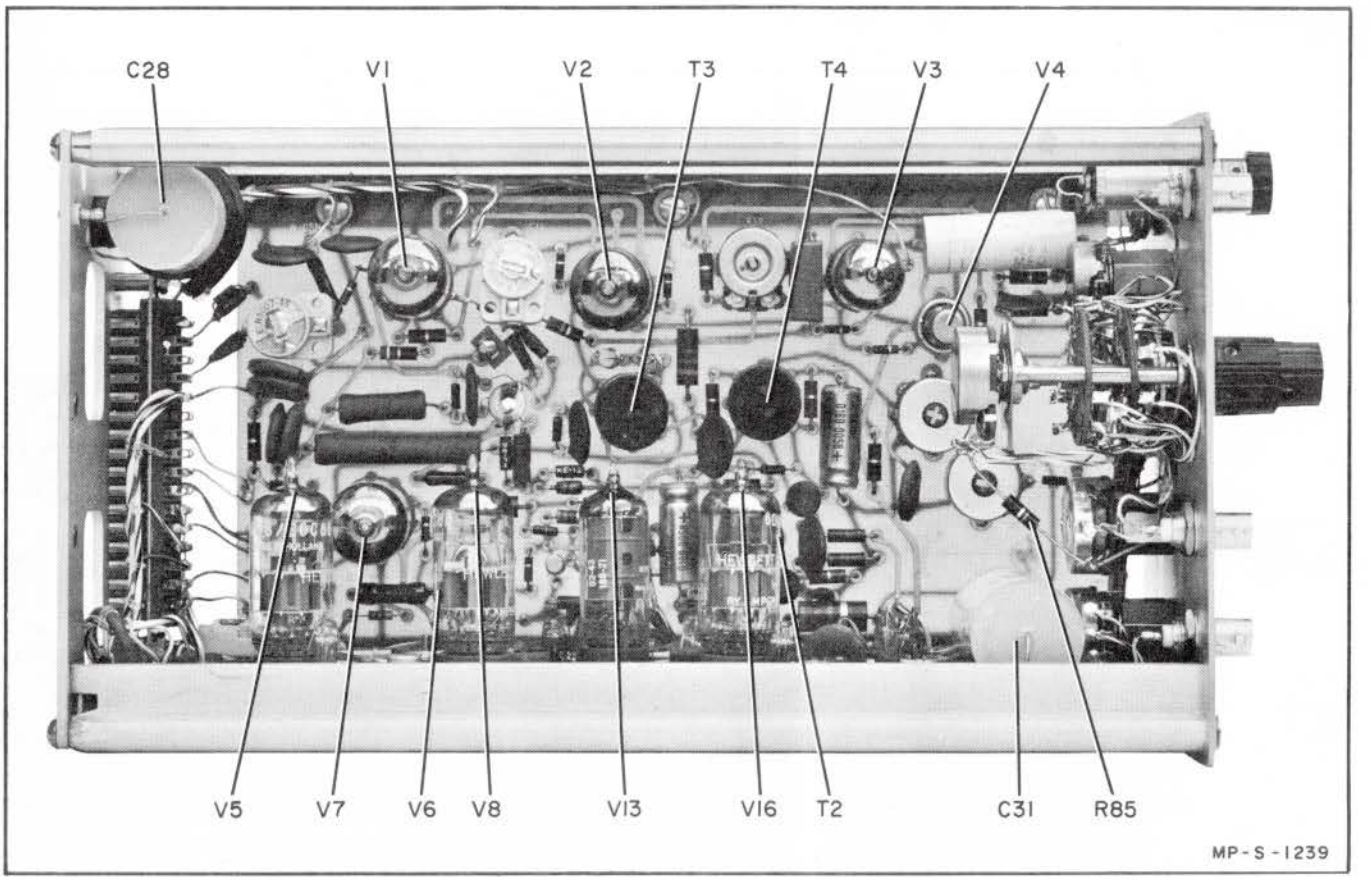


Figure 5-10. Component and Tube Locations, Bottom View

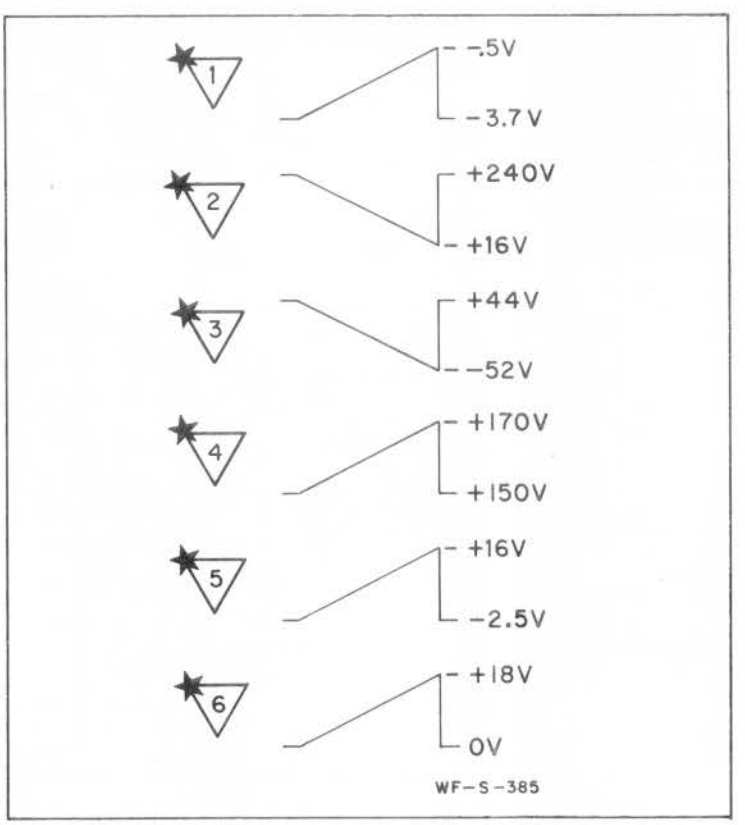


Figure 5-11. Scan Generator Waveforms (See schematic diagram notes, page 5-7).

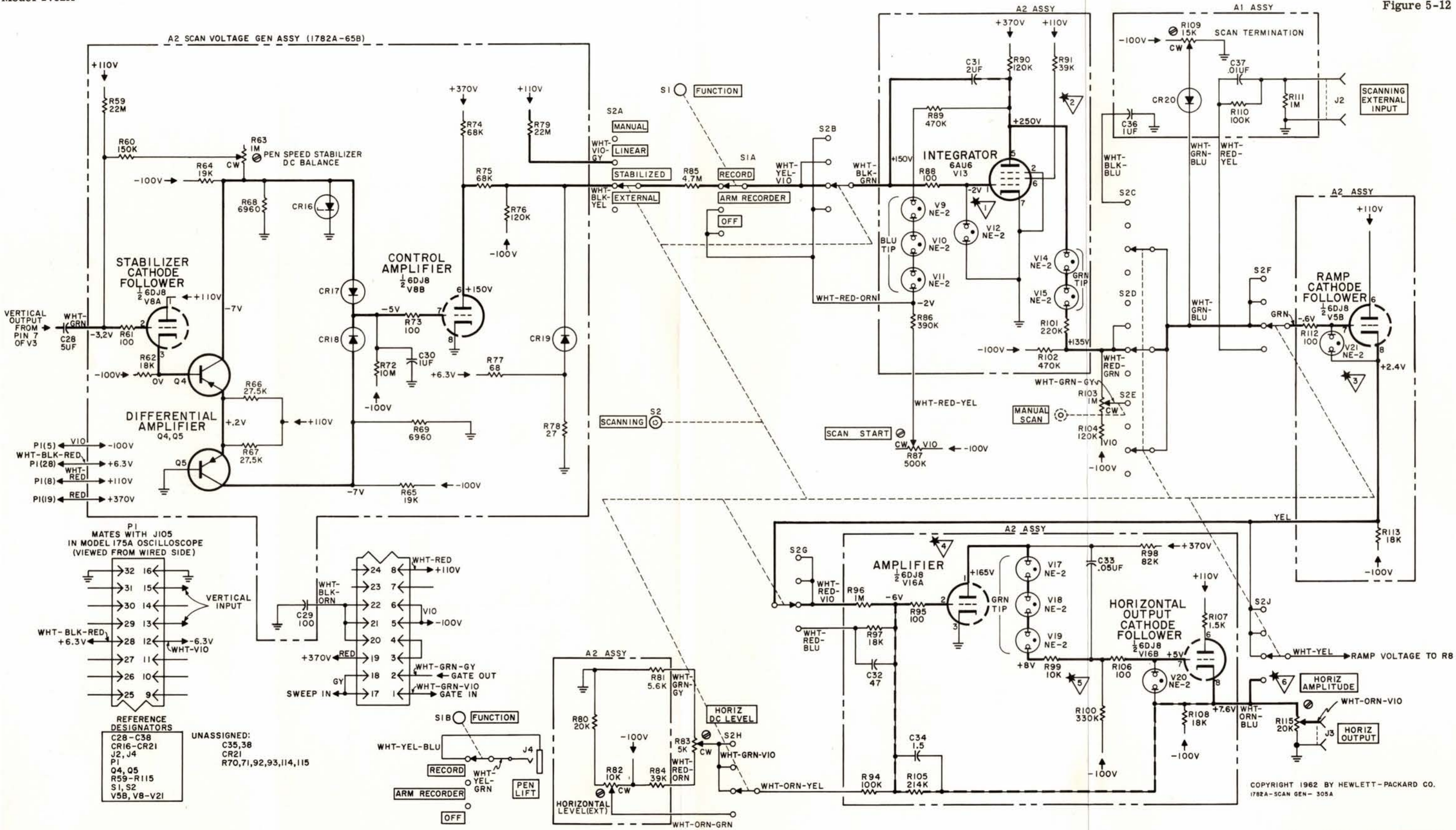


Figure 5-12. Scan Generator