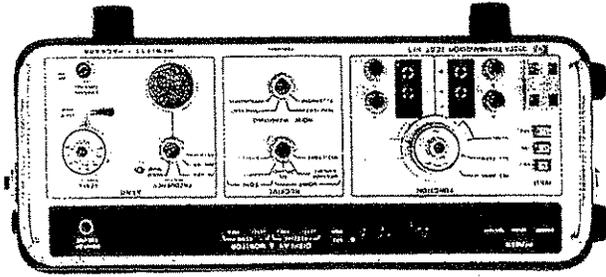
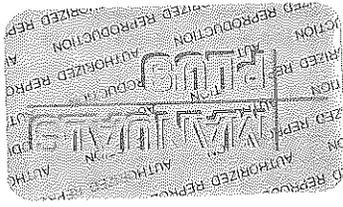

Model 3552A
Transmission Test Set

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TRANSMISSION TEST SET 3552A

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SOUTH QUEENSFERRY, WEST LOTHIAN, SCOTLAND

Microfiche Part No. 03552-90059

Manual Part No. 03552-90004

To help minimize the possibility of electrical fire or shock hazards, do not expose this instrument to rain or excess moisture.

WARNING

Any changes made in instruments with serial numbers greater than those stated on this title page will be noted on a change sheet supplied with this manual. If the serial number of your instrument is lower than that stated above, the manual can contain revisions that do not apply to your instrument. Backdating information located in Section VI adapts this manual to these instruments.

IMPORTANT NOTICE

Serial Number: 1604A00261 and higher
1652U00611 and higher

**OPERATING AND SERVICE MANUAL
MODEL 3552A
TRANSMISSION TEST SET**



HEWLETT  PACKARD

CERTIFICATION

Hewlett-Packard Company certifies that this instrument met its published specifications at the time of shipment from the factory. Hewlett-Packard Company further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

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This Hewlett-Packard product is warranted against defects in materials and workmanship for a period of one year from the date of shipment, except that in the case of certain components, if any, listed in Section I of this operating manual, the warranty shall be for the specified period. Hewlett-Packard will, at its option, repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard, and provided the proper preventive maintenance procedures as listed in this manual are followed. Repairs necessitated by misuse of the product are not covered by this warranty. NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. HEWLETT-PACKARD IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

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SECTION I GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. The hp-Model 3552A Transmission Test Set is designed for use in testing telecommunications equipment. It provides calibrated test signals while simultaneously making frequency or level measurements on voice frequency systems, program systems and data circuits. Some of the features provided are dial and hold capabilities, input impedances of 150 Ω , 600 Ω , and 900 Ω , choice of four noise weighting filters and digital readout of level or frequency.

1-3. This manual contains operating and service information necessary for operating and maintaining the 3552A. Included are specifications, installation information, operating instructions, circuit theory, performance tests, adjustment procedures, a complete replaceable parts list, troubleshooting information and schematics. Throughout this manual, the 3552A Transmission Test Set will be referred to as Test Set.

1-4. Section I of this manual contains general information about the Test Set. Information on specifications and instrument and manual identification is given.

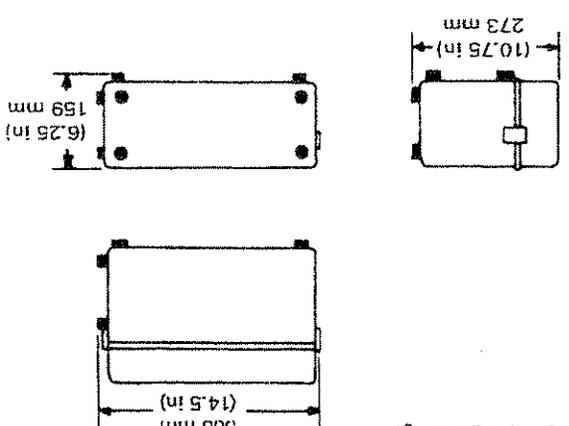
1-5. SPECIFICATIONS.

1-6. Table 1-1 is a complete list of the critical specifications.

Table 1-1. Specifications.

RECEIVER:		TRANSMITTER:																																					
INPUT LEVEL (dBm)	OUTPUT LEVEL (dBm)	FREQUENCY	FREQUENCY																																				
150 Ω Impedance not specified below 500 Hz or -65 dBm TC \pm 0.005 dB/ $^{\circ}$ C at T < 15 $^{\circ}$ C and T > 35 $^{\circ}$ C Noise Measurement Accuracy: Message circuit noise: \pm 1 dB (-70 dBm to -5 dBm) \pm 2 dB (-90 dBm to -70 dBm) Noise-with tone: \pm 1 dB (-70 dBm to -5 dBm) \pm 2 dB (-80 dBm to -70 dBm) Noise-to-ground: \pm 1 dB (-30 dBm to +35 dBm) \pm 2 dB (-50 dBm to -30 dBm) Frequency Measurement Accuracy: \pm 1 count	150 Ω Impedance not specified below 500 Hz TC \pm 0.005 dB/ $^{\circ}$ C at T < 15 $^{\circ}$ C and T > 35 $^{\circ}$ C Harmonic Distortion: \pm 50 dB (THD 100 Hz to 4 kHz); \pm 40 dB (THD 40 Hz to 100 Hz and 4 kHz to 20 kHz); \pm 55 dB (all harmonics 100 Hz to 4 kHz); \pm 30 dB (THD 20 kHz - 60 kHz); \pm 60 dB (THD 800 Hz Hold Tone). BRIDGING LOSS: $>$ 0.2 dB	Level Accuracy: \pm 1 count Frequency Accuracy: \pm 1 count Level Accuracy: \pm 1 count	Level Accuracy: \pm 1 count Frequency Accuracy: \pm 1 count																																				
<table border="1"> <tr> <td>15</td> <td>30</td> <td>65</td> </tr> <tr> <td>\pm 0.3 dB</td> <td>\pm 0.1 dB</td> <td>\pm 0.3 dB</td> </tr> <tr> <td>40 Hz 100 Hz</td> <td>1 kHz</td> <td>20 kHz 60 kHz</td> </tr> </table>	15	30	65	\pm 0.3 dB	\pm 0.1 dB	\pm 0.3 dB	40 Hz 100 Hz	1 kHz	20 kHz 60 kHz	<table border="1"> <tr> <td>10</td> <td>30</td> <td>60</td> </tr> <tr> <td>\pm 0.5 dB</td> <td>\pm 0.2 dB</td> <td>\pm 1 dB</td> </tr> <tr> <td>40 Hz 100 Hz</td> <td>1 kHz</td> <td>20 kHz 60 kHz</td> </tr> </table>	10	30	60	\pm 0.5 dB	\pm 0.2 dB	\pm 1 dB	40 Hz 100 Hz	1 kHz	20 kHz 60 kHz	<table border="1"> <tr> <td>10</td> <td>30</td> <td>60</td> </tr> <tr> <td>\pm 0.5 dB</td> <td>\pm 0.2 dB</td> <td>\pm 1 dB</td> </tr> <tr> <td>40 Hz 100 Hz</td> <td>1 kHz</td> <td>20 kHz 60 kHz</td> </tr> </table>	10	30	60	\pm 0.5 dB	\pm 0.2 dB	\pm 1 dB	40 Hz 100 Hz	1 kHz	20 kHz 60 kHz	<table border="1"> <tr> <td>10</td> <td>30</td> <td>60</td> </tr> <tr> <td>\pm 0.5 dB</td> <td>\pm 0.2 dB</td> <td>\pm 1 dB</td> </tr> <tr> <td>40 Hz 100 Hz</td> <td>1 kHz</td> <td>20 kHz 60 kHz</td> </tr> </table>	10	30	60	\pm 0.5 dB	\pm 0.2 dB	\pm 1 dB	40 Hz 100 Hz	1 kHz	20 kHz 60 kHz
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Table 1-2. General Information.

GENERAL:	RECEIVER:
<p>Monitor: built-in speaker, monitors received or transmitted signal.</p> <p>Balanced impedances: 150 Ω, 600 Ω, 900 Ω</p> <p>Maximum input/output voltage: 300 V dc metallic or 200 V peak longitudinal.</p> <p>Battery supply: 4 - 6 hours continuous operation on internal rechargeable batteries at 25° C. Battery drain is automatically turned off when discharged below proper operating level.</p> <p>Mains: 100 V, 120 V, 220 V, 240 V \pm 10%.</p> <p>Temperature range: 48 Hz to 440 Hz, 15 VA.</p> <p>Operating: 0° C to 55° C (32° F to 130° F)</p> <p>Storage: -20° C to 65° C (-4° F to 149° F)</p> <p>Relative humidity: 0 to 95% (< 100° F, > 40° C).</p> <p>Weight: Net: 6.6 kg (13 lb) Shipping: 7.3 kg (16 lb)</p>	<p>Level Measurements: Frequency range: 40 Hz to 60 kHz Resolution: 0.1 dB Dynamic range: +15 dBm to -70 dBm Sample rate: 10/second (NORMAL); 2/second (DAMPED)</p> <p>Detector type: average responding</p> <p>Noise Measurements: Dynamic range Message circuit noise: -90 dBm to -5 dBm Noise-with-tone: -80 dBm to -5 dBm (600 Ω, 900 Ω) Noise-to-ground: -50 dBm to +35 dBm Resolution: 1 dB Sample rate: 2/second Detector type: Quasi RMS Weighting filters: Telephone (CCITT Psophometric), 3 kHz Flat, 15 kHz Flat, Programme (CCITT)</p> <p>Frequency Measurements: Frequency range: 40 Hz to 60 kHz Dynamic range: +15 dBm to -70 dBm Resolution: 1 Hz (40 Hz to 10 kHz) 10 Hz (10 kHz to 60 kHz) Sample rate: 10/second</p> <p>TRANSMITTER: Frequency range: 40 Hz to 60 kHz Ranges: 40 Hz to 1 kHz 200 Hz to 6 kHz 2 kHz to 60 kHz 800 Hz fixed (Hold Tone) Resolution: 1 Hz (40 Hz to 10 kHz) 10 Hz (10 kHz to 60 kHz) Sample rate: 10/second Level range: +10 dBm to -60 dBm (40 Hz to 60 kHz) +6 dBm to -60 dBm (800 Hz fixed) (Hold Tone) Resolution: 0.1 dB Sample rate: 10/second</p> <p>HOLD CURRENT: > 20 mA constant current</p>
<p>Outline Drawing:</p>  <p>NOTE: Dimensions in millimeters and (inches).</p>	

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2-11. The cycle-life of the batteries is based, by the manufacturer, on an end point of 80% of the rated 225 milliamper-hour capacity. This is with a ten hour charge and discharge current of 22.5 milliamperes with discharge carried to the normal ten-hour end voltage (1.10 volts/battery) of every cycle. Under these conditions a cycle-life in excess of 100 cycles can be expected.

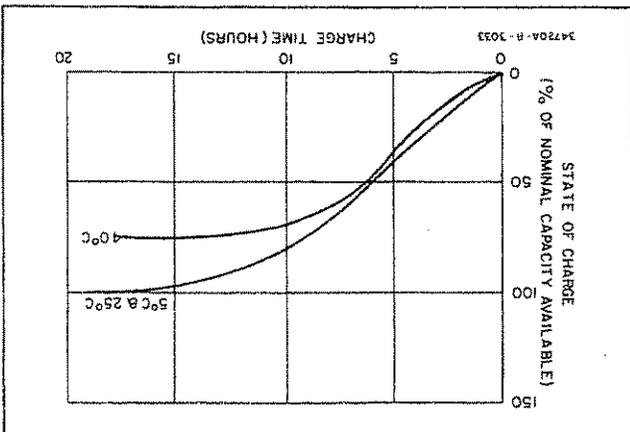
2-12. The internal power supply has a sensing circuit which monitors the three battery voltages. If battery voltage falls below minimum operating level (approximately +4 V dc for the +5 V dc battery and ±10 V dc for the respective ±12 V dc batteries), the voltage is automatically switched off to all circuitry except the sensing circuit. See Paragraph 2-8 for recharging procedures. Section V contains information concerning replacement of the batteries.

Permanent battery damage may result if the batteries are stored at high temperatures for a prolonged period.



2-10. When possible, the batteries should be stored in the discharged state. If the batteries are stored in the charged state they should be recharged for a period of 14 to 15 hours every 3 months. If this is not done, significant loss of battery capacity will occur. To minimize self-discharge during storage the batteries should be stored at a temperature of 20° C or lower. Although a nickel-cadmium battery will eventually lose all of its charge through self discharge it can be returned to service with a normal recharge.

Figure 2-1. Battery Charge Acceptance vs. Temperature.



SECTION II INSTALLATION

2-9. The battery packs may be charged at temperatures between 5° C and 40° C (41° F to 104° F), but will accept a greater charge if the temperature is between 5° C and 25° C. Figure 2-1 shows the decrease in charge acceptance at temperatures up to 40° C. Charging at temperatures outside the specified range may cause the batteries to vent, with a resulting decrease in capacity.

2-8. The internal battery pack consists of three rechargeable battery packs (+5 V, +12 V and -12 V) which provides four to six hours of continuous use without needing to be recharged. To recharge the battery, plug the Test Set into an external ac power source and press the POWER pushbutton labeled CHARGE or MAINS. Re-charging time for the batteries is approximately 12 hours.

2-7. Battery.

The Test Set cannot be operated in the battery mode while an external ac power source is connected to the instrument.

NOTE

2-6. The Test Set can be operated from the internal battery pack or from an external ac power source. Paragraph 2-7 explains the internal battery characteristics. Paragraph 2-13 explains the external ac power source characteristics.

2-5. POWER REQUIREMENTS.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be free of marks or scratches and operating correctly upon receipt. To confirm this, the instrument should be inspected for claim with the carrier. Test the electrical performance of the instrument using the Performance Test Procedures outlined in Section V. If there is damage or deficiency see the warranty on the reverse side of the title page in this manual.

2-3. INITIAL INSPECTION.

2-2. This section contains information and instructions necessary for installation and interfacing the Test Set. Included are initial inspection procedures, power and grounding requirements, environmental information, installation instructions, interfacing and instructions for repackaging for shipment.

2-1. INTRODUCTION.

the service or repair to be accomplished. Include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and full serial number. If you have any questions, contact your nearest hp-Sales and Service Office.

2-27. The following is a general guide for repackaging the instrument for shipment. If the original container is available, place the instrument in the container with appropriate packing material and seal with strong tape or metal bands. If the original container is not available, proceed as follows:

a. Wrap the instrument in heavy paper or plastic before placing in an inner container.

b. Place packing material around all sides of the instrument and protect panel face with cardboard strips or plastic foam.

c. Place instrument and inner container in a heavy carton and seal with strong tape or metal bands.

d. Mark shipping container "DELICATE INSTRUMENT," "FRAGILE," etc.

must be within the range of 0°C to +55°C (+32°F to +131°F). Refer to Paragraph 2-10 for storage information.

2-22. Relative Humidity.

2-23. The allowable relative humidity for proper operation of the Test Set is 0% to 95% for temperatures below 40°C (+105°F). As temperatures increase above 40°C, the allowable relative humidity for proper operation will decrease.

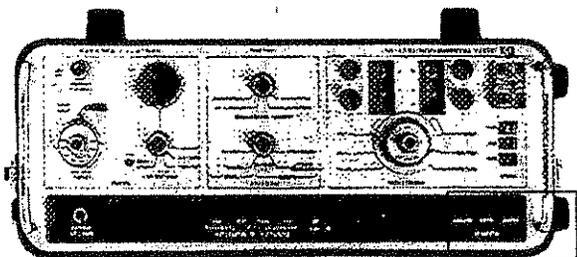
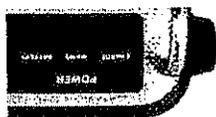
2-24. INTERFACE CONNECTIONS.

2-25. The Test Set is equipped with two types of input/output connectors. The a and the b connectors are both standard sized binding posts. These binding posts are spaced to accept the standard dual banana plug such as the Pomona 1269 dual banana plug adapter. The other type of connector is the Siemen's 9 REL STP-6AC jack.

2-26. REPACKAGING FOR SHIPMENT.

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating



3-12. Input power to the Test Set is controlled by three pushbutton switches (CHARGE, MAINS and BATTERY).

3-11. Power.

3-47.

3-10. In the following description the front panel controls, indicators and connectors have been divided into functional groups. The functional groups are: power, dial and hold, input/output function select, receive, send, and display and monitor. For step-by-step operation, refer to Paragraph

3-9. FRONT PANEL CONTROLS.

3-8. The Test Set should be allowed to warm up for a minimum of five minutes before use. This allows the instrument to stabilize.

Do not operate the Test Set in the BATTERY mode while it is connected to an external ac source. The instrument will not operate under these conditions. Refer to Section V for battery replacement. The Test Set can be operated from a 100 V, 120 V, 220 V or a 240 V external ac power source. Ensure that the ac power module is set for the ac voltage used, and the proper fuse is used. For instructions on setting the power module and selecting the fuse, see Section II, Figure 2-2.

NOTE

except the sensing circuit. To recharge the batteries, simply plug an external ac power source into the Test Set.

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains information and instructions necessary for proper operation of the Transmission Test Set. Included is a brief description of instrument capabilities, power and warm-up information, a functional description of all controls, indicators and connectors, and operating procedures.

3-3. INSTRUMENT CAPABILITIES.

3-4. The Model 3552A Transmission Test Set is capable of measuring noise level, tone level or tone frequency, while simultaneously sending tone. It features both two-wire and four-wire balanced circuits with selectable impedances of 150 ohms, 600 ohms, or 900 ohms. For frequency measurements, the autorangeing four-digit readout is calibrated in kHz. Resolution is 1 Hz from 40 Hz to 10 kHz, and 10 Hz from 10 kHz to 60 kHz. The send oscillator covers a frequency range from 40 Hz to 60 kHz in three bands, and the output level is variable from +10 dbm to -60 dbm. In addition, a fixed frequency position of 800 Hz is provided to be used as the holding tone when making noise-with-tone measurements. Noise measurement capability includes noise-with-tone, message circuit noise, and noise-to-ground. Four selectable weighting networks are provided: Telephone (CCTT); 3 kHz Flat; 15 kHz Flat; and Programme (CCTT).

3-6. POWER AND WARM-UP.

3-5. The digital LED (light emitting diode) readout displays either the level or frequency of the input or output. It is calibrated in dbm for tone and noise measurement, with a dynamic range of 85 dB. Overrange and underrange conditions are indicated by blanking the numerical display and flashing the polarity sign to indicate whether the level is above (+) or below (-) the range of the Test Set. A set of clip-on dial terminals is provided for connecting a lineman's handset. This allows a line connection to be dialed up and then held in an off-hook condition while making either send or receive measurements.

3-7. The Test Set can be operated from an internal battery pack, or from an external ac power source. The internal battery pack will provide four to six hours of continuous use without needing to be recharged, unless the audio monitor is on. Use of the audio monitor will discharge the batteries at a much faster rate. The internal power supply contains a sensing circuit, which monitors the battery voltage. If the voltage drops too low for proper operation, the voltage is automatically switched off to all circuitry.

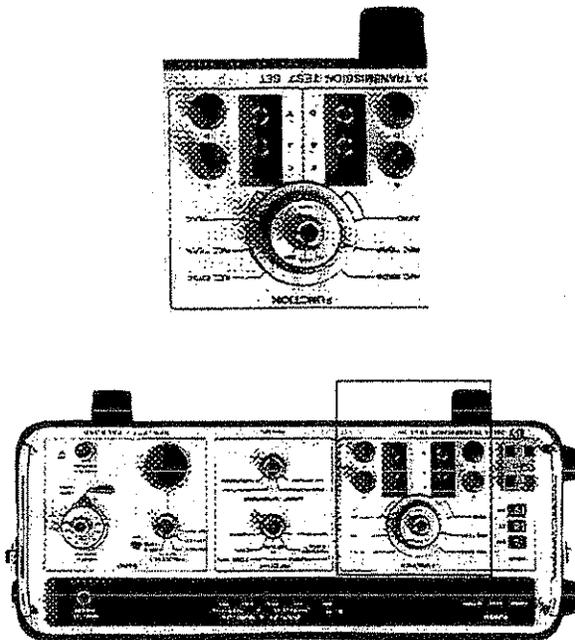
3-19. The input/output function select switch has four positions for each set of terminals—two send (SEND) positions, and two receive (RBC BRDG, REC TERM) positions. The send positions connect the corresponding terminal set to the Test Set Send Oscillator. The operator is

3-18. Either set of the input/output terminals can be used to receive or send. When one set is connected for receiving, the other set is simultaneously connected for sending. The selection of terminals is determined by the position of the input/output function select switch.

3-17. The Test Set has two sets of input/output terminals. Each set consists of a Siemens's 9 REL STP-6-AC jack connected in parallel with two binding posts. The binding posts, labeled a and b, will each accept a standard sized banana plug. The two binding posts for each set are spaced so they will also accept a standard sized dual banana plug.

3-16. The input/output function select section contains the input/output terminals, the input/output function select switch, and the impedance switch.

3-15. Input/Output Function Select



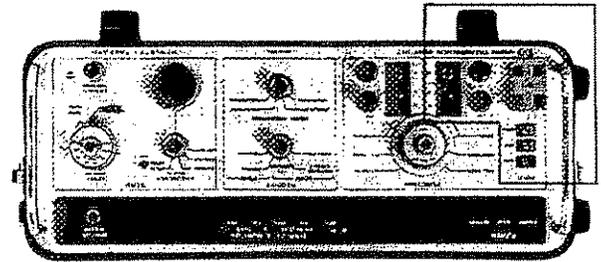
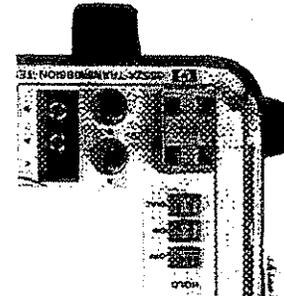
If a dry line is connected to the black input/output terminals, the HOLD OFF pushbutton must be pressed.

NOTE

black). After the line has been seized, the ON pushbutton will connect an internal holding circuit in parallel with the same input/output terminals. To release the line, the pushbutton labeled OFF is pressed.

3-14. The dial and hold operation is controlled by three pushbutton switches (OFF, ON and DIAL). This operation allows the operator to connect a lineman's handset to the DIAL terminals, dial a line and connect a hold circuit across the dialed line. When the DIAL pushbutton is pressed, the two terminals labeled DIAL, are connected in parallel with the input/output terminals a and b (labeled in black) and the Siemens's 9 REL STP-6-AC input/output jack (labeled in

3-13. Dial and Hold.



Do not try operating the Test Set in the BATTERY mode while it is plugged into an external ac source. The instrument will not operate under these conditions. For information concerning warm-up conditions, refer to Paragraph 3-6. For information concerning external power and fuse specifications and selection, refer to Paragraph 2-13, Section II.

NOTE

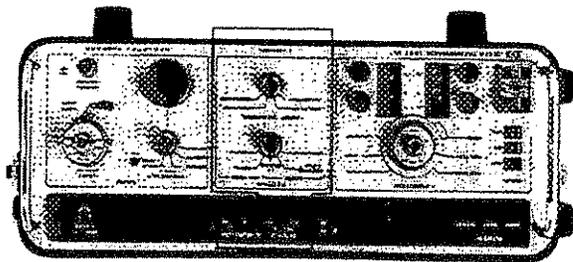
To turn on the Test Set, press the MAINS pushbutton if external ac power is connected, or the BATTERY pushbutton if no external ac power is available. Use of the audio monitor in battery operation will discharge the battery at a rate much faster than normal.

For operator protection connect the front panel ground terminal to earth ground when operating in the battery mode.

WARNING

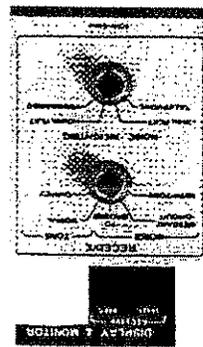
then provided with a calibrated test signal at this terminal set (see Paragraph 3-35 and Table 3-6). The receive position connects the corresponding terminal set to the Test Set receive circuits. The operator can connect a transmission line to this terminal set for making desired frequency and level measurements (see Paragraph 3-21 and Table 3-3).

3-20. The Test Set input/output impedance is determined by the position of the input/output function select switch, and the IMP (impedance) switch. In the REC TERM position and the SEND position of the input/output function select switch, the impedance of the corresponding terminal sets can be selected by the IMP switch. Three impedance selections are available—150 ohm, 600 ohm and 900 ohm. The impedance terminations are protected by a dc blocking capacitor. Accidental application of battery voltage, or ringing voltage to the input will not damage the instrument.



3-21. Receive.

3-22. The receive function of the Test Set is controlled by the RECEIVE NOISE/TONE switch, NOISE WEIGHTING switch, and DISPLAY & MONITOR RECEIVE control. The Test Set is capable of measuring noise with tone, message circuit noise, noise to ground, and tone, in the range of 40 Hz to 60 KHz. For noise measurements, there are four weighting filters available—Telephone (CITT Psophometric), 3 KHz Flat, 15 KHz Flat and Program (CITT). All measurements can be made for level, and frequency for receive tone. The results of these measurements are displayed in digital form, and can be monitored by a speaker.



3-23. Receive Noise/Tone. The RECEIVE NOISE/TONE switch selects the receive mode of operation. There are three noise measuring modes available (noise with tone, message circuit noise, and noise to ground) and two tone modes (40 Hz - 60 KHz), NORMAL and DAMPED.

3-24. Noise with Tone Mode. Noise measurements with tone may be used to give a measure of the noise encountered by a continuous data signal, or the noise a listener would hear during a speech burst. In the WITH TONE position of the RECEIVE NOISE/TONE switch, a sharp notch filter is switched into the Test Set input circuit. In the MESSAGE CIRCUIT position of the RECEIVE NOISE/TONE switch, background noise can be measured with both input lines isolated from earth ground (metallic noise). Any of the four weighting filters can be used. Dynamic range for the message circuit noise mode is -90 dbm to -5 dbm.

3-26. Noise-to-Ground Mode. In the TO GROUND position of the RECEIVE NOISE/TONE switch, the noise level between two balanced lines and ground can be measured. The signal is applied to ground through a 40 db pad in the Test Set. The loss due to the 40 db pad is automatically adjusted for in the Test Set display circuits. It is necessary to establish a good earth or system ground and connect it to the Test Set front panel ground binding post for this measurement. The dynamic range of the noise-to-ground mode is -50 dbm to +35 dbm.

3-27. Message circuit noise indications and noise-to-ground indications of a balanced line can be used to compute the balance of a line. The degree of balance, where the greater part of background noise is due to noise-to-ground, is given by the equation, Balance (in dB) = Message circuit noise minus noise-to-ground. For example, if the message circuit noise level is -64 dbm and the noise-to-ground level of the same circuit is 0 dbm, the balance is $64 - 0 = 64$ dB.

3-28. Tone Mode. In the NORMAL position of the RECEIVE NOISE/TONE switch, tone level and frequency measurements can be made in the frequency range of 40 Hz to 60 KHz and a dynamic range of -70 dbm to +15 dbm. These measurements can be used for determining loss and attenuation distortion on message trunks and data service. Level measurements can also be used in conjunction with noise measurements to determine the signal-to-noise ratio on a circuit. In the tone mode the noise weighting filters are bypassed. In the DAMPED position, the sample period is extended to increase readability of the display when noise is present.

3-29. Noise Weighting. The RECEIVE NOISE WEIGHTING switch selects one of four weighting filters for noise measurements. The weighting filters are Telephone (CITT Psophometric), 3 KHz Flat, 15 KHz Flat, and Program (CITT).

Figure 3-2. 3 kHz FLAT and 15 kHz FLAT Weighting Curves.

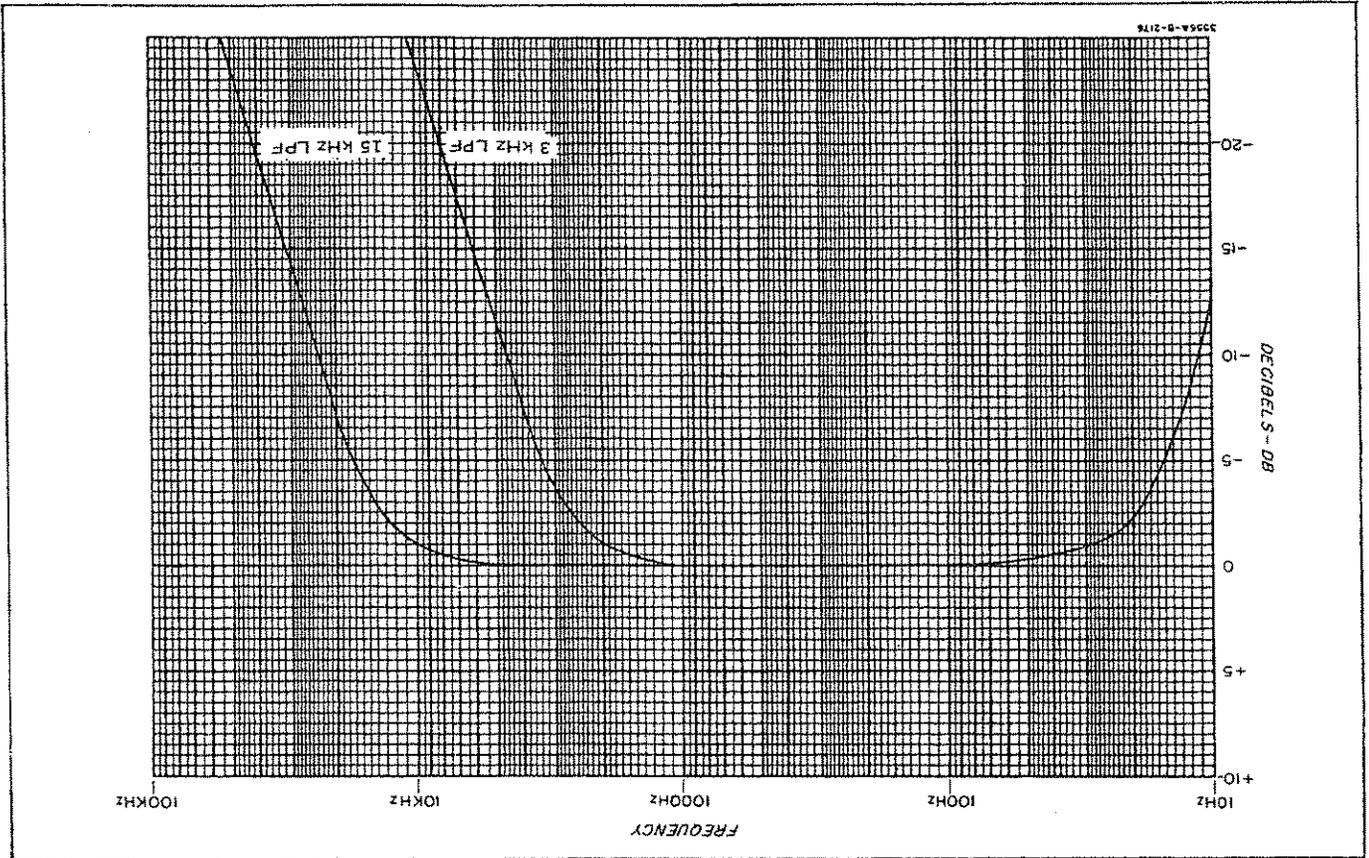
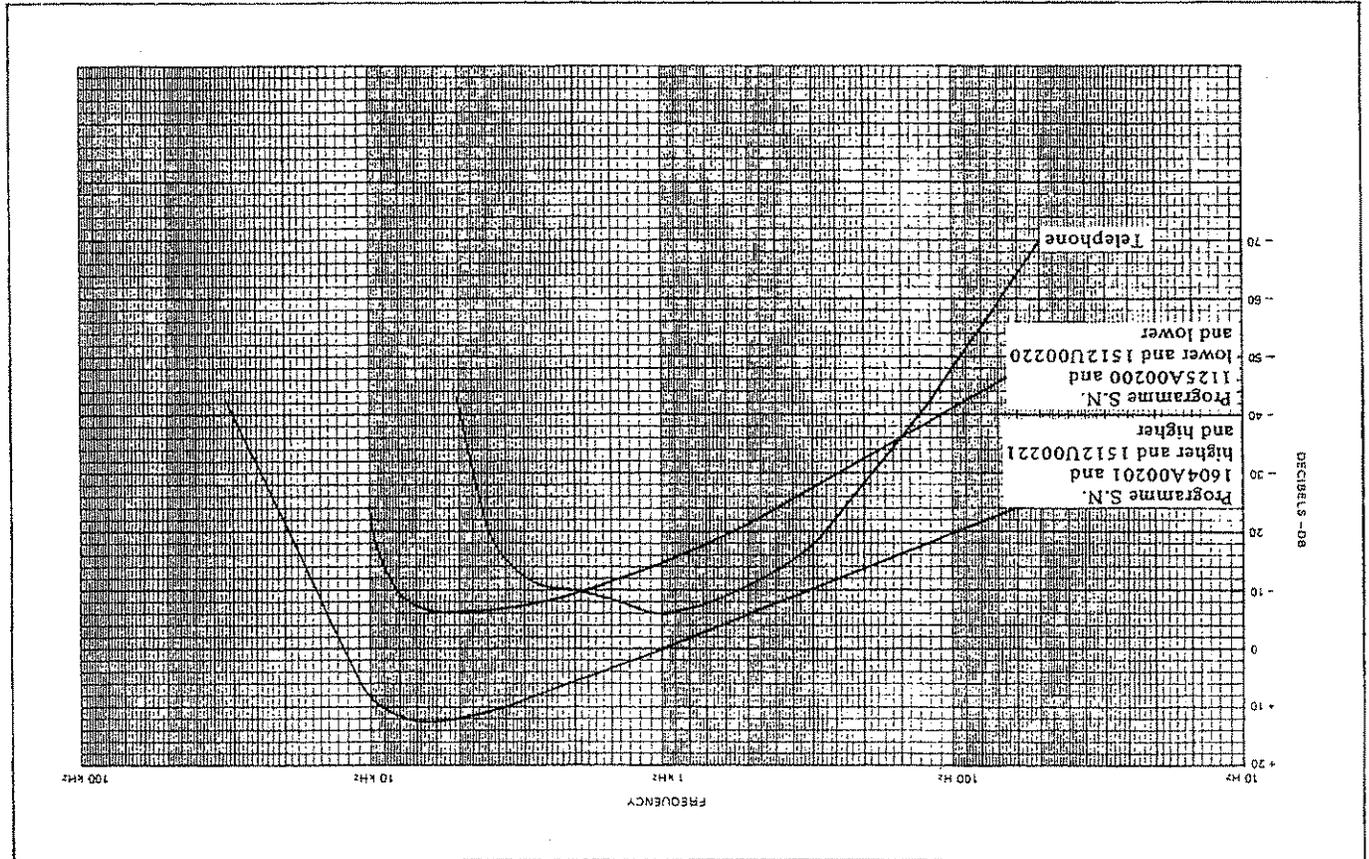


Figure 3-1. Telephone and Programme Weighting Curves.

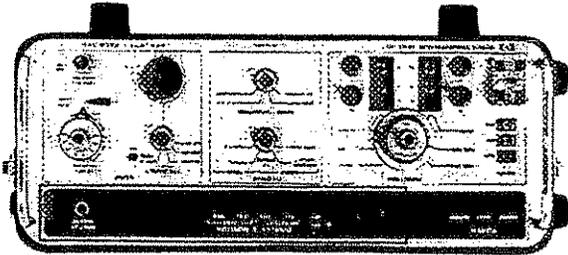


The test signal can be variable in frequency from 40 Hz to 60 kHz, or a steady tone of 800 Hz. The amplitude of the test signal is variable from -60 dBm to +10 dBm. Clipping may occur at levels above +10 dBm. Both frequency and amplitude can be monitored.

3-37. Frequency. The send frequency is controlled by the SEND FREQUENCY switch and the frequency vernier control. There are three overlapping range positions and one steady tone position. The range positions are 40 Hz to 1 kHz, 200 Hz to 6 kHz, and 2 kHz to 60 kHz. The HOLD TONE position provides an 800 Hz tone, which the operator may calibrate by means of a front panel screwdriver for adjustment. The frequency vernier is a dual (coarse and fine) frequency control.

3-38. Level. The send level is controlled by the SEND LEVEL switch and the level vernier. There are seven range positions on the range switch: -60 to -50, -50 to -40, -40 to -30, -30 to -20, -20 to -10, -10 to 0, 0 to +10. The range of the level vernier is greater than 10 dBm.

3-39. Display Monitor Send. The DISPLAY & MONITOR SEND pushbuttons select the display function desired for the send signal. Two functions, level or frequency, are available. Both level and frequency are fully autorangeing. For a complete description of the display and monitoring operation, refer to Paragraph 3-40.



3-40. Display-Monitor.

3-41. The display monitor function of the Test Set is controlled by the DISPLAY & MONITOR RECEIVE/MONITOR SEND pushbuttons and MONITOR VOLUME vernier. It features a digital LED display for visual indications of frequency and level measurements, and a speaker for audio aid in identifying transmission line noise.

3-42. Display. The display provides digitally controlled LED readout of both the send frequency and level, and the receive frequency and level. Send and receive frequency indications are displayed in four digits expressed in kHz units. Send level measurements and receive tone level

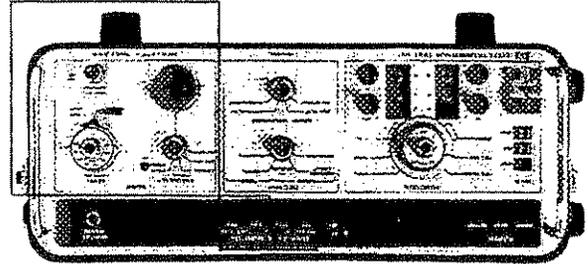
3-30. Telephone (CCITT Pophometric). The Telephone (CCITT Pophometric) filter has a frequency response which simulates the effects of noise on the human ear. This weighting is also used to evaluate the effects of noise on voice-grade data circuits. The frequency response of this filter is shown in Figure 3-1.

3-31. 3 kHz Flat. The 3 kHz Flat weighting filter is used on voice frequency circuits when investigating low-frequency noise, such as power induction. The frequency response of this filter is shown in Figure 3-2.

3-32. 15 kHz Flat. The 15 kHz Flat filter is used for unweighted measurements of noise on radio and television studio-transmitter and studio-remote audio links. The frequency response of this filter is shown in Figure 3-2.

3-33. Programme. The Programme filter is used for weighted measurements of noise on radio and television studio-transmitter and studio-remote audio links. The frequency response of this filter is shown in Figure 3-1.

3-34. Display Monitor Receive. The DISPLAY & MONITOR RECEIVE pushbuttons select the display function desired for the received signal. Two functions, level or frequency, are available. Both level and frequency are fully autorangeing. For a complete description of the display and monitoring operation, refer to Paragraph 3-40.



3-35. Send.

3-36. The send function of the Test Set provides the operator with a calibrated test signal at the output jack.

Operating Mode	Minimum Level	Maximum Level
Receive noise with tone	-80 dBm	-5 dBm
Receive message circuit noise	-90 dBm	-5 dBm
Receive noise to ground	-50 dBm	+35 dBm
Receive tone, send level and all frequency measurements	-70 dBm	+15 dBm

Table 3-1. Input Levels.

3-48. Tables 3-2 through 3-7 list the step-by-step procedures for dial and hold operation, making level and noise measurements, operating the Test Set send unit, and making balance and transmission loss measurements. For a detailed description of each of the controls used in these procedures, refer to Paragraph 3-9. For power and warm-up information, refer to Paragraph 3-6.

3-47. OPERATION.

3-46. Monitor. The audio monitor provides the operator audio indications of input signals. A monitor volume control is available for regulation of the audio signal. Care should be taken not to use the audio facility at maximum volume for extended lengths of time while operating in the battery mode. This causes a large drain on the battery.

3-45. Ranging in both level and frequency measurements is fully automatic. If an out-of-range condition in input level occurs, it is indicated by blanking of the display digits and a flashing plus or minus sign. The flashing plus sign indicates the instrument input signal is too small. Table 3-1 lists the minimum and maximum input levels and their respective operating modes. Both frequency and level ranging occurs in either frequency measurements or level measurements. Consequently, blanking of frequency digits will occur if the level of the input signal is out-of-range.

3-44. Sample rate for frequency measurements and tone level measurements is 10/sec in the NORMAL position, and 2/sec in DAMPED. The sample rate for noise measurements is 2/sec.

3-43. For frequency measurements below 10 kHz, the resolution is 1 Hz. For frequency measurements above 10 kHz, the resolution is 10 Hz. Tone level measurements are displayed with a 0.1 dB resolution. Noise level measurements are displayed with a 1.0 dB resolution.

measurements are displayed in three digits expressed in dBm. Receive noise level measurements are displayed in two digits expressed in dBm.

Step	Procedures
1.	Turn the Test Set POWER on.
2.	Set the FUNCTION switch to REC BRDG or REC TERM for desired input terminals.
3.	Set the IMP switch for the desired input impedance.
4.	Select the RECEIVE NOISE/TONE mode desired (MESSAGE CIRCUIT or WITH TONE).
5.	Select the desired weighting filter.
6.	Press the DISPLAY-MONITOR RECEIVE LEVEL pushbutton.
7.	Connect the line to be measured to the input terminals chosen in Step 2.

Table 3-4. Message Circuit Noise and Noise with Tone Measurements.

Step	Procedures
1.	Turn the Test Set POWER on.
2.	Set the FUNCTION switch to REC BRDG or REC TERM for the desired input terminals.
3.	Set the IMP switch to the desired input impedance.
4.	Set the RECEIVE NOISE/TONE switch to the NORMAL position.
5.	Select the DISPLAY-MONITOR RECEIVE mode (LEVEL or FREQ) desired.
6.	Connect the line to be measured to the input terminals chosen in Step 2.
7.	If the display is too noisy to read, set the RECEIVE NOISE/TONE switch to DAMPED.

Table 3-3. Receive Tone Level and Frequency Measurements.

Step	Procedures
1.	Turn the Test Set POWER on.
2.	Press the HOLD OFF pushbutton.
3.	Connect a linemans handset (but-in) to the DIAL terminals.
4.	Set the FUNCTION switch to REC BRDG or REC TERM for the black labeled terminals.
5.	Set the IMP switch to the desired impedance.
6.	Connect the line to the Stemens jack or TIP RING terminals labeled in black.
7.	Press the HOLD DIAL pushbutton and dial with the handset (but-in).
8.	Press the HOLD ON pushbutton to maintain connection during test.

Table 3-2. Dial and Hold Operation.

Step	Procedures
1.	Perform the message circuit noise measurement as described in Table 3-4.
2.	Perform the noise-to-ground measurement as described in Table 3-5.
3.	Compute the line balance in dB using the results of the above checks and the following formula: $\text{Balance (dB)} = \text{Nmc} - \text{Ng}$ Where: Nmc = Message circuit noise Ng = Noise-to-ground Example: Nmc = -64 dBm Ng = 0 dBm Balance = 64 - 0 = 64 dB

Table 3-7. Balance Measurements.

Step	Procedures
1.	Turn the Test Set POWER on.
2.	Set the FUNCTION switch to REC BRDG for the desired input terminals.
3.	Set the IMP switch to the desired input impedance.
4.	Set the RECEIVE NOISE/TONE switch to the TO GROUND position.
5.	Set the NOISE WEIGHTING switch for the desired weighting filter position.
6.	Press the DISPLAY-MONITOR RECEIVE LEVEL pushbutton.
7.	Connect a ground lead from the front panel CHASSIS GROUND terminal to earth or system ground.
8.	Connect the line to be measured to the input terminals chosen in Step 2.

Table 3-5. Noise-to-Ground Measurements.

Step	Procedures
1.	Turn the Test Set POWER on.
2.	Press the DISPLAY-MONITOR SEND LEVEL pushbutton.
3.	Set the SEND LEVEL RANGE dBm switch and vernier to the desired signal level as indicated on the display.
4.	Press the DISPLAY-MONITOR SEND FREQ. pushbutton.
5.	Set the SEND FREQUENCY RANGE Hz switch and the vernier to the desired frequency as indicated on the display.
6.	Set the FUNCTION switch to the SEND position for the desired output terminal.
7.	Set the IMP switch to the desired output impedance.
8.	Connect the line or circuit under test to the output terminals chosen in Step 6.

Table 3-6. Send Unit Operation.

4-1. INTRODUCTION.

4-2. This section contains the Theory of Operation for the Transmission Test Set. Included is a basic block description, a functional block description, a detailed block description, and basic circuit theory on unique circuits.

4-3. BASIC BLOCK DESCRIPTION.

4-4. The Test Set is designed for testing telecommunications equipment. It is capable of measuring frequency and level of tone or noise while simultaneously sending calibrated test signals. The level and frequency of both the received signal and the send signal can be monitored by a digital LED display or an audio monitor. Refer to Figure 4-1 for the following description.

4-5. Two front panel input/output terminal sets are provided. Either set can be used for sending or receiving. Both sets are balanced and can be used in a bridged or terminated mode. The dial and hold capability is common to the black input/output terminal set.

4-6. The receive circuits process the input signal or the send signal for use by the controller and display circuits. Automatic ranging of both the frequency and level of these signals is applied in the receive circuits.

4-7. The send oscillator generates the calibrated test signals. These signals are applied to the selected output terminal and to the receive circuits.

4-8. The controller directs, by means of digital signals, the overall operation of the instrument. The display provides digitally controlled LED readout of the measurement information from the receive circuits.

SECTION IV
THEORY OF OPERATION

4-9. FUNCTIONAL BLOCK DESCRIPTION.

4-10. Refer to the analog block diagram (Figure 4-14) and the digital block diagram (Figure 7-15) and the schematics for this description.

4-11. Dial and Hold.

4-12. The dial and hold circuitry consists of front panel pushbutton controls, a dial input terminal, a diode bridge and a current source circuit.

4-13. When pressed, the front panel HOLD DIAL pushbutton connects the DIAL terminals across the black input/output terminals. The operator can then connect a handset to the DIAL terminals for dialing a line. The front panel HOLD ON pushbutton disconnects the DIAL terminals and connects the diode bridge and the current source across the black input/output terminals. This circuitry simulates an "off-hook" condition for the dialed line.

4-14. The diode bridge provides the proper biasing polarity of the input/output line connection. A gas discharge tube (VT) provides protection against high voltage transients which may be on the line.

4-15. The current source is an active transistor circuit which receives its operating voltage from the dialed line.

NOTE

If a dry line is connected to the black input/output terminals, the HOLD OFF pushbutton must be pressed.

4-16. Function Select

4-17. The Function Select-block contains the circuitry for the front panel FUNCTION switch and the IMP switch. This block also contains the coupling transformers for the receive signal and the send signal.

4-18. The FUNCTION switch network allows the operator the choice of selecting either the black input/output terminal for receiving and the blue input/output terminal for sending or vice versa. This switch also determines the bridged or terminated mode of the receive terminal.

4-19. The IMP switch provides the operator with a choice of three impedances (150 ohm, 600 ohm or 900 ohm). The position of this switch determines both the receive terminating impedance and the send source impedance.

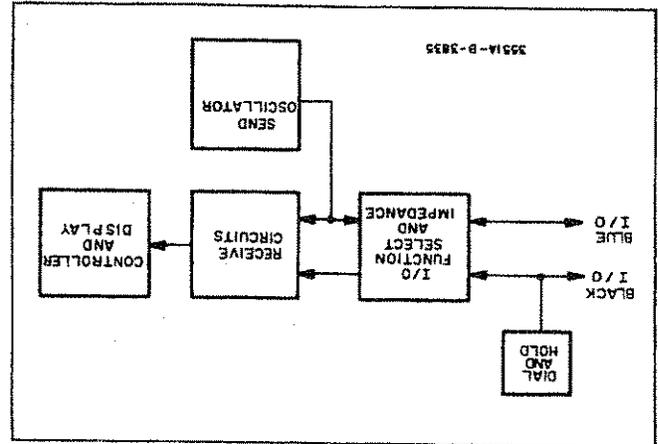


Figure 4-1. Test Set Simplified Block Diagram.

4-27. The X-AXIS symmetry adjustment is accomplished by monitoring the triangle output wave with an integrating operational amplifier. The negative-going ramp is integrated and the dc level is used to adjust the reference voltage in the comparator.

4-26. The X-AXIS and Y-AXIS symmetry circuits provide automatic symmetry adjustment to improve the distortion. The X-AXIS symmetry circuit ensures the signal is symmetrical about the X-AXIS. The Y-AXIS symmetry circuit ensures the signal is symmetrical about the Y-AXIS.

4-25. The triangle wave is shaped into a sine wave by a diode switching network in the sine shaper. The output of the sine shaper is applied to the output amplifier where the level is controlled by the front panel LEVEL control. The output of the output amplifier is applied to the impedance circuit in the function select circuitry and to the DISPLAY & MONITOR RECEIVE SEND switching networks. This switching network is located between the receive function circuit and the automatic amplitude ranging circuit.

4-24. The frequency range of the send oscillator signal is controlled by changing the size of the integrating capacitor with the front panel FREQUENCY RANGE Hz control.

4-23. In the comparator the amplitude of the charge ramp is compared to a positive reference voltage. When the two voltages are equal the comparator reverses the current flow through the capacitor. The reference voltage for the comparator is also changed to a negative voltage. This voltage is compared to the amplitude of the discharge ramp. When the ramp reaches the same level as the reference voltage, the comparator reverses the flow of current through the current source and the cycle repeats.

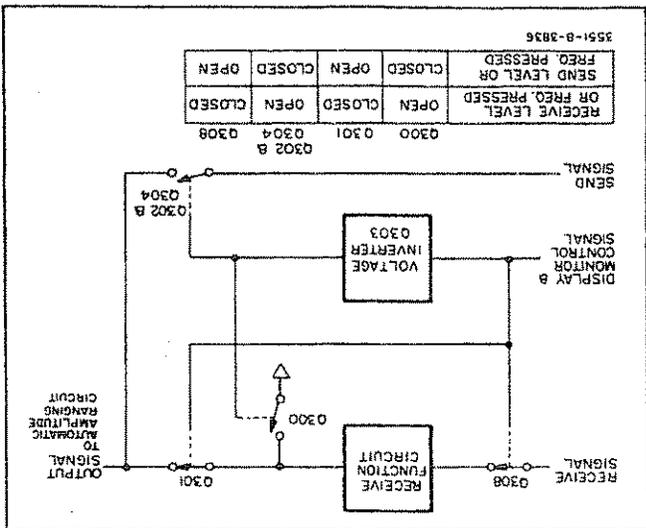
4-22. The send oscillator signal is derived from an integrating capacitor which is charged from a constant current source to generate a linear charge ramp. The capacitor is then discharged through the same constant current source to generate a linear discharge ramp. The two ramps form a triangle wave which is applied to a sine shaper and a comparator.

4-21. Send Oscillator.

4-20. Each of the input/output terminals is balanced. To accomplish this, the receive signal is coupled to the receive function circuit by a transformer with the primary windings terminated. For terminated measurements, one-half of the terminating impedance is switched in parallel with each of the primary windings to maintain balance. The send signal is coupled to the output terminals by a transformer with the secondary windings balanced. The source impedance is applied to the primary windings of this transformer.

4-33. In the WITH TONE position of the RECEIVE NOISE/TONE switch, the receive signal from the function select circuit is buffered and applied to a notch filter. The notch filter is a four-stage Butterworth filter which provides

Figure 4-2. Receive or Send Signal Switching.



4-32. The DISPLAY & MONITOR pushbuttons control a series of FET switches for selecting the receive signal or the send oscillator signal to display. The FET switching is shown in Figure 4-2. The FET switches are shown with the DISPLAY & MONITOR RECEIVE LEVEL or RECEIVE FREQ pushbutton pressed. Table 4-1 lists the FET switch status in relation to all positions of the DISPLAY & MONITOR pushbuttons. As indicated in Figure 4-2 and Table 4-1, if the send oscillator signal is to be displayed, the receive function circuit is bypassed. If the receive signal is to be displayed and monitored, it is applied to the receive function switch where the routine is dependent upon the position of the RECEIVE NOISE/TONE switch.

4-31. The Test Set is capable of displaying and monitoring either the receive signal or the send oscillator signal. The signal routing is dependent upon the position of the front panel DISPLAY & MONITOR switch. If the receive signal is being displayed, the routine of this signal is also dependent on the position of the RECEIVE NOISE/TONE switch.

4-30. The receive circuit contains the notch filter for noise with tone measurements, and the load resistor for noise-to-ground measurements. Also included is the switching network for signal routing of the receive and send signals.

4-29. Receive Circuits.

4-28. The Y-AXIS symmetry adjustment is accomplished by monitoring the switching square wave from the comparator. A difference in time for the negative half of the square-wave cycle in respect to the positive half of the square-wave cycle will alter the current from the switching transistors to the integrating capacitors.

1. Input signal level - 7 dbm
2. Initial range position* 0
3. Attenuation (Table 4-3) 60 dB
4. Output of select blocks - 67 dbm
5. Output of 4 dB amplifier - 63 dbm
6. Input to logger - 17 dbm
7. Controller ranges down to range 1.

Example 1:

4-40. The binary code from the controller is determined by the signal to the logger. If this signal is not between + 5 dBm and - 10 dBm, the controller will not receive the proper signal from the measurement circuit and will change the binary code. This will cause the range select block to either range up or down. The process repeats until the proper signal is received by the controller. For a detailed discussion on the measurement circuits refer to Paragraph 4-50.

Range	Range Bits				Attenuation (dB)	Gain (dB)
	ARNG0	ARNG1	ARNG2	ARNG3		
0	0	0	0	0	60	10
1	0	0	0	1	50	10
2	0	0	1	0	40	10
3	0	0	1	1	30	10
4	0	0	1	1	30	10
5	1	1	1	0	20	10
6	1	1	1	1	10	10
7	1	1	1	1	0	10

Table 4-3. Range Codes, Attenuation and Gain.

4-39. The signals from the resistive divider networks are applied to a range select block. The range select block selects the desired signal from the resistive dividers and applies this signal to a 4 dB amplifier. The 4 dB amplifier increases the - 45 dBm to - 60 dBm signal from the resistive dividers to the required - 41 dBm to - 56 dBm. The selection is determined by a 4-2-1 binary signal from the controller (Table 4-3).

4-38. The signal to the ranging circuit is applied to both a resistive divider network and a 10 dB amplifier. The output of the 10 dB amplifier is applied to a second resistive divider network. Each resistive divider network has four outputs for a total of eight ranges (0 to 7) (Table 4-2). The input signal is attenuated or amplified and attenuated to provide a signal level between - 45 dBm and - 60 dBm. Table 4-3 lists each range and its attenuation, amplification and range code.

The 46 dB amplification is nominal for 150 ohms input impedance and will vary for 600 ohms and 900 ohms input impedance. In the following description, the dbm levels given are simplifications of the actual dbm. Levels from instrument to instrument may vary ± 4 db.

NOTE

Signal Level to Logger	Range	Input Signal Level	
		Noise	Tone
+ 5 to - 10	R0	+ 5 dbm	+ 10 dbm
+ 5 to - 10	R1	0 dbm	+ 5 dbm
+ 5 to - 10	R2	- 5 dbm	- 10 dbm
+ 5 to - 10	R3	- 15 dbm	- 20 dbm
+ 5 to - 10	R4	- 25 dbm	- 30 dbm
+ 5 to - 10	R5	- 35 dbm	- 40 dbm
+ 5 to - 10	R6	- 45 dbm	- 50 dbm
+ 5 to - 10	R7	- 55 dbm	- 60 dbm
		- 60 dbm	- 70 dbm
		- 65 dbm	- 75 dbm
		- 70 dbm	- 80 dbm
		- 75 dbm	- 85 dbm
		- 80 dbm	- 90 dbm

Table 4-2. Input Signal Level vs. Range and Logger.

4-37. Tone Measurements. The automatic measuring circuit compresses the 85 dB dynamic range of the input signal (+ 15 dBm to - 70 dBm) to a 15 dB dynamic range required by the logger in the measuring circuit. This 15 dB range is a changing dc level, proportional to approximately + 5 dBm to - 10 dBm. There is approximately 46 dB of amplification between the ranging circuit and the logger, therefore, the signal from the ranging circuit must be maintained between - 41 dBm and - 56 dBm.

4-36. Automatic Ranging Circuit.

FET Switch Status					
Display Switch	Positions	Receive Level or Preset	Send Level or Preset	Q300	Q301
	Q308	Closed	Open	Open	Closed
	Q304	Open	Closed	Closed	Open
	Q302	Open	Open	Open	Closed
	Q301	Closed	Closed	Closed	Open
	Q300	Open	Open	Open	Open
	Q308	Closed	Closed	Closed	Closed

Table 4-1. FET Switch Status for Input to Receive Circuit and Automatic Ranging.

4-35. In the MESSAGE CIRCUIT, NORMAL, and DAMPED positions of the RECEIVE NOISE/TONE switch the receive signal bypasses the notch filter and load resistor. This signal is applied directly to the DISPLAY and MONITOR switching networks.

4-34. In the TO GROUND position of the RECEIVE NOISE/TONE switch, the receive signal from the function select circuit is applied to a resistor-to-ground. The load resistor produces 40 dB of attenuation. To correct for this loss, the controller supplies the display with a 40 dB correction factor (see Paragraph 4-75).

at least - 50 dB of signal suppression. The - 50 dB bandwidth is 316 Hz to 1343 Hz.

4-43. Noise Measurements. Noise measurements are ranged identically to the tone measurements. However, the -5 dBm to -90 dBm dynamic range is 20 dB lower than tone measurements, therefore, the signal must be amplified 20 dB more between the ranging circuit and the logger. There is 15 dB gain in the measuring circuits. The total gain in the detector in the measuring circuits. The total amplification between the ranging circuit and the logger is 66 dB for noise measurements.

4-42. If the input signal is above +15 dBm, the ranging circuit will range to the top range (range 0) and an overrange condition will be displayed (flashing plus sign and blanked digits). If the input signal is below -70 dBm, the ranging circuit will range to the bottom range (range 7) and an underrange condition will be displayed (flashing minus sign, and blanked digits).

4-41. As indicated by Examples 1 and 3, there is an overlap between ranges. A -7 dBm signal can be measured with the ranging circuit in either range 1 or range 2. The total overlap between any two consecutive ranges is 5 dB. For example, the signal of Examples 1 and 3 could be -5 dBm to -10 dBm and either range 1 or range 2 would provide the proper level to the logger (Table 4-2).

Example 3:

1.	Input signal level	-7 dBm
2.	Initial range position	2
3.	Attenuation (Table 4-3)	40 dB
4.	Output of select block	-47 dBm
5.	Output of 4 dB amplifier	-43 dBm
6.	Input to logger	+3 dBm

Example 2:

1.	Input signal level	-32 dBm
2.	Initial range position	5
3.	Attenuation (Table 4-3)	20 dB
4.	Gain (Table 4-3)	10 dB
4.	Output of select block	-42 dBm
5.	Output of 4 dB amplifier	-38 dBm
6.	Input to logger	+8 dBm
7.	Controller ranges up to range 4.	
8.	Attenuation (Table 4-3)	30 dB
9.	Gain (Table 4-3)	10 dB
10.	Output of select block	-52 dBm
11.	Output of 4 dB amplifier	-48 dBm
11.	Input to logger	-2 dBm

*The Test Set will always be in the 0 range position at instrument turn-on.

8.	Attenuation (Table 4-3)	50 dB
9.	Output of select block	-57 dBm
10.	Output of 4 dB amplifier	-53 dBm
11.	Input to logger	-7 dBm

4-52. Frequency Measurements. For frequency measurements, the input signal is buffered in the averaging

4-51. There are two classes of measurements performed by the measuring circuits (frequency and level). The measuring circuits transpose the frequency or level information of the input signal to digital signals which are applied to the controller and display circuits. A mnemonic dictionary is included in Section VII (Tables 7-8, 7-9, and 7-10) for explanation of the mnemonics used in the following description.

4-50. Measuring Circuits.

4-49. The output of the input amplifier is applied to both the measuring circuit and the audio amplifier. The audio amplifier consists of an operational amplifier and a complementary driver stage for driving a 4 ohm speaker. A front panel MONITOR VOLUME control regulates the amplifier gain.

4-48. The input amplifier is an operational amplifier which provides approximately 40 dB of amplification in the 150 ohm position of the front panel IMP switch. Since all level indications are in dBm the gain of the amplifier is decreased slightly in the 600 ohm position and again in the 900 ohm position. This is accomplished by increasing the negative feedback by switching in larger resistance to ground in the amplifiers feedback line with the front panel IMP switch.

4-47. Input Amplifier and Audio Amplifier.

4-46. Each active filter is a two-pole filter which utilizes both positive and negative feedback. The positive feedback is used to regulate the frequency response. The negative feedback is used to control the gain.

4-45. There are four noise weighting filters provided with the Test Set Telephone (CCITT Psophometric), 3 kHz Flat, 15 kHz Flat and Programme (CCITT). The filter used is selected by the front panel NOISE WEIGHTING switch. The noise weighting circuitry consists of five active filters and the switching sequence which determines the number of active filters used for each weighting. All active filters are bypassed when the RECEIVE NOISE/TONE switch is in the PLAY & MONITOR SEND pushbuttons is pressed.

4-44. Noise Weighting Filters.

Example 4:

1.	Input signal level	-82 dBm
2.	Range position	7
3.	Attenuation (Table 4-3)	0 dBm
4.	Gain (Table 4-3)	10 dBm
4.	Output of select block	-72 dBm
5.	Output of 4 dB amplifier	-68 dBm
6.	Input to logger	-2 dBm

4-62. The display circuit consists of a data accumulator, a display ROM, a seven segment decoder and the LED display. The display circuit converts the information from the analog circuits or the controller into a digital readout. There are three display modes which correspond to the different measurement modes (frequency, tone level and

4-61. Display.

4-60. As noted on Figure 4-4, there is a 15 ms time interval in which the controller will accept HXOVR for level information to be displayed ($T_2 - T_5$, $T_7 - T_{10}$). This 15 ms time interval represents the 15 dB dynamic range of the measuring circuit as noted in Paragraph 4-37. Refer to Paragraph 4-70 for level display description.

4-59. The controller measures the period between setting HCAPD low and receiving the HXOVR pulse. If HXOVR occurs during the first 5 ms after HCAPD goes low ($T_1 - T_2$, $T_6 - T_7$), the controller will interpret this as an overload condition and range the automatic ranging circuit up (see Paragraph 4-36). If HXOVR occurs between 5 ms and 20 ms after HCAPD goes low, ($T_2 - T_5$, $T_7 - T_{10}$), the controller interprets this as a valid signal and uses the exact time difference as the level information for the display (see Paragraph 4-70). If HXOVR occurs after 20 ms from HCAPD going low, the controller interprets this as an underload condition and ranges the automatic ranging circuit down.

4-58. The logger circuit consists of a comparator, a reference voltage circuit and an integrating capacitor (see Figure 4-4). At the beginning of the measurement sequence (T_0 , T_5) the controller will set the NCAPD control signal high, closing the FET switch. This will allow the integrating capacitor to charge to the reference voltage. The controller then sets HCAPD low, opening the FET switch (T_1 , T_6). The integrating capacitor discharges and the discharge voltage is applied to the comparator. The comparator compares the capacitive discharge signal with the signal from the summer. When these two signals are equal in level, the comparator will output a pulse (HXOVR) to the controller (T_5 , T_8).

4-57. In noise level measurements, the two signals applied to the summer from the peak detector and the averaging detector are summed to provide the quasi-rms signal. This signal is then amplified, filtered and applied to a comparator in the logger circuit. In tone measurements, the signal applied to the summer from the averaging detector is amplified, filtered and applied to the comparator in the logger circuit.

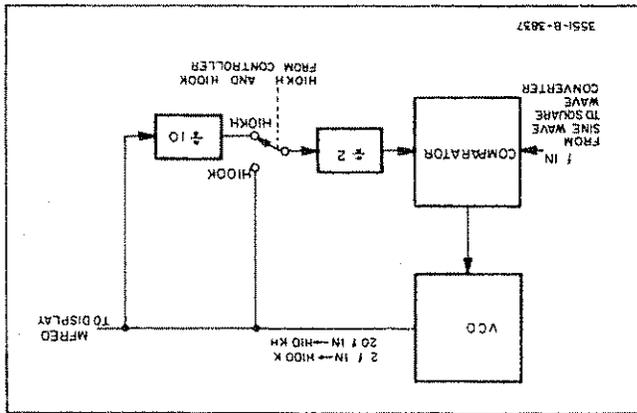
switch allowing the output of the peak detector to be applied to the summer. This increases the signal level to the logger approximately 5 dB. If the measurement to be made is a tone level measurement, LNOIS will be high and the peak detector output will be grounded.

4-56. With both level measurements, the input signal is applied to an averaging detector and a peak detector. The output from the average detector is applied to a summer. The output from the peak detector is applied to a FET switch control. If the measurement to be made is a noise level measurement, the FET switch control signal (LNOIS) from the controller will be low. This will open the FET

4-55. Level Measurements. There are two kinds of level measurements made (noise level and tone level). The noise level measurements use a quasi-rms detection process with a two/second reading rate. The tone level measurements use an average detection process with a reading rate of 10/second in the NORMAL position, and 2/second in DAMPED. Average detection level measurements are also performed for frequency measurements. This ensures the level of the signal input is large enough for proper instrument operation. Because there is no display of the level information in frequency measurements, the level measurement is performed very fast.

4-54. The output of the divide circuits is applied to the comparator in the phase-lock loop where it is compared with the signal from the sine-wave-to-square-wave converter. Any phase difference between these two signals will be developed as a dc error voltage and applied to the VCO to correct its frequency. The frequency of the VCO will therefore be equal to the input frequency multiplied by the ÷ number 2 or 20.

Figure 4-3. Phase-Lock Loop.



4-53. The phase-lock loop consists of a voltage controlled oscillator (VCO), two dividing networks and a comparator (see Figure 4-3). The VCO output signal (MFBEO) is applied to the display circuitry for frequency display information (see Paragraph 4-61) and to the dividing networks. If the input frequency is greater than 10 kHz, the ÷ 10 circuit is bypassed and only the ÷ 2 circuit is used. If the input signal is less than 10 kHz, both the ÷ 10 and the ÷ 2 circuits are used. The selection of these circuits is determined by the H100K and the H100K control signals from the controller. The controller bases the decision on the output frequency of the VCO (see Paragraph 4-64).

4-52. The square wave output of the converter is applied to a comparator in the phase-lock loop.

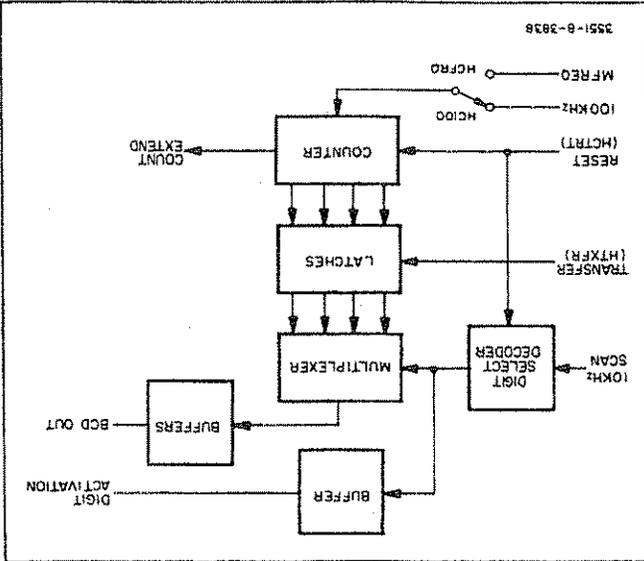
4-65. As noted in Paragraph 4-54, the MFREQ signal is equal in frequency to the Test Set input frequency multiplied by the divide number used. If, for example, the

4-64. Frequency Measurements. If the measurement to be made is a frequency measurement, the controller will set HCFRD high and MFREQ (from the VCO in the measuring circuits, see Paragraph 4-50) will be input to the counter. The counter consists of four divide by 10 circuits. The output of each circuit is a BCD number representing one digit of the Test Set input frequency.

4-63. The input signals for the display circuit are applied to the data accumulator. The data accumulator consists of a counter, data latches, a multiplexer, digit select decoder and output buffers (see Figure 4-5). At the beginning of the measurement, the controller will set the reset signal (HCTRT) high to initialize the counter and the digit select decoder.

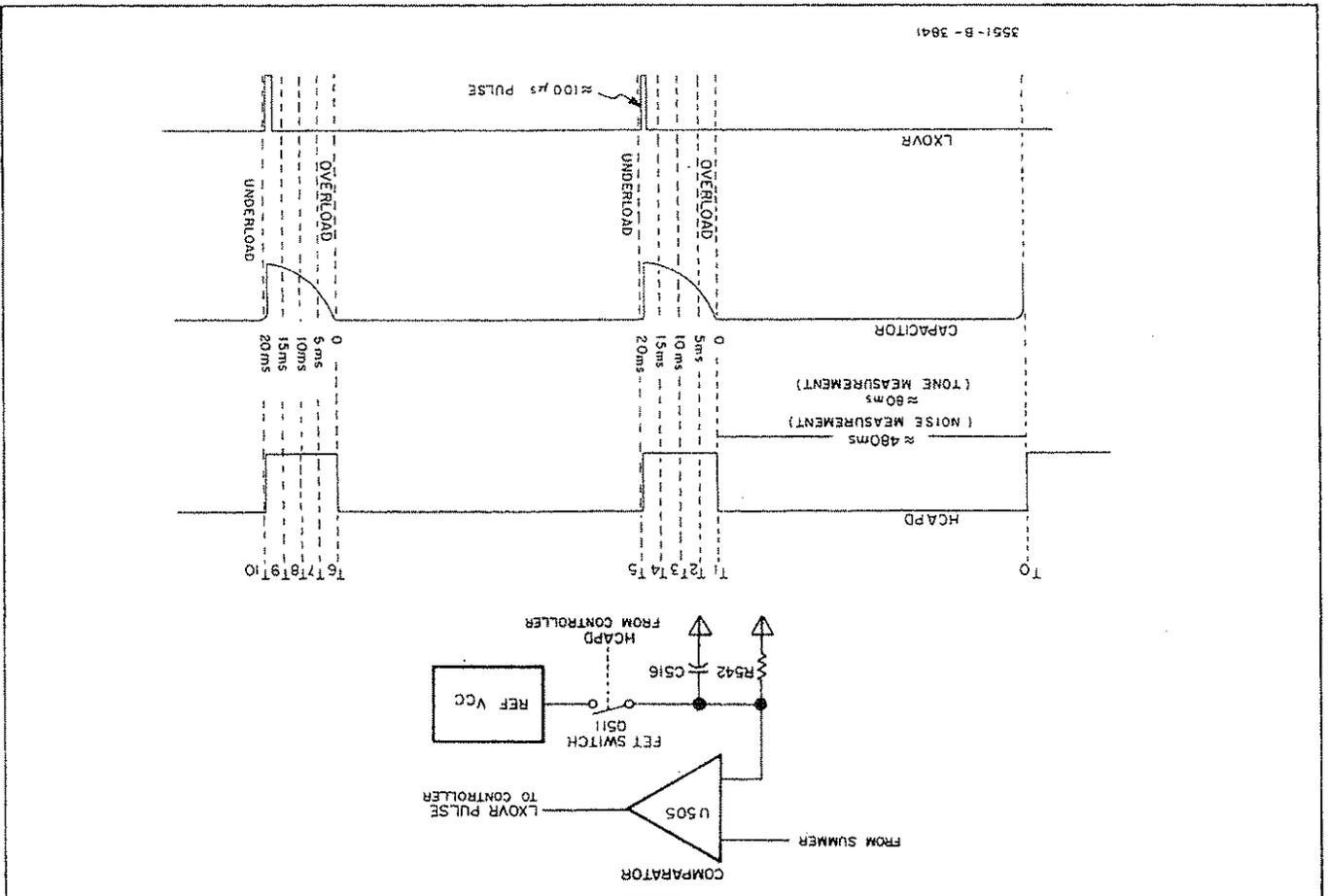
For frequency measurements, the display readout is in kHz with four digits. Frequency resolution in the 10 kHz range is 1 Hz and in the 100 kHz range is 10 Hz. For tone level measurements, the display readout is in dBm with three digits and a resolution of 0.1 dB. For noise level measurements, the display readout is in dBm with two digits and a resolution of 1 dBm.

Figure 4-5. Data Accumulator.



input frequency to the Test Set is 1000 Hz, the MFREQ frequency will be 20,000 Hz. This signal will be input to the counter for 50 ms. A 20,000 Hz signal input for 50 ms is equal to 1000 counts loaded into the counter. At the end of the 50 ms time period, the controller will set the transfer signal (HTXFR) high, storing the counter outputs in the latches.

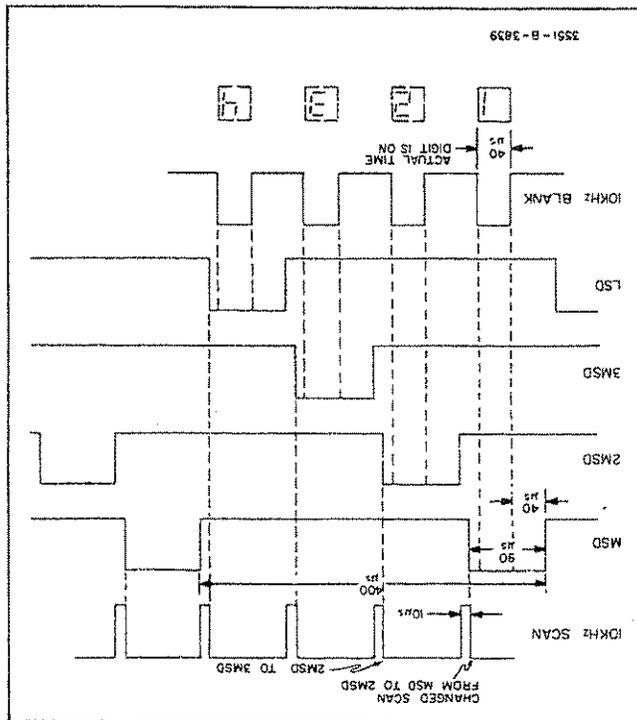
Figure 4-4. Logger.



4-66. The 10 kHz scan signal will gate each BCD signal from the latches, beginning with the most significant digit first, through the multiplexer to the output. At the same time that the 10 kHz scan gates the digits through the multiplexer, the gating signal is output to the display as a digit activation pulse.

4-67. The BCD output of the multiplexer is applied to the display ROM (Figure 7-12) where the polarity of the BCD logic is reversed from negative true to positive true. This signal is applied to the seven segment decoder where it is transformed to a seven bit binary number and applied to each numeral in the display. As the digit activation pulse from the data accumulator and the blanking pulse to the seven segment decoder activates each numeral, the binary data will be displayed (see Figure 4-6).

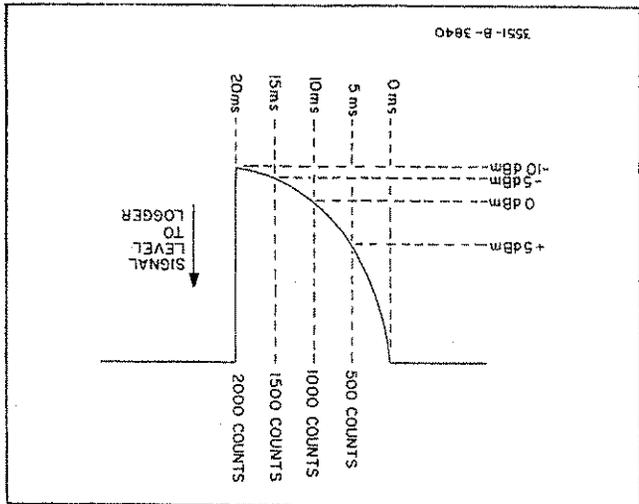
4-68. Frequency upranging is accomplished by the count extend signal from the counter in the data accumulator. If the counter fills up (9999 Hz from MFR EQ) before the 50 ms time interval is over, the next count will set the count extend signal high. The count extend high will set the HOVFL signal high. The controller will check HOVFL at the end of the 50 ms time period and will set H100K high to change the divide by number in the phase-lock loop (see Paragraph 4-53).



4-69. Frequency downranging is accomplished by the L1000 and L<900 output signals from the display ROM. When the BCD signals to the display ROM represent a number less than 9000 Hz, both the L1000 and the L<900 signals will be low. The controller checks these signals at the end of the 50 ms time interval and will set H10KH high to change the divide by number in the phase-lock loop.

Figure 4-6. Display Timing.

4-70. Level Measurements. If the measurement to be made is a level measurement, the controller will set H<100 high (Figure 4-5) and the 100 kHz signal will be input to the counter. This signal will be input until the controller receives HXOVR from the logger circuit (see Paragraph 4-55). As indicated by Paragraph 4-59 and the capacitive discharge curve of Figure 4-4, the controller will accept level information if HXOVR occurs between 5 ms and 20 ms after HCAPD is set low. This time period represents from 500 counts to 2000 counts loaded into the counter (see Figure 4-7).



4-71. The correlation between the number of counts loaded into the counter and the actual input signal level to the Test Set is as follows:

Example 1:

Assuming an input signal level (noise measurement mode) of -40 dBm.

1. Input signal level -40 dBm
2. Range position 3
3. Attenuation (Table 4-3) 30 dB
4. Output of select blocks -70 dBm
5. Output of 4 dB amplifier -66 dBm
6. Input to measuring circuit -5 dBm
7. Input to logger 0 dBm
8. Number of counts loaded 1000

Example 2:

Assuming an input signal level (noise measurement mode) of -20 dBm.

1. Input signal level -20 dBm
2. Range position 1
3. Attenuation (Table 4-3) 50 dB
4. Output of select blocks -70 dBm
5. Output of 4 dB amplifier -66 dBm

- 6. Input to measuring circuit 5 dBm
- 7. Input to logger 0 dBm
- 8. Number of counts loaded into counter 1000

4-72. Note that the same number of counts can be loaded into the counter with different input signal levels. The difference is the range being used. The display ROM will use the range information to decode the counts properly (see Paragraph 4-74).

4-73. The information in the counter is transferred to the latches when the transfer signal (HTXFR) is set high by the controller. The information from the latches is gated through the multiplexer to the display ROM by the 10 KHz scan in the same manner as is described in the frequency measurement (Paragraph 4-66).

4-74. The display ROM (Figure 7-12) transforms the three least significant digits from negative true logic to positive true logic. These BCD signals are applied to the seven segment decoder where they are decoded as a seven bit binary signal and applied to the display. The most significant digit is decoded in the display ROM according to the range and function qualifier information from the controller. If, as in Example 1 of Paragraph 4-71, the measurement mode is noise level and the automatic range circuit is in range 3, the LNOIS qualifier to the display ROM will be low and the range code on the range qualifier input lines will be 1000. The display ROM will decode the most significant digit (1) to a 5. This BCD signal is applied to the seven segment decoder where it is transformed into a seven bit binary code and applied to the display.

4-75. In noise-to-ground measurements, the controller will input counts into the counter for 50 ms before the HCAPD signal in the measuring circuits (see Paragraph 4-55) is set low. This means the counts in the counter are at 5000 when the measurement cycle begins. The display ROM will recognize the additional 5000 counts as indicating a noise-to-ground measurement and add 40 dB to the actual measured signal. The 40 dB addition compensates for the 40 dB loss noted in Paragraph 4-34.

4-76. Tone level measurements are performed the same as noise level measurements with the exception of the display ROM decoding. When the function qualifiers LRFREQ and LNOIS are both high, the display ROM decodes the level information as a dBm signal. The Test Set dynamic range for tone level measurements is +15 dBm to -70 dBm. If the input signal level is less than 0 dBm, the signal level to the ranging circuit gets smaller as the dBm number gets larger (0 dBm to -70 dBm). As the dBm number gets larger, a larger number of counts will be entered in the data accumulator (Figure 4-7). On the other hand, if the input signal level is above 0 dBm, the signal level to the ranging circuit gets larger as the dBm number gets larger (0 dBm to +15 dBm). As the dBm number gets larger a smaller

number of counts will be entered into the data accumulator. Note that with signal levels below 0 dBm, a large dBm number (70) is represented by a large count. With signal levels above 0 dBm, a large dBm number (15) is represented by a small number of counts.

4-77. The display ROM must be aware of the 0 dBm crossover point in order to decode the counts properly. This is accomplished by the count up-count down qualifiers. These qualifiers indicate above or below 0 dBm crossover point and the ROM will decode appropriately.

4-78. The display will indicate the digits as they are activated by the digit activation signals from the data accumulator. In noise level measurements, only the two most significant digits are indicated. The two least significant digits are blanked by the display. In tone level measurements, only the three most significant digits are indicated. The least significant digit is blanked.

4-79. Controller.

4-80. The controller directs, with digital signals, the automatic amplitude and frequency ranging and the measurement and display operations in the Test Set. The technique used to accomplish this is an Algorithmic State Machine (ASM). The controller description will begin with the concept of an ASM. These concepts will then be applied to the Test Set controller.

4-81. A simplified block diagram of the ASM is shown in Figure 4-8. The ASM operates by transforming input qualifier information and state addresses into output instructions. A state is defined as a unit of time in which some action, or actions, takes place. An address is defined as a binary signal which identifies a particular state. There are two state addresses in an ASM. The present state address identifies the present time (state). The next state address identifies the next period of time (state). The output instructions and the next state address of the ASM are determined by the present state address and the qualifier inputs.

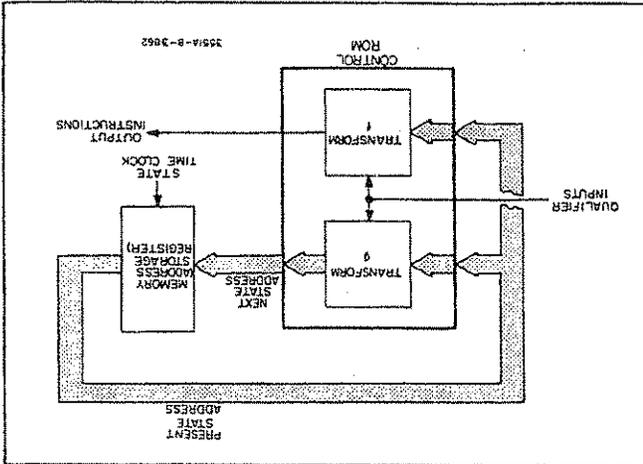


Figure 4-8. ASM Block Diagram.

4-82. The present state address is held (stored) in the memory (address storage register) during the present state interval. A state time clock is used to clock the next state address into the memory at the end of the present state address and new output instructions will occur.

4-83. This sequence, over many states, represents the state machine's algorithm. An algorithm is, therefore, defined as a group of instructions occurring over a sequential number of states. An Algorithmic State Machine is a device which performs a given set of instructions (algorithm) in sequence (one state at a time). The algorithm is set up by the designer to facilitate desired instrument operation. This operation is monitored by the input qualifier.

4-84. The input qualifier circuit and the output instruction circuit can be expanded to increase the capability of the ASM (see Figure 4-9). A switching circuit on the input qualifier line provides the capability of examining one of several input qualifiers. A decoder on the output instruction line provides the capability of outputting one of several instructions. Only one input and/or output can occur during any state.

4-85. These added circuits are controlled by coded lines from the ASM. Because it may be desired to input a qualifier and not output an instruction, the output enable line is added to regulate the decoder output. Table I (Figure 4-9), lists the select line codes and the input

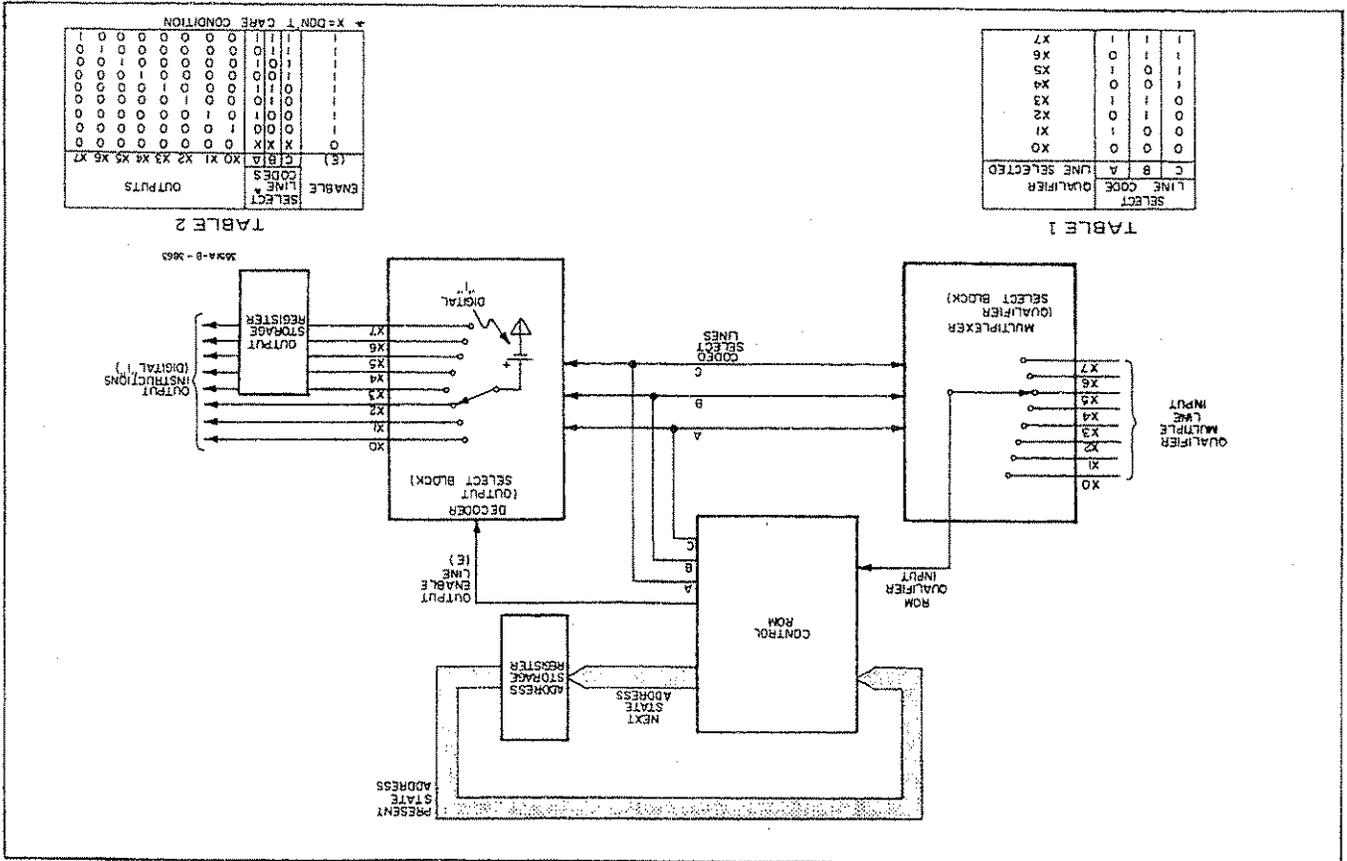
4-86. The ASM performs the operations of checking a qualifier, outputting an instruction, and changing state addresses in a logical, well timed sequence. This timing synchronization of the ASM is accomplished by a clock circuit (see Figure 4-10). The timing sequence is as follows:

- The next address is locked into the address storage register becoming the present address.
- The input qualifier is clocked into a D Flip-Flop where it is stored and applied to the ROM.
- If desired, an output instruction is clocked out of the output select block.

4-87. Also added to the ASM in Figure 4-10 is a turn-on circuit. This circuit applies a reset pulse to the address storage register to reset to the same starting address each time the instrument power is applied.

4-88. Comparison between Figure 4-10 and Figure 7-12 (Controller and Display Block Diagram) reveals the similarity between the previously described ASM and the Test Set ASM. For the following description of the Test Set controller, refer to Figure 7-12, Figure 7-18 (controller

Figure 4-9. Qualifier Select Block and Output Select Block for ASM.



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Q
R
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U
V
W
X
Y
Z

WARNING

These servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

Instrument Type	Required Characteristics	Recommended Model
AC Calibrator	Voltage Range: 0.1 mV to 10 V Accuracy: $\pm (0.02\%$ of setting + 0.002% of range + 10 μ V) 50 Hz to 20 kHz $\pm (0.05\%$ of setting + 0.005% of range + 50 μ V) 20 Hz to 50 Hz and 20 kHz to 60 kHz Frequency: 40 Hz to 60 kHz	-hp- Model 745A AC Calibrator
Attenuator	Attenuation: 10 dB	-hp- Model 355C Attenuator
AC/DC Voltmeter	DC Voltage range: 0 to 10 V DC Voltage accuracy: $\pm 0.01\%$ AC Voltage range: 100 mV to 10 V AC Voltage accuracy: $\pm (0.12\%$ of reading + 0.035% of range)	-hp- Model 3490A Multimeter
Feedthru Termination	50 ohms	-hp- Model 11048C 50 Ω Feedthru
Distortion Analyzer	Input Level: ≥ 5 V rms Measurement: ≥ 60 dB below reference	-hp- Model 333A Distortion Analyzer
Spectrum Analyzer	Frequency: 100 Hz to 50 kHz Dynamic Range: ≥ 55 dB	-hp- Model 3580A Spectrum Analyzer
DC Power Supply	Output: ≥ 60 V at ≥ 30 mA	-hp- Model 6211A DC Power Supply
Oscilloscope	Bandwidth: dc to 50 MHz Sweep: 0.1 μ s to sec/div Sensitivity: 5 mV/div	-hp- Model 180C/ 1801A/1821A Oscilloscope
Logic State Analyzer	TTL Logic Trigger Word: ≥ 8 bits Trigger: Positive and negative Delay: Preset	-hp- Model 1601A Logic State Analyzer (plug-in for 180C Oscilloscope)
Resistors	Value 75 Ω 0.1% (2 each) 100 Ω 0.1% 150 Ω 1% (2 each) 250 Ω 0.1% 300 Ω 0.1% (2 each) 400 Ω 0.1% 450 Ω 0.1% (2 each) 600 Ω 0.1% (2 each) 900 Ω 0.1% (2 each)	-hp- Part Number 0698-7363 0698-4343 0698-6774 0698-6782 0698-6346 0698-6355 0698-7089 0698-7408 0698-5453
Electronic Counter	40 Hz to 60 kHz	-hp- Model 5300B/5301A Counter

Table 5-1. Test Equipment Required.

SECTION V MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains information and instructions necessary for maintenance of the Test Set. Included are performance tests, adjustment procedures, a list of test equipment required, and disassembly information.

5-3. RECOMMENDED TEST EQUIPMENT.

5-4. The equipment required for the maintenance of the Test Set is listed in Table 5-1. If the recommended model is

not available, use a substitute that meets the required specifications given in the table.

5-5. TEST RECORD.

5-6. A Performance Test Record is provided at the end of this section for the purpose of recording the Performance Tests. This form lists all the Performance Tests and their acceptable limits. The form can be removed from the manual and retained as a permanent record. It may be reproduced without written permission from Hewlett-Packard.

PERFORMANCE TESTS

5-7. PERFORMANCE TESTS.

5-8. The following performance tests compare the Test Set operation with the specifications listed in Table 1-1. These tests may be used for incoming inspection, periodic maintenance or to determine operation after repair. If the instrument fails to meet any of its specifications, perform the adjustment procedures outlined in Paragraph 5-38. During the Performance Tests, periodically vary the line voltage $\pm 10\%$ with a power line transformer to determine operation at various ac line voltages.

NOTE

To ensure proper stabilization of all circuitry, allow a 30 minute warm-up period for the Test Set before beginning any performance tests.

5-9. Receiver Level Accuracy.

5-10. This test determines if the Test Set meets the receiver level measurement accuracy specifications listed in Table 1-1 (repeated in Table 5-2). This procedure uses an ac calibrator (-hp-Model 745A) to supply the Test Set input signals.

a. Set the Test Set front panel controls as follows:

- HOLD..... OFF
- FUNCTION..... REC BRDGC
- Left Terminals (black)..... NORMAL
- RECEIVE/TONE..... (or 40 to 60 KHz)

b. Connect the ac calibrator output to the Test Set left input.

- DISPLAY & MONITOR..... RECEIVE LEVEL
- IMP..... 150
- SEND FREQUENCY..... 40 - 1 K
- (or 40 - 600)
- FREQUENCY..... Fully counterclockwise
- VERNIER..... Fully counterclockwise
- SEND LEVEL RANGE..... -60 to -50
- SEND LEVEL.....
- VERNIER..... Fully counterclockwise
- POWER..... MAINS

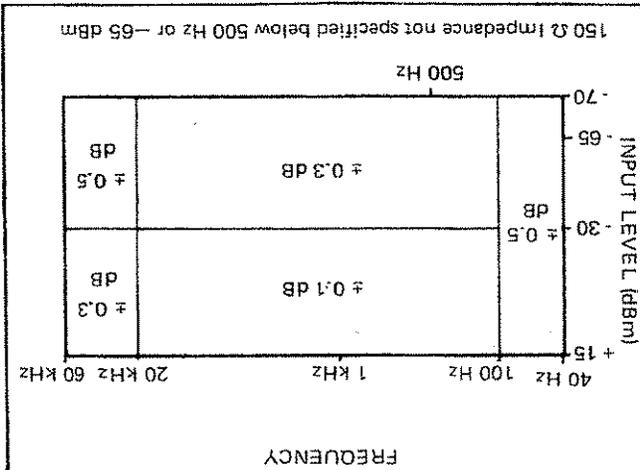


Table 5-2. Receiver Level Measurement Accuracy.

Make sure the ac calibrator output is set to the 1 V range or lower before connecting the 355C attenuator. Voltages higher than 5 V will damage the 355C.



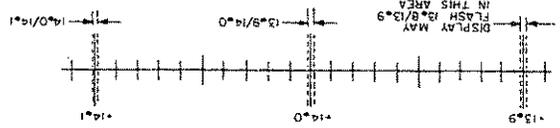
- d. Proceed to test the receiver level accuracy at the frequencies, impedances, and levels shown in Table 5-3. Be sure to change the ac calibrator output to the correct level for each impedance. The Test Set display should be as indicated for each test.
- e. Set the Test Set IMP to 600.
- f. Adjust the ac calibrator frequency to 1 kHz and set the output level to 3.882 V. The Test Set display should be +13.8/13.9 to +14.0/14.1. This is the first test in Table 5-4.
- g. Proceed to test the Test Set receiver level accuracy at the input levels shown in Table 5-4. The Test Set display should be as indicated in each case.

5-12. This performance test determines if the Test Set meets the Transmitter Level Accuracy specifications listed in Table I-1. The specifications are listed again in Table 5-5. During normal operation to set the Test Set output signal level, the send oscillator output is internally applied to the receive circuits and indicated by the Test Set display. The send oscillator level controls are adjusted until the

5-11. Transmitter Level Accuracy.

- h. Connect a 10 dB 50 ohm attenuator (Model 355C set to -10), a 50 ohm feed-thru termination (Model I1048C), and an ac voltmeter (Model 3490A) to the ac calibrator and the Test Set as shown in Figure 5-1. The ac voltmeter accuracy must be $\pm 0.12\%$ of reading + 0.035% of range) or better at 1 kHz.
- i. Set the ac calibrator output voltage to .8691 V (1 V range). (Frequency is still 1 kHz; Test Set in REC BRDG: IMP 600.) If the ac voltmeter reading is not 0.2748 V, adjust the ac calibrator output to obtain this reading.
- j. Change the ac calibrator to the 1 mV range (do not make any other changes). The Test Set display should be between (flashing) -68.6/68.7 and -69.2/69.3 dBm.

c. Adjust the ac calibrator frequency to 500 Hz, and set the output level to 1.9411 V. The Test Set display specification for this input is +14.0 dBm \pm 0.1 dB. Therefore, the display should be between an alternating (flashing) +13.8/13.9 and +14.0/14.1 dBm. The areas in which the display may flash are illustrated below. For example, the display may flash 13.9/14.0 at any point from 13.999 through 14.001.



Test Set Input Level (ac rms)	Display (dBm)
3.882 V	+13.8/13.9 to +14.0/14.1
2.449 V	+9.8/9.9 to +10.0/10.1
1.546 V	+5.8/5.9 to +6.0/6.1
.7746 V	-0.0/0.1 to +0.0/0.1
.4887 V	-3.8/3.9 to -4.0/4.1
1.546 V	-13.8/13.9 to -14.0/14.1
48.87 mV	-23.8/23.9 to -24.0/24.1
15.46 mV	-33.8/33.7 to -34.2/34.3
4.887 mV	-43.6/43.7 to -44.2/44.3
1.546 mV	-53.6/53.7 to -54.2/54.3
4887 mV	-63.6/63.7 to -64.2/64.3

Table 5-4. 1 kHz Test, 600 Ohms.

Test Set Input Levels -35 dBm Test 150 ohms = 6.887 mV 600 ohms = 13.77 mV 900 ohms = 16.87 mV	Test Set			Test Set		
	150 Ω	600 Ω	900 Ω	150 Ω	600 Ω	900 Ω
Test Set Input Levels +14 dBm Test 150 ohms = 1.9411 V 600 ohms = 3.882 V 900 ohms = 4.755 V	Test Set Frequencies			Test Set Frequencies		
	40 Hz					
	100 Hz					
	1 kHz					
	10 kHz					
	20 kHz					
	40 kHz					
	60 kHz					
	150 Ω	600 Ω	900 Ω	150 Ω	600 Ω	900 Ω
	+13.4/13.5 to +14.4/14.5	+13.8/13.9 to +14.0/14.1	+13.8/13.9 to +14.0/14.1	+13.4/13.5 to +14.4/14.5	+13.8/13.9 to +14.0/14.1	+13.8/13.9 to +14.0/14.1
	+13.6/13.7 to +14.2/14.3					
	+13.6/13.7 to +14.2/14.3					

Table 5-3. Receive Level Flatness, +14 dBm and -35 dBm.

PERFORMANCE TESTS

- m. Set the Test Set front panel SEND LEVEL RANGE control to the remaining positions of the range control greater than the top indication of the range control. At each setting the Test Set display indication should be fully CW and the SEND LEVEL RANGE control to the fully CCW and the SEND LEVEL RANGE control to the -60 to -50 position. The Test Set display indication should be less than -60.0 dBm.
- l. Set the Test Set front panel SEND LEVEL vernier control to the remaining positions of the range control greater than the top indication of the range control. At each setting the Test Set display indication should be fully CW. The Test Set display indication should be greater than +10.0 dBm.
- k. Repeat Step j for each of the remaining positions of the Test Set front panel SEND LEVEL RANGE control to the -10 to 0 position. The Test Set display indication should be greater than 0.0 dBm.

- j. Set the Test Set front panel SEND LEVEL RANGE control to the -10 to 0 position. The Test Set display indication should be greater than 0.0 dBm.
- i. Adjust the Test Set front panel SEND LEVEL vernier fully CW. The Test Set display indication should be greater than +10.0 dBm.
- h. Change the Test Set IMP control to 600 and repeat Step c through Step g at the frequencies listed under 600 ohms in Table 5-6. The ac voltmeter reading should be within the limits indicated for each frequency.
- g. Repeat Step e at the remaining frequencies in Table 5-6 under 150 ohms. The ac voltmeter indication should be within the limits shown in each case.
- f. The ac voltmeter indication should be from 1.1969 to 1.2533 V rms. This is the first test in Table 5-6.
- e. Adjust the Test Set front panel SEND LEVEL vernier for a Test Set display of +10.0 dBm.
- d. Set the Test Set front panel DISPLAY & MONITOR control to SEND LEVEL.
- c. Adjust the Test Set FREQUENCY vernier control for a Test Set display indication of 0.500 KHz.

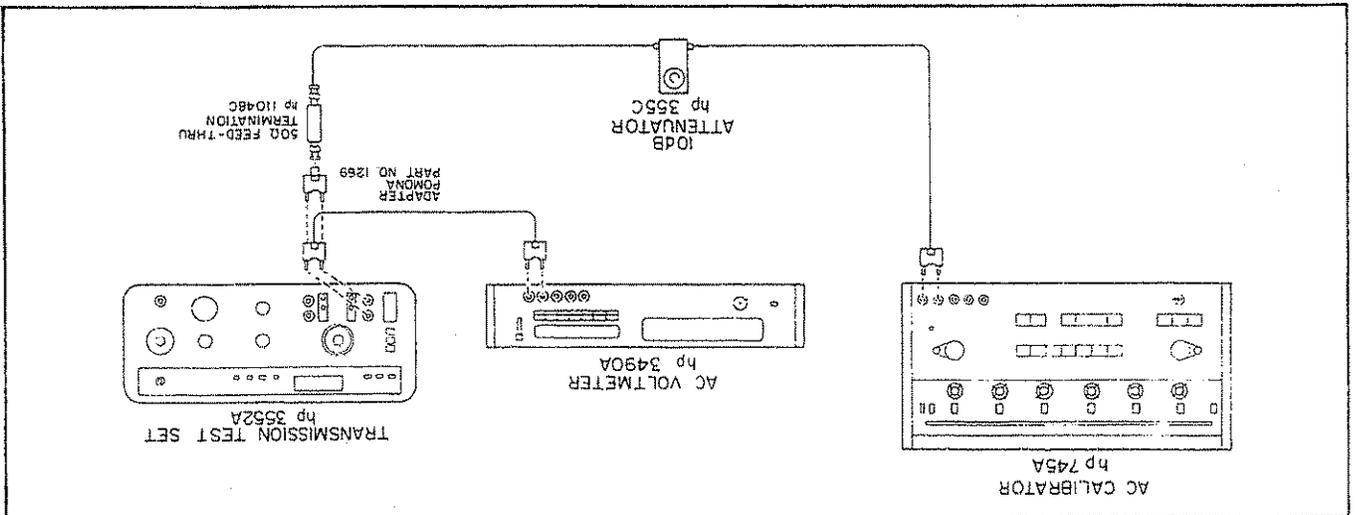
- b. Set the Test Set front panel controls as follows:
 - HOLD..... OFF
 - FUNCTION..... SEND
 - IMP (Blue Input/Output Terminals)..... 150
 - SEND FREQUENCY RANGE Hz..... 40 - 1 K
 - SEND LEVEL RANGE dBm..... 0 to +10
 - DISPLAY & MONITOR..... SEND FREQ
 - POWER..... MAINS
- a. Connect an ac voltmeter to the blue input/output terminals. Connect a 150 ohm resistor across these terminals.

FREQUENCY		OUTPUT LEVEL (dBm)	
40 Hz	100 Hz	± 0.5	± 1
1 KHz	4 KHz	± 0.2 dB	± 0.3 dB
150 Ω Impedance not specified below 500 Hz		500 Hz	

Table 5-5. Transmitter Level Measurement Accuracies.

display indicates the desired output level. For this reason, the accuracy of the Test Set output is determined by the accuracy of the receive circuits. These circuits were tested in the previous performance test. It is only necessary, in this procedure, to test the frequency response of the Test Set output transformer and the overall range of the send oscillator level controls. The procedure uses an ac voltmeter to monitor the Test Set output signal at +10 dBm over the specified frequency range. The range of the output level controls is then checked using the Test Set display.

Figure 5-1. Receiver Low Level Accuracy Test.



POWER..... MAINS
 DISPLAY & MONITOR..... RECEIVE FREQ
 (or 40 Hz - 60 KHz)
 NOISE/TONE..... TONE NORMAL
 RECEIVE.....
 IMP..... 600
 Output Terminals..... REC TERM
 FUNCTION (Black Input).....
 HOLD..... OFF

a. Connect the equipment as shown in Figure 5-2.
 b. Set the Test Set front panel controls as follows:

5-14. This performance test determines if the Test Set meets the Receiver Frequency Measurement Accuracy Specification listed in Table 1-1. The specification is ± 1 count.

5-13. Receiver Frequency Accuracy.

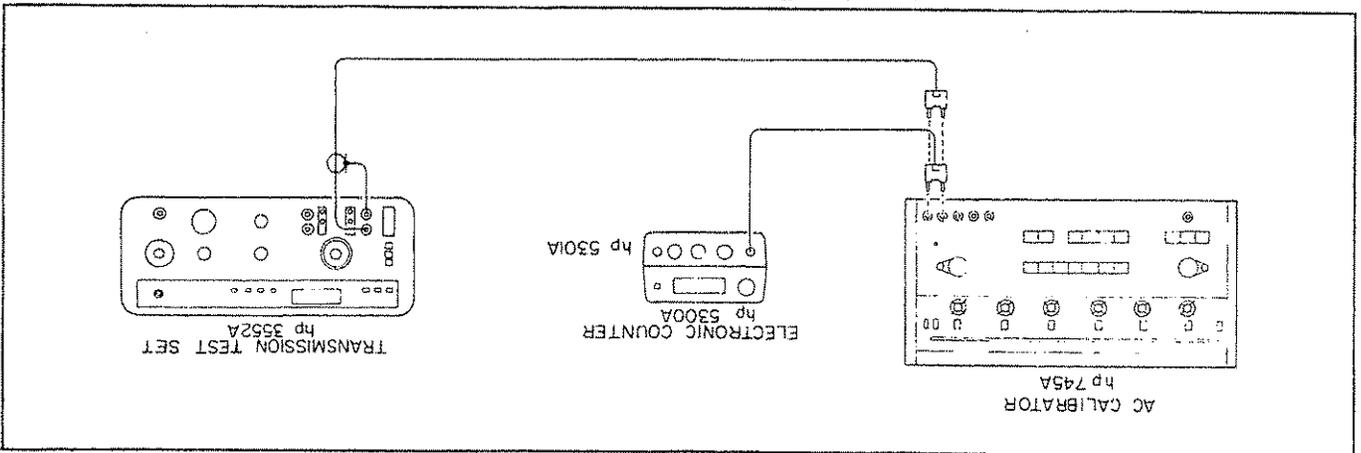
Frequency	AC Voltmeter Reading (V rms)
150 ohms	1.1969 to 1.2533
500 Hz	1.1969 to 1.2533
1 kHz	1.1969 to 1.2533
4 kHz	1.1969 to 1.2533
20 kHz	1.1562 to 1.2973
60 kHz	1.1562 to 1.2973
600 ohms	2.3125 to 2.5945
40 Hz	2.3125 to 2.5945
100 Hz	2.3937 to 2.5065
1 kHz	2.3937 to 2.5065
4 kHz	2.3937 to 2.5065
20 kHz	2.3125 to 2.5945
60 kHz	2.3125 to 2.5945

Table 5-6. Transmitter Level Accuracy.

n. Repeat Step m for each of the remaining positions of the Test Set front panel SEND LEVEL RANGE control. At each setting the Test Set display indication should be less than the bottom indication of the range control position.

control to the -50 to -40 position. The Test Set display indication should be less than -50.0 dBm.

Figure 5-2. Frequency Accuracy Test Setup.



5-15. Transmitter Frequency Accuracy.

Test Set Display	Synthesizer Frequency
0.100 \pm 0.001	100 Hz
1.000 \pm 0.001	1 kHz
10.00 \pm 0.01	10 kHz
20.00 \pm 0.01	20 kHz
60.00 \pm 0.01	60 kHz

and Specifications.

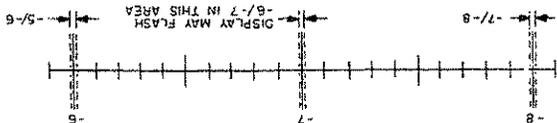
Table 5-7. Receiver Frequency Accuracy Test Frequencies and Tolerances listed in Table 5-7.

e. Repeat Steps c and d for the frequency settings and ± 0.001 kHz.
 d. The Test Set display should indicate 0.040 kHz.
 c. Set the ac calibrator frequency to 40 Hz, 7746 V.

a. Set the Test Set front panel controls as follows:
 SEND FREQUENCY RANGE Hz..... 40 -1 K
 (or 40 - 600)
 SEND LEVEL RANGE dbm..... 0 to +10
 DISPLAY & MONITOR..... SEND FREQ
 POWER..... MAINS
 b. Adjust the Test Set SEND FREQUENCY vernier slowly CCW. The minimum stable Test Set display indication should be less than 0.040 kHz.

5-16. This performance test determines if the Test Set meets the transmitter Frequency Accuracy specification listed in Table 1-1. The specification is ± 1 count. Under normal operation, to set the Test Set output frequency, the send oscillator output is internally applied to the receive circuits and indicated by the Test Set display. The send oscillator frequency controls are adjusted until the display indicates the desired frequency. For this reason the frequency accuracy of the Test Set output is determined by the receive circuits. These circuits were tested in the previous performance test. It is only necessary, in this test, to check the overall range of the send oscillator frequency controls. The procedure uses the Test Set display to monitor the frequency at the top and bottom of each range.

At 400 Hz, for example (Table 5-9), the reference significant digit of the specification (Table 1-1), compensate for the inability to read the least voltage must be adjusted at some frequencies to For a non-expanded (2-digit) display, the input



1. If the Test Set display has been expanded for this test, adjust the AC Calibrator output voltage so that the Test Set display alternates between .6 and .7 dBm. This sets the reference point as near as possible to -7.0 dBm. Then adjust the AC Calibrator to the frequencies shown in Table 5-8. Do not readjust the output voltage. The Test Set display should be as shown for each frequency.
2. If the Test Set does not have an expanded display, adjust the AC Calibrator output voltage so that the Test Set display alternates between .6 and .7 dBm. This sets the reference point as near as possible to -7.0 dBm. Then adjust the AC Calibrator to the frequencies shown in Table 5-8. Do not readjust the output voltage. The Test Set display should be as shown for each frequency.

c. Adjust the AC Calibrator frequency to 800 Hz and the output voltage to .3460 V.

HOLD OFF
 FUNCTION (Black Input) OFF
 Output Terminals) REC TERM
 IMP 600
 NOISE/TONE MESSAGE CIRCUIT
 DISPLAY & MONITOR TELEPHONE
 POWER MAINS

- a. Connect the AC Calibrator output to the Test Set left (black) input/output terminals as shown in Figure 5-2. using an electronic counter to monitor the calibrator frequency.
- b. Set the Test Set front panel controls as follows:

below 00111 do not have this jumper, and consequently can be tested only to integer number resolution. For these instruments, use the following tables marked "For 2-Digit Display". For instruments in which the jumper is moved for these tests, use the tables marked "For Expanded Display".

In order to test the Noise Weighting Filters Response accuracy to one decimal place, it is necessary to move a jumper within the instrument. With the 3552A disconnected from mains, release the cover as shown in Figure 5-12 and slide the cover back approximately three inches. Change the position of "Jumper for dBm Resolution" (see Figure 5-16) from the N position to the 3 position. Be sure to return this jumper to the N position after completing the Noise Weighting Filter tests. Some instruments with serial number suffix

NOTE

To avoid the possibility of electrical shock, disconnect the ac power cord before releasing the instrument cover.

WARNING

5-18. This performance test determines if the Test Set meets the specifications listed in Table 1-1 for the Telephone, 3 kHz, and 15 kHz Noise Weighting Filters. The specifications conform to the standards adopted by the Consultative Committee on International Telephone and Telegraph (CCITT) Recommendation P53. This performance test uses a 745A AC Calibrator to provide the input signals. Because the Test Set display is used to monitor the filter accuracies, the Receiver Level Accuracy Test Paragraph 5-9) must be performed before this test.

5-17. Telephone, 3 kHz, and 15 kHz Noise Weighting Filters Response.

- a. Adjust the Test Set SEND FREQUENCY vernier slowly CW. The maximum stable Test Set display indication should be greater than 60.00 kHz.
- b. Adjust the Test Set SEND FREQUENCY vernier to the 2 K -60 K position. The Test Set display indication should be less than 2.000 kHz.
- c. Set the Test Set SEND FREQUENCY RANGE Hz control to the 200 -6 K position. The Test Set display indication should be greater than 6.000 kHz.
- d. Adjust the Test Set SEND FREQUENCY vernier fully CCW. The Test Set display indication should be less than 0.200 kHz.
- e. Set the Test Set SEND FREQUENCY RANGE Hz control to the 2 K -60 K position. The Test Set display indication should be less than 2.000 kHz.
- f. Adjust the Test Set SEND FREQUENCY vernier slowly CW. The Test Set display indication should be greater than 1.000 kHz (or 0.600 kHz).
- g. Set the Test Set SEND FREQUENCY RANGE Hz control to the 200 -6 K position. The Test Set display indication should be greater than 6.000 kHz.
- h. Adjust the Test Set SEND FREQUENCY vernier fully CCW. The Test Set display indication should be greater than 1.000 kHz (or 0.600 kHz).
- i. Set the Test Set SEND FREQUENCY RANGE Hz control to the 200 -6 K position. The Test Set display indication should be greater than 6.000 kHz.
- j. Adjust the Test Set SEND FREQUENCY vernier slowly CW. The Test Set display indication should be greater than 60.00 kHz.

Transmitter performance is not specified below 40 Hz or above 60 kHz.

NOTE

- c. Adjust the ac calibrator frequency to 1 kHz and the output voltage to .1377 V.
- d. Adjust the ac calibrator to the frequencies shown in Table 5-12. Do not readjust the voltage. The Test Set display should be as shown for each frequency.
- e. Adjust the ac calibrator frequency to 6.3 kHz, and not -5.9/6.0 dbm adjust the ac calibrator output voltage to obtain this reading.
- f. Adjust the ac calibrator frequency to 6.3 kHz, and not -5.9/6.0 dbm adjust the ac calibrator output voltage to obtain this reading.

- a. Connect the ac calibrator to the Test Set left (black) input/output terminals.
- b. Set the Test Set front panel controls as follows:
- HOLD..... OFF
 FUNCTION (Black Input/Output Terminals)..... OFF
 REC TERM..... 600
 IMP..... 600
 MESSAGE CIRCUIT..... PROGRAMME
 NOISE WEIGHTING..... DISPLAY & MONITOR
 RECEIVE LEVEL..... MAINS POWER

Frequency (Hz)	Test Set Display Limits (dbm)
6300	-5.9/6.0 dbm REF
63	-40.6/40.7 to -43.4/43.5
100	-36.9/37.0 to -38.9/39.0
200	-31.0/31.1 to -32.8/32.9
400	-25.2/25.3 to -26.6/26.7
800	-19.4/19.5 to -20.6/20.7
1000	-17.6/17.7 to -18.6/18.7
2000	-12.0/12.1 to -13.0/13.1
3150	-8.6/ 8.7 to - 9.6/ 9.7
4000	- 7.1/ 7.2 to - 8.1/ 8.2
5000	- 5.9/ 6.0 to - 6.9/ 7.0
7100	- 5.9/ 6.0 to - 6.3/ 6.4
8000	- 6.3/ 6.4 to - 7.1/ 7.2
9000	- 7.4/ 7.5 to - 8.6/ 8.7
10,000	- 9.2/ 9.3 to -10.6/10.7
12,500	-16.9/17.0 to -19.3/19.4
14,000	-22.0/22.1 to -24.8/24.9
16,000	-27.4/27.5 to -30.8/30.9
20,000	-38.3/38.4 to -42.3/42.4
31,500	≤-58.1 dbm

Table 5-12. Noise Weighting Filter, Programme. (For Serial No. 1604A00201 and higher) (For Serial No. 1512U00221 and higher)

- a. Connect the ac calibrator output to the Test Set left (black) input/output terminals.
- b. Set the Test Set front panel controls as follows:
- HOLD..... OFF
 FUNCTION (Black Input/Output Terminals)..... OFF
 REC TERM..... 600
 IMP..... 600
 MESSAGE CIRCUIT..... PROGRAMME
 NOISE WEIGHTING..... DISPLAY & MONITOR
 RECEIVE LEVEL..... MAINS POWER

Table 5-12. Noise Weighting Filter Response. (Serial No. 1604A00201 and higher) (Serial No. 1512U00221 and higher)

Frequency (Hz)	Test Set Input	Frequency (Hz)	Test Set Input	Display Limits (dbm)
1000	REF*	1000	REF*	-7/8 dbm REF
60	REF	60	REF	-5/6 to - 9/10
250	REF	250	REF	-6/7 to - 8/9
2000	REF -0.173 V	10,000	REF + .0108 V	-6/7 to - 9/10
2500	REF -0.173 V	15,000	REF	-7/ 8 to -13/14
3000	REF	20,000	REF + .0072 V	-10/11 to -16/17
30,000	REF	30,000	REF + .0108 V	-16/17 to -22/23
60,000	REF	60,000	REF + .0108 V	≥ 12 dB below 30 kHz

Table 5-11. Noise Weighting Filter, 3 kHz Flat, 15 kHz Flat. (For 2-Digit, Non-Expanded Display)

*REF voltage determined in Paragraph 5-18, Step e (2).

5-24. This performance test determines if the Test Set meets the Receiver Noise Measurement Accuracy Specifications listed in Table I-1. The specifications are:

- ± 1 dB (-70 dBm to -5 dBm).
- ± 2 dB (-90 dBm to -70 dBm).

Message circuit noise:

- d. Proceed with the remaining tests in Table 5-15 at the input levels listed. The display should be as shown in each case.
- c. Adjust the ac calibrator output to 1 kHz and .6920 V (Test Set input of .3460 V). The Test Set display should be between -5/6 dBm (flashing) and -7/8 dBm. This is the first test in Table 5-15.

5-23. Receiver Noise Accuracy.

d. If the "Jumper for dBm resolution" was moved to expand the display for the noise weighting filter tests, return the jumper to the N position.

To avoid the possibility of electrical shock, disconnect the ac power cord before opening the instrument.



2. If the Test Set does not have an expanded display, adjust the ac calibrator output voltage so that the Test Set display alternates between -14 dBm and -15 dBm. This sets the reference point as near as possible to -15 dBm. Perform this test at the frequencies listed in Table 5-14. The display should be as shown for each frequency.

HOLD..... OFF
 FUNCTION (Black Input).....
 REC TERM..... 600
 IMP.....
 RECEIVE
 NOISE/TONE..... MESSAGE CIRCUIT
 NOISE WEIGHTING..... 3 kHz FLAT
 DISPLAY & MONITOR..... RECEIVE LEVEL
 POWER..... MAINS

b. Set the Test Set front panel controls as follows:

- a. Connect an ac calibrator through two 300 ohm resistors (one in each lead) to the Test Set black input/output terminals. Monitor the calibrator frequency with an electronic counter.

This performance test uses an ac calibrator to supply a reference signal at levels through the dynamic range of the Test Set.

* REF voltage determined in Paragraph 5-22, Step c (2).

Noise—with tone:
 ± 1 dB (-70 dBm to -5 dBm).
 ± 2 dB (-80 dBm to -70 dBm).
 Noise—to-ground:
 ± 1 dB (-30 dBm to +35 dBm).
 ± 2 dB (-50 dBm to -30 dBm).

Test Set Display Indication and Tolerances (dBm)	Test Set Input	Frequency (Hz)
REF*	REF +.0047 V	1000
-14/15 dBm REF	REF +.0047 V	60
-45/46 to -48/49	REF -.0062 V	100
-39/40 to -42/43	REF -.0031 V	200
-21/22 to -24/26	REF +.0048 V	400
-14/15 to -17/18	REF +.0065 V	800
-7/8 to -10/11	REF +.0032 V	2000
-4/5 to -7/8	REF +.0048 V	4000
-4/5 to -7/8	REF +.0016 V	5000
-4/5 to -7/8	REF +.0048 V	6000
-4/5 to -7/8	REF +.0032 V	7000
-5/6 to -8/9	REF +.0065 V	8000
-7/8 to -10/11	REF +.0048 V	9000
-11/12 to -17/18	REF +.0047 V	10,000
-21/22 to -27/28	REF -.0047 V	20,000
≥ 12 dB below 10 kHz reading	REF -.0047 V	20,000
≥ 24 dB below 10 kHz reading	REF -.0047 V	40,000
≥ 31 dB below 10 kHz reading	REF -.0047 V	60,000

Table 5-14. Noise Weighting Filter, Programme. (For Serial No. 1125A00200 and lower, and for 1512U00220 and lower, 2-Digit Display)

Frequency (Hz)	Test Set Display Limits (dBm)
1000	-14.9/15.0 dBm REF
60	-45.6/45.7 to -48.6/48.7
100	-39.5/39.6 to -42.5/42.6
200	-30.7/30.8 to -33.7/33.8
400	-22.2/22.3 to -25.2/25.3
800	-15.3/15.4 to -18.3/18.4
2000	-8.1/8.2 to -11.1/11.2
4000	-5.2/5.3 to -8.2/8.3
5000	-5.0/5.1 to -8.0/8.1
6000	-5.2/5.3 to -8.2/8.3
7000	-6.2/6.2 to -9.1/9.2
8000	-8.3/8.4 to -11.3/11.4
9000	-12.2/12.3 to -18.2/18.3
10,000	-21.6/21.7 to -27.6/27.7
20,000	≥ 12 dB below 10 kHz reading
40,000	≥ 24 dB below 10 kHz reading
60,000	≥ 31 dB below 10 kHz reading

Table 5-13. Noise Weighting Filter, Programme. (For Serial No. 1125A00200 and lower, and for 1512U00220 and lower, Expanded Display)

1. If the Test Set display has been expanded for this test, adjust the ac calibrator output level for a Test Set display of -14.9/15.0 dBm. Then adjust the ac calibrator to the frequencies shown in Table 5-13. Do not readjust the output voltage level. The Test Set display should be as shown for each frequency.

5-26. This performance test determines if the Test Set meets the Transmitter Harmonic Distortion specifications listed in Table 1-1. The specifications list the harmonic distortion in two categories—total harmonic distortion from 40 Hz to 60 kHz and discrete harmonics from 100 Hz to 4 kHz. The total harmonic distortion specifications are > 50 dB below reference from 100 Hz to 4 kHz, > 40 dB below reference from 40 Hz to 100 Hz and 4 kHz to 20 kHz and > 30 dB below reference from 20 kHz to 60 kHz. The discrete harmonic distortion specification is > 55 dB below reference from 100 Hz to 4 kHz. The harmonic distortion specification for the 800 Hz hold tone is > 60 dB below reference for total harmonic distortion.

5-25. Transmitter Harmonic Distortion.
 n. Repeat Step n for a frequency of 932 Hz.

m. Adjust the ac calibrator to 682 Hz and .6920 V. The Test Set display indication should be at least -10 dBm.

l. Repeat Step k for an ac calibrator frequency setting of 812 Hz.

k. Adjust the ac calibrator to 783 Hz and .6920 V. The Test Set display indication should be less than -57 dBm.

j. Repeat the tests shown in Table 5-15 at 1343 Hz. The Test Set display should be as indicated in each case.

i. Adjust the ac calibrator for 1343 Hz. The Test Set display indication should be between -5/6 and -7/8 dBm.

h. Set the Test Set front panel RECEIVE NOISE/TONE control to the WITH TONE position. The Test Set display indication should be between -5/6 and -7/8 dBm.

g. Adjust the ac calibrator frequency to 316 Hz.

f. Set the Test Set front panel RECEIVE NOISE/TONE control to the TO GROUND position. The Test Set display should be between -5/6 and -7/8 dBm.

e. Set the ac calibrator output level to .6920 V. Ground the Test Set chassis GROUND terminal to earth ground.

AC Calibrator Level	Test Set Input Level	Test Set Display Limits (dBm)
.6920 V	.3460 V	- 5/ 6 to - 7/ 8
.2188 V	.1094 V	-15/16 to -17/18
69.20 mV	34.60 mV	-25/26 to -27/28
21.88 mV	10.94 mV	-35/36 to -37/38
6.920 mV	3.460 mV	-45/46 to -47/48
2.188 mV	1.094 mV	-55/56 to -57/58
.6920 mV	.3460 mV	-65/66 to -67/68
.2188 mV	.1094 mV	-74/75 to -78/79
.10968 mV	.05484 mV	-80/81 to -84/85

Table 5-15. Receiver Noise Level Test.

5-27. This performance test uses a distortion analyzer (333A) to test the total harmonic distortion and a spectrum analyzer (3580A) to test the discrete harmonic distortion.

a. Connect a 150 ohm resistor across the distortion analyzer input terminals. Connect the Test Set chassis ground terminal to the right-hand (blue) "b" terminal, and connect "b" to the distortion analyzer LOW input. Connect the Test Set right-hand (blue) "a" terminal to the distortion analyzer HIGH input.

b. Set the Test Set front panel controls as follows:

HOLD..... OFF
 FUNCTION (Blue Input/Output Terminals)..... SEND
 IMP..... 150
 SEND FREQUENCY RANGE Hz..... 40 - 1K
 (or 40 - 600)
 SEND LEVEL RANGE dbm..... 0 to +10
 DISPLAY & MONITOR..... SEND LEVEL

e. Using the procedures outlined in the distortion analyzer's Operating and Service manual, measure the distortion of the Test Set output signal. The distortion should be more than 40 dB below the reference set in Step c.

f. Repeat Step e for the frequencies and specifications listed in Table 5-16.

g. Disconnect the distortion analyzer and connect a spectrum analyzer to the Test Set right (blue) input/output terminals. Connect a 150 ohm resistor across the spectrum analyzer input terminals.

Table 5-16. Transmitter THD Test Frequencies and Specifications.

Test Set Frequency	Specification (dB Below Reference)
800 Hz Hold Tone	> 60
60 kHz	> 30
40 kHz	> 30
20 kHz	> 40
15 kHz	> 40
10 kHz	> 40
4 kHz	> 40
2 kHz	> 50
1 kHz	> 50
500 Hz	> 50
100 Hz	> 50
60 Hz	> 40

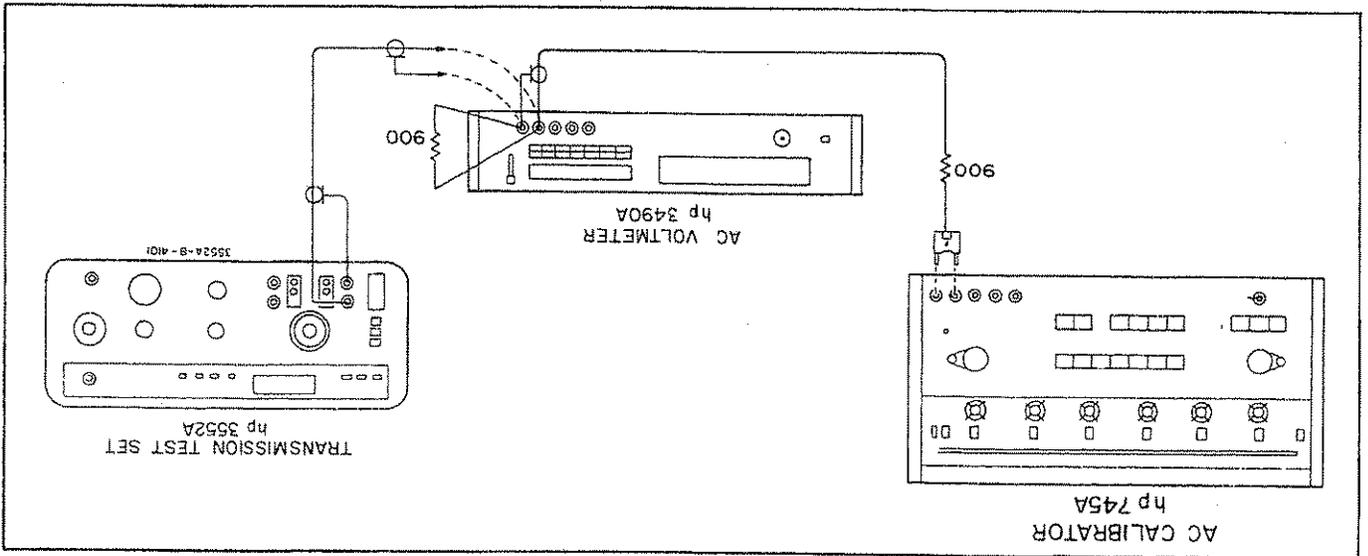


Figure 5-3. Bridging Loss Test Setup.

- e. Repeat the procedures with the ac calibrator set to 20 kHz. The voltmeter indication should not vary more than 20 mV ac.
- f. Repeat the procedure at 60 kHz. The voltmeter indication should not vary more than 20 mV ac.

5-30. Return Loss.

5-31. This performance test determines if the Test Set meets the Return Loss specification in Table 1-1. The specification is greater than 30 dB below reference from 500 Hz to 20 kHz for 150 ohm impedance and greater than 30 dB below the reference from 40 Hz to 20 kHz for the 600 ohm and 900 ohm impedance. An adapter for R_s may be constructed as shown in Figure 5-4.

Receiver:

- a. Return loss in dB may be found using the following equation:

$$RL = -20 \log \left| \frac{R_2 + R_1}{R_2 - R_1} \right| = -20 \log \left| \frac{2V_2 - V_1}{V_1} \right|$$

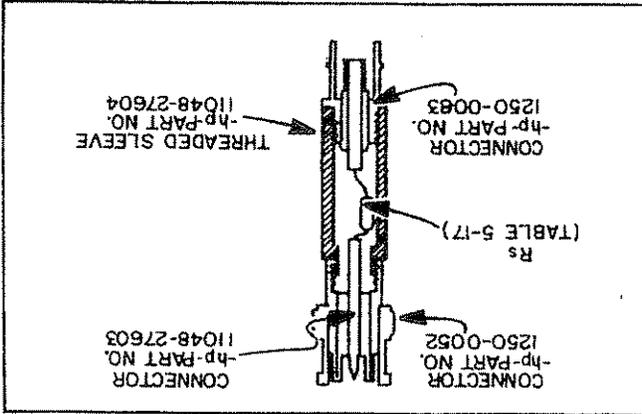


Figure 5-4. Return Loss Test Adapter.

- h. Using the procedures outlined in the spectrum analyzer manual, measure the harmonics of the following frequencies, paying special attention to the second, third, and eleventh harmonics. Each harmonic should be more than 55 dB below the reference (fundamental).

- 100 Hz
- 500 Hz
- 1 kHz
- 2 kHz
- 4 kHz

5-28. Bridging Loss.

5-29. This performance test determines if the Test Set meets the Bridging Loss specification listed in Table 1-1. The specification is < 0.2 dB. In this performance test an ac calibrator output is applied to an ac voltmeter loaded by 900 ohms and a reference voltage is set up on the ac voltmeter. The input impedance of the Test Set is then bridged across the reference impedance to determine the bridging loss.

- a. Connect the equipment as shown in Figure 5-3 with the Test Set disconnected.

- b. Set the Test Set front panel controls as follows:

HOLD..... OFF
 FUNCTION (Black Input Terminals)..... REC BRDG
 IMP..... 900
 POWER..... MAINS

- c. Adjust the ac calibrator output for 100 Hz and an ac voltmeter indication of 1,000 V ac.

- d. Connect the Test Set leads across the ac voltmeter input leads and the 900 ohm resistor. The ac voltmeter indication should not vary more than 20 mV ac.

1. Transmitter return loss in dB may be determined by using the same equation used for receiver return loss:

$$RL = -20 \log \left| \frac{V_2 - V_1}{2V_2 - V_1} \right|$$

Transmitter:

3552A Impedance		R _s /R _L -hp-Part No.
150	150 Ω ± 0.1%	0698-6774
600	600 Ω ± 0.1%	0698-7408
900	900 Ω ± 0.1%	0698-5453

Table 5-17. Return Loss Test Resistors.

If any of the Return Losses were out of specifications, recheck Step e at the questionable frequency and impedance before starting repairs.

NOTE

- i. Calculate the return loss for both cases where V₁ is the voltage from Step h and V₂ is the voltage from Step g. The Return Loss must be greater than 30 dB.
- j. Change R_s to 600 ohms and the 3552A IMP to 600 ohms. Repeat Steps c through i, using a 600 ohm resistor for R_L and sweeping from 40 Hz to 20 kHz. The return loss must be greater than 30 dB.
- k. Change R_s to 900 ohms and the 3552A IMP to 900 ohms. Repeat Steps c through i, using a 900 ohm resistor for R_L and sweeping from 40 Hz to 20 kHz. The return loss must be greater than 30 dB.

- g. Remove R_L and connect the dual banana plug to the 3552A black (left) input terminals. Sweep the ac calibrator frequency from 500 Hz to 20 kHz and record the highest and lowest voltages measured on the ac voltmeter, along with the frequencies at which these voltages were measured.

HOLD..... OFF
 FUNCTION (Black Input/ Output Terminals) REC TERM
 IMP..... 150
 POWER..... MAINS

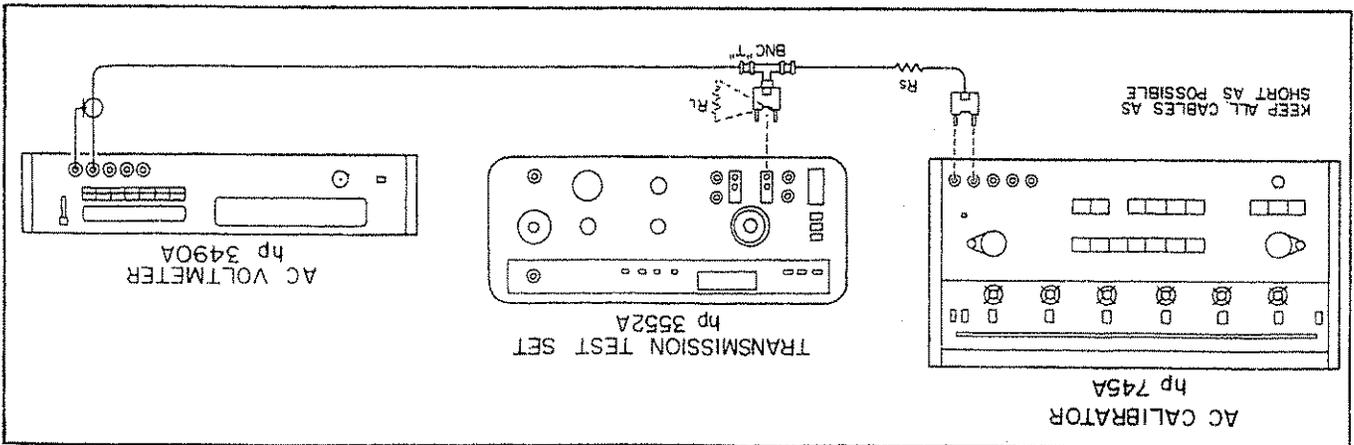
- f. Set the 3552A controls as follows:

If $2V_2 = V_1$ the return loss is "infinite". It is not actually infinite but is beyond the measuring capability of the test equipment.

NOTE

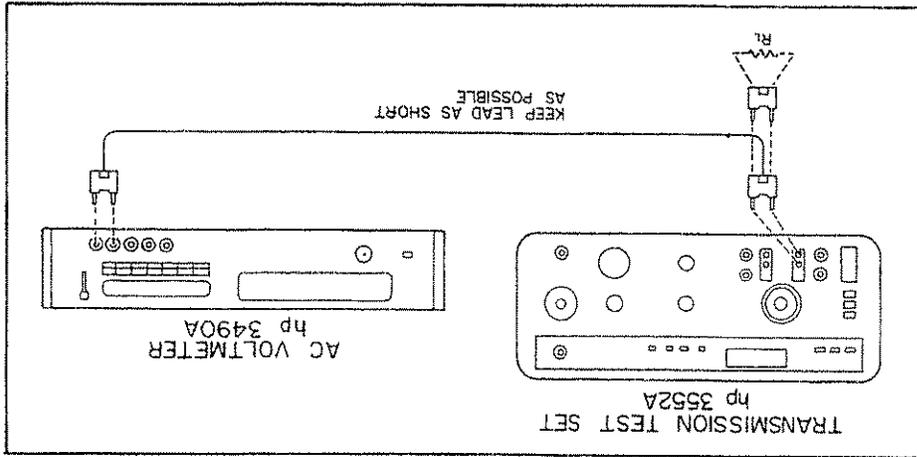
- e. Calculate the return loss of the test equipment, using the formula in Step a. Return loss must be greater than 40 dB in order to be accurate enough to test the 3552A. If it is not, check R_s, the ac calibrator, and the interconnecting wiring.
 - d. Connect a 150 ohm resistor (Table 5-17) to the dual banana plug (R_L in Figure 5-5). Record the ac voltmeter reading. This is V₂.
 - c. Set the ac calibrator output to 1 V at 20 kHz. Record the ac voltmeter reading. This is V₁.
 - b. Connect the equipment as shown in Figure 5-5. Do not connect the 3552A or R_L at this time. Make R_s = 150 ohms (see Table 5-17). Set the ac voltmeter to the 1 V range.
 - a. Set the ac calibrator output to 1 V at 20 kHz. Record the ac voltmeter reading. This is V₁.
- When R₁ is the source resistance, V₁ is its open circuit voltage, R₂ is the load resistance, and V₂ is the voltage across the load.

Figure 5-5. Return Loss Test Setup.



- t. Change R_L to 600 ohms and the Test Set IMP to 600. Repeat Steps p through s, sweeping the frequency from 40 Hz to 20 kHz. The return loss must be greater than 30 dB.
- s. Calculate the return loss for both cases, using the equation in Step l. V_2 is the voltage measured in Step q, and V_1 is the voltage measured in Step r. The return loss must be greater than 30 dB.
- r. Disconnect R_L and measure the open circuit voltage at both frequencies recorded in Step f. (This is V_1 in the equation.)
- q. Return the display to SEND FREQ. Sweep the Test Set output frequency from 500 Hz to 20 kHz, and record the highest and lowest voltages measured on the ac voltmeter, along with the frequencies at which these voltages were measured. (This is V_2 in the equation.)
- p. Press DISPLAY & MONITOR SEND LEVEL and adjust the SEND LEVEL VERNIER for a display of -10.0 dbm.
- o. Press DISPLAY & MONITOR SEND FREQ and adjust the FREQUENCY VERNIER for a display of 0.500 kHz.
- n. Set the Test Set controls as follows:
 HOLD..... OFF
 FUNCTION (Black Input/ Output Terminals)..... SEND
 IMP..... 150
 SEND FREQUENCY..... 40 - 1 K
 (or 40 - 600)
 SEND LEVEL..... -10 to 0
 POWER..... ~ AC
- m. Connect the equipment as shown in Figure 5-6. Connect a $150 \Omega \pm 0.1\%$ Resistor (R_L) across the Test Set left-hand (black) terminals.

Figure 5-6. Transmitter Return Loss Test.



- u. Change R_L to 900 ohms and the Test Set IMP to 900. Repeat Steps p through s, sweeping the frequency from 40 Hz to 20 kHz. The return loss must be greater than 30 dB.
- 5-32. Longitudinal Balance.
- 5-33. This performance test determines if the Test Set meets the Longitudinal Balance specification listed in Table 1-1. The specification is greater than 60 dB below reference at 6 kHz for the receive mode and greater than 50 dB below the reference at 6 kHz for the send mode. Both the receiver balance and the transmitter balance are checked.
- 5-34. The procedure for the receiver balance uses a 745A ac calibrator to supply an unbalanced signal to the Test Set balanced input. This supplies the Test Set with a maximum unbalance for a reference. The same signal is then applied equally between the Test Set input terminals and referenced to the Test Set ground. The difference between these signals as read on the Test Set display is the receiver balance.
- 5-35. The transmitter balance is tested in the same way except the Test Set serves as the oscillator and an external ac voltmeter serves as the monitor.
- Receiver:
 a. Connect the equipment as shown in Figure 5-7(a).
 b. Set the Test Set front panel controls as follows:
 HOLD..... OFF
 FUNCTION (Black Input/ Output Terminals)..... REC BRDG
 IMP..... 600
 RECEIVE TONE NORMAL
 NOISE/TONE..... (or 40 - 60 K)
 DISPLAY & MONITOR..... RECEIVE LEVEL
 POWER..... MAINS
- c. Adjust the ac calibrator output for 6 kHz and a Test Set display indication of -6.0dbm (approximately 1.549V).

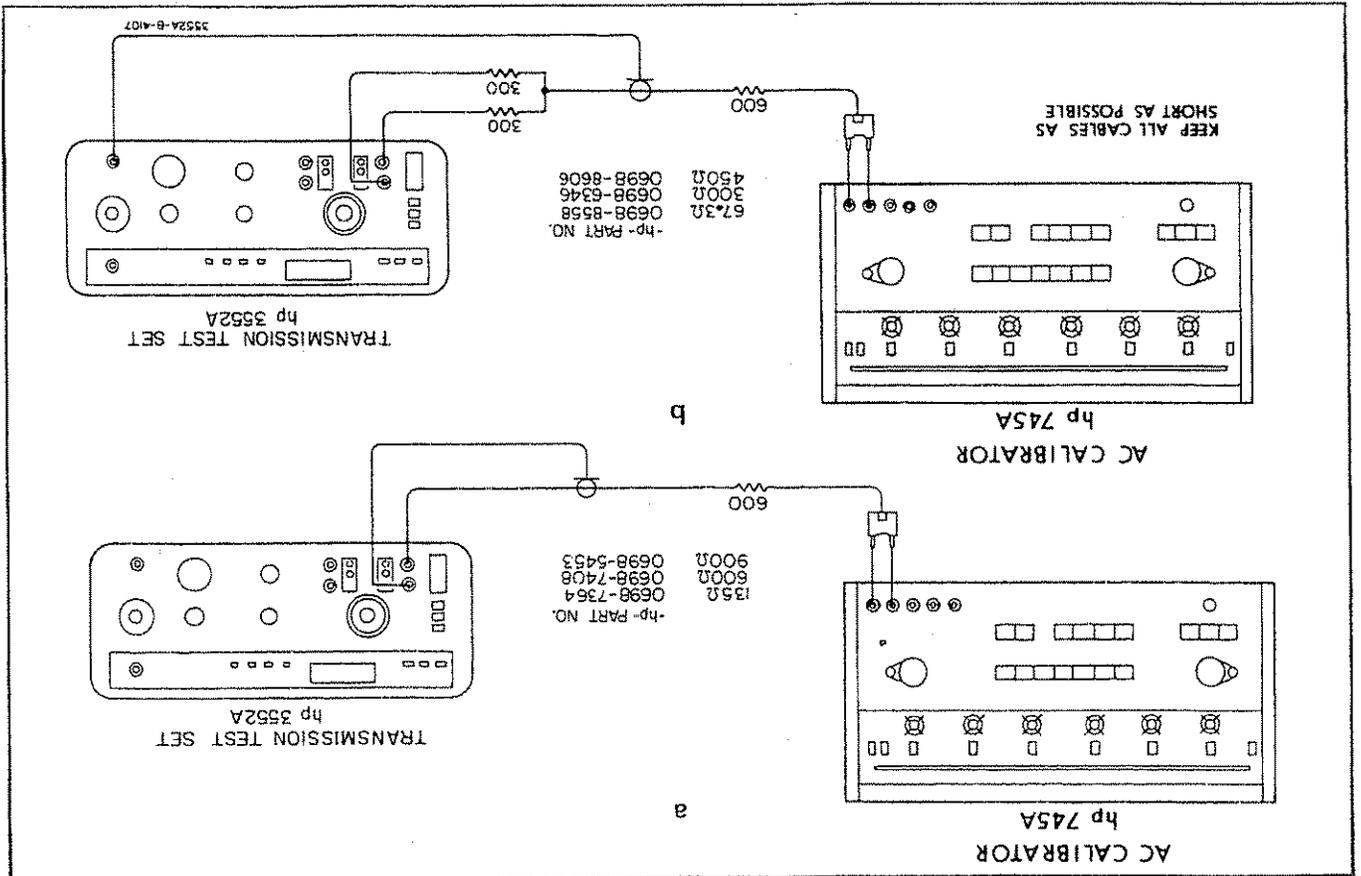
- POWER. MAINS
 - DISPLAY & MONITOR. SEND FREQ
 - SEND LEVEL RANGE dbm. 0 to +10
 - SEND FREQUENCY RANGE Hz. 2 K - 60 K
 - IMP. 150
 - Output Terminals) SEND
 - FUNCTION (Blue Input/
 - HOLD. OFF
- i. Set the Test Set front panel controls as follows:

- Test Set terminals.
- h. Connect the ac voltmeter to the Test Set blue input/output terminals. Connect a 150 ohm resistor across the Test Set terminals.
- Transmitter:
- g. Repeat Steps c through e with IMP set to 900. Substitute a 900 ohm resistor for the 600 ohm resistor in Figure 5-7, and two 450 ohm resistors for the 300 ohm resistors. (AC calibrator output approximately 1.897 V.)
- f. Repeat Steps c through e with IMP set to 150. Substitute a 150 ohm resistor for the 600 ohm resistor in Figure 5-7, and two 75 ohm resistors for the 300 ohm resistors. (AC calibrator output approximately 1.746 V.)
- e. The Test Set display indication should be greater than 60 dB below the -6.0 dbm reference of Step c.
- d. Connect the test equipment as shown in Figure 5-7(b).

Figure 5-7 (a,b). Receiver Balance Test Setup.

- HOLD. OFF
 - FUNCTION (Left Terminals) REC TERM
 - IMP. 900
- a. Set the Test Set front panel controls as follows:

- 5-37. This test determines whether the hold circuit is operating correctly. Hold current absolute value and tolerances are not part of the 3552A specifications.
- 5-36. Hold Current
 - n. Repeat Steps h through m for the 600 and 900 positions of the Test Set IMP control. For the 600 position, use a 600 ohm resistor in Step h and two 300 ohm resistors in Figure 5-8 for R1 and R2, and SEND LEVEL of 1 V ($\approx +2.2$ dbm). For the 900 position use a 900 ohm resistor in Step h and two 450 ohm resistors in Figure 5-8 for R1 and R2, and SEND LEVEL of 1 V ($\approx +0.5$ dbm).
 - m. The ac voltmeter indication should be less than 3.0 mV ac.
 - l. Connect the equipment as shown in Figure 5-8. Use two 75 ohm resistors for R1 and R2.
 - k. Adjust the Test Set SEND LEVEL for a 1.00 V ac indication on the ac voltmeter ($\approx +8.7$ dbm).
 - j. Adjust the Test Set SEND FREQUENCY vernier for 6 kHz on the Test Set display.



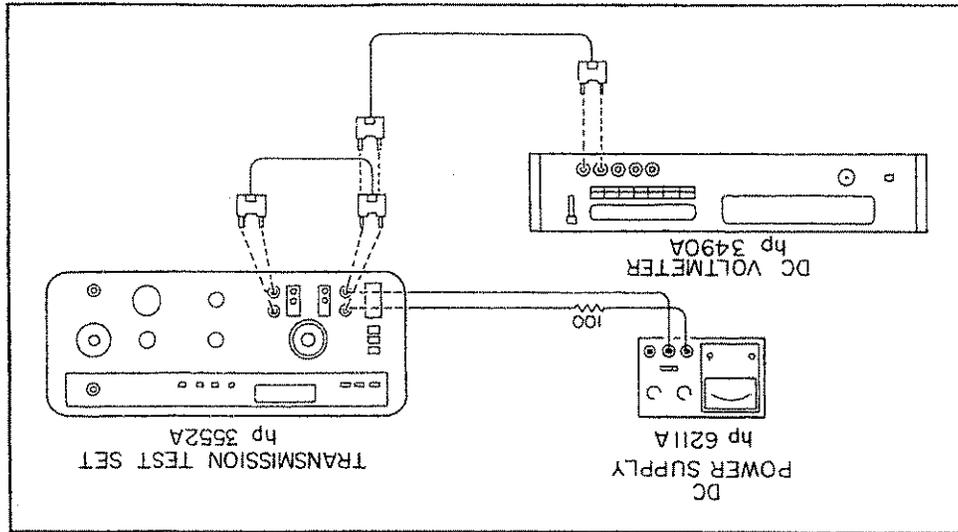


Figure 5-9. Hold Circuit Test.

The DISPLAY & MONITOR RECEIVE LEVEL must be selected for this test. The display will not be the same if SEND LEVEL is selected.

NOTE

- b. Connect the left (receive) terminals to the right (send) terminals, and connect a dc voltmeter to the left terminals as indicated in Figure 5-9.
- c. Connect a dc power supply capable of supplying 30 mA at 60 V to the Test Set left terminals through a 100 ohm series resistor.
- d. Adjust the dc power supply until the dc voltmeter indicates 53 V dc. Note the indication on the Test Set display.

- e. Press the Test Set HOLD ON pushbutton. The Test Set display should not change more than ± 0.1 dBm. (A switching transient may be observed. This is normal.) If the reading changes more than 0.1 dBm, the hold circuit is defective.
- f. Decrease the dc power supply voltage and verify that when HOLD is turned on and off the display reads the same (± 0.1 dBm, excluding switching transients) for any voltage greater than 6 V.
- g. Set HOLD to OFF and adjust the dc power supply for a dc voltmeter reading of 12 V.
- h. Set HOLD to ON and note the dc voltmeter reading, V_1 . The hold current = $12 - V_1$. (V_1 is in volts.) This current should be approximately 20 mA. In some instruments below Serial No. 1125A00170 the hold current may be about 27 mA (see Appendix B).

DISPLAY & MONITOR... RECEIVE LEVEL
 RECEIVE NOISE/TONE... NORMAL
 SEND FREQUENCY RANGE... 200 - 6 K
 SEND LEVEL RANGE... -10 to 0 dBm
 POWER... MAINS

Figure 5-8. Transmitter Balance Test Setup.

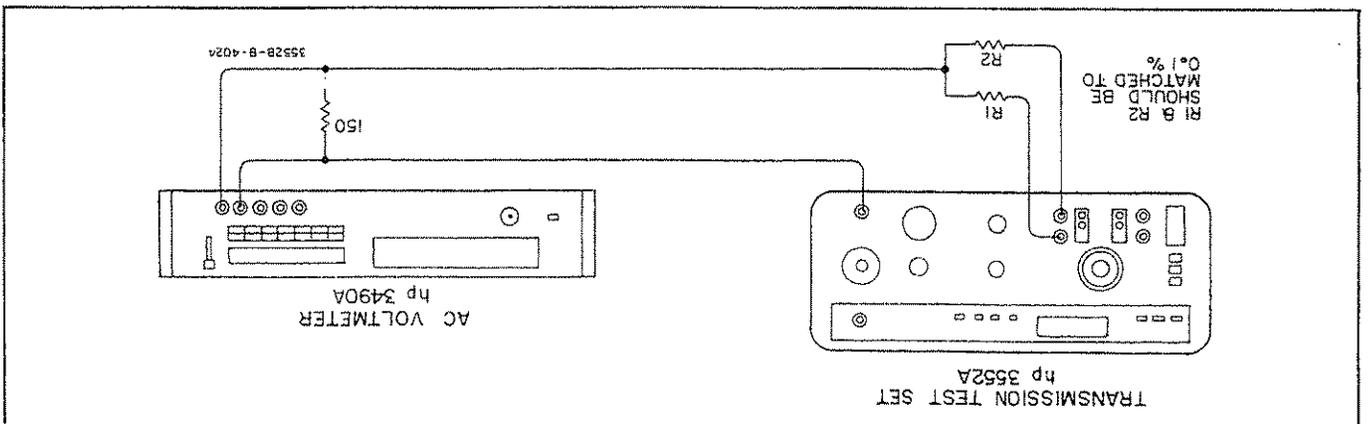
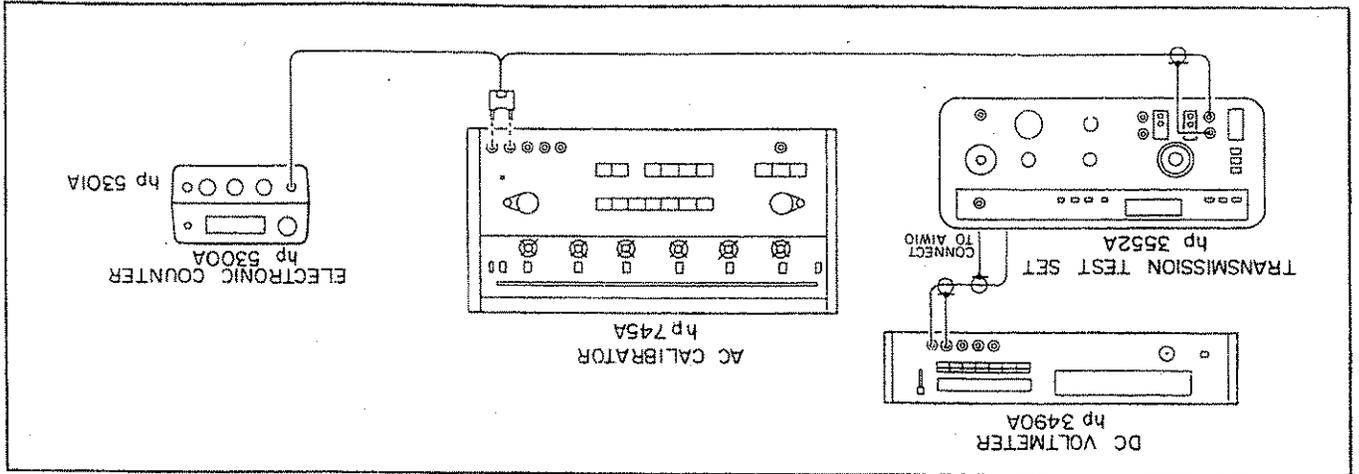


Figure 5-10. Receive Level and Noise Weighting Filters Adjustment.



- MAINS
- DISPLAY & MONITOR RECEIVE LEVEL
- (40 - 60 K)
- TONE NORMAL
- RECEIVE
- IMP 600
- REC TERM
- (Output Terminals)
- FUNCTION (Black Input/
- OFF
- HOLD

When the display is expanded, the location of the decimal point is a function of the input

NOTE

5-41. Because the Test Set display is used to monitor adjustments, it should have all digits operating to provide the best possible resolution. Move the dBm jumper (Figure 5-16) from the N to the 3 position, and move the dBm jumper from the NORM to the LSD position. Make sure the jumpers are returned to their original location after adjustments are completed.

- b. Set the Test Set front panel controls as follows:
 - a. Connect an ac calibrator (745A) to the Test Set black input/output terminals. Refer to Figure 5-10 for Test Set Connection.

5-40. To remove the Test Set from the adjustment locations for A1, A3 and A4.

To ensure proper stabilization of all circuitry, allow a 30 minute warm-up period for the Test Set before beginning any adjustment procedures.

NOTE

5-39. The following is a complete set of adjustment procedures for the Test Set. These procedures can be used for periodic maintenance or if the Test Set has failed the performance tests. If proper performance cannot be achieved by the adjustment procedures, refer to the troubleshooting procedures in Section VII. Some problems in Serial No. 1125A00231 and lower and 1615U00300 and lower can be corrected by modifications to the instrument. Table C-1 in Appendix C is a quick checklist of these problems.

5-38. ADJUSTMENT PROCEDURES.

ADJUSTMENT PROCEDURES

5-42. Receive Level Adjustment.

5-43. This adjustment procedure sets the 15 dB dynamic range of the measuring circuits. The test set is locked in range 1 and a signal level for the high end of the 15 dB range is applied to the input and adjusted in the measuring circuit. The input signal is then reduced for the low end of the dynamic range and adjusted for in the measuring circuit. This procedure is repeated until both ends are within specification.

5-44. Sets that contain A or B revisions of the A1 board, Part No. 03551-66501, the jumpers may not be present. Where the display readings are different from the current revision boards, they will be given in parentheses.

For Test Sets with the 03551-66503 (A3) board not containing R507, verify a display of $-2 \pm .05$ dBm. If the Test Set is not in tolerance, check R501 for the proper value.

The Receive Level adjustment must be completed before performing the Noise Weighting Filters adjustment.

NOTE

5-44. Noise Weighting Filters Adjustment. (Serial No. 1604A00201 and higher) (Serial No. 1512U00221 and higher)

Value	Part No.	Value	Part No.	Value	Part No.	Value	Part No.
300 pF	0140-0200	10 pF	0160-0205	43 pF	0160-2200	43 pF	0160-2200
430 pF	0160-0939	12 pF	0140-0201	47 pF	0160-2307	47 pF	0160-2307
460 pF	0140-0232	15 pF	0140-0202	56 pF	0140-0191	56 pF	0140-0191
470 pF	0140-0145	18 pF	0160-2198	68 pF	0140-0192	68 pF	0140-0192
510 pF	0160-0362						
560 pF	0140-0178						
620 pF	0160-0363						

Table 5-18. Capacitor Padding Value.

If the display is not within tolerance, A3C318 may be padded using the values shown in Table 5-18. Increasing the value of C318 will cause the Test Set to display a larger relative number.

NOTE

u. Repeat Steps s and t until the Test Set readings are within tolerance.
v. Set the ac calibrator to 2.918 V and observe the Test Set for a display of $-4.201 \pm .1$ dBm (42.0).

If Step s or t is not within tolerance, A3C315 and/or A3C317 may be padded using the values shown in Table 5-18. Increasing the value of A3C315 and/or decreasing the value of A3C317 will cause the test set to display a larger negative number. When the Test Set is turned back on after padding, the display may read a full decade high (i.e., 22.01), this is due to the frequency control of the decimal point. Ignore the decimal point location and read the Test Set for 2201 ± 20 counts.

NOTE

t. Set the ac calibrator to 29.18 mV and observe the Test Set for a display of $-2.201 \pm .02$ dBm (22.01 or 2.20).
If the display is not in tolerance, record the value and proceed to the next step.

NOTE

s. Remove A1TP8 short and observe the Test Set display for a reading of $-.201 \pm .02$ dBm (2.0).
r. Set the ac calibrator to 60 kHz.

g. Adjust A3R507 for a display flashing between $-.199$ and $-.201$ dBm (1.99/2.01 or 1.9/2.0).

p. Switch the 3552A front panel IMP selector to 150 ohm.
o. Set the ac calibrator to .3076 V.

For Test Sets with the 03551-66503 (A3) board not containing R508, verify a display of $-2 \pm .05$ dBm. If the Test Set is not in tolerance, check R503 for the proper value.

NOTE

n. Adjust A3R508 for a display flashing between $-.199$ and $-.201$ dBm (1.99/2.01 or 1.9/2.0).

m. Switch the 3552A IMP selector to 900 ohm.
l. Set the ac calibrator to .7533 V.

k. Repeat Step g through j until the Test Set is calibrated.

j. Adjust AIR524 on the Test Set for a display of $-.800 \pm .002$ dBm (-8.00 ± 0.02 or 8.0/7.9).

i. Set the ac calibrator to .3083 V.
If $+ .399$ to $+ .401$ dBm cannot be reached, adjust A3R505 for a reading of $+ .410$ dBm (4.10 or 4.1).

NOTE

h. Adjust AIR801 on the Test Set for a display flashing between $+ .401$ and $+ .399$ dBm (4.01/3.99 or 40/39).

g. Set the ac calibrator to 1.2274 V.

f. Short A1TP8 to ground. (Pin mark TEST adjacent to TP8, is ground)

e. Remove the ground clip from A1TP19 and the dc voltmeter from A1W10.

d. Connect the dc voltmeter to A1W10. Ground A1TP19 with a short clip lead. Adjust AIR524 for minimum indication on the dc voltmeter.

c. Adjust the ac calibrator frequency for 1 kHz at an amplitude of .6152 V.

ADJUSTMENT PROCEDURES

5-45. This procedure sets the gain level for each of the noise weighting filters. The Test Set is set to the RECEIVE NOISE mode, and as each of the four weighting filters are switched into the signal path, the gain of each filter is adjusted to the desired level. The location of the adjustments in this procedure is shown in Figure 5-16.

a. Connect the ac calibrator to the Test Set as shown in Figure 5-10.

b. Set the Test Set front panel controls as follows:

HOLD..... OFF
FUNCTION (Black Input).....
Output Terminals)..... REC TERM
IMP..... 600
RECEIVE
NOISE/TONE..... MESSAGE CIRCUIT
DISPLAY & MONITOR..... RECEIVE LEVEL
NOISE WEIGHTING..... TELEPHONE
POWER..... MAINS

c. Adjust the ac calibrator output for 800 Hz and 1228 V.

d. Short A1TP8 to ground.

e. Adjust A4R430 (TEL) for a Test Set display of $-1.600 \pm .005$ (or $-16.00 \pm .05$).

f. Remove short from A1TP8.

g. Adjust the ac calibrator output to 3.8 kHz, and adjust A4R440 (T3.8) for a Test Set display of $-2.830 \pm .005$ (or $28.30 \pm .05$).

h. Repeat Steps c through g until both readings are within tolerance.

i. Short A1TP8 to ground.

j. Set the Test Set NOISE WEIGHTING control to 3 KHZ FLAT.

k. Adjust the ac calibrator output to 1 kHz and 1228 V.

l. Adjust A4R410 (3/15) for a Test Set display of $-1.600 \pm .05$ (or $-16.00 \pm .5$).

m. Change the NOISE WEIGHTING control to 15 kHz FLAT and note the Test Set display. If the display is not $-1.600 \pm .05$ (or $-16.00 \pm .5$), adjust A4R410 so that the readings for both the 3 kHz FLAT and 15 kHz FLAT filters are within tolerance.

n. Change the NOISE WEIGHTING control to the PROGRAMME position.

o. Adjust the ac calibrator output to 1 kHz and 61.5 mV.

p. Adjust A4R402 (PR) for a Test Set display of $-2.200 \pm .005$ (or $-22.00 \pm .05$).

q. Change the synthesizer frequency to 6.3 kHz and adjust A4R445 (F6.3) for a Test Set display of $0.980 \pm .005$.

r. Remove short from A1TP8.

5-46. Noise Weighting Filters Adjustments.
(Serial No. 1125A00200 and lower)
(Serial No. 1512U00220 and lower)

NOTE

The Receive Level adjustment must be completed before performing the Noise Weighting Filters adjustment.

5-47. This procedure sets the gain level for each of the noise weighting filters. The Test Set is set to the RECEIVE NOISE mode, and as each of the four weighting filters are switched into the signal path, the gain of each filter is adjusted to the desired level. The location of the adjustments in this procedure is shown in Figure 5-16.

a. Connect the ac calibrator to the Test Set as shown in Figure 5-9.

b. Set the Test Set front panel controls as follows:

HOLD..... OFF
FUNCTION (Black Input).....
Output Terminals)..... REC TERM
IMP..... 600
RECEIVE
NOISE/TONE..... MESSAGE CIRCUIT
DISPLAY & MONITOR..... RECEIVE LEVEL
NOISE WEIGHTING..... TELEPHONE
POWER..... MAINS

c. Adjust the ac calibrator output for 800 Hz and 1228 V.

d. Short A1TP8 to ground.

e. Adjust A4R430 (TEL ADJ) for a Test Set display of $-1.600 \pm .005$ (or $-16.00 \pm .05$).

f. Remove short from A1TP8.

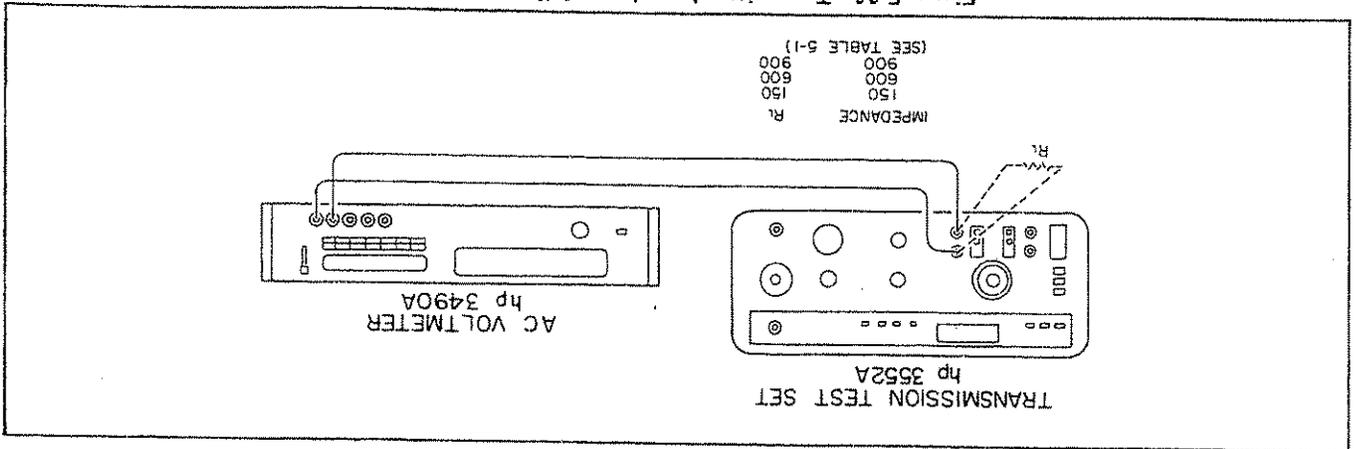
g. Adjust the ac calibrator output to 3.8 kHz, and adjust A4R440 (TEL ADJ 3.8 KHZ) for a Test Set display of $-2.830 \pm .005$ (or $-28.30 \pm .05$).

h. Repeat Steps c through g until both readings are within tolerance.

i. Short A1TP8 to ground.

j. Set the Test Set NOISE WEIGHTING control to 3 KHZ FLAT.

Figure 5-11. Transmitter Impedance Adjustment Setup.



Value	Part No.	Value	Part No.
220 pF	0160-2198	120 pF	0160-2205
39 pF	0140-0190	200 pF	0140-0198
56 pF	0140-0191		
68 pF	0160-0376		
82 pF	0140-0193		
100 pF	0160-2204		
A3C103		A3C323, A3C327	
Value	Part No.	Value	Part No.
33 pF	0160-2150	200 pF	0140-0198
43 pF	0160-2200	240 pF	0140-0199
		270 pF	0140-0206
		300 pF	0160-2207
		330 pF	0160-0207
		360 pF	0160-2209
		390 pF	0140-0200
		430 pF	0160-0939
		470 pF	0140-0149
		510 pF	0160-0362

Table 5-19. Capacitor Padding Lists.

5-53. This adjustment procedure sets the source impedance of the send oscillator. An ac voltmeter and a precision resistor are used in this procedure.

5-52. Transmitter Impedance Adjustment.

1. If A3C102 is a minimum capacitance, decrease the value of A3C103 or increase the value of A3C108.
 2. If A3C102 is at a maximum capacitance, increase the value of A3C103 or decrease the value of A3C108.
- The display should be indicating less than -4.2 (-4.2 dbm). If the minimum display cannot be adjusted to less than this specification, then change A3C103* and/or A3C108* as follows (refer to Table 5-19 for padding values):

NOTE

a. Set the Test Set front panel controls as follows:

- FUNCTION (Blue Input) SEND
- Output Terminals) SEND
- IMP 150
- SEND LEVEL RANGE dbm 0 to +10
- SEND LEVEL vernier CCW
- POWER MAINS

b. Connect the ac voltmeter to the Test Set as shown in Figure 5-11.

c. Adjust the Test Set frequency for 1 kHz and amplitude for a 2.000 V ac indication on the ac voltmeter.

d. Connect the precision 150 ohm resistor to the Test Set.

e. Adjust A3R121 (150 Output IMP) for an ac voltmeter indication of 1.000 V ac \pm 0.005 V ac.

f. Repeat Steps c, d and e for the 600 ohm position on the Test Set IMP controls using a \pm 0.1% 600 ohm precision resistor for RL. Adjust A3R122 (600 Output IMP) for the 600 ohm position.

g. Repeat Steps c, d and e for the 900 ohm position on the Test Set IMP controls using a \pm 0.1% 900 ohm precision resistor for RL. Adjust A3R123 (900 Output IMP) for the 900 ohm position.

5-54. High Frequency Symmetry Adjustment.

5-55. This adjustment procedure calibrates the Send Oscillator constant current sources for Y axis symmetry. A DCVM is used to measure a reference voltage at A3TP8 with the Test Set at the 200 to 6 kHz frequency range. The Test Set is then set to the 2 kHz to 60 kHz range and the compensating capacitor is adjusted to provide the same voltage at A3TP8 as the reference level.

- Set the Test Set front panel controls as follows:

- HOLD
- SEND FREQUENCY RANGE 200 - 6 kHz
- SEND FREQUENCY vernier MAX CW

g. Adjust A3R255, A3R283 and A3R236 until the THD is at least 63 dB below the reference level.

f. Adjust the distortion analyzer to measure total Harmonic distortion (THD).

e. Press the DISPLAY & MONITOR SEND LEVEL and adjust the output for +11.0 dBm (or maximum ≥ 10.0 dBm).

If the Test Set cannot be adjusted to 800 Hz pad A3R244 using the values shown in Table 5-20.

NOTE

d. Switch the Test Set to HOLD TONE and adjust front panel CAL (R246) for a displayed frequency of 800 Hz ± 1 Hz.

c. Set the Test Set output frequency to the 200 to 6 K range and adjust the frequency vernier control for 800 Hz.

b. Connect a 600 ohm resistor across the distortion analyzer input terminals. Connect the Test Set chassis ground terminal to the left (black) "b" terminal, and connect "b" to the distortion analyzer LOW input. Connect the Test Set left (black) "a" terminal to the distortion analyzer HIGH input.

HOLD OFF
 FUNCTION (Black Input) OFF
 Output Terminals SEND
 IMP 600
 DISPLAY & MONITOR SEND FREQ

a. Set the Test Set front panel controls as follows:
 the Send Frequency.
 and CAL pot located on the front panel, is used to calibrate distortion of 63 dB below reference. The Test Set display procedure adjust the Test Set for a maximum Harmonic 5-57. Through the use of a distortion analyzer (333A), this

5-56. Harmonic Distortion and Hold Tone Calibration.
 d. Adjust A3C211 for the reading in Step b, ± 30 mV.

c. Switch the frequency range control to 2 kHz to 60 kHz.
 instrument.
 or the end of A3R223 nearest the front of the connect the DCVM to the collector of A3Q211. On earlier instruments that do not have A3TP8, A3TP8.

NOTE

b. Connect a DCVM to A3TP8 and record the reading. (Allow sufficient settling time, which may be greater than 30 seconds for older instruments.)

A3C107 should only be padded if padding A3C104 will not cause the Test Set to meet the desired specifications.

NOTE

a. Perform the Transmitter Longitudinal Balance Performance Test outlined in Paragraph 5-32. If the specifications cannot be met, change A3C104* or A3C107*. Refer to Table 5-19 for padding values.

5-59. This adjustment procedure sets the Test Set transmitter balance. The Transmitter Longitudinal Balance Performance Test is performed and the Test Set transmitter balance capacitor is changed to meet the specifications indicated.

5-58. Transmitter Balance Adjust.

k. Adjust front panel CAL (R246) for a displayed frequency of 800 ± 1 Hz.

j. Press the Test Set DISPLAY & MONITOR SEND FREQ switch. Place the frequency range switch to the HOLD TONE position.

If the reading is not within the specified values, repeat Steps d through l.

NOTE

i. The distortion must be at least 53 dB below reference.

Value	Part No.	Value	Part No.
2000 ohm	0757-0283	29.4 K	0698-4490
2320 ohm	0698-4434	30.9 K	0698-4491
2490 ohm	0698-4435	32.4 K	0698-4492
2670 ohm	0698-3492	34.0 K	0698-4493
2870 ohm	0698-3151	35.7 K	0698-4494
3160 ohm	0757-0279	37.4 K	0698-4495
3320 ohm	0757-0433	39.2 K	0757-0124
3480 ohm	0698-3152	41.2 K	0698-3582
		42.2 K	0698-3450
		43.2 K	0757-0456

Table 5-20. Resistor Padding List.

h. Switch the SEND FREQUENCY switch to the 200 to 6 kHz range position (1 kHz). Adjust the output level, using the SEND LEVEL adjust to +11.0 dBm (or maximum ≥ 10.0 dBm).

If A3R255 or A3R283 do not have sufficient range to reach the specified THD, then pad A3R256 to increase the range for A3R255 and pad A3R284 for A3R283. Refer to Table 5-20 for padding values.

NOTE

q. If the jumpers for dbm resolution and dbm resolution were present and were moved for these adjustment procedures. Return the jumpers to their original positions.

r. Adjust the SEND LEVEL vernier for an ac voltmeter reading of .387 V \pm .002 V. The Test Set display should be .000 dBm \pm .02 dBm (between -0.2/0.1 and +0.1/0.2 on non-expandable display). If not, repeat Steps a through p.

s. Set IMP to 150 and change the load at the ac voltmeter to 150 ohms.

The 60 kHz level will be raised by lowering the value of A3C323 or raising the value of A3C327.

NOTE

t. Adjust the Test Set SEND LEVEL vernier control for an output level of .7746 V \pm 0.001 V. The Test Set display should be .000 dBm \pm .02 dBm (between -0.2/0.1 and +0.1/0.2 on non-expandable display). If not, pad A3C323 or A3C327 until the display is within specifications. Refer to Table 5-19 for capacitor padding values.

u. Adjust the Test Set IMP selector to 600 ohms and change the output termination to 600 ohms.

v. Set the Test Set output frequency for 60 kHz \pm 1 kHz.

w. Adjust the Test Set front panel SEND LEVEL vernier for an ac voltmeter indication of 0.9487 V \pm 0.001 V ac. The Test Set display indication should be .000 dBm \pm .005 dBm (\pm 0.0 on non-expandable display). If not, adjust A3R377 until the reading is just within the specifications. Recheck the 600 ohm display level for .000 \pm .005 dBm (\pm 0.0).

x. Set the Test Set output frequency for 60 kHz \pm 1 kHz.

y. Set the Test Set front panel IMP control to 900 ohm. Change the 150 ohm load on the ac voltmeter to a 900 ohm load.

z. Adjust A3R397 (Send Level) for a Test Set display indication of .000 dBm \pm .001 dBm (non-expandable display flashing \pm 0.0).

aa. Adjust the Test Set front panel SEND LEVEL vernier for an ac voltmeter indication of 0.3873 V ac \pm 0.001 V ac.

ab. Adjust the Test Set front panel IMP control to 150. Change the 600 ohm load on the ac voltmeter to a 150 ohm load.

ac. Adjust A3R377 for a Test Set display indication of .000 dBm \pm .001 dBm (non-expandable display flashing \pm 0.0).

ad. Press the Test Set front panel DISPLAY & MONITOR SEND LEVEL pushbutton.

ae. Connect the Test Set chassis to the "b" terminal.

af. Adjust the Test Set front panel SEND FREQUENCY vernier for a Test Set display indication of 1.000 kHz. Adjust the Test Set front panel SEND LEVEL vernier for an ac voltmeter indication of 0.775 V ac \pm 0.002 V ac.

FUNCTION (Blue Input/Output Terminals)	SEND
IMP	600
SEND FREQUENCY RANGE Hz	200 - 6 K
SEND LEVEL RANGE dbm	0 to +10
DISPLAY & MONITOR SEND FREQ	POWER
	MAINS

ag. Set the Test Set front panel controls as follows:

ah. Connect an ac voltmeter through a 600 ohm load to the Test Set blue input/output terminals.

ai. This adjustment procedure sets the level of the Test Set send oscillator to the Test Set display. The ac voltmeter is used to monitor the send oscillator output level and the signal to the Test Set display is adjusted for a display indication equal to the ac voltmeter indication.

The RECEIVE LEVEL must be calibrated before performing the transmitter level adjustment.

NOTE

5-60. Transmitter Level Display Adjustment.

5-66. In order to repair the A1, A2, or A3 boards, the A1, A2 board assembly and shield must first be removed. The A3 and A4 board may be repaired still attached to the front panel and do not have to be removed unless replacement of the panel switches or the board is necessary. The following procedure provides the information necessary for disassembly of the A1 and A2 boards.

5-65. Printed Circuit Card Removal.

Remove and replace the internal power cable carefully so as not to damage the connector pins or short the battery connectors. Shorting the battery voltages may cause severe burns.

WARNING

- a. To remove the case for access to the internal parts, remove the five phillips head screws shown in Figure 5-12.
- b. Slide the front panel out from the case, disconnect the internal power cable and monitor plug cable. The power cable must be disconnected at the power supply assembly, which remains in the case (see Figure 5-15).

5-64. Test Set Case Removal.

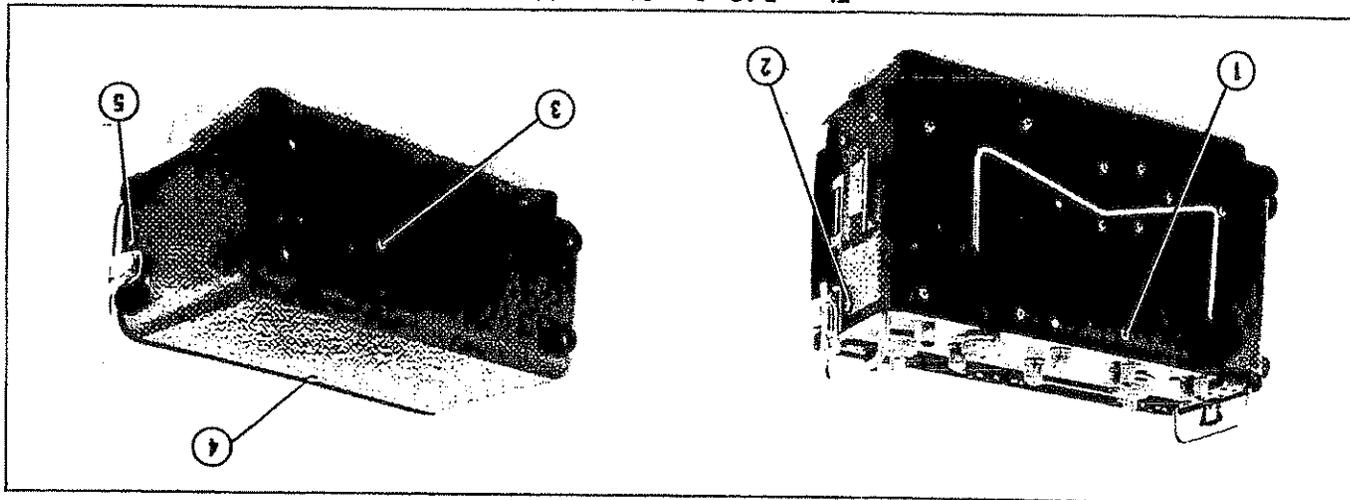
To avoid the possibility of electrical shock, disconnect the ac power cord before removing the Test Set case.

WARNING

5-63. The following paragraphs provide information for the removal of the Test Set case and printed circuit boards. Also included is information concerning proper installation of the Test Set internal power cable.

5-62. DISASSEMBLY INFORMATION.

Figure 5-12. Case Disassembly.



- a. To remove the A1 and A2 boards, unplug the A1 to A3 ribbon connector and A1 speaker connection. Remove the board assembly so as not to damage the POWER and DISPLAY & MONITOR switches.
- b. Turn the unit over to obtain access to the component side of the A3 board and remove the five phillips head screws shown in Figure 5-14. The shield should now be loose and can be easily removed.

NOTE

No further disassembly of the Test Set is recommended.

- c. Reassembly of the unit can be done in the reverse order of assembly.

5-67. The internal Power Cable should be installed in the case and on the A1 board as shown in Figure 5-15.

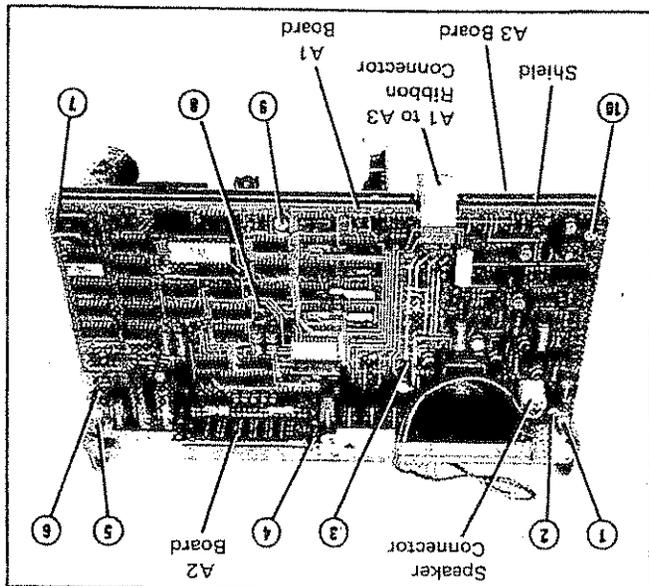


Figure 5-13. A1 and A2 Board Assembly Removal.

Figure 5-15. Power Cable Installation.

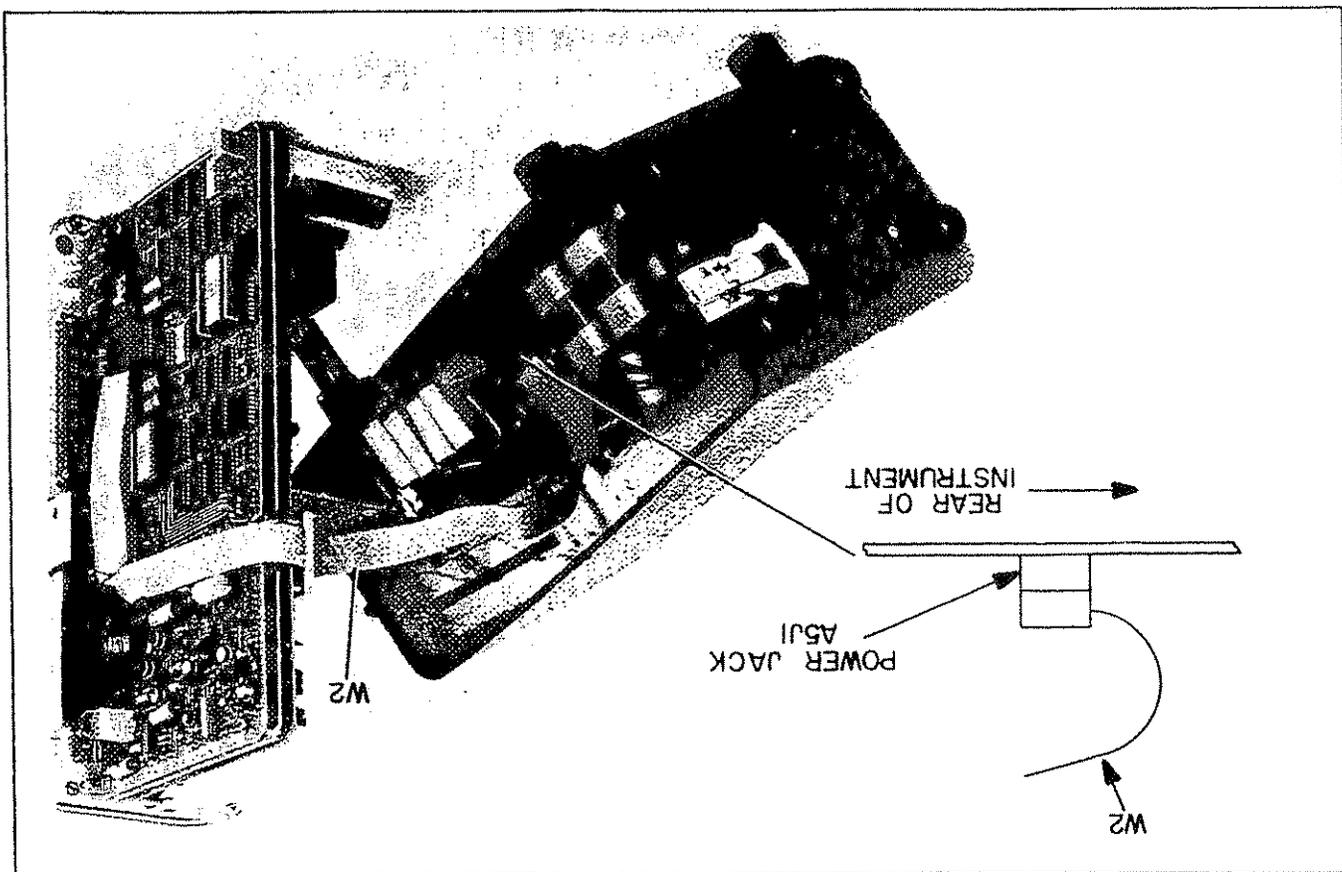
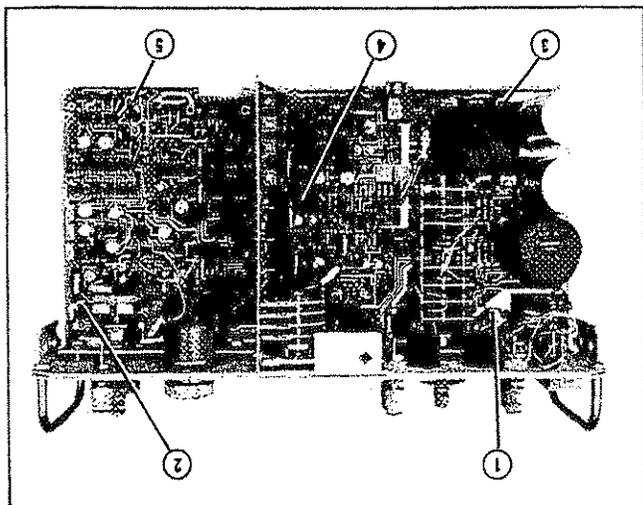


Figure 5-14. Shield Removal.



Mfr. No.	Manufacturer	Address
0004A	Arizona Coil Inc.	Nogales, AZ 85621
00213	Sage Electronics Corp.	Rochester, NY 14610
0059R	Rathbone Corp.	Palmer, MA 01069
00779	Amp Inc.	Harrisburg, PA 17105
01121	Allen Bradley Co.	Milwaukee, WI 53212
01295	Texas Instr. Inc. Semicond. Component Division	Dallas, TX 75231
02735	RCA Corp. Solid State Division	Somerville, NJ 08876
03888	Pyrofilm Corp.	Whippany, NJ 07981
04713	Motorola Semiconductor Products	Phoenix, AZ 85008
07263	Fairchild Semiconductor Div.	Mountain View, CA 94040
12697	Clarostat Mfg. Co. Inc.	Dover, NH 03820
16299	Corning Glass Work Elec. Component Div.	Raleigh, NC 27604
17856	Siliconix Inc.	Santa Clara, CA 95050
19701	Mepco/Electra Corp.	Mineral Wells, TX 76067
23880	Stanford Applied Engineering Inc.	Santa Clara, CA 95050
24226	Gowanda Electronics Corp.	Gowanda, NY 14070
24546	Corning Glass Works	Bradford, PA 16701
27014	National Semiconductor Corp.	Santa Clara, CA 95051
27264	Molex Products Co.	Downers Grove, IL 60515
28480	Hewlett-Packard Co. Corporate HQ	Palo Alto, CA 94304
30983	Mepco/Electra Corp.	San Diego, CA 92121
32997	Bourns Inc. Trimpot Prod. Div.	Riverside, CA 92507
34344	Motorola Inc.	Franklin Park, IL 60131
34371	Harris Semicon. Division Harris-Intertype	Melbourne, FL 32901
50088	Mostek Corp.	Carrollton, TX 75006
53021	Sangamo Electric Co.	Springfield, IL 62705
56289	Sprague Electric Co.	North Adams, MA 01247
71400	Bussman Mfg. Div. of McGraw-Edison Co.	St. Louis, MO 63017
71785	TRW Elec. Components Cinch Div.	Elk Grove Village, IL 60007
72136	Electro Motive Mfg. Co. Inc.	Williamantic, CT 06226
73138	Beckman Instruments Inc. Helipot Div.	Fullerton, CA 92634
73899	J F D Electronics Corp.	Brooklyn, NY 11219
75915	Littelfuse, Inc.	Des Plaines, IL 60016
82389	Switchcraft Inc.	Chicago, IL 60630
84411	TRW Capacitor Div.	Ogallah, NE 69153
86684	RCA Corp. Electronic Components	Harrison, NJ 07029
90201	Mahory Capacitor Co.	Indianapolis, IN 46206
91637	Dale Electronics Inc.	Columbus, NE 68601
95121	Quality Components Inc.	St. Marys, PA 15857

Table 6-2. Code List of Manufacturers.

REFERENCE DESIGNATOR	hp- PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
A1	03551-66501	PC ASSY, LOGIC	28480	03551-66501
A1C500	0180-1800	CAPACITOR-FXD: 100UF+100-10% 6VDC AL	28480	0180-1800
A1C501	0180-1701	CAPACITOR-FXD: 5PF +10% 500WVDC MICA 0+	28480	0180-1701
A1C502	0180-1701	CAPACITOR-FXD: 6.8UF +20% 6VDC	56289	1500685X0006A2
A1C503	0180-1800	CAPACITOR-FXD: 100UF+100-10% 6VDC AL	28480	0180-1800
A1C505	0160-0298	CAPACITOR-FXD: 1500PF+10% 200WVDC	56289	292P15292
A1C506	0160-0156	CAPACITOR-FXD: 3900PF+10% 200WVDC	56289	292P39292
A1C508	0160-0093	CAPACITOR-FXD: 1UF +20% 25WVDC	28480	0160-0127
A1C510	0160-3622	CAPACITOR-FXD: 1UF +80-20% 100WVDC CER	28480	0160-3622
A1C511	0160-3622	CAPACITOR-FXD: 1UF +80-20% 100WVDC CER	28480	0160-3622
A1C512	0160-0127	CAPACITOR-FXD: 1UF +20% 25WVDC CER	28480	0160-0127
A1C513	0160-3501	CAPACITOR-FXD: 4UF +10% 50WVDC	28480	0160-3501
A1C514	0160-0127	CAPACITOR-FXD: 1UF +20% 25WVDC CER	28480	0160-0127
A1C515	0160-0128	CAPACITOR-FXD: 2.2UF +20% 25WVDC CER	28480	0160-0128
A1C516	0160-3548	CAPACITOR-FXD: .01UF +1% 100WVDC MICA	28480	0160-3548
A1C520	0180-0309	CAPACITOR-FXD: 4.7UF +20% 10VDC TA	56289	150D475X0010A2
A1C521	0160-2214	CAPACITOR-FXD: 100PF +5% 300WVDC MICA	28480	0160-2214
A1C522	0180-1701	CAPACITOR-FXD: 6.8UF +20% 6VDC	56289	1500685X0006A2
A1C525	0180-0376	CAPACITOR-FXD: .47UF +10% 35VDC TA	56289	150D474X9035A2
A1C526	0160-2204	CAPACITOR-FXD: 100PF +5% 300WVDC MICA	28480	0160-2204
A1C527	0180-0303	CAPACITOR-FXD: 100UF +75-10% 3VDC AL	56289	30D1076003C82
A1C528	0160-0127	CAPACITOR-FXD: 5000PF +100-0% 500WVDC	28480	0160-0127
A1C529	0160-0127	CAPACITOR-FXD: 2.2UF +20% 25WVDC	28480	0160-0127
A1C601	0160-0128	CAPACITOR-FXD: 1UF +20% 25WVDC	28480	0160-0128
A1C610*	0160-2198	CAPACITOR-FXD: 20PF +5% 300WVDC MICA 0+ * FACTORY SELECTED PART	28480	0160-2198
A1C611	0160-3622	CAPACITOR-FXD: 1UF +80-20% 100WVDC CER	28480	0160-3622
A1C612*	0160-2198	CAPACITOR-FXD: 20PF +5% 300WVDC MICA 0+ * FACTORY SELECTED PART	28480	0160-2198
A1C620	0180-0195	CAPACITOR-FXD: .33UF +20% 35VDC TA	56289	150D334X0035A2
A1C640	0150-0093	CAPACITOR-FXD: .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C641	0150-0093	CAPACITOR-FXD: .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C642	0150-0093	CAPACITOR-FXD: .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C702, C703	0160-2204	CAPACITOR-FXD: 100PF +5% 300WVDC	28480	0160-2204
A1C704	0180-1702	CAPACITOR-FXD: 180UF +20% 6VDC TA-SOLID	56289	150D187X0006R2
A1C801	0180-0374	CAPACITOR-FXD: 10UF +10% 20VDC TA-SOLID	28480	0160-2204
A1C802	0180-0374	CAPACITOR-FXD: 10UF +10% 20VDC TA-SOLID	56289	150D106X9020B2
A1C803	0180-0374	CAPACITOR-FXD: 100PF +5% 300WVDC	28480	0160-2204
A1C804	0180-0374	CAPACITOR-FXD: 10UF +10% 20VDC TA-SOLID	56289	150D106X9020B2
A1C810	0180-1702	CAPACITOR-FXD: 180UF +20% 6VDC TA-SOLID	56289	150D187X0006R2
A1C811	0180-1702	CAPACITOR-FXD: 180UF +20% 6VDC TA-SOLID	56289	150D187X0006R2
A1C812	0180-1746	CAPACITOR-FXD: 15UF +10% 20VDC TA-SOLID	56289	150D156X9020B2
A1C813	0180-1746	CAPACITOR-FXD: 15UF +10% 20VDC TA-SOLID	56289	150D156X9020B2
A1C814	0160-3622	CAPACITOR-FXD: 1UF +80-20% 100WVDC CER	28480	0160-3622
A1C815	0160-3622	CAPACITOR-FXD: 1UF +80-20% 100WVDC CER	28480	0160-3622
A1C816	0160-3622	CAPACITOR-FXD: 1UF +80-20% 100WVDC CER	28480	0160-3622
A1C8501	1901-0518	DIODE-SCHOTTKY	28480	1901-0518
A1C8502	1901-0518	DIODE-SCHOTTKY	28480	1901-0518
A1C8504	1901-0040	DIODE-SCHOTTKY	28480	1901-0040
A1C8505	1901-0040	DIODE-SCHOTTKY	28480	1901-0040
A1C8506	1902-3062	DIODE-ZNR 3.92V 5% DO-7 PD=.4W TC=	04713	SZ 10939-65
A1C8507	1902-0041	DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=	04713	SZ 10939-65
A1C8508	1901-0040	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1C8509	1901-0040	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1C8512	1901-0040	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1C8601	1901-0040	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1C8602	1901-0040	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1C8603	1901-0040	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1C8604	1901-0040	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1C8605, CR606	1901-0040	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1C8705	1901-0518	DIODE-SCHOTTKY	28480	1901-0518
A1C8801	1902-3182	DIODE-ZNR 12.1V 5% DO-7 PD=.4W	04713	SZ 10939-206
A1C8802	1902-3149	DIODE-ZNR 9.09V 5% DO-7 PD=.4W	04713	SZ 10939-170

Table 6-3. Replaceable Parts

REFERENCE DESIGNATOR	Part No. -hp	DESCRIPTION	MFR.	MFR. PART NO.
A3C109	0150-0050	CAPACITOR-FXD; 80-201 100WVDC	72480	0150-0050
A3C110	0150-0050	CAPACITOR-FXD; 100PF +80-201 100WVDC	72480	0150-0050
A3C112	0150-0050	CAPACITOR-FXD; 100PF +80-201 100WVDC	72480	0150-0050
A3C113	0150-0099	CAPACITOR-FXD; 100PF +80-201 100WVDC	72480	0150-0099
A3C201	0150-0093	CAPACITOR-FXD; 100PF +80-201 100WVDC	72480	0150-0093
A3C202	0150-0093	CAPACITOR-FXD; 100PF +80-201 100WVDC	72480	0150-0093
A3C203	0150-0093	CAPACITOR-FXD; 100PF +80-201 100WVDC	72480	0150-0093
A3C204	0150-0093	CAPACITOR-FXD; 100PF +80-201 100WVDC	72480	0150-0093
A3C205	0150-0093	CAPACITOR-FXD; 100PF +80-201 100WVDC	72480	0150-0093
A3C206	0150-0093	CAPACITOR-FXD; 100PF +80-201 100WVDC	72480	0150-0093
A3C207	0150-0093	CAPACITOR-FXD; 100PF +80-201 100WVDC	72480	0150-0093
A3C208	0150-0093	CAPACITOR-FXD; 100PF +80-201 100WVDC	72480	0150-0093
A3C209	0150-0093	CAPACITOR-FXD; 100PF +80-201 100WVDC	72480	0150-0093
A3C210	0150-0093	CAPACITOR-FXD; 100PF +80-201 100WVDC	72480	0150-0093
A3C211	0150-0093	CAPACITOR-FXD; 100PF +80-201 100WVDC	72480	0150-0093
A3C215*	0140-0176	CAPACITOR-FXD; 100PF +80-201 100WVDC	72136	DM15F101G0300WVICR
A3C216	0160-0093	CAPACITOR-FXD; 100PF +80-201 100WVDC	28480	0160-0093
A3C217	0160-0093	CAPACITOR-FXD; 100PF +80-201 100WVDC	28480	0160-0093
A3C218*	0150-0045	CAPACITOR-FXD; 8.2PF +5% 500WVDC	95121	TYPE GC
A3C219	0150-0093	CAPACITOR-FXD; 01UF +80-20% 100WVDC CER	28480	0150-0093
A3C220	0150-0093	CAPACITOR-FXD; 01UF +80-20% 100WVDC CER	28480	0150-0093
A3C223	0150-0093	CAPACITOR-FXD; 01UF +80-20% 100WVDC CER	28480	0150-0093
A3C224	0150-0093	CAPACITOR-FXD; 01UF +80-20% 100WVDC CER	28480	0150-0093
A3C225	0150-0093	CAPACITOR-FXD; 01UF +80-20% 100WVDC CER	28480	0150-0093
A3C226	0150-0093	CAPACITOR-FXD; 01UF +80-20% 100WVDC CER	28480	0150-0093
A3C227	0150-0093	CAPACITOR-FXD; 01UF +80-20% 100WVDC CER	28480	0150-0093
A3C228	0150-0093	CAPACITOR-FXD; 01UF +80-20% 100WVDC CER	28480	0150-0093
A3C229	0150-0093	CAPACITOR-FXD; 01UF +80-20% 100WVDC CER	28480	0150-0093
A3C230	0150-0093	CAPACITOR-FXD; 01UF +80-20% 100WVDC CER	28480	0150-0093
A3C231	0150-0093	CAPACITOR-FXD; 01UF +80-20% 100WVDC CER	28480	0150-0093
A3C232	0150-0093	CAPACITOR-FXD; 01UF +80-20% 100WVDC CER	28480	0150-0093
A3C233, 234	0160-0127	CAPACITOR-FXD; 1UF +20% 25WVDC	28480	0160-0127
A3C300	0160-2204	CAPACITOR-FXD; 100PF +5% MICA 300WVDC	28480	0160-2204
A3C302-306	0160-3548	CAPACITOR-FXD; 01UF +1% 100WVDC MICA	28480	0160-3548
A3C307	0160-3548	CAPACITOR-FXD; 01UF +1% 100WVDC MICA	28480	0160-3548
A3C308	0160-3548	CAPACITOR-FXD; 01UF +1% 100WVDC MICA	28480	0160-3548
A3C309	0160-3548	CAPACITOR-FXD; 01UF +1% 100WVDC MICA	28480	0160-3548
A3C310	0160-3548	CAPACITOR-FXD; 01UF +1% 100WVDC MICA	28480	0160-3548
A3C311	0180-0161	CAPACITOR-FXD; 3.3UF +20% 35VDC	56289	150D385X003582
A3C312	0180-0161	CAPACITOR-FXD; 60UF +20% 6VDC TA-SOLID	56289	150D506X000682
A3C313	0180-0161	CAPACITOR-FXD; 60UF +20% 6VDC TA-SOLID	56289	150D506X000682
A3C315	0140-0149	CAPACITOR-FXD; D 470PF +5% 300WVDC	72136	DM15F471J0300WVICR
A3C317	0160-0205	CAPACITOR-FXD; 10PF +5% 500WVDC MICA 0+	28480	0160-0205
A3C318*	0160-0205	CAPACITOR-FXD; 10PF +5% 500WVDC MICA 0+	28480	0160-0205
A3C319	0160-0205	CAPACITOR-FXD; 10PF +5% 500WVDC MICA 0+	28480	0160-0205
A3C320	0160-0205	CAPACITOR-FXD; 10PF +5% 500WVDC MICA 0+	28480	0160-0205
A3C321	0160-0205	CAPACITOR-FXD; 10PF +5% 500WVDC MICA 0+	28480	0160-0205
A3C322	0160-0205	CAPACITOR-FXD; 10PF +5% 500WVDC MICA 0+	28480	0160-0205
A3C323	0160-0205	CAPACITOR-FXD; 10PF +5% 500WVDC MICA 0+	28480	0160-0205
A3C324	0160-0205	CAPACITOR-FXD; 10PF +5% 500WVDC MICA 0+	28480	0160-0205
A3C325	0160-0205	CAPACITOR-FXD; 10PF +5% 500WVDC MICA 0+	28480	0160-0205
A3C326	0160-0269	CAPACITOR-FXD; 1UF +20% 500WVDC	28480	0160-0269
A3C327	0140-0149	CAPACITOR-FXD; 470PF +5% 300WVDC	72136	DM15F471J0300WVICR
A3C328	0160-2204	CAPACITOR-FXD; 100PF +5% 300WVDC MICA	28480	0160-2204
A3C330	0160-3622	CAPACITOR-FXD; 1UF +80-20% 100WVDC CER	28480	0160-3622
A3C335	0160-2035	CAPACITOR-FXD; 750PF +5% 300 WVDC MICA	28480	0160-2035
A3C348*	0140-0199	CAPACITOR-FXD; 240PF +5% 300 WVDC	72136	DM15F241J0300WVICR
A3C501	0150-0093	CAPACITOR-FXD; 01UF +80-20% 100WVDC CER	28480	0150-0093
A3C502	0140-0209	CAPACITOR-FXD; 5PF 10% 500WVDC MICA 0+	72136	DM15C050K0500WVICR
A3C503	0150-0093	CAPACITOR-FXD; 01UF +80-20% 100WVDC CER	28480	0150-0093
A3C504	0180-0100	CAPACITOR-FXD; 4.7UF 10% 35VDC TA	56289	150D475X903582
A3C316	0180-0228	CAPACITOR-FXD; 22UF +10% 15VDC TA-SOLID	56289	150D226X901582
A3C317	0180-1704	CAPACITOR-FXD; 47UF +10% 6VDC TA-SOLID	56289	150D476X900682
A3C318	0180-1835	CAPACITOR-FXD; 68UF +20% 15VDC	56289	150D686X001582
A3C310 Δ2	1901-0758	DIODE	28480	1901-0758

Table 6-3. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	PART NO. -hp-	DESCRIPTION	MFR.	MFR. PART NO.
A3R10*	0698-8559	RESISTOR 302 OHM 1% .125W F TUBULAR	28480	0698-8559
A3R11C*	0698-8561	*FACTORY SELECTED PART RESISTOR 454.6 OHM 1% .125W F TUBULAR	28480	0698-8561
A3R11	0757-0402	RESISTOR 110 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-111-F
A3R112	0698-4419	RESISTOR 210 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-210R-F
A3R113	0698-4451	RESISTOR 210 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-210R-F
A3R115	0757-0472	RESISTOR 200K 1% .125W F TUBULAR	24546	C4-1/8-T0-2003-F
A3R116, R117	0698-6965	RESISTOR 505 1% .125W F	24546	NE55
A3R121	2100-3426	RESISTOR-VAR 20 OHM .10	28480	2100-3426
A3R122	2100-0552	RESISTOR-VAR TRMR 50 OHM 20% C TOP ADJ	73138	72XR50M
A3R123	2100-0552	RESISTOR-VAR TRMR 50 OHM 20% C TOP ADJ	73138	72XR50M
A3R200	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R201	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R202	0757-0280	RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A3R203	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R204	0698-3228	RESISTOR 49.9K 1% .125W F TUBULAR	24546	PM555
A3R205	0698-3228	RESISTOR 49.9K 1% .125W F TUBULAR	24546	PM555
A3R206	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R207	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R208	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R209	0757-0283	RESISTOR 2K 1% .125W F TUBULAR	24546	C4-1/8-T0-2001-F
A3R210	0757-0283	RESISTOR 2K 1% .125W F TUBULAR	24546	C4-1/8-T0-2001-F
A3R211	0757-0427	RESISTOR 1.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-1501-F
A3R213	0698-3258	RESISTOR 5.36K 1% .125W F	16299	C4-1/8-T0-5361-F
A3R214	0757-0273	RESISTOR 2.41K 1% .125W F TUBULAR	24546	C4-1/8-T0-2411-F
A3R215	0698-7880	RESISTOR 24.7K 1% .125W F TUBULAR	30943	M4C1/8-T0-2472-F
A3R216	0698-4473	RESISTOR 8.06K 1% .125W F	24546	C4-1/8-T0-8061-F
A3R217*	0757-0273	*FACTORY SELECTED PART RESISTOR 3.01K 1% .125W F TUBULAR	24546	C4-1/8-T0-3011-F
A3R218	0698-4470	RESISTOR 6.98K 1% .125W F TUBULAR	24546	C4-1/8-T0-6981-F
A3R219	0757-0463	RESISTOR 82.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-8252-F
A3R220	0698-7880	RESISTOR 28.7K 1% .125W F TUBULAR	30983	M4C1/8-T0-2872-F
A3R221, R222	0757-0427	RESISTOR 15000HM 1% .125W	24546	C4-1/8-T0-1501-F
A3R222	0757-0476	RESISTOR 301K 1% .125W F TUBULAR	24546	C4-1/8-T0-3011-F
A3R224	0757-0453	RESISTOR 30.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-3012-F
A3R225	0698-3279	RESISTOR 4990 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4991-F
A3R226	0698-3279	RESISTOR 4990 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4991-F
A3R227	0757-0457	RESISTOR 47.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-4752-F
A3R228	0698-4520	RESISTOR 143K 1% .125W F TUBULAR	24546	C4-1/8-T0-1433-F
A3R230	0757-0426	RESISTOR 1300 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-1301-F
A3R233	0698-1045	RESISTOR 100K 5% .125W CC TUBULAR	01121	C4-1/8-T0-6982-F
A3R234	0698-4504	RESISTOR 69.8K 1% .125W CC TUBULAR	01121	C4-1/8-T0-6982-F
A3R235	0698-7880	RESISTOR 28.7K 1% .125W F TUBULAR	30943	M4C1/8-T0-2872-F
A3R236	2100-3273	RESISTOR-VAR TRMR 2K OHM 10% C SIDE ADJ	30943	M4C1/8-T0-2872-F
A3R237	0698-7880	RESISTOR 28.7K 1% .125W F TUBULAR	30943	M4C1/8-T0-2872-F
A3R238	0698-7956	RESISTOR 99K 1% .125W F TUBULAR	30943	M4C1/8-T0-9932-F
A3R239	0698-4539	RESISTOR 402K 1% .125W F TUBULAR	30943	M4C1/8-T0-4023-F
A3R240	0698-4539	RESISTOR 402K 1% .125W F TUBULAR	30943	M4C1/8-T0-4023-F
A3R243	0698-3228	RESISTOR 49.9K 1% .125W F TUBULAR	03888	PM555
A3R244*	0698-0085	RESISTOR 2.61K 1% .125W F	16299	C4-1/8-T0-2611-F
A3R245	0757-0447	*FACTORY SELECTED PART RESISTOR 16.2K 1% .125W F TUBULAR	24546	C4-1/8-T0-1622-F
A3R246	2100-1656	RESISTOR-VAR TRMR 500 OHM 5% KM SIDE ADJ	42927	3097R-1-501
A3R247	0757-0450	RESISTOR 7.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-7501-F
A3R248	0757-0465	RESISTOR 100K 5% .125W CC TUBULAR	24546	C4-1/8-T0-1003-F
A3R249	0757-0410	RESISTOR 301 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-301R-F
A3R250	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R253	0757-0421	RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A3R254	0698-3499	RESISTOR 40.2K 1% .125W F TUBULAR	16299	C4-1/8-T0-4022-F
A3R255	2100-3273	RESISTOR-VAR TRMR 2K OHM 10%	73138	72XR2K
A3R256	0757-0124	RESISTOR-39.2K 1% .125W F TC = 0 + -100	24546	C5-1/4-T0-3922-F
A3R257	0757-0413	RESISTOR 5.12K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A3R258	0757-0413	RESISTOR 5.12K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A3R259	0757-0410	RESISTOR 301 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-301R-F
A3R275	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R276	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R277	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R278	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R279	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R280	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R281	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R282	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R283	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R284	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R285	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R286	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R287	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R288	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R289	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R290	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R291	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R292	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R293	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R294	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R295	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R296	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R297	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R298	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R299	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R300	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R301	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R302	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R303	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R304	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R305	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R306	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R307	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R308	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R309	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R310	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R311	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R312	0698-4419	RESISTOR 210 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-210R-F
A3R313	0698-4451	RESISTOR 210 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-210R-F
A3R314	0698-4451	RESISTOR 210 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-210R-F
A3R315	0757-0472	RESISTOR 200K 1% .125W F TUBULAR	24546	C4-1/8-T0-2003-F
A3R316, R117	0698-6965	RESISTOR 505 1% .125W F	24546	NE55
A3R317	2100-3426	RESISTOR-VAR 20 OHM .10	28480	2100-3426
A3R318	2100-0552	RESISTOR-VAR TRMR 50 OHM 20% C TOP ADJ	73138	72XR50M
A3R319	2100-0552	RESISTOR-VAR TRMR 50 OHM 20% C TOP ADJ	73138	72XR50M
A3R320	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R321	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R322	0757-0280	RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A3R323	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R324	0698-3228	RESISTOR 49.9K 1% .125W F TUBULAR	24546	PM555
A3R325	0698-3228	RESISTOR 49.9K 1% .125W F TUBULAR	24546	PM555
A3R326	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R327	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R328	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R329	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R330	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R331	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R332	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R333	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R334	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R335	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R336	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R337	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R338	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R339	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R340	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R341	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R342	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R343	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R344	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R345	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R346	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R347	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R348	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R349	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R350	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R351	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R352	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-T0-1002-F
A3R353	0757-0442	RESISTOR 10K 1% .125W	24546	C

Table 6-3. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	Part No.	DESCRIPTION	MFR.	MFR. PART NO.
AR366	0698-7574	RESISTOR 31.62 OHM .1% .125W F TUBULAR	3098A	MFA41/8-19-3182-B
AR367	0698-6448	RESISTOR 68.38 OHM .1% .125W F TUBULAR	0388B	PME35-1-9
AR368	0698-6448	RESISTOR 210.2 OHM .1% .125W F TUBULAR	0388B	PME35-1-9
AR369	0698-6447	RESISTOR 68.8 OHM .1% .125W F TUBULAR	0388B	PME35-1-9
AR370	0698-3511	RESISTOR 665 OHM .1% .125W F TUBULAR	16299	C4-1/8-10-665R-F
AR371	0683-5145	RESISTOR 510R 5% .25W CC TUBULAR	01121	CB5145
AR372	0683-5145	RESISTOR 510R 5% .25W CC TUBULAR	01121	CB5145
AR373	0698-3275	RESISTOR 2.5K 1% .125W F TUBULAR	19701	MFA41/8-19-2501-F
AR374	0683-5145	RESISTOR 510R 5% .25W CC TUBULAR	01121	CB5145
AR375	0757-0472	RESISTOR 200K 1% .125W F TUBULAR	24546	C4-1/8-10-200K-F
AR376	0698-3275	RESISTOR 2.5K 1% .125W F TUBULAR	19701	MFA41/8-19-2501-F
AR377	2100-3212	RESISTOR-VAR TRMR 200 OHM 10% C SIDE ADJ	32997	3A89P-1-201
AR378	0683-5145	RESISTOR 510R 5% .25W CC TUBULAR	01121	CB5145
AR379	0683-1045	RESISTOR 100R 5% .25W CC TUBULAR	01121	CB1045
AR380	0757-1094	RESISTOR 1.09K 1% .125W F TUBULAR	24546	C4-1/8-10-1471-F
AR381	0683-5145	RESISTOR 510R 5% .25W CC TUBULAR	01121	CB5145
AR382	0683-1045	RESISTOR 100R 5% .25W CC TUBULAR	01121	CB1045
AR383	0683-3945	RESISTOR 390R 5% .25W CC TUBULAR	01121	CB3945
AR384	0683-1055	RESISTOR 105R 5% .25W CC TUBULAR	01121	CB1055
AR385	0698-6302	RESISTOR 1K .1% .125W F TUBULAR	19701	MFA41/8-19-1001-B
AR386	0698-6446	RESISTOR 2.62K 1% .125W F TUBULAR	24546	PME35-1-9
AR387	0757-0438	RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-10-5111-F
AR388	0757-0446	RESISTOR 15K 1% .125W F TUBULAR	24546	C4-1/8-10-1502-F
AR389	0698-4123	RESISTOR 499 OHM 1% .125W F TUBULAR	16299	C4-1/8-10-499R-F
AR390	0683-4735	RESISTOR 47K 5% .25W CC TUBULAR	01121	CB4735
AR391	0683-4735	RESISTOR 47K 5% .25W CC TUBULAR	01121	CB4735
AR392	0698-8107	RESISTOR 2.21K 1% .125W F TUBULAR	3098A	MFA41/8-19-2211-F
AR393	0698-8107	RESISTOR 2.21K 1% .125W F TUBULAR	3098A	MFA41/8-19-2211-F
AR394	0698-8107	RESISTOR 2.21K 1% .125W F TUBULAR	3098A	MFA41/8-19-2211-F
AR395	0757-0447	RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-10-1002-F
AR396	2100-3212	RESISTOR-VAR TRMR 200 OHM 10% C SIDE ADJ	32997	3A89P-1-201
AR397	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-10-2002-F
AR398	0757-0280	RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-10-1001-F
AR402	0757-0439	RESISTOR-6.8K 1% .125W F TC = 0 + -100	24546	C4-1/8-10-6811-F
AR403, 404	0683-5145	RESISTOR-510K 5% .25W CC TUBULAR	01121	CB5145
AR501	0698-6448	RESISTOR-FXD 262.2 001 .125W	24546	NE55
AR502	0698-6448	RESISTOR-FXD 262.2 001 .125W	24546	NE55
AR503	0698-5399	RESISTOR-FXD 262.2 001 .125W	24546	NE55
AR504	0698-5399	RESISTOR-FXD 262.2 001 .125W	24546	NE55
AR505	0757-0284	RESISTOR-VAR TRMR 500OHM 10% C SIDE ADJ	32997	3A89P-1-201
AR506	2100-3245	RESISTOR-VAR TRMR 100OHM 10% C TOP ADJ	32997	3A89P-1-201
AR507, 508	0683-2405	RESISTOR 2K OHM 5% .25W CC TUBULAR	01121	CB2405
AR508	0683-1021	RESISTOR 10K 10% .25W CC TUBULAR	01121	CB1021
AR509	0757-0277	RESISTOR 499 OHM 1% .125W F TUBULAR	24546	C4-1/8-10-4992-F
AS36	3100-2735	SWITCH, ROTARY: FREQUENCY RANGE 4Z	24540	03551-61901
AS37	3100-3377	SWITCH, ROTARY: RECEIVE NOISE/TONE	28480	3100-3377
AS38	3100-3377	SWITCH, ROTARY: RECEIVE NOISE/TONE	28480	3100-3377
AS39	9100-3489	TRANSFORMER, RECEIVE	28480	9100-3489
AS40	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS41	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS42	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS43	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS44	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS45	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS46	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS47	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS48	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS49	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS50	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS51	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS52	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS53	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS54	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS55	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS56	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS57	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS58	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS59	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS60	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS61	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS62	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS63	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS64	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS65	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS66	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS67	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS68	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS69	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS70	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS71	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS72	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS73	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS74	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS75	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS76	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS77	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS78	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS79	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS80	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS81	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS82	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS83	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS84	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS85	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS86	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS87	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS88	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS89	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS90	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS91	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS92	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS93	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS94	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS95	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS96	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS97	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS98	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS99	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS100	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS101	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS102	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS103	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS104	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS105	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS106	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS107	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS108	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS109	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS110	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS111	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS112	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS113	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS114	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS115	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS116	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS117	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS118	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS119	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS120	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS121	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS122	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS123	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS124	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS125	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS126	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS127	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS128	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS129	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS130	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS131	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS132	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS133	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS134	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS135	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS136	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS137	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS138	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS139	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS140	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS141	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS142	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS143	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS144	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS145	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS146	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS147	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS148	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS149	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS150	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS151	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS152	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS153	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS154	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS155	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS156	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS157	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS158	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS159	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS160	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS161	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS162	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS163	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
AS164	1826-0			

REFERENCE DESIGNATOR	PART NO. -hp-	DESCRIPTION	MFR.	MFR. PART NO.
A4 Δ3	03552-66514	PC ASSY-NOISE FILTER	28480	03552-66514
A4C401	0160-0166	CAPACITOR-FXD; 820PF +-10% 200WVDC	56289	292P82292
A4C402	0180-0197	CAPACITOR-FXD; 2.2UF +-10% 20VDC	56289	150D225X9020A2
A4C408	0160-2387	CAPACITOR-FXD; 1000PF +-1% 500WVDC	28480	0160-2387
A4C412, 413	0140-0163	CAPACITOR-FXD; 4751PF +-1% 300WVDC	72136	DM20F4751F0300WV1CR
A4C419	0160-3024	CAPACITOR-FXD; 1700PF +-1% 100WVDC	28480	0160-3024
A4C421, 422	0160-3024	CAPACITOR-FXD; 1700PF +-1% 100WVDC	28480	0160-3024
A4C424	0140-0184	CAPACITOR-FXD; 8200PF +-1% 100WVDC	72136	DM20F8222F0100WV1CR
A4C435	0180-0197	CAPACITOR-FXD; 2.2UF +-10% 20VDC	56289	150D225X9020A2
A4C436	0160-0128	CAPACITOR-FXD; 2.2UF +-20% 25WVDC	28480	0160-0128
A4C437	0150-0093	CAPACITOR-FXD; 01UF +80 -20% 100WVDC	28480	0150-0093
A4R401	0698-4498	RESISTOR 53.6K 1% .125W F	24546	C4-1/8-T0-5362-F
A4R402	2100-3354	RESISTOR-VAR 50K OHM 10%	72138	72XR50K
A4R403	0757-0476	RESISTOR 301K 1% .125W F	24546	C4-1/8-T0-3013-F
A4R405	0698-3499	RESISTOR 40.2K 1% .125W F	16299	C4-1/8-T0-4022-F
A4R406	0757-0442	RESISTOR 10K 1% .125W F	24546	C4-1/8-T0-1002-F
A4R408	0757-0442	RESISTOR 10K 1% .125W F	24546	C4-1/8-T0-1002-F
A4R410	2100-3274	RESISTOR-TMR 10K 10%	72138	72XR10K
A4R421	0698-8724	RESISTOR-FXD; 16.06K	28480	0698-8724
A4R425	0757-0470	RESISTOR 162K 1% .125W F	24546	C4-1/8-T0-1623-F
A4R427	0698-8039	RESISTOR 8.87K 1% .125W F	19701	MFA1/8-T9-8871-B
A4R428	0757-0427	RESISTOR 1.5K 1% .125W F	24546	C4-1/8-T0-1501-F
A4R429	0698-3279	RESISTOR 4.99K 1% .125W F	16299	C4-1/8-T0-4991-F
A4R430	2100-3274	RESISTOR-TMR 10K 10%	72138	72XR10K
A4R431	0698-7671	RESISTOR 47.96K 1% .125W F	19701	MFA1/8-T2-47961-B
A4R432, 433	0698-7673	RESISTOR 49.39K 1% .125W F	19701	MFA1/8-T2-49391-B
A4R434	0698-8039	RESISTOR 8.87K 1% .125W F	19701	MFA1/8-T9-8871-B
A4R435	0698-7674	RESISTOR 13.19K 1% .125W F	19701	MFA1/8-T2-13191-B
A4R436	0698-6943	RESISTOR 20K 1% .125W F	24546	NC55
A4R437	0698-7675	RESISTOR 24.06K 1% .125W F	19701	MFA1/8-T2-24061-B
A4R438	0698-7670	RESISTOR-23.69K 1% .125 W F	19701	MFA1/8-T2-23691-B
A4R440	2100-3354	RESISTOR-VAR TMR 50K OHM 10%	72138	72XR50K
A4R442	0698-6629	RESISTOR 60K 1% .125W F	24546	NC55
A4R443	0698-6943	RESISTOR 20K 1% .125W F	24546	NC55
A4R444	0698-8723	RESISTOR-FXD; 13.95K	28480	0698-8723
A4R446	2100-3207	RESISTOR-TMR 5K 10%	32997	86X-1-502
A4R447	0757-0123	RESISTOR 34.8K 1% .125W F	24546	CS-1/4-T0-3482-F
A4R448	0698-7668	RESISTOR 39.91K 1% .125W F	19701	MFA1/8-T2-39911-B
A4R450	0698-8722	RESISTOR-FXD; 13.58K	28480	0698-8722
A4R451	0698-7668	RESISTOR 39.91 K 1% .125W F	19701	MFA1/8-T2-39911-B
A4R452	0698-7682	RESISTOR 52.98K 1% .125W F	19701	MFA1/8-T2-52981-B
A4R454, 455	0698-7680	RESISTOR 59.41K 1% .125W F	19701	MFA1/8-T2-59411-B
A4R457	0698-7679	RESISTOR 19.41K 1% .125W F	19701	MFA1/8-T2-19411-B
A4R458	0698-6943	RESISTOR 20K 1% .125W F	24546	NC55
A4R459	0698-6407	RESISTOR 32.8K 1% .1W F	07716	MAR5/HP023
A4R460	0698-7376	RESISTOR 11.39K 1% .125W F	19701	MFA1/8-T2-11397R-B
A4R461	0698-4488	RESISTOR 26.7K 1% .125W F	24546	C4-1/8-T0-2672-F
A4R462	0698-3258	RESISTOR-5.36K 1% .125 W F TC = 0 +-100	16299	C4-1/8-T0-5361-F
A4R465	0698-6943	RESISTOR-20K 1% .125 W F	24546	NC55
A4R466	0698-4307	RESISTOR 14.3K 1% .125W F	16299	C4-1/8-T0-1432-F
A4R467	0698-4473	RESISTOR 8.06K 1% .125W F	24546	C4-1/8-T0-8061-F
A4R468	0698-3268	RESISTOR 11.5K 1% .125W F	16299	C4-1/8-T0-1152-F
A4R471	0698-8721	RESISTOR-FXD; 38.1K	28480	0698-8721

Table 6-3. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
A4R473	0757-0451	RESISTOR—24.3K 1% .125W F C = 0 +100	24546	C4-1/8-T0-2432-F
A4R474	0698-6943	RESISTOR—20K 1% .125W F	24546	NC55
A4R477	0684-1011	RESISTOR 100 10% .125W	01121	CB1011
A4R478	0684-1041	RESISTOR 100K 10% .25W	01121	CB1041
A451	3100-2755	SWITCH—ROTARY 1.031 IN CTR SPCG	28480	3100-2755
A4U401, 402	1826-0323	IN—LINEAR	28480	1826-0323
A5	03551-66515	PC ASSY, POWER SUPPLY	28480	03551-66515
A5C801	0180-2563	CAPACITOR-FXD: 2600UF +75-10% 12VDC AL	28480	0180-2563
A5C802	0180-2563	CAPACITOR-FXD: 2600UF +75-10% 12VDC AL	28480	0180-2563
A5C803	0180-2511	CAPACITOR-FXD: 370UF+100-10% 20VDC AL	90201	MTV377N02DELJP
A5C804	0180-2511	CAPACITOR-FXD: 370UF+100-10% 20VDC AL	90201	MTV377N02DELJP
A5C805	0180-2511	CAPACITOR-FXD: 370UF+100-10% 20VDC AL	90201	MTV377N02DELJP
A5C806	0180-2511	CAPACITOR-FXD: 370UF+100-10% 20VDC AL	90201	MTV377N02DELJP
A5C810	0180-2511	CAPACITOR-FXD: 370UF+100-10% 20VDC AL	90201	MTV377N02DELJP
A5C811	0180-2228	CAPACITOR-FXD: 22UF+10% 15VDC 1A-50LID	90201	MTV377N02DELJP
A5C812	0180-0093	CAPACITOR-FXD: 01UF +80-20% 100VDC CER	28480	0150-0093
A5C813	0180-0097	CAPACITOR-FXD: 47UF+10% 35VDC 1A-50LID	56289	1500476X9035S2
A5C820	1901-0050	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0050
A5C821	1901-0158	DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5C822	1901-0158	DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5C823, 814	1901-0158	DIODE-SWITCHING 30 V 50 MA ZNS	28480	1901-0040
A5C824	1901-0158	DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5C825	1901-0158	DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5C826	1901-0158	DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5C827	1901-0158	DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5C828	1901-0158	DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5C829	1901-0158	DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5C830	1901-0158	DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5C831	1901-0158	DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5C832	1901-0158	DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5C833	1901-0158	DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5C834	1901-0158	DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5C835	1901-0158	DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5C836	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C837	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C838	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C839	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C840	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C841	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C842	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C843	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C844	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C845	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C846	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C847	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C848	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C849	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C850	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C851	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C852	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C853	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C854	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C855	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C856	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C857	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C858	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C859	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5C860	1901-0040	DIODE-SWITCHING ZNS 30V 50MA	28480	1901-0040
A5J1	1200-0423	SOCKET: IC BLK 16 CONTACT	23880	CSA2900-16B
A5J2	1251-3751	CONNECTOR: 8-PIN	27264	09-65-1081
A5J3	1251-3745	CONNECTOR PLUG: 8P INCLUDES THE FOLLOWING:	28480	1251-3746
A5J4	1251-3745	CONNECTOR PLUG: +12V INCLUDES THE FOLLOWING:	28480	1251-3746
A5J5	1251-3745	CONNECTOR PLUG: -12V INCLUDES THE FOLLOWING:	28480	1251-3747
A5K 601	0490-8349	RELAY	28480	1251-3747
A5Q11	1853-0233	TRANSISTOR NPN SI PD = 40 W FT = 3 MHZ	28480	1853-0233
A5Q12	1854-0402	TRANSISTOR NPN SI PD = 30 W FT = 3 MHZ	28480	1854-0402
A5R804	0683-1305	RESISTOR 13K 5% .25 W FC TC = -400/+500	01121	CB1305
A5R805	0757-0427	RESISTOR 1.5K 1% .125 W F TC = +100	24546	C4-1/8-T0-1501-F
A5R806	0813-0009	RESISTOR 125K 3% 4 W PW TC = 0 +20	07088	KM-350
A5R807	0811-0939	RESISTOR 100 OHM 3% 5 T PW TC = 0 +20	07088	KM-500
A5R809	0698-4494	RESISTOR 36.7 K 1% .125W F TUBULAR	24546	C4-1/8-T0-3572-F
A5Q809	1893-8046	TRANSISTOR PNP SI CHIP T0-92 80-200MHZ	28480	1893-8046
A5Q810	1894-0071	TRANSISTOR NPN SI PD=300MHZ FT=200MHZ	28480	1894-0071
A5R804	0613-0040	RESISTOR 20 OHM 5% 5 W PW TUBULAR	91637	M5-2-5W-12-20R-J
A5R805	0612-0070	RESISTOR 15 OHM 5% 5 W PW TUBULAR	91637	M5-2-5W-12-10R-J
A5R806	0611-1114	RESISTOR 15 OHM 5% 5 W PW TUBULAR	91637	M5-2-5W-12-10R-J
A5R807	0611-1854	RESISTOR 50 OHM 5% 5 W PW TUBULAR	91637	M5-2-5W-12-10R-J
A5R809	0698-4494	RESISTOR 35.7K 1% .125W F TUBULAR	24546	C4-1/8-T0-3572-F
A5R810	0698-3451	RESISTOR 13K 1% .125W F TUBULAR	16299	C4-1/8-T0-1333-F
A5R811	0698-4499	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2802-F
A5R812	0698-3162	RESISTOR 46.4K 1% .125W F TUBULAR	16299	C4-1/8-T0-4642-F
A5R813	0698-4502	RESISTOR 64.9K 1% .125W F TUBULAR	24546	C4-1/8-T0-6492-F
A5R814	0698-3451	RESISTOR 13K 1% .125W F TUBULAR	16299	C4-1/8-T0-1333-F
A5R815	0698-4494	RESISTOR 35.7K 1% .125W F TUBULAR	24546	C4-1/8-T0-3572-F
A5R816	0683-1045	RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A5R817	0683-1045	RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A5R818	0683-1045	RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A5R819	0683-1045	RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045

Table 6-3. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	PART NO. -hp-	DESCRIPTION	MFR. PART NO.
A5R820	0683-1045	RESISTOR 100K 5% .25W CC TUBULAR	01121
A5R821	0683-1045	RESISTOR 10K 5% .25W CC TUBULAR	01121
A5R822	0683-1045	RESISTOR 100K 5% .25W CC TUBULAR	01121
A5R823	0683-1045	RESISTOR 100K 5% .25W CC TUBULAR	01121
A5R824	0757-0427	RESISTOR 1.5K 1% .125W F TUBULAR	01121
A5R825	0757-0427	RESISTOR 1.5K 1% .125W F TUBULAR	01121
A5R826	0683-1015	RESISTOR 100 OHM 5% .25W CC TUBULAR	24546
A5R827	0683-1305	RESISTOR 13K 5% .25 W FC TC = -400/+500	01121
A5R828	0757-0427	RESISTOR 1.5K 1% .125 W F TC = +100	01121
A5U801	1820-0430	IC LIN LM309K REGULATOR	27014
A5U802	1826-0117	IC LIN REGULATOR	07263
A5U803	1826-0123	IC LIN LM320K-12 REGULATOR	LM320K-12
A5R820	03551-01205	BRACKET, BATTERY CONNECTOR	28480
A5R821	0380-0160	STANDOFF	28480
A5R822	0490-0541	RETAINER, SOCKET	28480
A5R823	0490-0570	SOCKET, RELAY	28480
A5R824	1251-2551	CONNECTOR, SINGLE CONTACT	00719
F1	2110-0201	FUSE .25A 250V SLO-BLO	75915
J3	1510-0091	BINDING-POST; SINGLE:3/8-32:JGK/RED:56L	28480
J4	1510-0091	BINDING-POST; SINGLE:3/8-32:JGK/RED:56L	28480
J5	1251-2533	CONNECTOR; TEL: 3-CKT JACK .25 SIK DIA	28480
J6	1510-0091	BINDING-POST; SINGLE:3/8-32:JGK/RED:56L	28480
J7	1510-0091	BINDING-POST; SINGLE:3/8-32:JGK/RED:56L	28480
J8	1251-2533	CONNECTOR; TEL: 3-CKT JACK .25 SIK DIA	28480
J9	1510-0087	BINDING-POST; SINGLE:6-32:JGK/BLK	28480
L1-L4	9100-3551	COIL-FXD; 1UH 5%	24226
PM11	0960-0444	LINE MODULE	9493
R200	2100-0552	RESISTOR-VAR 50K OHM 5% 2W	12697
R500	2100-0352	RESISTOR-VAR 50K OHM 5% 2W	12697
S1	3101-1849	SWITCH: PUSHBUTTON, HOLD	28480
T1	9100-3882	TRANSFORMER: POWER	28480
W2	03570-61625	CABLE ASSY	28480
A3	03552-00221	PANEL, FRONT	28480
A4	03552-00212	PANEL, FRONT, SUB	28480
A5	03551-01202	BRACKET, PRIMARY POWER MOUNTING	28480
A6	03551-01202	CLAMP, CABLE	28480
A7	03551-04101	INSULATOR, LINE A	28480
A8	03551-04301	PLATE, PC BOARD MOUNTING	28480
A9	03551-21701	RDD, AUTO OFF	28480
A10	03552-64101	COVER ASSY	28480
A11	03552-64501	CASE ASSY	28480
A12	0370-1005	KNOB, IMP & SEND LEVEL RANGE	28480
A13	0370-1099	KNOB, SEND FREQUENCY RANGE	28480
A14	0370-1303	KNOB, RECEIVE NOISE TONE	28480
A15	0370-1303	KNOB, NOISE REIGHING	28480
A16	0370-1303	KNOB, SEND FREQUENCY VERIFIER	28480
A17	0370-1318	KNOB, FUNCTION	28480
A18	0370-2446	PUSHBUTTON, COVER HOLD	28480
A19	0370-2497	PUSHBUTTON, COVER:POWER, DISPLAY & MONIT	28480
A20	0370-2627	KNOB ASSY, SEND LEVEL REMINDER	28480
A21	1251-3167	CONNECTOR; 4-CONT; FEM; POST TYPE	27264
A22	1251-3301	CONNECTOR; 8-CONT; FEM; POST TYPE	28480
A23	1460-1341	SPRING WFRM STL	28480
A24	4040-1092	LENS DISPLAY	28480
A25	5040-7695	MOUNT, SPEAKER	28480
A26	5060-7452	DIAL CONT ASSY	28480
A27	525C-49A	HANDLES	28480
A28	8120-1348	CABLE, POWER	28480
A29	9160-0229	SPEAKER	28480
A30	03551-65001	LOCK	28480
A31	0370-1005	KNOB, IMP & SEND LEVEL RANGE	28480
A32	0370-1099	KNOB, SEND FREQUENCY RANGE	28480
A33	0370-1303	KNOB, RECEIVE NOISE TONE	28480
A34	0370-1303	KNOB, NOISE REIGHING	28480
A35	0370-1303	KNOB, SEND FREQUENCY VERIFIER	28480
A36	0370-1318	KNOB, FUNCTION	28480
A37	0370-2446	PUSHBUTTON, COVER HOLD	28480
A38	0370-2497	PUSHBUTTON, COVER:POWER, DISPLAY & MONIT	28480
A39	0370-2627	KNOB ASSY, SEND LEVEL REMINDER	28480
A40	1251-3167	CONNECTOR; 4-CONT; FEM; POST TYPE	27264
A41	1251-3301	CONNECTOR; 8-CONT; FEM; POST TYPE	28480
A42	1460-1341	SPRING WFRM STL	28480
A43	4040-1092	LENS DISPLAY	28480
A44	5040-7695	MOUNT, SPEAKER	28480
A45	5060-7452	DIAL CONT ASSY	28480
A46	525C-49A	HANDLES	28480
A47	8120-1348	CABLE, POWER	28480
A48	9160-0229	SPEAKER	28480
A49	03551-65001	LOCK	28480
A50	0370-1005	KNOB, IMP & SEND LEVEL RANGE	28480
A51	0370-1099	KNOB, SEND FREQUENCY RANGE	28480
A52	0370-1303	KNOB, RECEIVE NOISE TONE	28480
A53	0370-1303	KNOB, NOISE REIGHING	28480
A54	0370-1303	KNOB, SEND FREQUENCY VERIFIER	28480
A55	0370-1318	KNOB, FUNCTION	28480
A56	0370-2446	PUSHBUTTON, COVER HOLD	28480
A57	0370-2497	PUSHBUTTON, COVER:POWER, DISPLAY & MONIT	28480
A58	0370-2627	KNOB ASSY, SEND LEVEL REMINDER	28480
A59	1251-3167	CONNECTOR; 4-CONT; FEM; POST TYPE	27264
A60	1251-3301	CONNECTOR; 8-CONT; FEM; POST TYPE	28480
A61	1460-1341	SPRING WFRM STL	28480
A62	4040-1092	LENS DISPLAY	28480
A63	5040-7695	MOUNT, SPEAKER	28480
A64	5060-7452	DIAL CONT ASSY	28480
A65	525C-49A	HANDLES	28480
A66	8120-1348	CABLE, POWER	28480
A67	9160-0229	SPEAKER	28480
A68	03551-65001	LOCK	28480
A69	0370-1005	KNOB, IMP & SEND LEVEL RANGE	28480
A70	0370-1099	KNOB, SEND FREQUENCY RANGE	28480
A71	0370-1303	KNOB, RECEIVE NOISE TONE	28480
A72	0370-1303	KNOB, NOISE REIGHING	28480
A73	0370-1303	KNOB, SEND FREQUENCY VERIFIER	28480
A74	0370-1318	KNOB, FUNCTION	28480
A75	0370-2446	PUSHBUTTON, COVER HOLD	28480
A76	0370-2497	PUSHBUTTON, COVER:POWER, DISPLAY & MONIT	28480
A77	0370-2627	KNOB ASSY, SEND LEVEL REMINDER	28480
A78	1251-3167	CONNECTOR; 4-CONT; FEM; POST TYPE	27264
A79	1251-3301	CONNECTOR; 8-CONT; FEM; POST TYPE	28480
A80	1460-1341	SPRING WFRM STL	28480
A81	4040-1092	LENS DISPLAY	28480
A82	5040-7695	MOUNT, SPEAKER	28480
A83	5060-7452	DIAL CONT ASSY	28480
A84	525C-49A	HANDLES	28480
A85	8120-1348	CABLE, POWER	28480
A86	9160-0229	SPEAKER	28480
A87	03551-65001	LOCK	28480
A88	0370-1005	KNOB, IMP & SEND LEVEL RANGE	28480
A89	0370-1099	KNOB, SEND FREQUENCY RANGE	28480
A90	0370-1303	KNOB, RECEIVE NOISE TONE	28480
A91	0370-1303	KNOB, NOISE REIGHING	28480
A92	0370-1303	KNOB, SEND FREQUENCY VERIFIER	28480
A93	0370-1318	KNOB, FUNCTION	28480
A94	0370-2446	PUSHBUTTON, COVER HOLD	28480
A95	0370-2497	PUSHBUTTON, COVER:POWER, DISPLAY & MONIT	28480
A96	0370-2627	KNOB ASSY, SEND LEVEL REMINDER	28480
A97	1251-3167	CONNECTOR; 4-CONT; FEM; POST TYPE	27264
A98	1251-3301	CONNECTOR; 8-CONT; FEM; POST TYPE	28480
A99	1460-1341	SPRING WFRM STL	28480
A100	4040-1092	LENS DISPLAY	28480
A101	5040-7695	MOUNT, SPEAKER	28480
A102	5060-7452	DIAL CONT ASSY	28480
A103	525C-49A	HANDLES	28480
A104	8120-1348	CABLE, POWER	28480
A105	9160-0229	SPEAKER	28480
A106	03551-65001	LOCK	28480
A107	0370-1005	KNOB, IMP & SEND LEVEL RANGE	28480
A108	0370-1099	KNOB, SEND FREQUENCY RANGE	28480
A109	0370-1303	KNOB, RECEIVE NOISE TONE	28480
A110	0370-1303	KNOB, NOISE REIGHING	28480
A111	0370-1303	KNOB, SEND FREQUENCY VERIFIER	28480
A112	0370-1318	KNOB, FUNCTION	28480
A113	0370-2446	PUSHBUTTON, COVER HOLD	28480
A114	0370-2497	PUSHBUTTON, COVER:POWER, DISPLAY & MONIT	28480
A115	0370-2627	KNOB ASSY, SEND LEVEL REMINDER	28480
A116	1251-3167	CONNECTOR; 4-CONT; FEM; POST TYPE	27264
A117	1251-3301	CONNECTOR; 8-CONT; FEM; POST TYPE	28480
A118	1460-1341	SPRING WFRM STL	28480
A119	4040-1092	LENS DISPLAY	28480
A120	5040-7695	MOUNT, SPEAKER	28480
A121	5060-7452	DIAL CONT ASSY	28480
A122	525C-49A	HANDLES	28480
A123	8120-1348	CABLE, POWER	28480
A124	9160-0229	SPEAKER	28480
A125	03551-65001	LOCK	28480
A126	0370-1005	KNOB, IMP & SEND LEVEL RANGE	28480
A127	0370-1099	KNOB, SEND FREQUENCY RANGE	28480
A128	0370-1303	KNOB, RECEIVE NOISE TONE	28480
A129	0370-1303	KNOB, NOISE REIGHING	28480
A130	0370-1303	KNOB, SEND FREQUENCY VERIFIER	28480
A131	0370-1318	KNOB, FUNCTION	28480
A132	0370-2446	PUSHBUTTON, COVER HOLD	28480
A133	0370-2497	PUSHBUTTON, COVER:POWER, DISPLAY & MONIT	28480
A134	0370-2627	KNOB ASSY, SEND LEVEL REMINDER	28480
A135	1251-3167	CONNECTOR; 4-CONT; FEM; POST TYPE	27264
A136	1251-3301	CONNECTOR; 8-CONT; FEM; POST TYPE	28480
A137	1460-1341	SPRING WFRM STL	28480
A138	4040-1092	LENS DISPLAY	28480
A139	5040-7695	MOUNT, SPEAKER	28480
A140	5060-7452	DIAL CONT ASSY	28480
A141	525C-49A	HANDLES	28480
A142	8120-1348	CABLE, POWER	28480
A143	9160-0229	SPEAKER	28480
A144	03551-65001	LOCK	28480
A145	0370-1005	KNOB, IMP & SEND LEVEL RANGE	28480
A146	0370-1099	KNOB, SEND FREQUENCY RANGE	28480
A147	0370-1303	KNOB, RECEIVE NOISE TONE	28480
A148	0370-1303	KNOB, NOISE REIGHING	28480
A149	0370-1303	KNOB, SEND FREQUENCY VERIFIER	28480
A150	0370-1318	KNOB, FUNCTION	28480
A151	0370-2446	PUSHBUTTON, COVER HOLD	28480
A152	0370-2497	PUSHBUTTON, COVER:POWER, DISPLAY & MONIT	28480
A153	0370-2627	KNOB ASSY, SEND LEVEL REMINDER	28480
A154	1251-3167	CONNECTOR; 4-CONT; FEM; POST TYPE	27264
A155	1251-3301	CONNECTOR; 8-CONT; FEM; POST TYPE	28480
A156	1460-1341	SPRING WFRM STL	28480
A157	4040-1092	LENS DISPLAY	28480
A158	5040-7695	MOUNT, SPEAKER	28480
A159	5060-7452	DIAL CONT ASSY	28480
A160	525C-49A	HANDLES	28480
A161	8120-1348	CABLE, POWER	28480
A162	9160-0229	SPEAKER	28480
A163	03551-65001	LOCK	28480
A164	0370-1005	KNOB, IMP & SEND LEVEL RANGE	28480
A165	0370-1099	KNOB, SEND FREQUENCY RANGE	28480
A166	0370-1303	KNOB, RECEIVE NOISE TONE	28480
A167	0370-1303	KNOB, NOISE REIGHING	28480
A168	0370-1303	KNOB, SEND FREQUENCY VERIFIER	28480
A169	0370-1318	KNOB, FUNCTION	28480
A170	0370-2446	PUSHBUTTON, COVER HOLD	28480
A171	0370-2497	PUSHBUTTON, COVER:POWER, DISPLAY & MONIT	28480
A172	0370-2627	KNOB ASSY, SEND LEVEL REMINDER	28480
A173	1251-3167	CONNECTOR; 4-CONT; FEM; POST TYPE	27264
A174	1251-3301	CONNECTOR; 8-CONT; FEM; POST TYPE	28480
A175	1460-1341	SPRING WFRM STL	28480
A176	4040-1092	LENS DISPLAY	28480
A177	5040-7695	MOUNT, SPEAKER	28480
A178	5060-7452	DIAL CONT ASSY	28480
A179	525C-49A	HANDLES	28480
A180	8120-1348	CABLE, POWER	28480
A181	9160-0229	SPEAKER	28480
A182	03551-65001	LOCK	28480
A183	0370-1005	KNOB, IMP & SEND LEVEL RANGE	28480
A184	0370-1099	KNOB, SEND FREQUENCY RANGE	28480
A185	0370-1303	KNOB, RECEIVE NOISE TONE	28480
A186	0370-1303	KNOB, NOISE REIGHING	28480
A187	0370-1303	KNOB, SEND FREQUENCY VERIFIER	28480
A188	0370-1318	KNOB, FUNCTION	28480
A189	0370-2446	PUSHBUTTON, COVER HOLD	28480
A190	0370-2497	PUSHBUTTON, COVER:POWER, DISPLAY & MONIT	28480
A191	0370-2627	KNOB ASSY, SEND LEVEL REMINDER	284

REFERENCE DESIGNATOR	PART NO. -hp-	DESCRIPTION	MFR.	MFR. PART NO.
<p style="text-align: center;">△ △ △ △ △</p>	<p>1440-0071 1440-0050 1440-0049 2200-0143 2260-0001 2190-0004</p>	<p>HANDLE-PLSTC W/STL INSR 4.25-L.25-THK HANDLE-CMPNT .75-L HANDLE-CMPNT .75-L SCREW-MACH 4-40 .375-IN-LG PAN-HD NUT-HEX-DBL CHAM 4-40 -THD .094-THK WASHER-LK INTL T NO. 4.115 IN ID .27 IN</p>	<p>12136 12136 12136 1875-376-370 1875-376-370 1876-372</p>	<p>1876-372 1875-376-370 1875-376-370 2200-0143 2260-0001 1904</p>
	<p>03551-24710 03551-24901 03551-27901 0370-1810</p>	<p>HANDLE, CARRYING (CONSISTS OF THE FOLLOWING PARTS): HANDLE-PLSTC W/STL INSR 4.25-L.25-THK HANDLE-CMPNT .75-L HANDLE-CMPNT .75-L SCREW-MACH 4-40 .375-IN-LG PAN-HD NUT-HEX-DBL CHAM 4-40 -THD .094-THK WASHER-LK INTL T NO. 4.115 IN ID .27 IN</p>	<p>12136 12136 12136 1875-376-370 1875-376-370 1876-372</p>	<p>1876-372 1875-376-370 1875-376-370 2200-0143 2260-0001 1904</p>
	<p>03551-24710 03551-24901 03551-27901 0370-1810</p>	<p>HANDLE, CARRYING (CONSISTS OF THE FOLLOWING PARTS): HANDLE-PLSTC W/STL INSR 4.25-L.25-THK HANDLE-CMPNT .75-L HANDLE-CMPNT .75-L SCREW-MACH 4-40 .375-IN-LG PAN-HD NUT-HEX-DBL CHAM 4-40 -THD .094-THK WASHER-LK INTL T NO. 4.115 IN ID .27 IN</p>	<p>12136 12136 12136 1875-376-370 1875-376-370 1876-372</p>	<p>1876-372 1875-376-370 1875-376-370 2200-0143 2260-0001 1904</p>
	<p>03551-24710 03551-24901 03551-27901 0370-1810</p>	<p>HANDLE, CARRYING (CONSISTS OF THE FOLLOWING PARTS): HANDLE-PLSTC W/STL INSR 4.25-L.25-THK HANDLE-CMPNT .75-L HANDLE-CMPNT .75-L SCREW-MACH 4-40 .375-IN-LG PAN-HD NUT-HEX-DBL CHAM 4-40 -THD .094-THK WASHER-LK INTL T NO. 4.115 IN ID .27 IN</p>	<p>12136 12136 12136 1875-376-370 1875-376-370 1876-372</p>	<p>1876-372 1875-376-370 1875-376-370 2200-0143 2260-0001 1904</p>
	<p>03551-24710 03551-24901 03551-27901 0370-1810</p>	<p>HANDLE, CARRYING (CONSISTS OF THE FOLLOWING PARTS): HANDLE-PLSTC W/STL INSR 4.25-L.25-THK HANDLE-CMPNT .75-L HANDLE-CMPNT .75-L SCREW-MACH 4-40 .375-IN-LG PAN-HD NUT-HEX-DBL CHAM 4-40 -THD .094-THK WASHER-LK INTL T NO. 4.115 IN ID .27 IN</p>	<p>12136 12136 12136 1875-376-370 1875-376-370 1876-372</p>	<p>1876-372 1875-376-370 1875-376-370 2200-0143 2260-0001 1904</p>
	<p>03551-24710 03551-24901 03551-27901 0370-1810</p>	<p>HANDLE, CARRYING (CONSISTS OF THE FOLLOWING PARTS): HANDLE-PLSTC W/STL INSR 4.25-L.25-THK HANDLE-CMPNT .75-L HANDLE-CMPNT .75-L SCREW-MACH 4-40 .375-IN-LG PAN-HD NUT-HEX-DBL CHAM 4-40 -THD .094-THK WASHER-LK INTL T NO. 4.115 IN ID .27 IN</p>	<p>12136 12136 12136 1875-376-370 1875-376-370 1876-372</p>	<p>1876-372 1875-376-370 1875-376-370 2200-0143 2260-0001 1904</p>

Table 6-1. Replaceable Parts (Cont'd)

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SECTION VII TROUBLESHOOTING AND CIRCUIT DIAGRAMS

7-1. INTRODUCTION.

7-2. This section of the manual contains troubleshooting information and circuit diagrams for the Test Set. Included are digital troubleshooting procedures, functional block diagrams, schematic diagrams and component location diagrams.

7-3. TROUBLESHOOTING.

7-4. The following troubleshooting information is designed to eliminate needless unrelated checks in locating instrument malfunctions. It should first be determined that a malfunction does exist and that it does not exist externally to the Test Set. Before troubleshooting, become familiar with the principles of operation (Section III) and the functional composition (Section IV).

7-5. The troubleshooting procedure is separated into three parts. The first part will separate the problem into two categories, i.e., analog or digital. If the problem is an analog or A3 board, the procedure will also direct the user to the A1 or A3 board. The second part provides analog troubleshooting-ing procedures. The digital troubleshooting procedures, using the ASM flow charts, form the third section. In all of the procedures the intent is to aid the user in finding the problem area associated with his system. Where a specific component or a particular area is given as the location of the malfunction, it should be remembered that these are only possible solution. The schematics should always be used in conjunction with the procedures to troubleshoot the system.

7-6. To isolate a malfunction between the analog and digital circuitry, use the following procedure:



The Test Set utilizes several CMOS components. Improper troubleshooting techniques can damage these components. To minimize failures resulting from troubleshooting, observe the following rules:

- 1. Always use grounded soldering tips and grounded test fixtures.

- 2. Never insert or remove a CMOS device with the Test Set power on.

- f. Measure A1TP14 with an oscilloscope. The oscilloscope should indicate an 85 mV p-p sine wave at 1 kHz. If the reading is bad refer to the analog troubleshooting section. The malfunction is most likely to have occurred on the A3 board.
- g. Measure A1TP12 with the 180C Oscilloscope. The oscilloscope should indicate a 1 kHz square wave 4 V p-p. If

If both readings in Steps d and e are correct, perform the performance tests to verify proper operation. If either or both readings were wrong, continue to Step f.

NOTE

- e. Press the DISPLAY & MONITOR Frequency Level button and verify a display of 1 kHz.
- d. Press the DISPLAY & MONITOR Receive Level button and verify a display of 0 dbm.

The instrument's SEND OSC can be used to provide the input signal, if it is known to be operating properly. Refer to the analog troubleshooting section for verification of the Send Oscillator if it is to be used.

NOTE

- c. Adjust the ac calibrator to 1 kHz at a level of .7746 V.
- b. Connect a 745A ac calibrator to the Test Set input terminals.

FUNCTION REC TERM
IMP 600
RECEIVE NOISE/
TONE NORMAL
HOLD OFF
POWER MAINS

- a. Set the Test Set controls as follows:

3. Do not load CMOS devices. The input impedance for the test devices must, in most cases, be greater than 50 kΩ.

7-7. ANALOG TROUBLESHOOTING.

7-8. The troubleshooting procedures are broken into two major groups, consisting of Receive Circuits and Send Circuits. To use the troubleshooting procedure, the symptom of a problem should first be isolated to one of these two groups, then the procedure for that group performed in the sequence given. Each procedure provides setup, test points, and representative voltages to aid in isolating the location of a malfunction. Waveforms and test points used within the procedures are shown on the analog block diagram. Schematics one through five and eight also have representative voltages shown at various points and should be used with the procedure to isolate the malfunction to the component level.

7-9. Receive Tone Circuits.

a. Connect an ac calibrator to the Test Set black input/output terminals.

b. Adjust the ac calibrator to 1 KHz at 0.7746 V.

c. Set the Test Set front panel controls as follows:

FUNCTION (Black Input/Output Terminals), REC TERM IMP, 600
 DISPLAY & MONITOR, REC LEVEL
 RECEIVE NOISE/TONE, TONE NORMAL
 HOLD, OFF

d. The Test Set display should read 0 dbm. If this reading is not present refer to Table 7-1 for specific test points and voltage measurements.

NOTE

If incorrect voltage readings are obtained at the test points, refer to Schematics 1, 3, 4 or 5 for component level troubleshooting. If correct readings are obtained at all tested points, the problem is most likely to be found in the logic section of the AI board. Refer to the Digital Troubleshooting Section.

7-10. Receive Noise Circuits.

7-11. Noise Weighting Filters.

NOTE

RECEIVE TONE LEVEL should check good before proceeding.

In order to test the Noise Weighting Filters Response accuracy to one decimal place, it is necessary to move a jumper within the instrument. With the 352A disconnected from mains, release the cover as shown in Figure 5-12 and slide the cover back approximately three inches. Change the position of "Jumper for dbm Resolution" (see Figure 5-16) from the N position to the 3 position. Be sure to return this jumper to the N position after completing the Noise Weighting Filter tests. Some instruments with serial number suffix below 00111 do not have this jumper, and consequently can be tested only to integer number resolution.

Table 7-1. Receive Tone Test Points.

Test Point	Reading	
	AC	DC
1. Test Set Input Terminals	774.6 mV	+1.68 V
2. A1W10C	1.6 mV	
3. A3TP19	511.5 mV	
4. Attenuator Input	511.8 mV	
5. A3TP1	511.6 mV	
6. A3TP10	130 mV	
7. A3TP21	2.6 mV	
8. Pm 3, A3U500	130 mV	
9. A1TP14	980 mV	-2.54 V
10. A1TP18		
11. A1TP19		

a. Adjust the ac calibrator frequency to 1 kHz and amplitude level to 0.4355 V.

b. Set the Test Set front panel controls to:

FUNCTION (Black input/output terminals), REC TERM IMP, 600
 DISPLAY MONITOR, REC LEVEL
 RECEIVE NOISE/MESSAGE NOISE HOLD, OFF

c. Connect the ac calibrator to the Test Set black input terminals.

d. Switch the NOISE WEIGHTING control through each of the four switch positions. Observe the Test Set display for -4.9 to -5.1 or flashing between -4/-5 dbm. If any of the four switch positions are out of tolerance, then refer to Table 7-2 for specific test points and voltage measurements.

NOTE

If incorrect voltage readings are obtained at the test points, refer to Schematics 4 and 5 for component level troubleshooting. Correct readings at all tested points indicated that the problem is most likely to be found in the logic section of the AI board. Refer to the Digital Troubleshooting Section.

If incorrect voltage readings are obtained at any test points, refer to Schematic 3 for component level troubleshooting. Correct readings indicate a problem existing on the AI board, logic section. Refer to the Digital Troubleshooting section.

NOTE

d. Observe the display for - 4.9 to - 5.1 or flashing between - 4/ - 5 dbm. If the display readings are out of tolerance, then refer to Table 7-3 for specific test points and voltage readings.

c. Connect the ac calibrator to the black input terminals of the Test Set.

FUNCTION
 (Black input/output terminals) REC TERM
 IMP 600
 DISPLAY & MONITOR REC LEVEL
 RECEIVE NOISE/
 NOISE WITH TONE
 NOISE WEIGHTING 15 kHz Flat
 HOLD OFF

b. Set the Test Set controls as follows:

a. Adjust the ac calibrator frequency to 400 Hz at an output amplitude of 0.4355 V.

The NOISE WEIGHTING FILTERS should check good before proceeding.

NOTE

7-12. Noise with Tone (Notch Filter).

Test Point	Reading	
	AC	DC
1. A1W10	3.6 mV	+2.84 V
2. A4TP1	3.6 mV	
3. Pin 6, U401	3.6 mV	
4. Pin 1, XA4	3.6 mV	
5. A4TP5 (3 kHz Flat)	3.6 mV	
6. A4TP5 (3 kHz Flat)	1.07 mV	
7. A4TP5 (15 kHz Flat)	1.07 mV	
8. A4TP5 (Program)	1.07 mV	
9. A4TP3	1.5 mV	
10. A4TP2	1.07 mV	
11. A4TP4 (Program)	2.8 mV	
12. A4TP4 (C Message)	4.4 mV	
13. A4TP4 (3 kHz Flat)	4.4 mV	
14. A4TP4 (15 kHz Flat)	4.4 mV	
15. A1TP14	178 mV	
16. A3TP21	178 mV	
17. Pin 3, XA4	3.6 mV	
18. Q402 Source	3.6 mV	
19. A1TP19	1.33 V	
20. A1TP18	-486 mV	

Table 7-2. Noise Weighting Filters Test Points.

a. Adjust the ac calibrator frequency to 1 kHz at an output level of 3.159 V.

b. Set the Test Set front panel controls as follows:

FUNCTION (Black input/output terminals) REC TERM OR BRIDGED
 IMP 600
 DISPLAY & MONITOR REC LEVEL
 RECEIVE NOISE/
 NOISE TO GROUND
 NOISE WEIGHTING 15 kHz Flat
 HOLD OFF

c. Short the Test Set input terminals (a and b) together.

d. Connect the ac calibrator between the shorted input terminals and the chassis ground.

e. Observe the Test Set display for + 17 to + 18 dbm. If the display readings are out of tolerance refer to Table 7-4 for specific test points and voltage readings.

NOTE

If the initial display readings are flashing between - 22 to - 23 dbm the AI board is most likely to be bad. If incorrect voltage readings are obtained at any test points, refer to schematic 1 and 3 for component level troubleshooting. Correct voltage readings indicate a problem existing on the AI board, logic section. Refer to the Digital Troubleshooting section.

7-14. Send Circuits, Troubleshooting Level Problems.

NOTE

The RECEIVE TONE LEVEL should check good before proceeding.

NOTE

The NOISE WEIGHTING FILTERS should check good before proceeding.

e. Adjust the ac calibrator frequency to 804 Hz and 936 Hz and repeat Step d for each frequency level.

7-13. Noise to Ground.

Test Point	Reading in RMS		
	400 Hz	1015 Hz	1182 Hz
1. Q301 Source	288 mV	0.3 mV	288 mV
2. A3TP10	290 mV	290 mV	290 mV
3. A3TP13	211 mV	0.3 mV	528 mV
4. A3TP11	220 mV	8.6 mV	783 mV
5. A3TP12	192 mV	0.3 mV	781 mV
6. A3TP14	288 mV	0.3 mV	288 mV

Table 7-3. Notch Filters Test Points.

7-29. An example of a flow chart is shown in Figure 7-3. This flow chart is a hypothetical chart which illustrates the algorithm which may be used to turn on the Test Set. There are two geometrical figures represented in the flow chart. The rectangular box signifies instructions or groups of instructions which are performed during the state (time

7-28. **Basic Flow Charts.** As explained in Section IV, Paragraph 4-83, the step-by-step operation of the controller is described by the algorithm. The algorithm is illustrated by a flow chart which can be compared to a computer or calculator program.

For a better understanding of the following troubleshooting information, it is suggested that the controller theory of operation (Section IV, Paragraph 4-79) be read carefully before continuing to Paragraph 7-28.

NOTE

7-27. If a digital malfunction exists, study Paragraphs 7-28 through 7-31, then perform the internal test procedure (Paragraph 7-32). If this fails to locate the malfunction, go to the operational flow charts (Paragraph 7-38) and the schematics.

7-26. The following troubleshooting procedures are designed to provide information for isolating digital malfunctions. These procedures contain a brief explanation of flow charts, an internal troubleshooting procedure for analyzing the controller output signals and operational flow charts for the controller and display section of the Test Set.

7-25. Digital Troubleshooting.

i. The voltage across A3CR200 should be switching from + 4 V to - 2.7 V with the signal changes at TP2.

h. The signal at TP2 and TP3 should be a square wave without distortion.

g. A3U201 output should be a square wave with a small slope on the trailing edge.

f. The current through the switching transistors A3Q21 and A3Q212 should be approximately equal.

e. A3U205 will provide compensation, whenever the average DCV at TP4 is above or below 0 V.

d. The output of A3U205 is normally - 7 V dc.

c. The dc voltage to the emitters of A3Q205 and A3Q206 controls the amount of current used to charge the integrating capacitor. This voltage should not approach supply voltage.

b. U205 and associated circuitry control X Axis symmetry.

a. U202 and U203 and associated circuitry, control Y Axis symmetry.

7-24. The notes listed below provide information to aid in troubleshooting the Test Set.

A1TP14 must be checked good (Paragraph 7-9) before proceeding.

NOTE

d. Check the measure circuit using the flow chart shown in Figure 7-2.

c. Adjust the ac calibrator to 1 kHz at a level of 0.7746 V.

b. Connect an ac calibrator to the Test Set input terminals.

FUNCTION REC TERM
IMP 600
RECEIVE NOISE/
TONE NORMAL OFF
HOLD POWER
MAINS

a. Set the Test Set controls as follows:

7-23. Measure Circuit Troubleshooting.

7-22. Typically, problems with the frequency rate can be attributed to failure of the active components in the integrator, control circuit, or in the current switching networks. Two passive components, A3R210 and A3R211, establish the value of switching current which ultimately controls the frequency and output level. These resistor values as well as active component operation should be closely checked for problems involving frequency and/or distortion in the Test Set.

7-21. The frequency of the Test Set is generated and controlled by the Send Oscillator. Problems with frequency or distortion are generally confined to the Oscillator circuitry shown on Schematic 2.

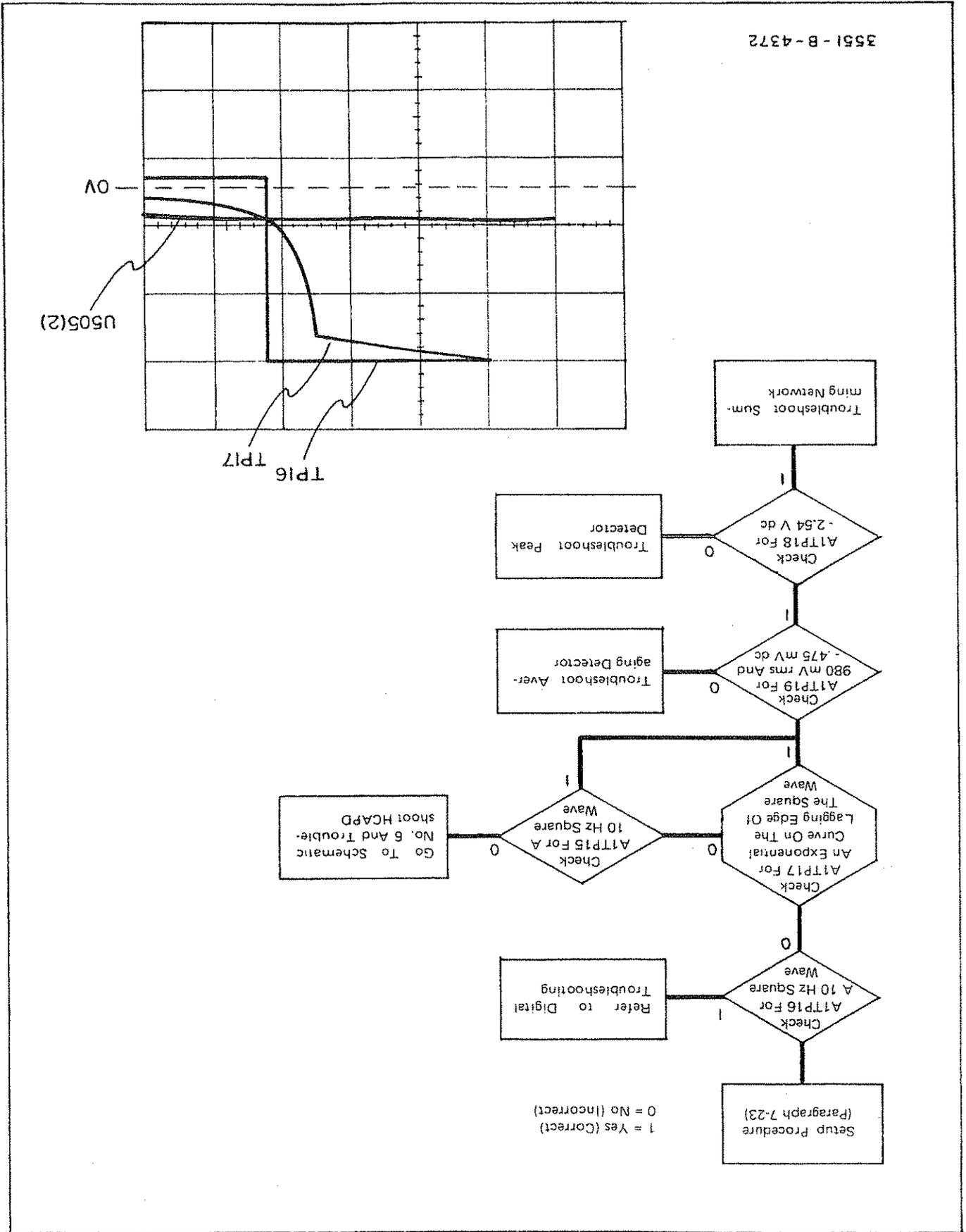
7-20. Send Circuits, Troubleshooting Frequency and Distortion Problems.

1. Q302 Drain	540 mV
2. Q304 Source	512 mV
Test Point	Reading
	AC

Table 7-7. Send Oscillator Display Level Test Points.

c. Measure the voltage at the test points shown in Table 7-7. Refer to Schematic 2 for component level troubleshooting when a measurement is out of tolerance.

Figure 7-2. Measure Circuit Troubleshooting Flow Chart.



7-30. The three digit number on the upper right-hand corner of each rectangle and diamond signifies the state address (Paragraph 4-81). These addresses are octal coded. In the instrument ROM, the octal address is represented by a seven-digit binary number. For troubleshooting purposes it is necessary to be able to transfer from octal to binary and binary to octal.

7-31. Each of the two least significant digits of the octal code is represented by a three digit binary coded number (4-2-1). Since the highest number which can be represented achievable for the two least significant octal digits is 77. The most significant digit is represented by only one binary digit. This means the octal digit can only be a 1 or 0. The total octal range, therefore, is 000 to 177. In binary form, this would be 0000000 to 1111111. The following examples illustrate this conversion:

Example No. 1.

octal	0	0	1
binary	000	000	001
Octal Code 001	binary equivalent		
	0000001		

Example No. 2.

octal	1	5	6
binary	101	110	1101110
Octal Code 156	binary equivalent		
	1101110		

Example No. 3.

octal	0	7	7
binary	0	111	111
Octal Code 077	binary equivalent		
	0111111		

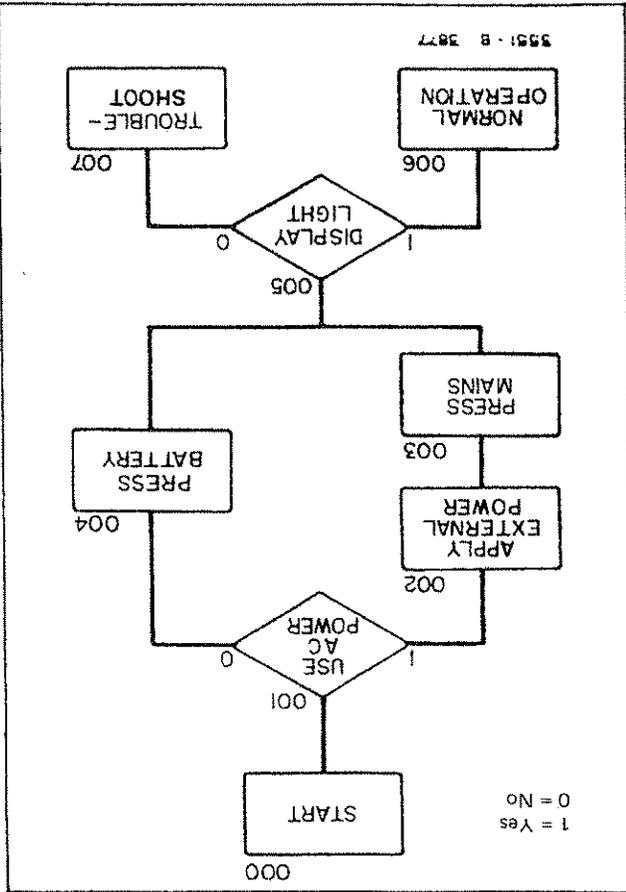
Example No. 4.

octal	1	2	5
binary	101	010	101
Octal Code 1010101	binary equivalent		
	1010101		

Example No. 5.

octal	0	5	0
binary	0	101	010
Octal Code 0101010	binary equivalent		
	0101010		

Figure 7-3. Hypothetical Flow Chart.



7-32. Internal Test Procedure. The internal test procedure sets the Test Set controller into testing routines. There are five routines in the controller; each routine sets the controller for a specific test (ROM timing, Loop No. 1; frequency measurement, Loop No. 5; etc.). These signals in each routine are pulsed by the controller in the order shown in the flow chart. These pulses can be monitored with an oscilloscope to verify they are being set to their true state and thereby ensuring the proper operation of the controller for the function being tested.

7-33. The instrument always proceeds through a start and turn-on sequence when power is initially applied. From here it can branch into the internal test procedure or into the normal operating procedure. If it is in the internal test procedure, it will enter Test Loop No. 1 and remain in that loop until the technician sets it to the next loop. Once a loop has been left, there is no way to reenter that loop except to turn the Test Set power off and begin the entire procedure over. Figure 7-4 shows the basic blocks of the Test Set flow chart.

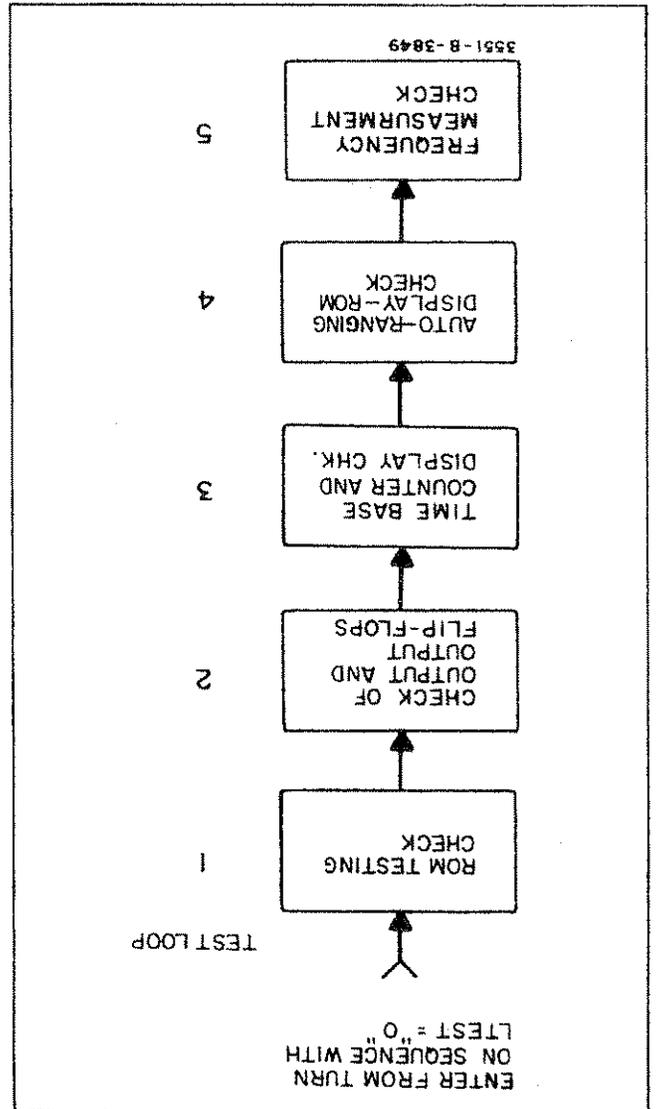
7-34. By observing the Test Set front panel indications as each test loop is entered, the existence of a malfunction, in most cases, can be noted. For this reason it is beneficial to step through each loop first, observing the front panel indications, before performing any of the step-by-step procedures within a loop.

a. Connect the 180C/1601A Logic State Analyzer 6 Bit Data Probes, Part No. 10231A, to AIU602 and AIU603 as shown below.

7-36. Abbreviated Test Loop Procedure. The following paragraphs and Simplified Test Loop Flow Chart provide the required procedures to quickly step through each Test Loop. At certain points a branch will point out initial problem areas which should be corrected before proceeding to the next Test Loop. After completion of the simplified procedures, each Test Loop should be stepped through again, carefully checking all waveforms. Refer to Paragraph 7-37 for the detailed procedures.

7-35. The procedure for stepping through the loops is outlined in Paragraph 7-36. However, it must be noted that *all malfunctions will not be discovered in this manner*. It will be necessary to return to Test Loop No. 1 and perform the step-by-step procedures within each loop as outlined in Paragraph 7-37 to insure proper operation of the Test Set logic section.

Figure 7-4. Basic Test Loop Block Flow Chart.



* L - Indicates Low True
 H - Indicates High True
 A - Indicates active line whether High or Low

Qualifier	Meaning	Origin
*LFREQ	(L)FREQ = 0, display in frequency mode	Display select switches
LANGND	(L)NGND = 0, receive section in noise to gnd	Receive function switch
ARNG0	Least significant range bit	
ARNG1	Second most significant range bit	Range counter AIU621
ARNG2	Most significant range bit	
HOVFW	Counter overflow	AIU618
HXOVR	Crossover, logger circuit comparison	AIU614 (12)
HSIGN	Polarity sign on if HSIGN = "1"	Flip flop AIU617
ATMBS	Time base.	Clock circuit AIU612
L1000	Counts in counter less than 1 K	Display section AIU612
L>900	Counts in counter less than 900	
H10KH	Freq counter in 10 kHz range	Flip flop AIU509
LTEST	Instrument in test mode	Board Jumper Point TP8
LRMT	Instrument in remote operation	Held high in 3551A
L3552	For European design, held high in U.S. version 3551A	

Table 7-8. Qualifier Signals to Control ROM.

b. Connect the 180C/1601A clock probe to A1TP4.
 c. Set the 180C/1601A trigger word to the selected octal code for the 3552A Test Loops.

Data Probe	IC	IC Pin No.
Bit 0	AIU602	6
Bit 1	AIU602	5
Bit 2	AIU602	4
Bit 3	AIU602	3
Bit 4	AIU603	3
Bit 5	AIU603	4
Bit 6	AIU603	5
Bit 7		TP7

Use Pomona 3916 IC test clip to connect directly to the IC's and then connect the data probes.

NOTE

7-37. Step-by-Step Procedure. The following paragraphs and associated flow charts provide the step-by-step procedure for each of the Test Loops. Reference Figures 7-7 through 7-11 for flow charts of each loop test, explanations, tests to be performed, timing diagrams of signals to be tested, and possible solutions to malfunctions. Tables 7-8, 7-9, and 7-10 contain definitions for all the mnemonics used in the Logic Section. To enter the first Test Loop, perform the start-up procedure as shown in Figure 7-5, then proceed as indicated.

7-39. A simplified block diagram of the operational flow charts is shown in Figure 7-6. The Test Set will always proceed through a start and turn-on sequence when power is first applied. After the turn-on sequence, the Test Set can branch into the internal test routine or into the normal operating routine. Once it is in the normal operating routine, it will run in a loop between the amplitude measuring sequence and the frequency measuring sequence.

NOTE
Refer to the Logic Analyzer Operating Manual for information on operation of the logic analyzer.

Table 7-10. Other Control Signals.

Signal	Meaning	Origin
LTONN	Turn on, activates display upon turn-on	Turn on circuits A1U614
HCLEAR	Clears address storage registers U602, 603, 604	Turn on circuits A1U614
LPLUS	Activates + polarity sign	Display ROM A1U702
LNOIS	"0" in receive noise level mode. Qualifier to display ROM and display LED	Front panel switches
LDAMP	"0" in receive level tone damped mode	Front panel switches
LNSDP	Combination of LNOIS and LDAMP. High when LNOIS and LDAMP are both high. Low if either LNOIS or LDAMP is low	Front panel switches
HMSD H3MSD H2MSD H1MSD	Digit enable lines	Counter Outputs A1U701
LKOUT	Display ROM output indicating count up-down status	A1U702
LOVR1	Activates "1" digit of display in noise mode	A1U702
LNONE	When low, lights dbm LED on display	Receive switch

Table 7-9. Direct or Indirect ROM Output Control Signals.

Signal	Meaning	Origin
HCAPD	Logger capacitor charge signal	A1U603
HFLAG	ROM general control signal	A1U601
ATMB1	Least significant time base programming bit	A1U611 Time B2 B1
ATMB2	Most significant time base programming bit	A1U611 1 0 500 ms 1 1 5000 ms
HSRST	Set reset controls HTBRT and HCTR	A1U606
HTBRT	Time base reset	A1U611
HCTR	Counter reset	A1U611
HCLK	Set clock controls HC100 and HCFRC	A1U606
HC100	Selects 100 kHz clock to counter U701	A1U615
HCFRC	Selects measured frequency to counter U701	A1U615
HTXFR	Data transfer pulse to counter U701	A1U606
HRNGC	Clocks or steps storage counter U621	A1U606
HFRQC	Clocks or steps frequency range U509	A1U606
H10KH	10 kHz freq range	A1U509
H100K	100 kHz freq range	A1U509
HSBLK	Set blank controls LBLNK	A1U606
HBLNK	Blanks display	A1U611 (2)
HSPOL	Set polarity, polarity control	A1U606
HENAB	ROM output enable	A1U601 (13)
AOSLT	Qualifier block select	A1U601 (11)
ASELA	Coded ROM output and qualifier select lines	A1U601
ASELB		A1U601
ASELC		A1U601 (18, 12, 17)

d. Follow the test procedure as shown in Figure 7-5.

Switches seven through eleven on the 1601A plug-in module should be in the OFF position. Use switches zero through six to set up the binary equivalent of the selected octal code.

NOTE

7-41. A test socket (TX 601) has been provided on the Test Set controller assembly (A1) for connection of the logic analyzer. A dummy IC socket can be inserted into this socket and a logic clip, such as the Pomona 3916, can be connected to the dummy IC. The -1p- Model 1601 probes with the probe clips removed can then be connected to the Pomona 3916.

7-42. An alternate connection method would be to connect two Pomona 3916 clips to the Address Storage Registers (A1U602 and A1U603). The logic analyzer probes can then be connected to the appropriate pins on the Pomona clip.

7-43. Connect the logic analyzer as follows:

Logic Analyzer Inputs	Test Set Signals
Bit 0	Address bit I0
Bit 1	Address bit I1
Bit 2	Address bit I2
Bit 3	Address bit I3
Bit 4	Address bit I4
Bit 5	Address bit I5
Bit 6	Address bit I6
Bit 7	Address bit I7
clock	100 kHz TX601 pin 10
grnd	grnd U602 pin 7

Set the logic analyzer to trigger on the positive edge of the clock at TTL level threshold. Go to the flow charts of Figures 7-12 and 7-13 and ensure the Test Set controller is operating as outlined in the charts.

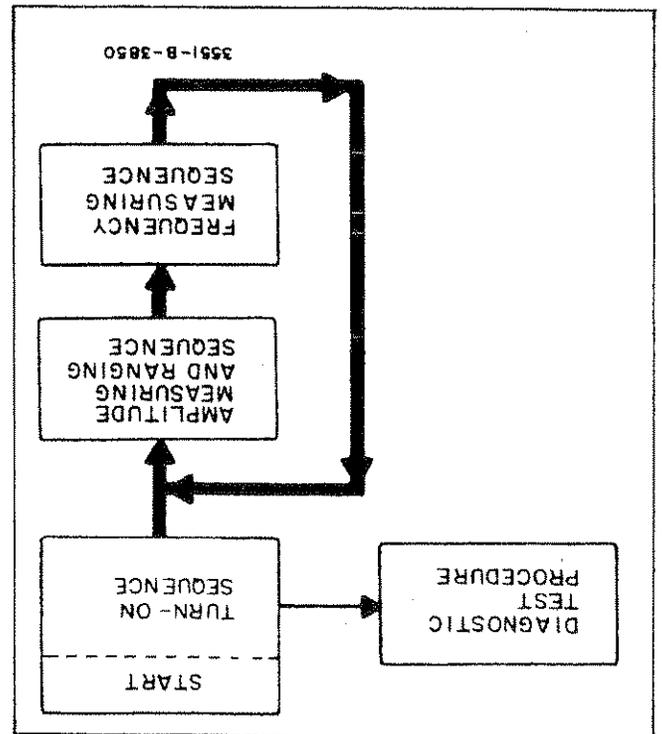


Figure 7-6. Operational Block Flow Chart.

7-40. The operational flow charts are shown in Figures 7-12 and 7-13. The dark line on the diagram indicates the normal step-by-step operation in the frequency measurement mode assuming an input frequency of less than 9 KHz and an input amplitude between 0 dBm and -5 dBm. Explanations of the procedures performed are also given on the flow chart.

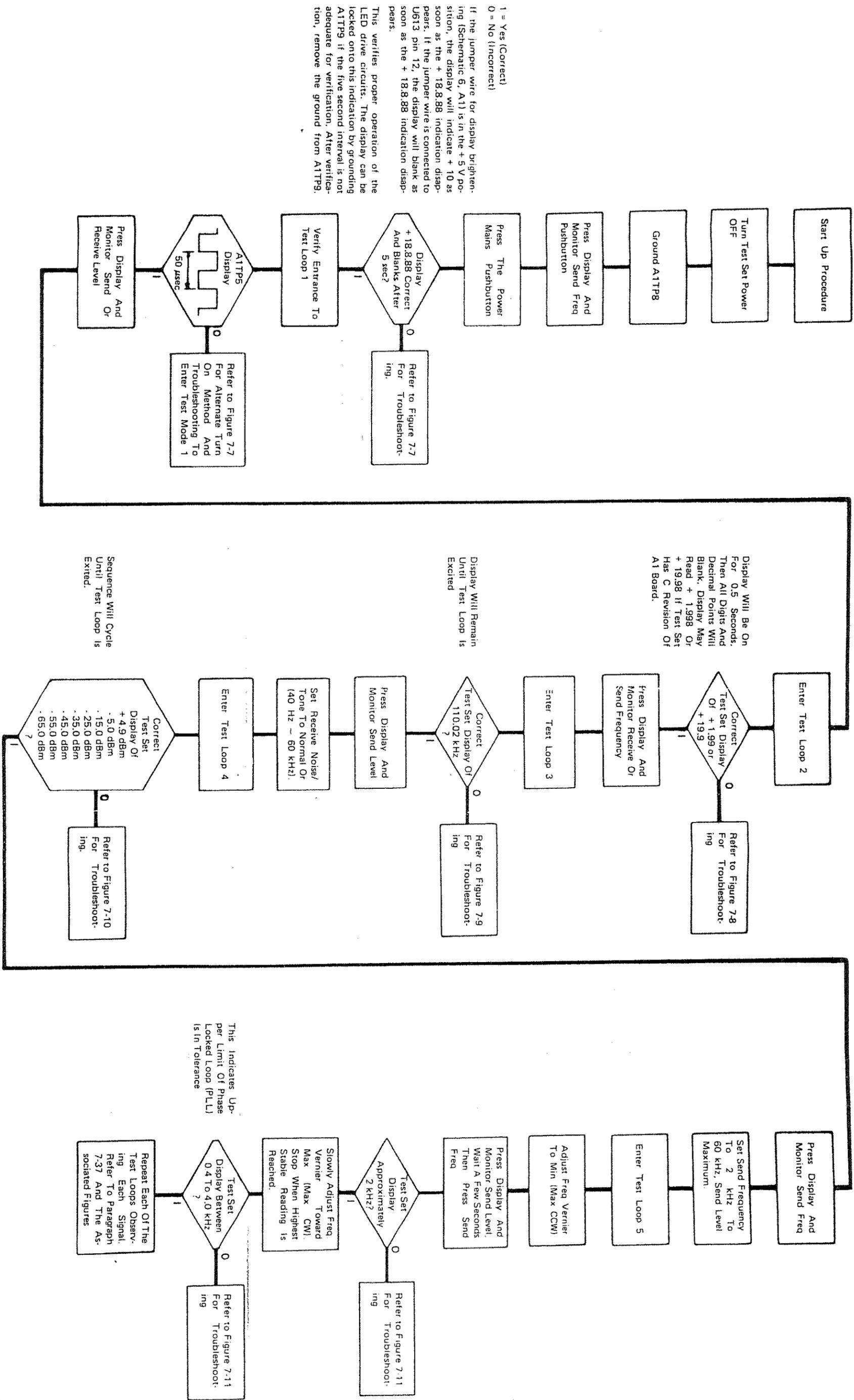
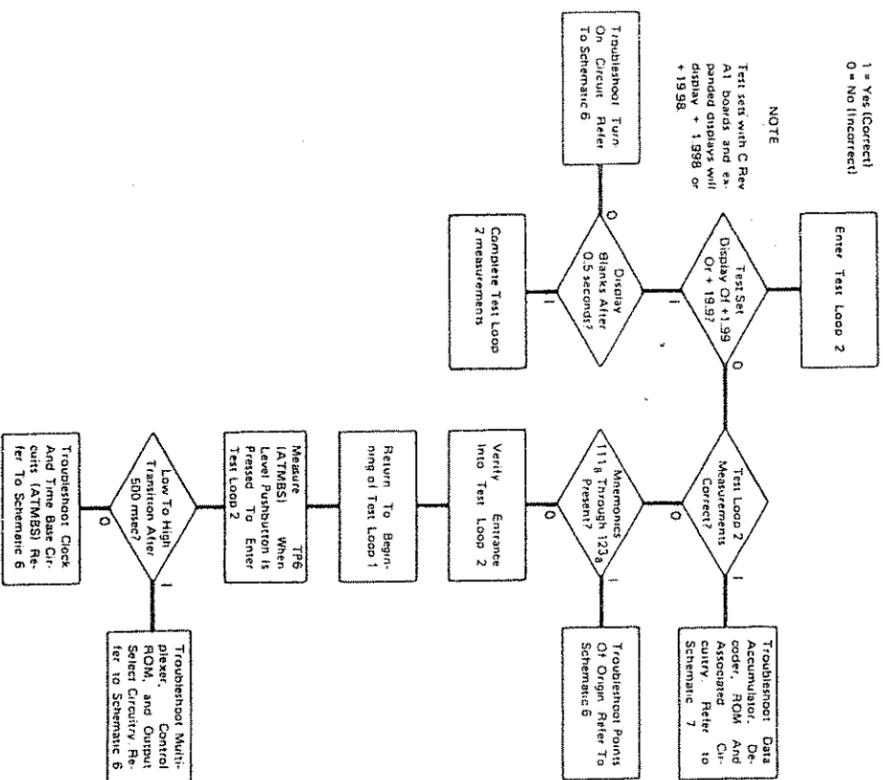


Figure 7-5. Simplified Test Loop Flow Chart. 7-11/7-12





INTRODUCTION.

Test Loop No. 2 verifies the operation of the ROM output and the output storage registers. Once the controller has entered the loop, it will run between states 107 and 124 as long as L.FREQ is high (DISPLAY & MONITOR RECEIVE LEVEL or SEND LEVEL pushbutton is pressed). There are 13 instruction states in this test loop; each state is approximately 10 μ sec long. To verify if the Test Set is in Test Loop No. 2, connect an oscilloscope to ATTP5 and verify that the repetition rate of HTBRT pulses is approximately 140 μ sec.

Connect the external trigger input of an oscilloscope to ATTP5 (HTBRT) and verify the shape and timing of the signals listed in Notes 1 through 12. The troubleshooting flow chart shown in this figure provides possible solutions to problems encountered in Test Loop 2. If a malfunction is discovered, it must be corrected before entering Test Loop 3.

- NOTE 1. Signals were verified in Test Loop No. 1.
- NOTE 2. Verify HFRQC at A1U606 pin 1.
- NOTE 3. Verify H10KH at A1U509 pin 13.
- NOTE 4. Verify HTXFR at A1U701 pin 5.
- NOTE 5. Verify HSCLK at A1U606 pin 3.
- NOTE 6. Verify HC100 at A1U615 pin 1.
- NOTE 7. Verify HSPOL at A1U606 pin 4.
- NOTE 8. Verify HSIGN at A1U617 pin 1.
- NOTE 9. Verify HSBLK at A1U606 pin 6.
- NOTE 10. Verify pulse at A1U617 pin 13.
- NOTE 11. Verify HRNGC at A1U606 pin 15.
- NOTE 12. Verify ARNGO at A1U621 pin 6.

If all signals have been verified at this point, exiting Test Loop No. 2 can be accomplished by pressing DISPLAY & MONITOR RECEIVE or SEND FREQ pushbutton.

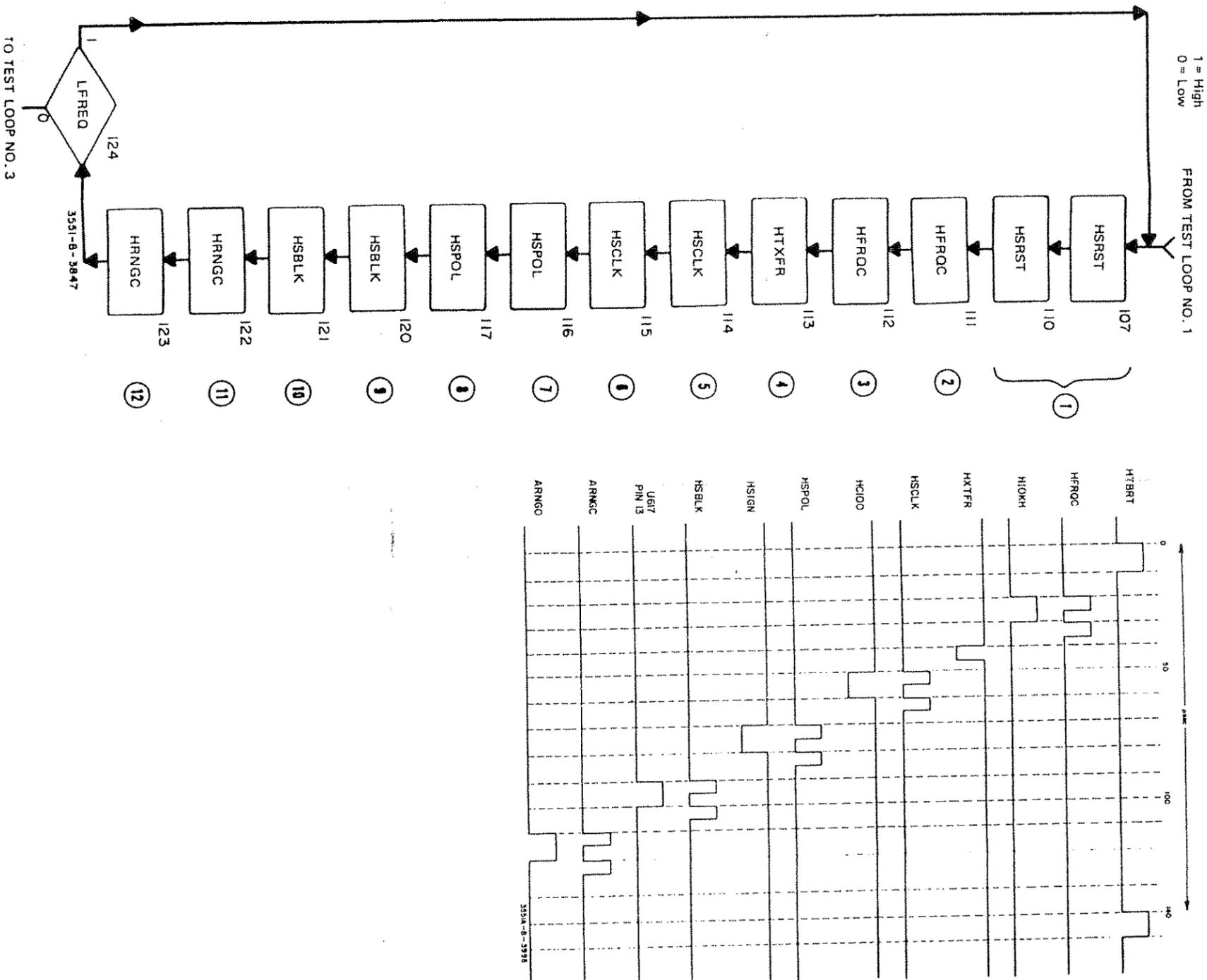


Figure 7-8. Test Loop Number 2. 7-15/7-16



INTRODUCTION.

Test Loop No. 3 verifies the operation of the display circuits and the various time delays required for proper instrument measurement operations. Once the controller has entered the loop, it will run between states 125 and 136 as long as LFREQ is low (DISPLAY & MONITOR RECEIVE FREQ or SEND FREQ pushbutton pressed). There is an accumulation of approximately 1 sec delay in Test Loop No. 3. To verify if the Test Set is in this loop, connect an oscilloscope to A1TP5 and verify that the repetition rate of the HTBRT pulse is approximately 1 second. To verify the operation of Test Loop No. 3, externally trigger the oscilloscope at A1TP5 and verify the signals in Notes 1 through 4 as shown in the timing diagram.

NOTE 1. Signals were verified in Test Loop No. 1.
NOTE 2. In states 127 and 130 the controller will exercise HTMB1 and HTMB2 from A1U604. These signals program the programmable time base A1U612. During this exercise the 100 KHz signal will be loaded into the Data Accumulator A1U701 for a 10 msec period (1000 counts).

NOTE 3. a. The HXTFR pulse transfers the 1000 counts to the display. The display indication should be +110.02.
 b. If the display indication is incorrect, verify the ATMBS signal at A1TP6. If this signal is not correct, troubleshoot the time base circuitry. If this signal is correct and the display indication in Step a was incorrect, troubleshoot the display circuitry.

NOTE 4. 1.1 second delay.

If all signals have been verified at this point, exiting Loop No. 3 can be accomplished by pressing the DISPLAY & MONITOR SEND LEVEL pushbutton and setting the RECEIVE NOISE/TONE control to the TONE NORMAL position.

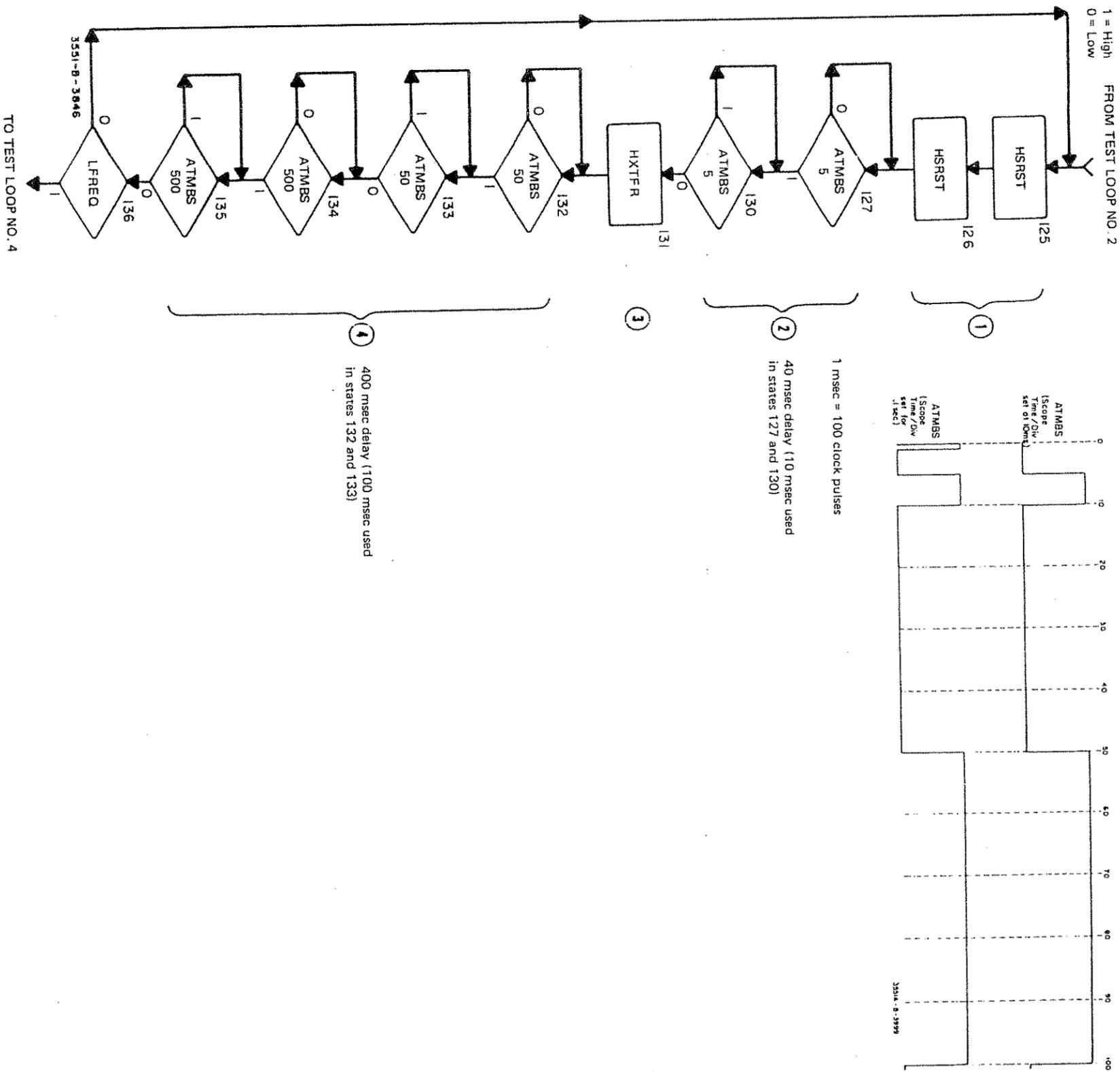


Figure 7-9. Test Loop Number 3.
7-17/7-18



INTRODUCTION.

Test Loop No. 4 verifies the operation of the range up-down counter (A1U621), the automatic amplitude ranging circuits and the display ROM amplitude decoding process. The analog ranging circuits and amplitude measurement circuits will also be tested. Once the controller has entered the loop, it will run between states 137 and 150 or 151 as long as LFREQ is high (DISPLAY & MONITOR SEND LEVEL pushbutton pressed).

When LTEST is low (A1TP8 grounded) there is a 500 ms delay in the loop. When LTEST is high (A1TP8 ground removed) there is only a 15 ms delay. To verify if the Test Set is in Test Loop No. 4, connect an oscilloscope to A1TP5 with A1TP8 grounded and verify that the HTBRT pulse repetition rate is approximately 500 ms. Remove the ground from A1TP8 and verify that the HTBRT repetition rate is approximately 15 ms. To verify the operation of Test Loop No. 4, externally trigger the oscilloscope at A1TP5 and verify the signals in Notes 1 through 4 as shown in the timing diagram.

NOTE 1 HSRST verified in Test Loop No. 1.

NOTE 2 During this routine, the controller will load the 100 kHz clock into the Data Accumulator (A1U701) for 15 ms (1500 counts). The HTXFR pulse will transfer the counts to the display.

NOTE 3 Connect an oscilloscope to A1U606 pin 15 and verify the signal (HRNGC). Verify ARNG0, ARNG1 and ARNG2 at A1U621 pins 6, 11 and 14 respectively.

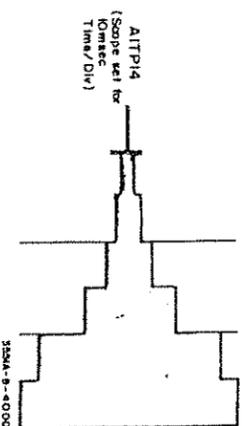
NOTE 4
 a. Connect a ground lead to A1TP8. Set the Test Set front panel RECEIVE NOISE/TONE control to the TONE NORMAL position. The display indication should change as follows:

- + 4.9
- 5.0
- 15.0
- 25.0
- 35.0
- 45.0
- 55.0
- 65.0

This sequence should repeat as long as LFREQ is high (DISPLAY & MONITOR SEND LEVEL is pressed).

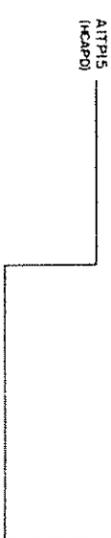
b. Remove the ground lead from A1TP8. Externally trigger the oscilloscope at

A1TP13. Connect the oscilloscope to A1TP14. Set the Test Set front panel SEND FREQUENCY RANGE Hz to the 200 - 6 K position and the SEND LEVEL RANGE dBm to the .30 to .20 position. The oscilloscope indication should be as follows:



This verifies proper operation of the Range Select Block A3U306.

c. Connect one channel of a dual channel oscilloscope to A1TP14 (HCAPD). The oscilloscope indication should be a square wave. Connect the other channel of the oscilloscope to A1TP17. The oscilloscope indication should be the charge and discharge pattern of A1C516. Verify the charge of A1C516 occurs while HCAPD is high and the discharge occurs while HCAPD is low.



If all signals have been verified at this point, exiting Loop No. 4 can be accomplished by pressing the DISPLAY & MONITOR SEND FREQ pushbutton. Set the Send Frequency Range switch to 2 kHz, 60 kHz position.

Disconnect Ground From A1TP8 For LTEST = 1

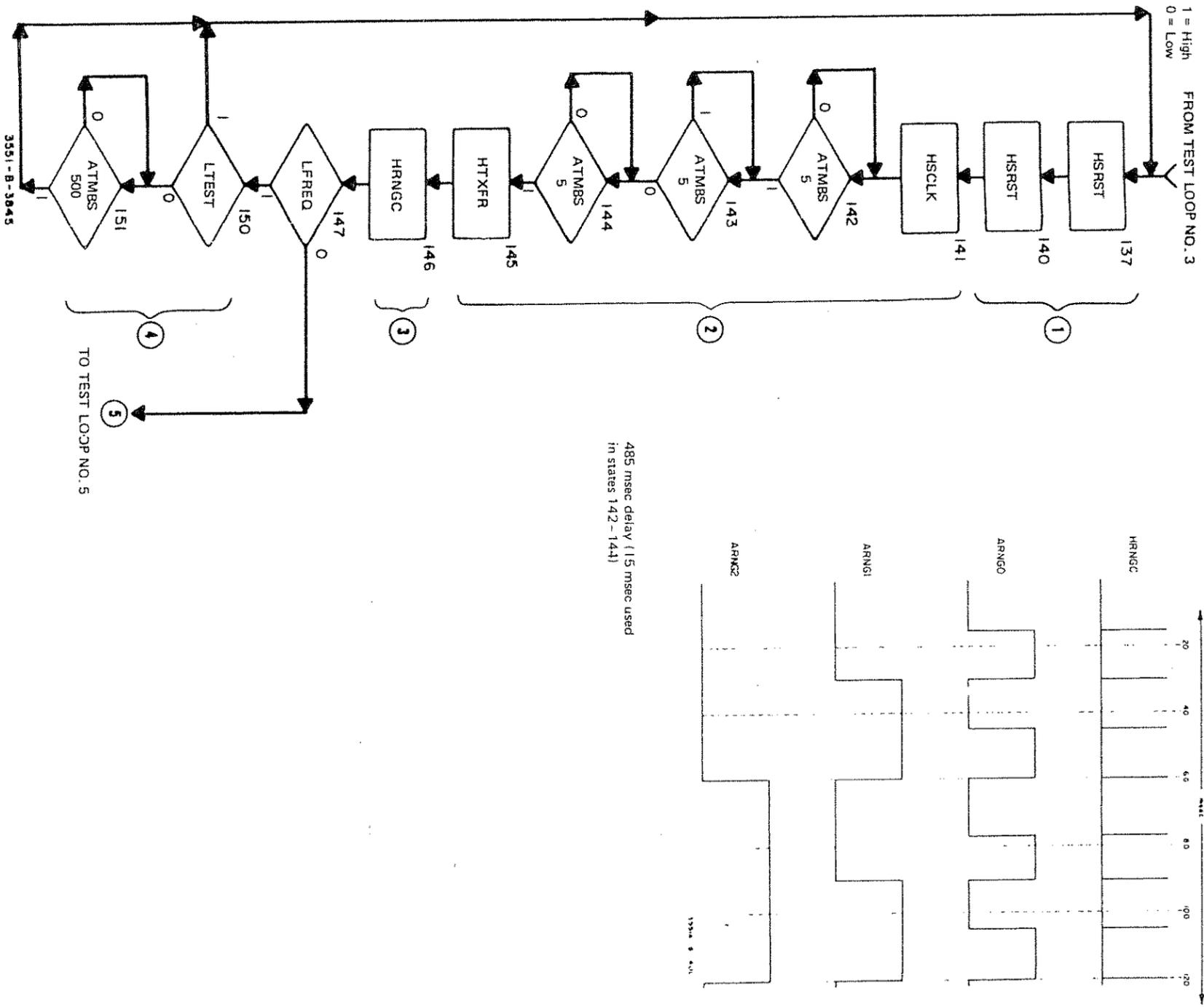


Figure 7-10. Test Loop Number 4. 7-19/7-20



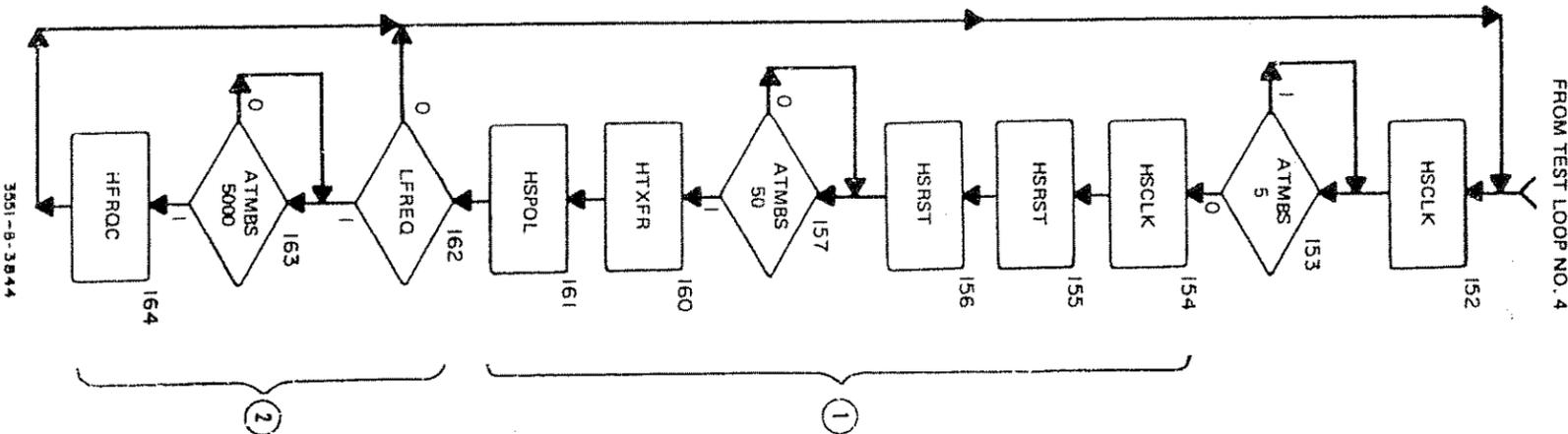
INTRODUCTION.

Test Loop No. 5 verifies the operation of the frequency measuring circuits and the display ROM frequency decoding process. Once the controller has entered the loop, it will run between states 152 and 162 as long as the LFREQ low signal (DISPLAY & MONITOR SEND FREQ pushbutton is pressed) is uninterrupted. If LFREQ is set high (DISPLAY & MONITOR SEND LEVEL pushbutton is pressed) then set low again (DISPLAY & MONITOR SEND FREQ pushbutton pressed) the controller will step from state 162 to state 164, then continue to run between states 152 and 162.

NOTE 1. With the FREQUENCY VERNIER set fully counterclockwise, the display should be approximately 2 kHz. This will be in the greater than 10 kHz range.

NOTE 2. Press the DISPLAY & MONITOR SEND LEVEL pushbutton. After a few seconds, press the SEND FREQ pushbutton. The Test Set display should downrange to the less than 10 kHz range. Verify the upper limit of the phase locked loop (PLL) by adjusting the frequency vernier towards maximum frequency (CW) until the display stabilizes. The display should read between 0.4 kHz and 4.0 kHz. If the upper limit of PLL is reading greater than 4.0 but less than 6.0 pad A1R561 with a 27 kilohm resistor. If the reading is greater than 6.0 or if padding does not bring the reading within specification, replace A1U507. The first digit is blanked so the readings in frequency are actually 10.4 kHz to 14.0 kHz.

1 = High
0 = Low



*Cannot check to 5000. Greater than 1000 indicates correct operation

Figure 7-11. Test Loop Number 5.
7-21/7-22







GENERAL SCHEMATIC NOTES

18. DC VOLTAGE LEVELS WERE MEASURED WITH RESPECT TO CIRCUIT GROUND USING A VTVM WITH 10 MEGOHM INPUT IMPEDANCE. THE VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY FROM ONE INSTRUMENT TO ANOTHER DUE TO CHANGE IN TRANSISTOR CHARACTERISTICS. A VARIATION OF $\pm 10\%$ SHOULD BE ALLOWED.

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
 2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.
 RESISTANCE IN OHMS
 CAPACITANCE IN MICROFARADS
 INDUCTANCE IN MILLIHENRYS

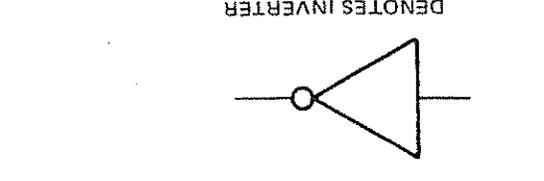
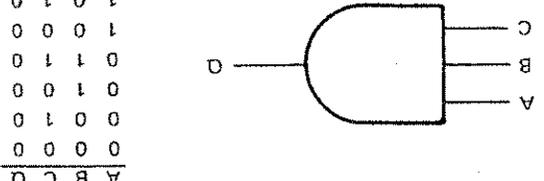
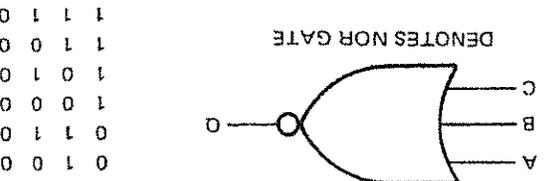
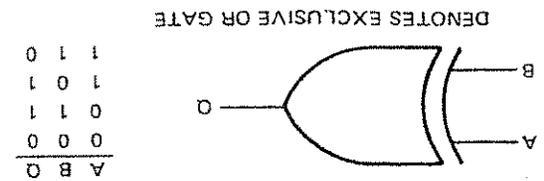
3. DENOTES EARTH GROUND.
 NO. 18 GAUGE WIRE CONNECTED BETWEEN TERMINAL AND EARTH GROUND TERMINAL OR AC POWER RECEPTACLE.
 4. DENOTES FRAME GROUND.
 USED FOR TERMINALS WHICH ARE PERMANENTLY CONNECTED WITHIN APPROXIMATELY 0.1 OHM OF EARTH GROUND.
 5. DENOTES GROUND ON PRINTED CIRCUIT ASSEMBLY. (PERMANENTLY CONNECTED TO FRAME GROUND).
 6. DENOTES FLOATABLE CIRCUIT GROUND.
 7. SCREWDRIVER GROUND.

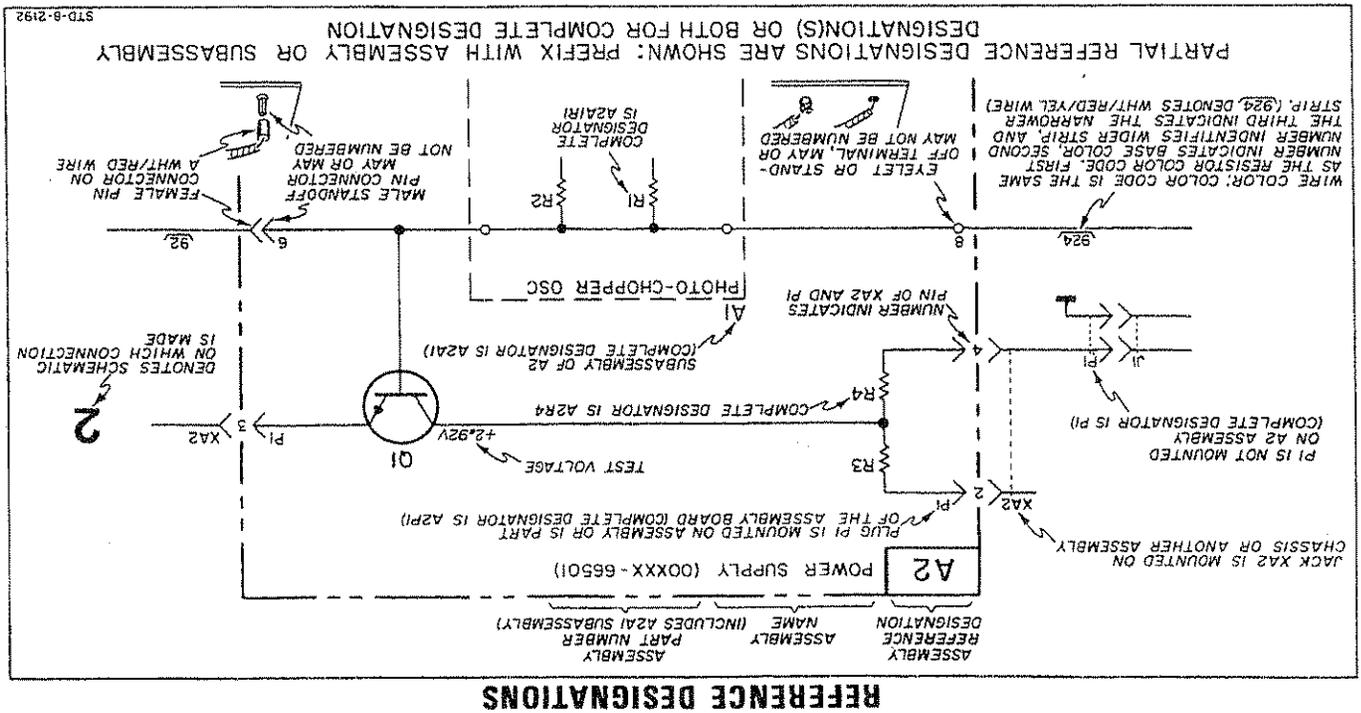
8. DENOTES ASSEMBLY.
 9. DENOTES FEEDBACK PATH.
 10. DENOTES FRONT PANEL MARKING.
 11. DENOTES REAR PANEL MARKING.
 12. DENOTES SCREWDRIVER ADJUST.

13. * AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY. THE VALUE OF THESE COMPONENTS MAY VARY FROM ONE INSTRUMENT TO ANOTHER.
 14. DENOTES SECOND APPEARANCE OF A CONNECTOR PIN.

15. $\sqrt{924}$ DENOTES WIRE COLOR: COLOR CODE SAME AS RESISTOR COLOR CODE. FIRST NUMBER IDENTIFIES BASE COLOR, SECOND NUMBER IDENTIFIES TIES WIDER STRIP, THIRD NUMBER IDENTIFIES NARROWER STRIP. (e.g. $\sqrt{924}$ = WHITE, RED, YELLOW)
 16. ALL RELAYS ARE SHOWN DEENERGIZED.

17. WAVEFORMS AND AC VOLTAGE MEASUREMENTS WERE MADE WITH RESPECT TO CHASSIS GROUND USING AN OSCILLOSCOPE WITH A 1:1 PROBE. THE VOLTAGE LEVELS SHOWN ON THE WAVEFORMS ARE ACTUAL VOLTAGE LEVELS AND ARE NOT TO BE CONFUSED WITH OSCILLOSCOPE SETTING. THE VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY FROM ONE INSTRUMENT TO ANOTHER. A VARIATION OF $\pm 10\%$ IN MEASUREMENTS SHOULD BE ALLOWED.





Set the Test Set front panel controls as follows:

FUNCTION	OFF
HOLD	OFF
FUNCTION	OFF
Oblock input/output terminals	REC BRNG
IMP	130
RECEIVE NOISE/TONE	NORMAL
NOISE WEIGHTING	C MESSAGE
SEND FREQUENCY	1000
SEND BY	HOLD TONE
SEND LEVEL RANGE/ dBm	0 to +10
SEND LEVEL CENTER	CCW
DISPLAY & MONITOR	RECEIVE ERRO
POWER	MAINS

Apply an input signal of 5 V P-P amplitude into I50 ohms and a frequency of 2000 Hz.

Test Point	Time/div	Volts/div
A3P2	2 msec	5
A3T2	2 msec	5
A3T3	2 msec	5
A3T4	2 msec	5
A3T5	2 msec	5
A3T6	2 msec	5
A3T7	2 msec	5

Set the Test Set front panel RECEIVE NOISE/TONE control to the WITH TONE position.

Test Point	Time/div	Volts/div
A3T10	2 msec	1
A3T11	1.2, 1.3, 1.4	1

Set the Test Set front panel RECEIVE NOISE/TONE control to the TONE NORMAL NIZ position.

Test Point	Time/div	Volts/div
A4T10	2 msec	0.5
A4T12	2 msec	5
A4T13	2 msec	1
A4T14	2 msec	0.5
A4T15	2 msec	0.5
A4T16	2 msec	0.5
A4T17	2 msec	0.5
A4T18	2 msec	0.5
A4T19	2 msec	0.5
A4T20	2 msec	0.5
A4T21	2 msec	0.5
A4T22	2 msec	0.5
A4T23	2 msec	0.5
A4T24	2 msec	0.5
A4T25	2 msec	0.5
A4T26	2 msec	0.5
A4T27	2 msec	0.5
A4T28	2 msec	0.5
A4T29	2 msec	0.5
A4T30	2 msec	0.5
A4T31	2 msec	0.5
A4T32	2 msec	0.5

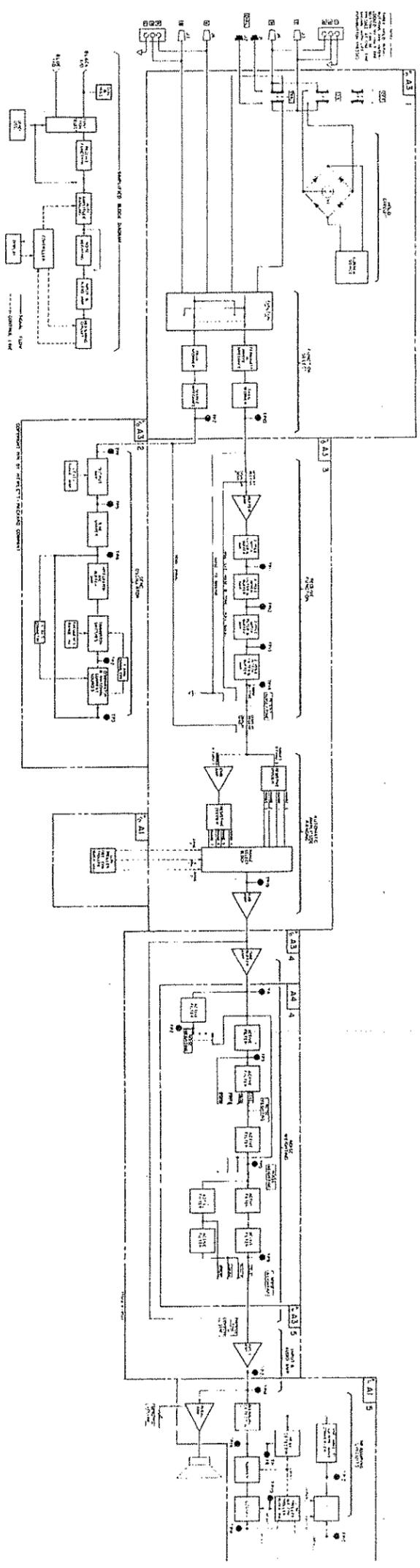
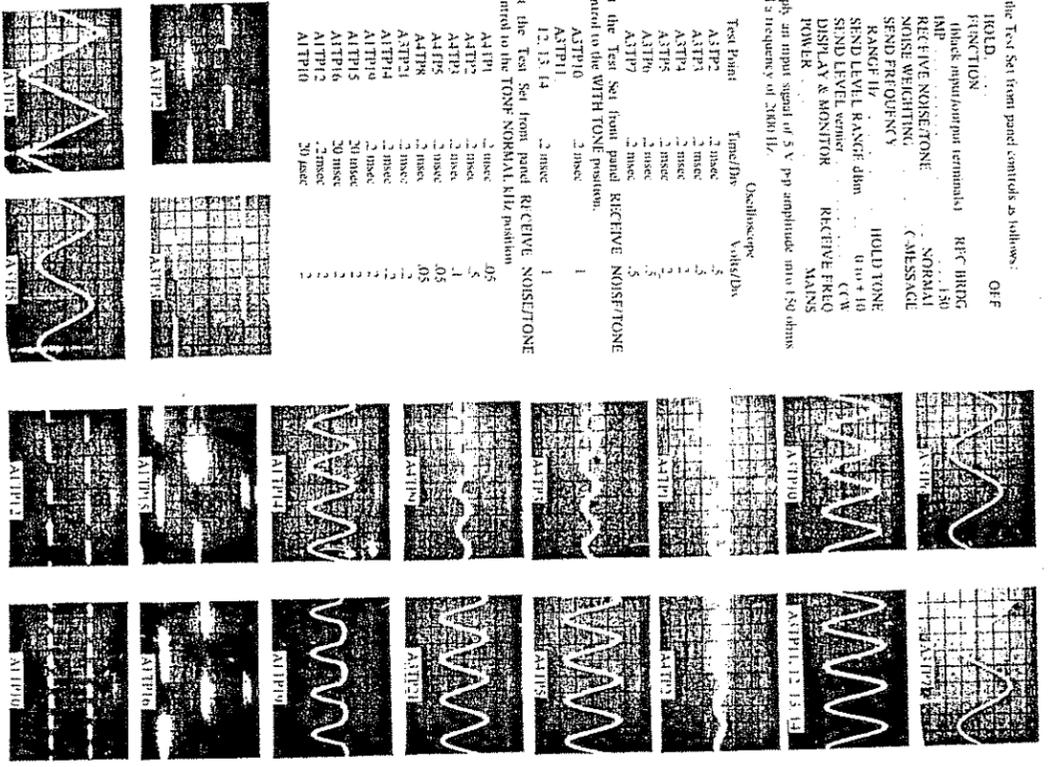


Figure 7-14. Analog Block Diagram. 7-29/7-30



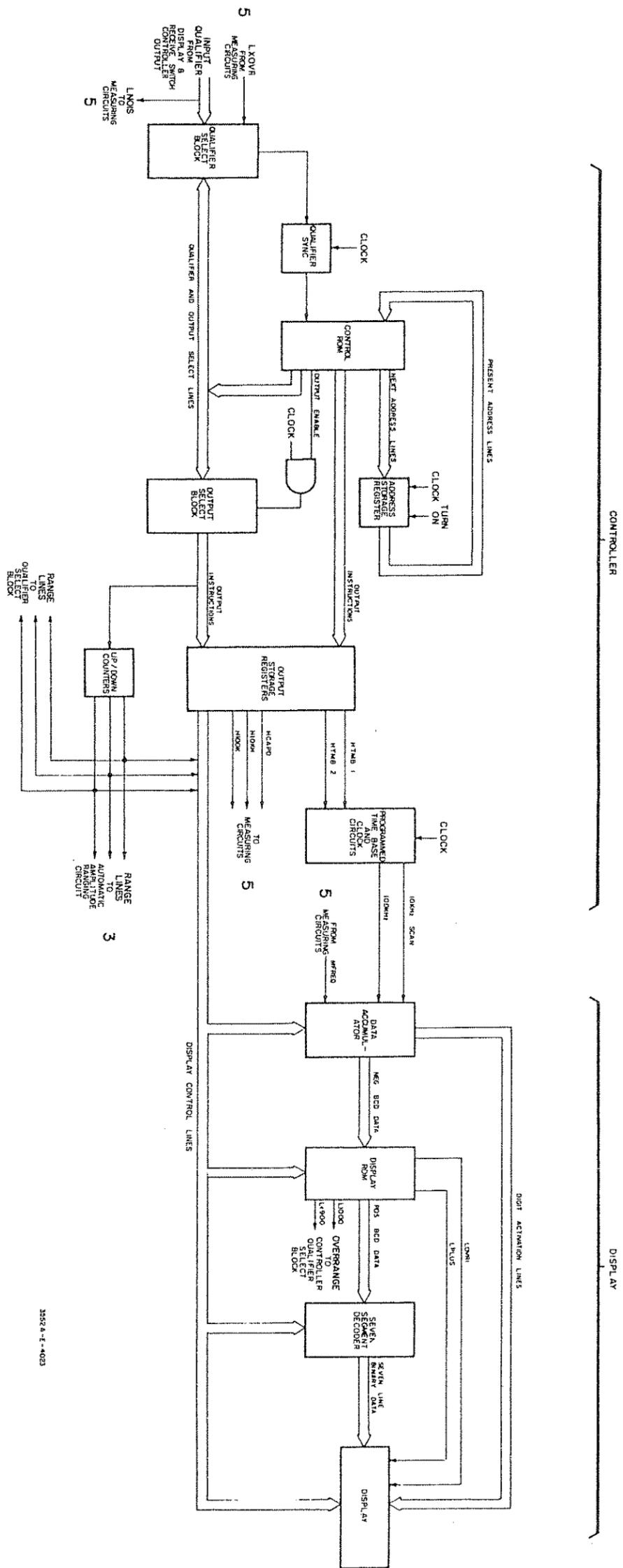
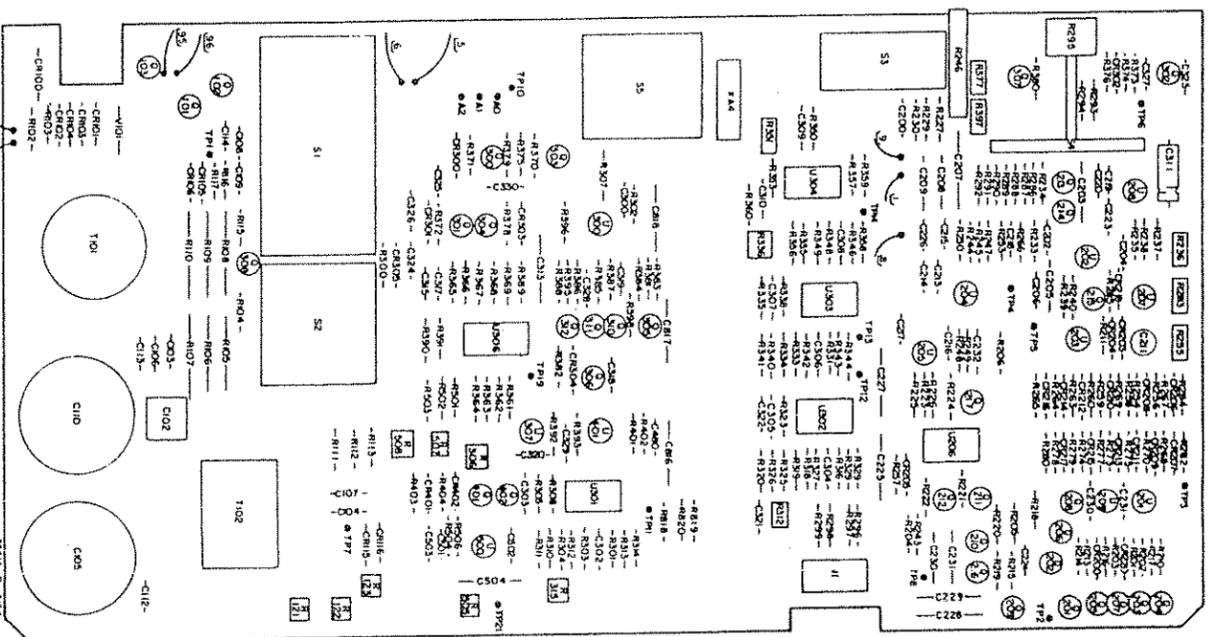
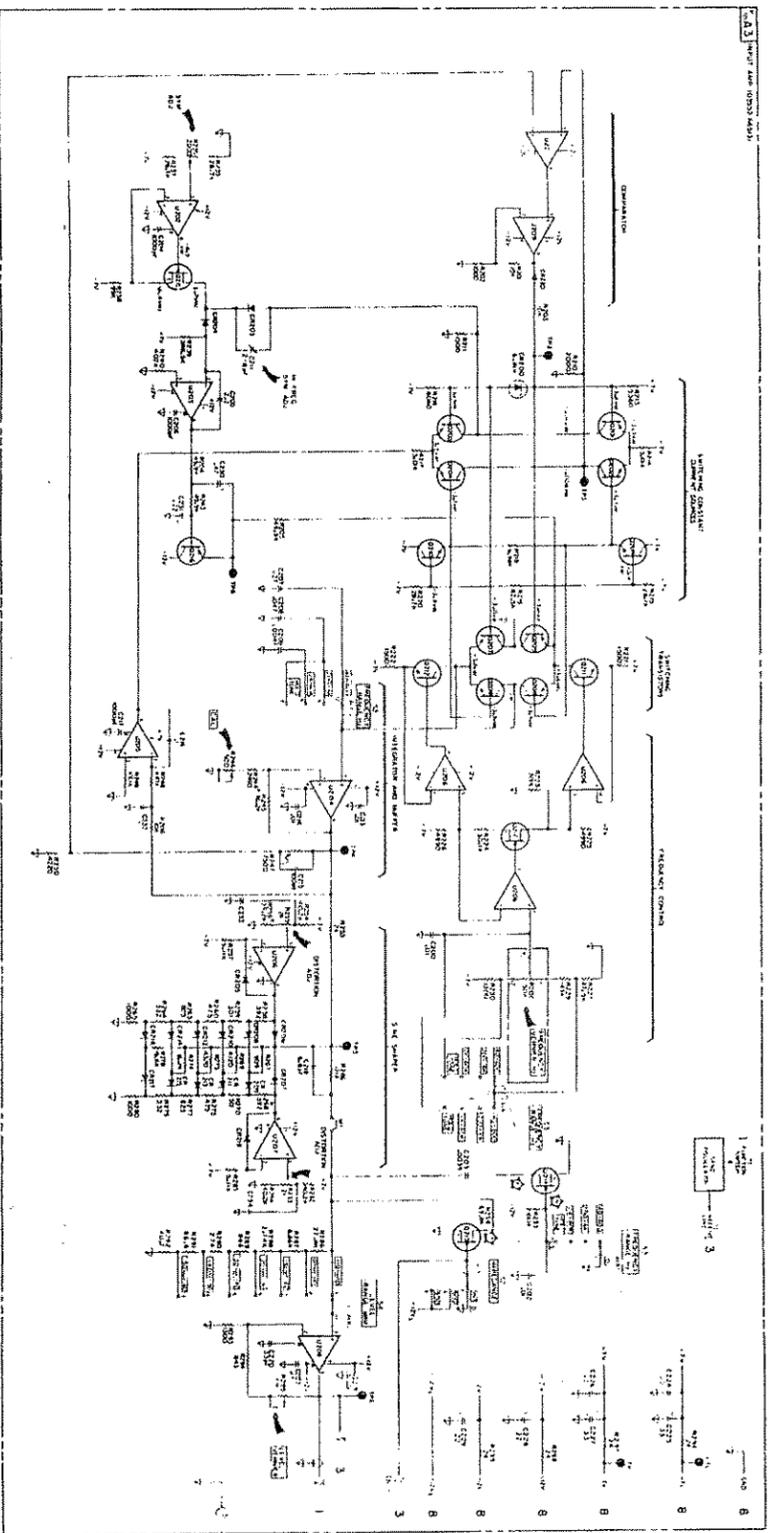


Figure 7-15. Controller and Display Block Diagram. 7-31/7-32







A3
Part No. 03551-66513
Rev B

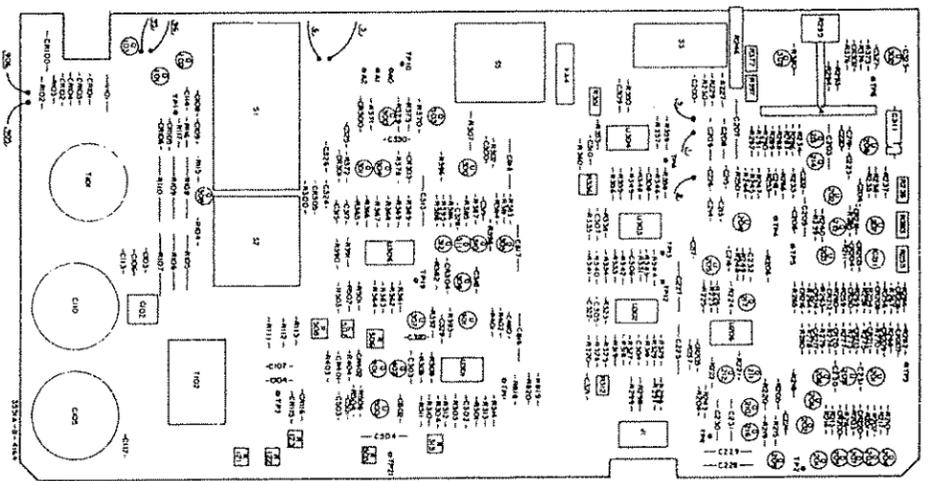
- 1 0 V dc
-12 V dc
 - 2 0 V dc
-0.5 V dc
 - 3 0 V dc
-4 mV dc
 - 4 +2.6 V dc
+1.6 V dc
0 V dc
-2.5 V dc
 - 5 +2.0 V dc
-2.1 V dc
0 V dc
-2.5 V dc
 - 6 -2.1 V dc
0 V dc
-2.5 V dc
 - 7 -2.5 V dc
0 V dc
-2.5 V dc
- Top voltage measured with FREQUENCY RANGE Hz in all but HOLD TONE position and FREQUENCY vernier CCW. For second voltage, set FREQUENCY vernier CW. Third Hz in HOLD TONE position and FREQUENCY vernier CCW. For fourth voltage, set FREQUENCY vernier CW.
- Top voltage measured with FREQUENCY RANGE Hz in all but HOLD TONE position. Second voltage measured with FREQUENCY RANGE Hz in HOLD TONE position and FREQUENCY vernier CCW. For third voltage, set FREQUENCY vernier CW.
- Top voltage measured with IMP in 150 position. Bottom voltage measured with IMP in 600 and 900 position.

- Because of the closed-loop nature of the Input Amplifier, the following troubleshooting procedure is suggested.
- a. Adjust the front panel Frequency Vernier fully clockwise.
 - b. Unsolder one end of A3R205.
 - c. Unsolder the end of A3R217 that connects to A3U205 Pin 6. Connect -7 V dc (from -7 Test Point) to the open end of A3R217.
 - d. Unsolder the end of A3R247 that connects to A3TP4. Apply a 1 kHz sine wave at 2.24 V rms from an ac calibrator to the open end of A3R247.
 - e. The signals at the following points should be approximately the levels shown below, measured with an oscilloscope.
- | | |
|--------------|-----------------------|
| A3U201 Pin 2 | 4.6 V p-p sine wave |
| A3TP2 | 2.6 V p-p square wave |
| A3TP3 | 3.4 V p-p square wave |
| A3TP4 | 18 V p-p square wave |
| A3TP5 | 7 V p-p square wave |
| A3TP6 | 17 V p-p square wave |
| A3U205 Pin 6 | 200 mV p-p sine wave |
- f. Also check A3U206 in the Frequency Control circuit.

Figure 7-17. Send Oscillator, A3.
7-35/7-36

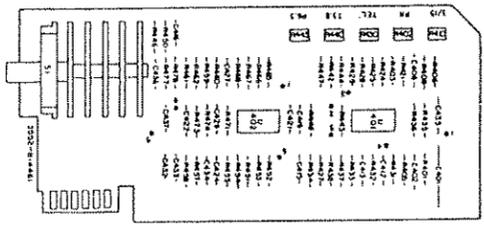






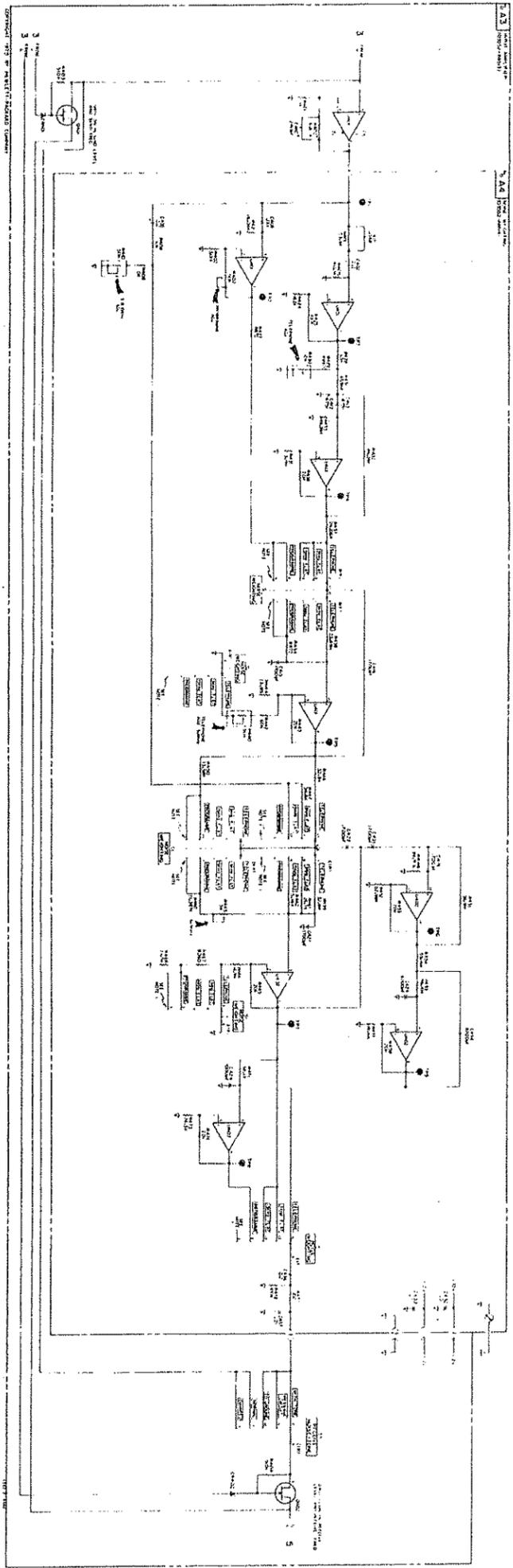
A3
hp-Part No. 03551-66513
Rev B

1	+9.5	Top voltage measured with the NOISE WEIGHTING in the TELEPHONE position.
2	+10.1	Second voltage measured with the NOISE WEIGHTING in 3KHz FLAT or 15 KHz FLAT position.
3	+0.8	Bottom voltage measured with NOISE WEIGHTING in the PROGRAMME position.
4	+1.0	
5	-0.12	
6	-1.98	
7	-0.04	
8	+0.24	
9	-0.30	
10	+0.46	



A4
hp-Part No. 03552-66514
Rev B

1	+0.87	Top voltage measured with NOISE WEIGHTING in the TELEPHONE position.
2	-0.82	Bottom voltage measured with NOISE WEIGHTING in the TELEPHONE position.
3	-0.07	
4	-0.05	
5	-0.04	
6	-1.2	Top voltage measured with NOISE WEIGHTING in TELEPHONE position.
7	+0.96	Second voltage measured with NOISE WEIGHTING in 3 KHz FLAT position.
8	+0.91	Third voltage measured with NOISE WEIGHTING in 15 KHz FLAT position.
9	+0.94	Bottom voltage measured with NOISE WEIGHTING in PROGRAMME position.
10	-0.84	
11	-0.084	
12	-0.087	
13	-0.057	

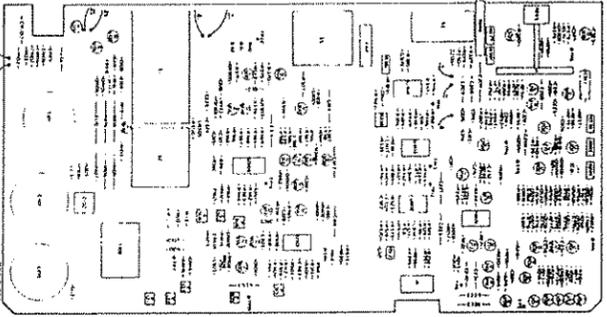
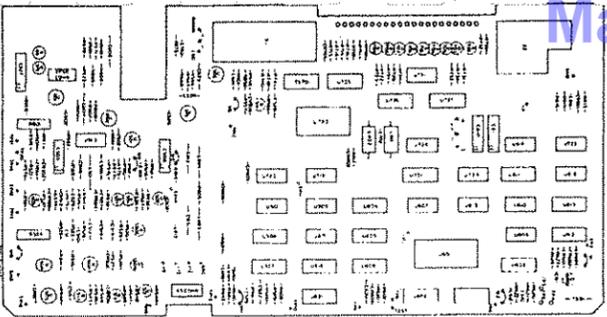


A4
hp-Part No. 03552-66514
Rev B

1	+0.25	Top voltage measured with NOISE WEIGHTING in the TELEPHONE position.
2	+1.0	Bottom voltage measured in any other NOISE WEIGHTING position.
3	-0.3	
4	-0.03	
5	+0.5	
6	-1.36	
7	-0.82	Top voltage measured with NOISE WEIGHTING in TELEPHONE position.
8	-0.07	Second voltage measured with NOISE WEIGHTING in 3 KHz FLAT position.
9	-0.05	Third voltage measured with NOISE WEIGHTING in 15 KHz FLAT position.
10	-0.04	Bottom voltage measured with NOISE WEIGHTING in PROGRAMME position.
11	-1.7	
12	+0.30	
13	+0.36	

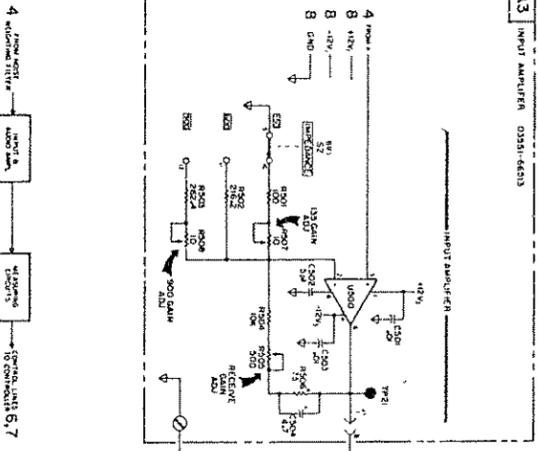
Figure 7-19. Noise Weighting Filters, A3, A4.
7-39/7-40



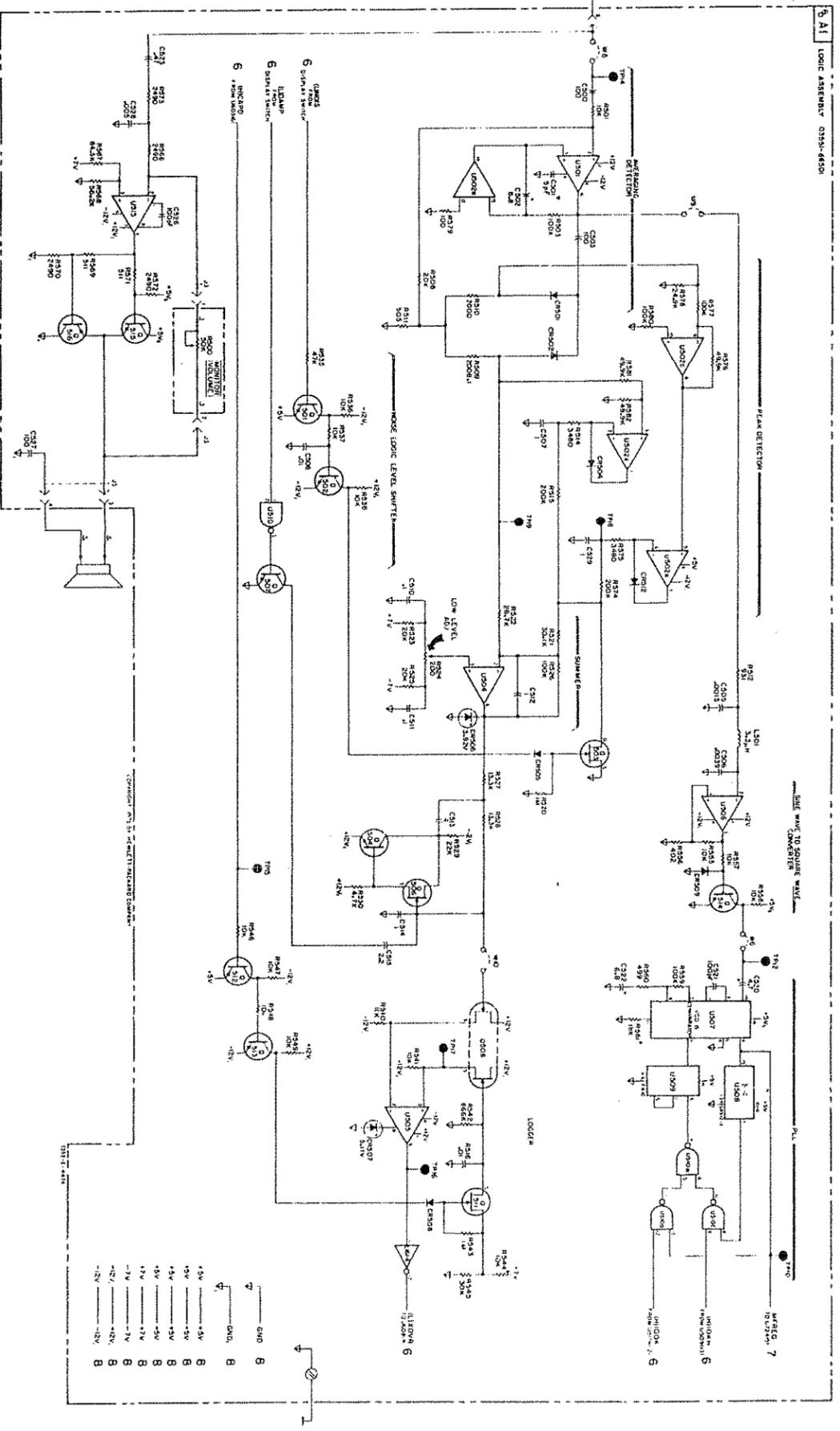


NOTE

Because of the digital signals present in this circuitry, dc levels on the transistors are not meaningful. For troubleshooting, refer to the waveform on the analog block diagram, Figure 7-11.



4. FROM UNIT 4
 4. FROM UNIT 5
 6. FROM UNIT 6



- 7 — GND 8
- 1 — GND 8
- 2 — GND 8
- 3 — GND 8
- 4 — GND 8
- 5 — GND 8
- 6 — GND 8
- 7 — GND 8
- 8 — GND 8
- 9 — GND 8
- 10 — GND 8
- 11 — GND 8
- 12 — GND 8
- 13 — GND 8
- 14 — GND 8
- 15 — GND 8
- 16 — GND 8
- 17 — GND 8
- 18 — GND 8
- 19 — GND 8
- 20 — GND 8
- 21 — GND 8
- 22 — GND 8
- 23 — GND 8
- 24 — GND 8
- 25 — GND 8
- 26 — GND 8
- 27 — GND 8
- 28 — GND 8
- 29 — GND 8
- 30 — GND 8
- 31 — GND 8
- 32 — GND 8
- 33 — GND 8
- 34 — GND 8
- 35 — GND 8
- 36 — GND 8
- 37 — GND 8
- 38 — GND 8
- 39 — GND 8
- 40 — GND 8
- 41 — GND 8
- 42 — GND 8
- 43 — GND 8
- 44 — GND 8
- 45 — GND 8
- 46 — GND 8
- 47 — GND 8
- 48 — GND 8
- 49 — GND 8
- 50 — GND 8
- 51 — GND 8
- 52 — GND 8
- 53 — GND 8
- 54 — GND 8
- 55 — GND 8
- 56 — GND 8
- 57 — GND 8
- 58 — GND 8
- 59 — GND 8
- 60 — GND 8
- 61 — GND 8
- 62 — GND 8
- 63 — GND 8
- 64 — GND 8
- 65 — GND 8
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- 67 — GND 8
- 68 — GND 8
- 69 — GND 8
- 70 — GND 8
- 71 — GND 8
- 72 — GND 8
- 73 — GND 8
- 74 — GND 8
- 75 — GND 8
- 76 — GND 8
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- 87 — GND 8
- 88 — GND 8
- 89 — GND 8
- 90 — GND 8
- 91 — GND 8
- 92 — GND 8
- 93 — GND 8
- 94 — GND 8
- 95 — GND 8
- 96 — GND 8
- 97 — GND 8
- 98 — GND 8
- 99 — GND 8
- 100 — GND 8

Figure 7-20. Input and Audio Amp, Measuring Circuits, A1, A3, 7-41/7-42

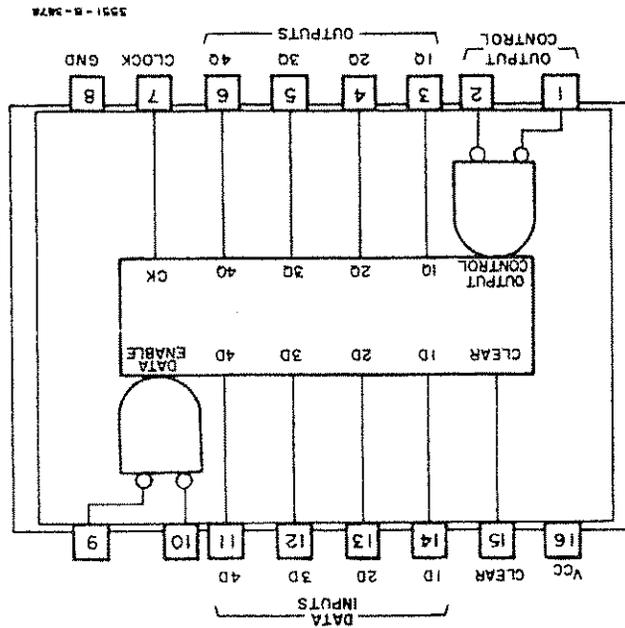


U602 and U603

When pin 1 is high the output is disabled to the high-impedance state; however sequential operation of the flip-flops is not affected.
 H = high level (steady state)
 L = low level (steady state)
 ↓ = irrelevant (any input including transients)
 Q₀ = the level of Q before the indicated steady-state input conditions were established.

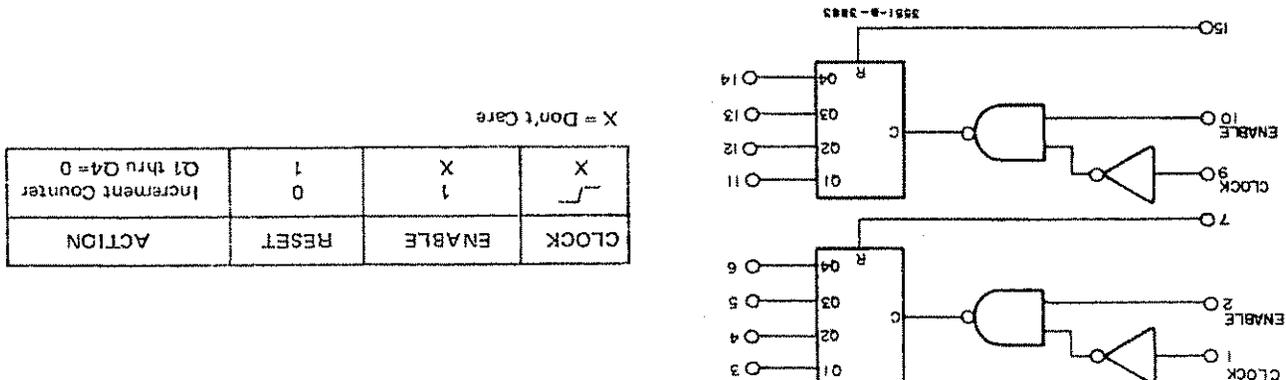
INPUTS				CLEAR	CLOCK	DATA ENABLE	DATA	OUTPUT
L	L	L	L	H	↓	L	X	L
L	L	L	L	L	↓	L	X	L
L	L	L	L	L	L	X	X	L
L	L	L	L	L	L	X	X	Q ₀
L	L	L	L	L	L	X	X	H

FUNCTION TABLE



3552A - B - 3474

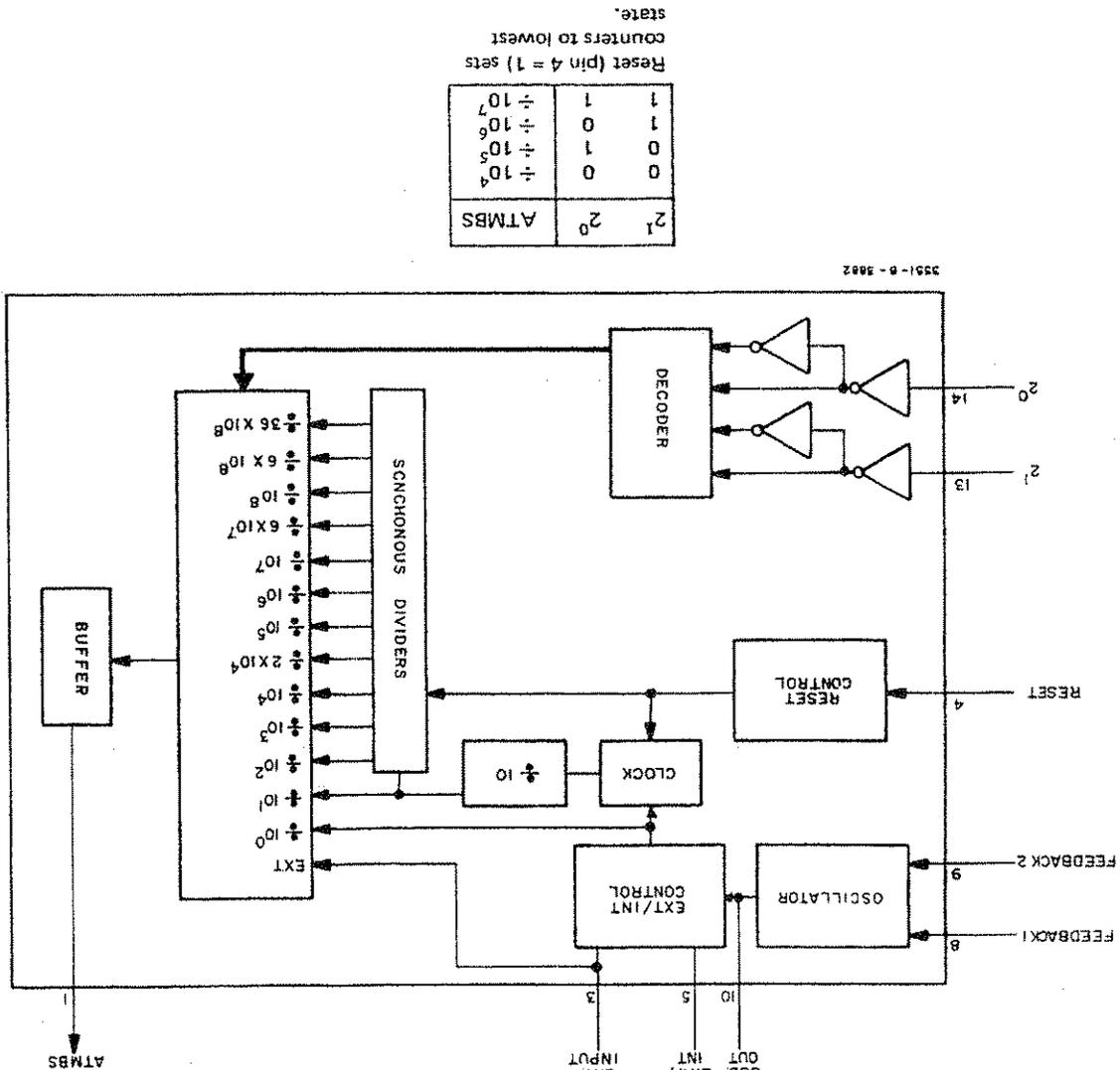
U613



CLOCK	ENABLE	RESET	ACTION
X	1	0	Increment Counter
X	X	1	Increment Counter Q1 thru Q4=0

X = Don't Care

U612



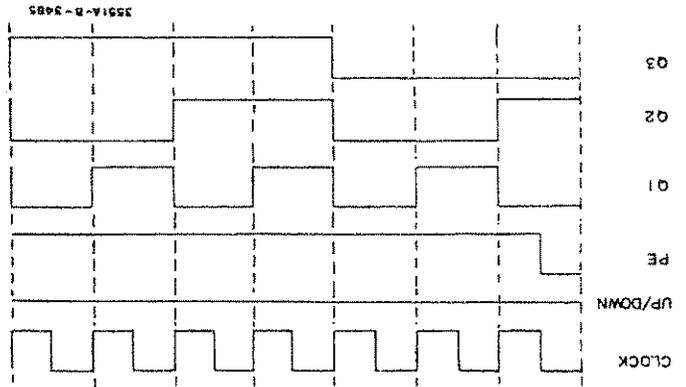
2 ¹	2 ⁰	ATMBS
1	1	÷ 10 ⁷
0	0	÷ 10 ⁶
0	1	÷ 10 ⁵
0	0	÷ 10 ⁴
1	0	÷ 10 ³
1	1	÷ 10 ²
1	1	÷ 10 ¹
1	1	÷ 10 ⁰

Reset (pin 4 = 1) sets counters to lowest state.

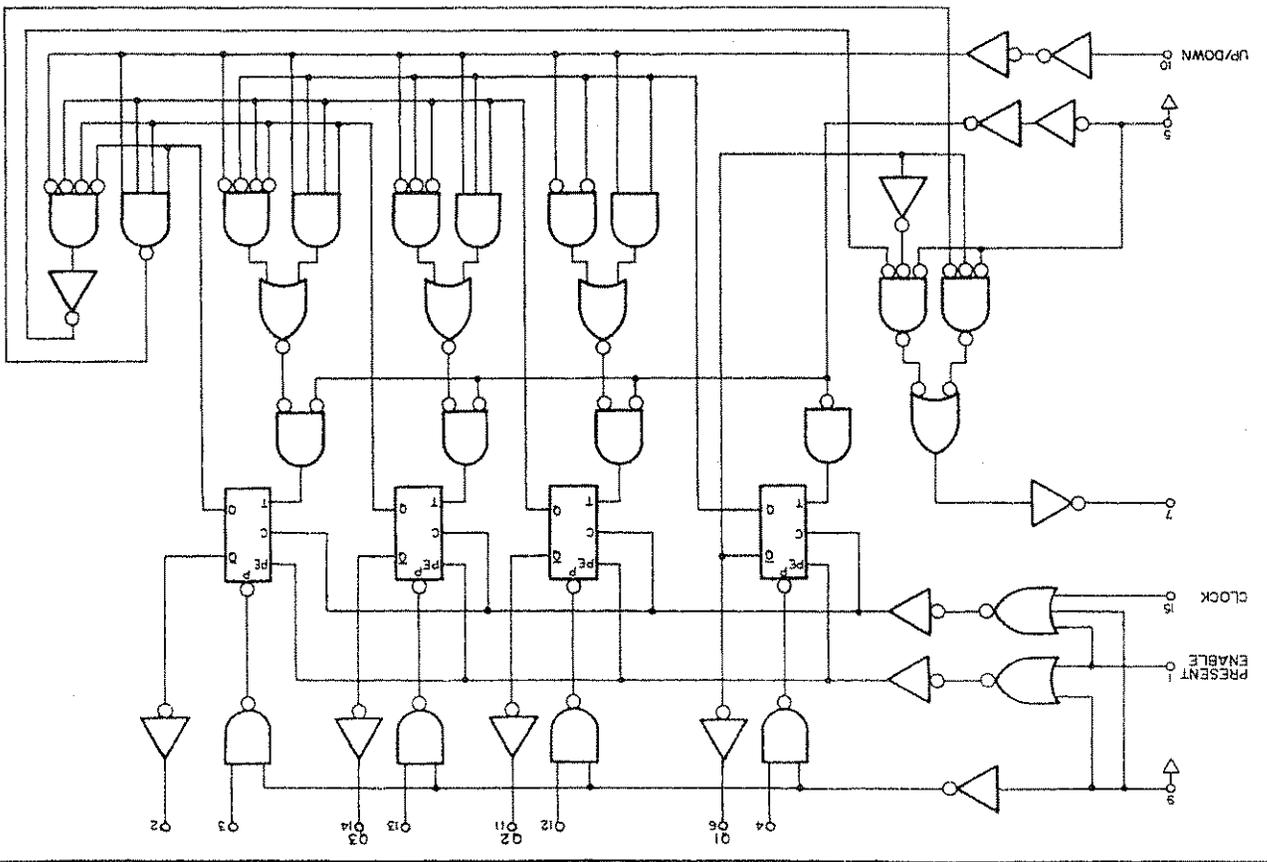
U621

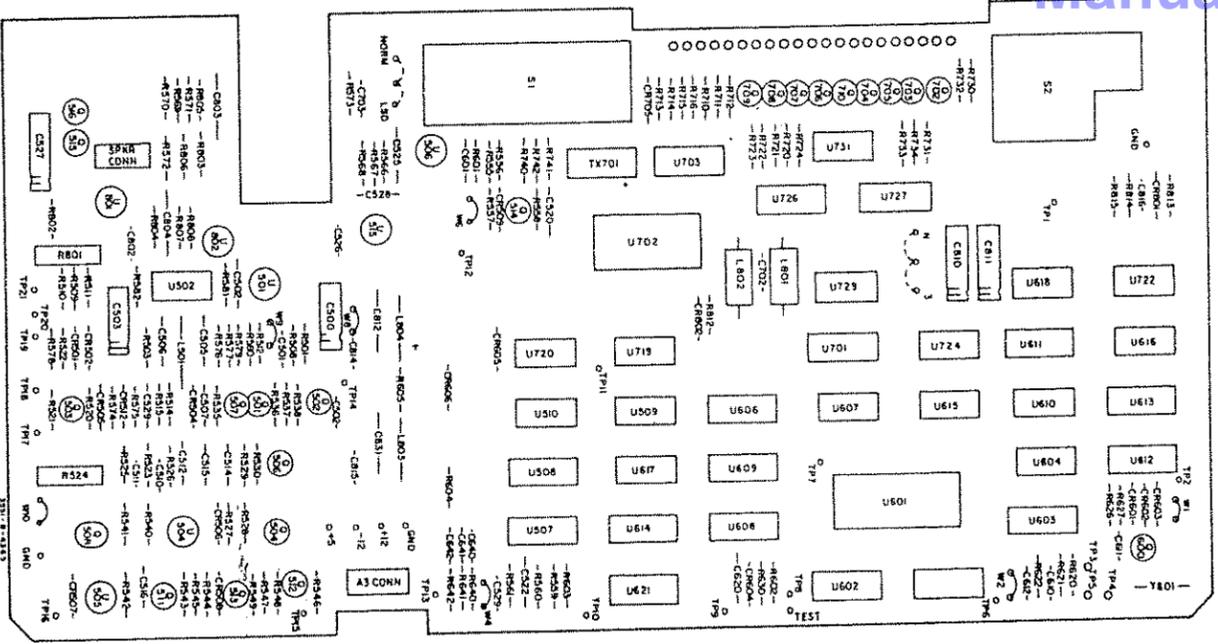
OUTPUT TRUTH TABLES			
Scan	Digit	BCD OUTPUTS	
0	1	MSB	LSE
0	1	1	1
1	1	1	1
2	1	1	1
3	1	1	1
4	1	1	1
5	1	1	1
6	1	1	1
7	1	1	1
8	1	0	0
9	1	0	0
0	1	1	1
1	1	1	1
2	1	1	1
3	1	1	1
4	1	1	1
5	1	1	1
6	1	1	1
7	1	1	1
8	1	0	0
9	1	0	0
0	1	1	1
1	1	1	1
2	1	1	1
3	1	1	1
4	1	1	1
5	1	1	1
6	1	1	1
7	1	1	1
8	1	0	0
9	1	0	0

TRUTH TABLE, OTHER OUTPUTS			
Other Outputs	Logic State	Time of Occurrence	
Digit Activation	1	One-of-four, following Scan Input rising edge; all off when Scan Input is low.	
Count Extend	1	Occurs each time the counter state attains 9,999 count. Remains true until the next Count Input or Reset occurs (When the counter returns to 0,000).	



INPUT TRUTH TABLE	
Input	Logic Condition to Activate
Clock	Negative Edge
Reset	0
Transfer	0
Scan	0 (Negative Edge)







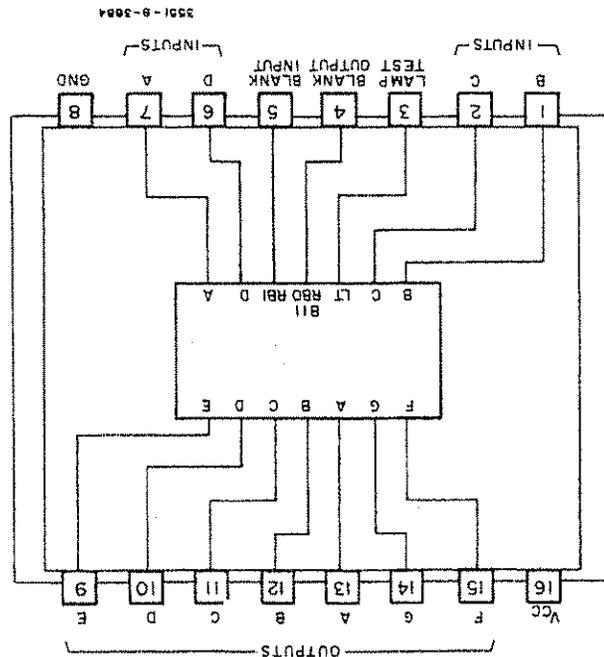
U703

- NOTES: 1. The blanking input must be open or high if blanking of a decimal zero is not desired.
 2. When blanking input and inputs A, B, C, and D are at a low level with the lamp test input high, all segment outputs go off and the blanking output goes to a low level (response condition).
 3. When the blanking output is open or held high and a low is applied to the lamp-test input, all segment outputs are on.

H = high level, L = low level, X = irrelevant

DECIMAL OR FUNCTION	INPUTS				OUTPUTS								
	LT	Blank Input	D	C	A	B	C	D	e	f	g	NOTE	
0	H	H	L	L	L	L	L	L	ON	ON	ON	1	
1	H	H	X	X	L	L	L	L	OFF	OFF	OFF	1	
2	H	H	X	X	L	L	L	L	ON	ON	ON	1	
3	H	H	X	X	L	L	L	L	ON	ON	ON	1	
4	H	H	X	X	L	L	L	L	OFF	ON	ON	1	
5	H	H	X	X	L	L	L	L	OFF	ON	ON	1	
6	H	H	X	X	L	L	L	L	OFF	ON	ON	1	
7	H	H	X	X	L	L	L	L	OFF	OFF	OFF	1	
8	H	H	X	X	L	L	L	L	ON	ON	ON	1	
9	H	H	X	X	L	L	L	L	ON	ON	ON	1	
Blank Input	L	H	L	L	L	L	L	L	OFF	OFF	OFF	2	
LT	L	H	L	L	L	L	L	L	OFF	OFF	OFF	3	

FUNCTION TABLE



3521-B-3084

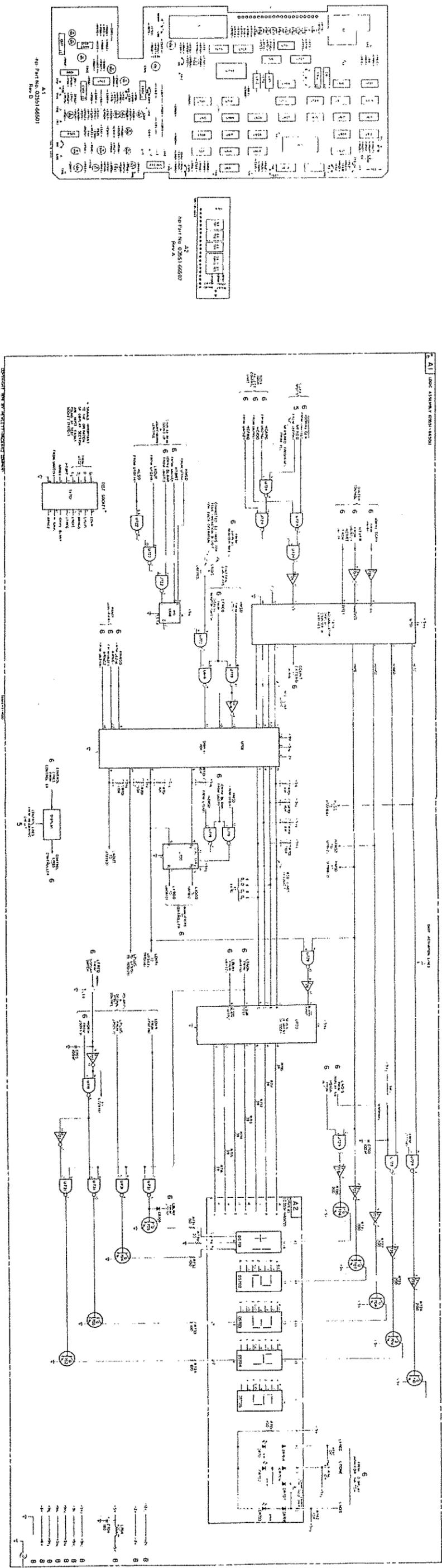


Figure 7-22. Display, A1, A2.
7-51/7-52



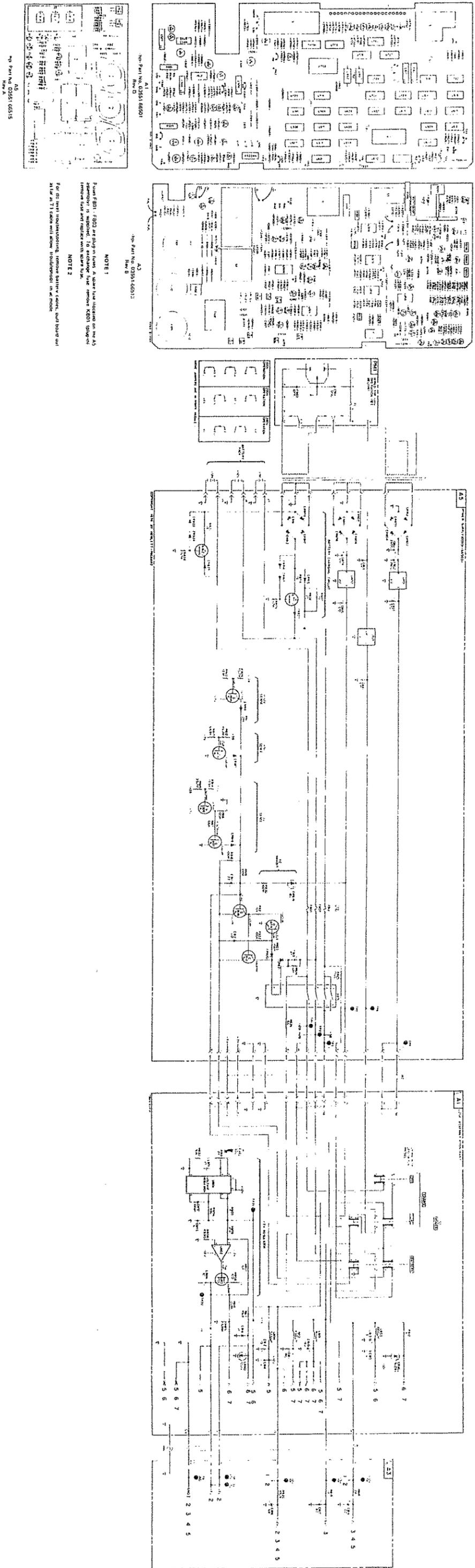
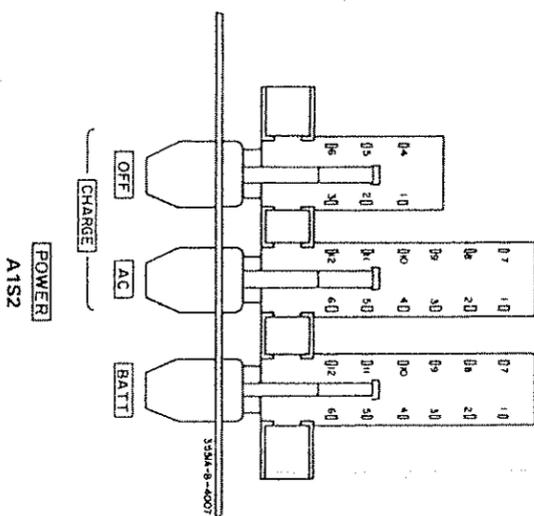
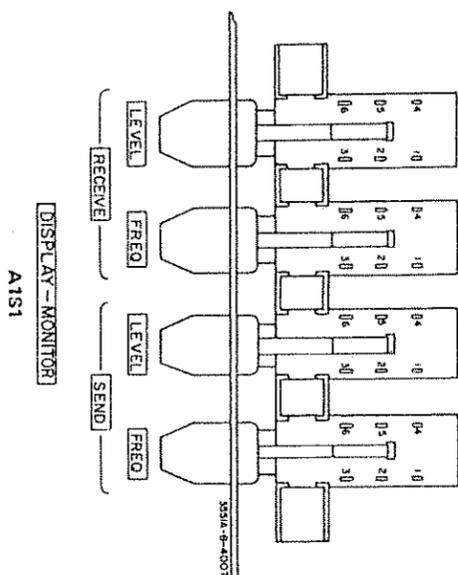
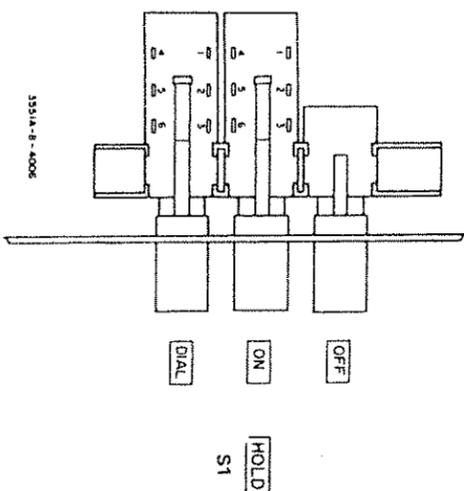
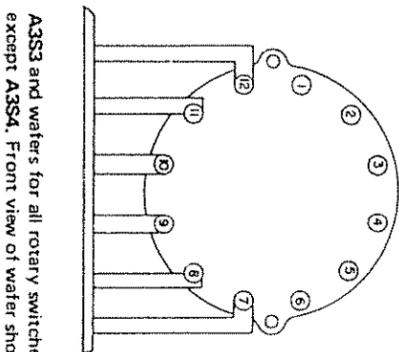
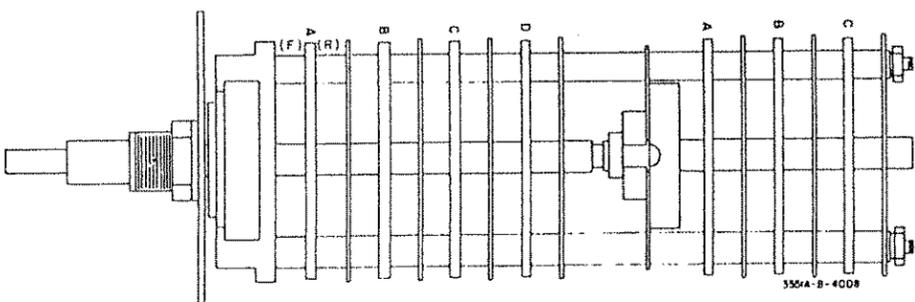


Figure 7-23. Power Supply A1, A3, A5, 7-5317-54



FUNCTION
A3S1



A3S3 and wafers for all rotary switches except A3S4. Front view of wafers shown.

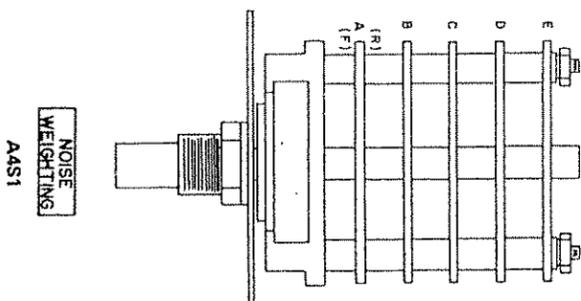
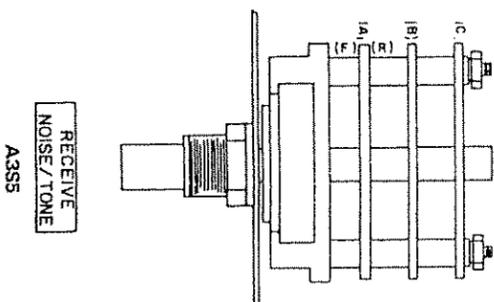
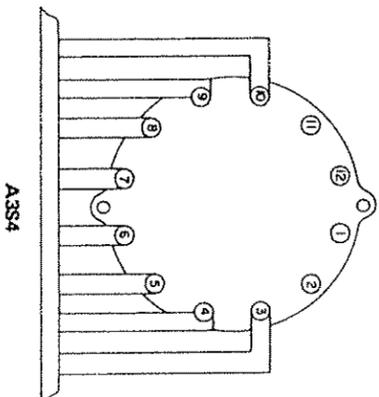


Figure 7-24. Switch Drawings.
7-51/7-56



SECTION VIII BACKDATING

8-1. INTRODUCTION.

8-2. This section, in conjunction with the integrated backdating, makes this manual applicable to earlier instruments. Where practical, the backdating change has been integrated into the text, parts list or schematic. This type of change is denoted by an open delta or a lettered delta (Δ or ΔB). The delta refers to the corresponding backdating note on that page. If the backdating change is too long or otherwise impractical to incorporate into the text, the entry will be denoted by a numbered delta ($\Delta 1$). The numbered delta refers to the corresponding numbered delta in this section.

8-3. Only those changes which cannot be adapted to earlier instruments or which do not benefit the operation or the specification of earlier instruments are listed. If a component value or a component part number differs from the value or part number listed in the Replaceable Parts List, yet is not listed in this section or integrated into the text, the value and part number listed in the Replaceable Parts List is to be used if replacement is necessary. The new component is to be considered as beneficial to instrument operation or specification.

8-4. BACKDATING CHANGES.

$\Delta 1$ 8-5. Serial No. 1435A00140 and Lower.

8-6. The Input Amplifier assembly, A3, in instruments with Serial No. 1435A00140 and lower is Part No. 03552-66503. The Replaceable Parts List for this assembly is shown on Pages 8-4 through 8-9. Schematic diagrams affected are Nos. 1, 2, 3, and 5. These diagrams are Figure 8-3, 8-4, 8-5, and 8-7 respectively. The location of adjustments on this assembly is shown in Figure 8-1.

8-7. Make the following changes in Table 6-3, Replaceable Parts, for Serial No. 1435A00140 and lower:

Delete: Housing, Lock, 03551-24710
 Handle, Lock, 03551-24901
 Screw, Lock, 03551-27901
 Knob, Lever, 0370-1810
 L1 through L4, Coil-Fxd, 1 μ H, 9100-3551
 A1L501, Coil-Fxd, 3.3 mH, 9100-1665
 A1R513, R-Fxd, 3 K, 0683-3025
 A4R475, R-Fxd, 470 Ω , 0684-4711

Change: Panel, Front, 03552-00201
 Panel, Front-Sub, 03552-00202
 A1C505, C-Fxd, 1000 pF, 0160-0153
 A1C506, C-Fxd, 1000 pF, 0160-0153

A1C522, C-Fxd, 4.7 μ F, 0180-0309
 A1C601, C-Fxd, 0.1 μ F, 0150-0093
 A1R512, R-Fxd, 3 K, 0683-3025
 A1R556, R-Fxd, 100 Ω , 0757-0401

$\Delta 2$ 8-8. Serial No. 1125A00170 and Lower.
 Serial No. 1604U00260 and Lower.

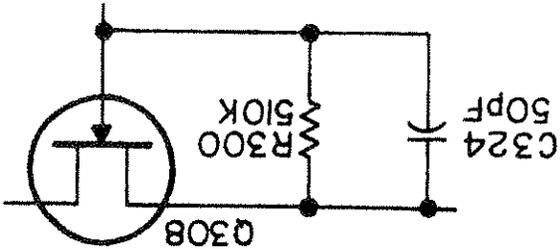
8-9. Make the following changes in Table 6-3, Replaceable Parts:

Delete: A3CR100, Diode, 1901-0758
 Lock, 03551-65001

Add: A3C101, C-Fxd, 60 μ F, 0180-0106
 A3R101, R-Fxd, 100 K, 0683-1045

Change: A3C230, C-Fxd, 47 μ F, 0180-0376
 A3C231, C-Fxd, 22 μ F, 0180-1745
 A3T101, Transformer, Receive, 9100-3485

Make the following change in Schematic No. 3, Figure 7-18:



$\Delta 3$ 8-10. Serial No. 1125A00200 and Lower.
 Serial No. 1512U00220 and Lower.

8-11. Make the following changes in Table 6-3, Replaceable Parts:

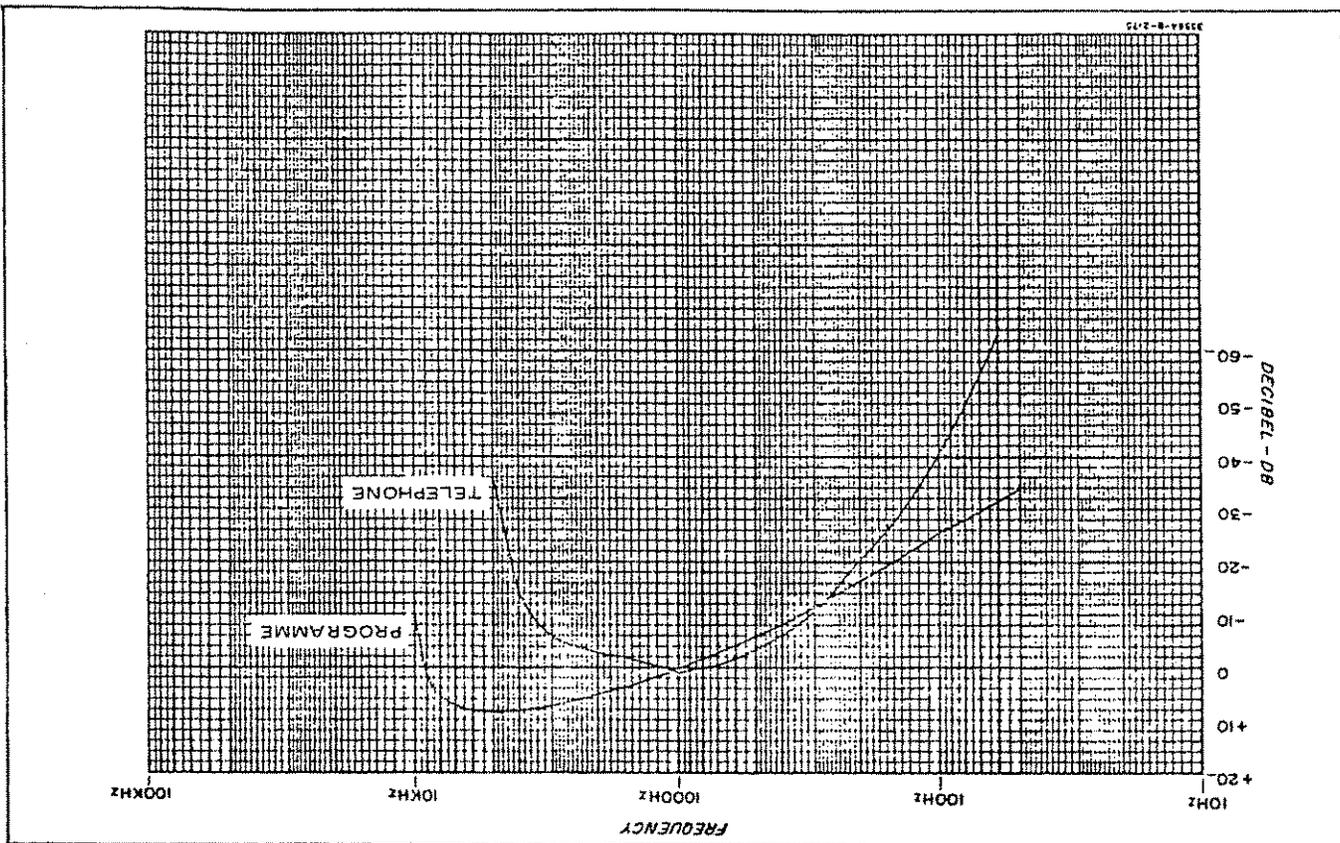
Change: A3S5, Switch, Rotary, 3100-2751
 Panel, Front, 03551-00211

8-12. For instruments with Serial No. 1125A00200 and lower and 1512U00220 and lower, use the diagram shown in Figure 8-8, Schematic No. 5, for the Input and Audio Amp. Measuring Circuits. Make the following changes in Table 6-3, Replaceable Parts:

Delete: A1C528, S29, 702, 703
 A1CR512, 605, 606

A1R573 through 582, 604, 605
 Add: A1U503, IC-Op Amp, 1820-0233

Figure 8-2. Programme Noise Weighting Curve, S/N
1125A00200 and Lower and 1152U00220 and Lower.



*Increases at \geq a two-pole Butterworth Roll off to 60 dB below reference.

FREQUENCY	Programme (CCITT)
Hz	dB REF to 1000 Hz
10,000	- 34.3 \pm 1.5 dB
9000	- 32.2 \pm 1.5 dB
8000	- 26.1 \pm 1.5 dB
7000	- 17.3 \pm 1.5 dB
6000	- 8.8 \pm 1.5 dB
5000	0 REF
4000	+ 5.3 \pm 1.5 dB
3000	+ 8.2 \pm 1.5 dB
2000	+ 8.4 \pm 1.5 dB
1000	+ 8.2 \pm 1.5 dB
800	+ 7.3 \pm 1.5 dB
600	+ 5.1 \pm 1.5 dB
400	+ 0.3 \pm 3.0 dB
200	- 9.7 \pm 3.0 dB

and Lower.

Table 8-1 Programme Noise Weighting Filter Specifications for Serial No. 1125A00200 and Lower and 1152U00220

Procedure are given in Section V.

8-13. The Programme noise weighting filter in instruments with Serial No. 1125A00200 and lower and 1152U00220 and lower conforms to the specifications shown in Table 8-1 and the curve shown in Figure 8-2. Use Schematic No. 4, Figure 8-6, and the Replaceable Parts List shown on Pages 8-9 through 8-11. The Performance Test and Adjustment

8-15. Make the following changes in Table 6-3, Page 6-13 and 6-14.
Change: AS, Power Supply Assembly to 03551-66505
ASR804 to 0813-0040 R: fxd 20.5 Ω 5 W
ASR805 to 0812-0070 R: fxd 10 Ω 1/2 W
ASR806 to 0811-3114 R: fxd 75 Ω 5 W
ASR807 to 0811-1854 R: fxd 50 Ω 1/2 W
Delete: AS5CR822 thru CR825; A3Q811, Q812; A3R827, 828

8-16. Make the following changes in Figure 7-23, Page 7-53/7-54. Replace schematic diagram No. 8 with the schematic diagram in Figure 8-9.

8-14. Serial No. 1604A00260 and Lower.
Serial No. 1635U00440 and Lower.

REFERENCE DESIGNATOR	Part No. -hp	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A3C101	0180-0106	2	CAPACITOR-FKD: 50UF +/-20% 50VDC AL	56269	1500606X000682
A3C102	0121-0045	1	CAPACITOR-FKD: 56PF +/-5% 300VDC MICA	73899	D11P350
A3C103	0160-0191	1	CAPACITOR-FKD: 56PF +/-5% 300VDC MICA	72136	D11S560J0300V1CR
A3C104	0160-2206	1	CAPACITOR-FKD: 160PF +/-5% 300VDC MICA	28480	0160-2206
A3C105	0180-0543	2	CAPACITOR-FKD: 75UF+100-20% 300VDC AL	90201	5P0 3Z-84Z8
A3C106	0150-0050	4	CAPACITOR-FKD: 1000PF +/-80-20% 100VDC	28480	0150-0050
A3C107	0150-0050	4	CAPACITOR-FKD: 1000PF +/-80-20% 100VDC	28480	0150-0050
A3C108			NORMALLY NOT LOADED		
A3C109	0150-0050	2	CAPACITOR-FKD: 1000PF +/-80-20% 100VDC	28480	0150-0050
A3C110	0180-0543	2	CAPACITOR-FKD: 75UF+100-20% 300VDC AL	90201	5P0 3Z-84Z8
A3C112	0150-0050	4	CAPACITOR-FKD: 1000PF +/-80-20% 100VDC	28480	0150-0050
A3C200	0150-0093	1	CAPACITOR-FKD: 01UF +/-80-20% 100VDC CER	28480	0150-0093
A3C201	0150-0093	1	CAPACITOR-FKD: 01UF +/-80-20% 100VDC CER	28480	0150-0093
A3C202	0150-0093	1	CAPACITOR-FKD: 01UF +/-80-20% 100VDC CER	28480	0150-0093
A3C203	0160-0156	1	CAPACITOR-FKD: 3900PF +/-10% 200VDC POLY	56269	292P39292
A3C204	0160-0938	3	CAPACITOR-FKD: 1000PF +/-5% 100VDC MICA	53021	D15C1E102J
A3C205	0160-0128	3	CAPACITOR-FKD: 2.2UF +/-20% 250VDC CER	28480	0160-0128
A3C206	0160-0938	1	CAPACITOR-FKD: 1000PF +/-5% 100VDC MICA	53021	D15C1E102J
A3C207	0160-4233	1	CAPACITOR-FKD: 47UF +/-5% 50VDC MET	28480	0160-4233
A3C208	0160-4232	1	CAPACITOR-FKD: 47UF +/-5% 50VDC MET	28480	0160-4232
A3C209	0160-4231	1	CAPACITOR-FKD: 4700PF +/-5% 50VDC MET	28480	0160-4231
A3C210	0160-2856	1	CAPACITOR-FKD: 33UF +/-10% 50WVDC MET	84411	X663F33452W2
A3C211	0121-0063	1	CAPACITOR-VAR 2-BPF	73899	DV11A8A
A3	03552-66503	1	PC ASSY, INPUT AMPLIFIER	28480	03552-66503

Table 6-3. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	PART NO. -hp	TO	DESCRIPTION	MFR.	MFR. PART NO.
A3R214	0757-0273	4	RESISTOR 3.01K Ω ±.125% F TUBULAR	24546	C4-1/B-10-3011-F
A3R215	0698-1880	1	RESISTOR 4.02K Ω ±.125% F TUBULAR	30983	M4C1/B-19-2872-F
A3R216	0698-3558	1	RESISTOR 4.70K Ω ±.125% F TUBULAR	30983	M4C1/B-19-2872-F
A3R217*	0757-0273	4	RESISTOR 3.01K Ω ±.125% F TUBULAR	24546	C4-1/B-10-3011-F
A3R218	0698-4470	1	RESISTOR 6.96K Ω ±.125% F TUBULAR	24546	C4-1/B-10-6982-F
A3R219	0757-0463	1	RESISTOR 28.7K Ω ±.125% F TUBULAR	30983	M4C1/B-19-2872-F
A3R220	0698-4996	1	RESISTOR 2.15K Ω ±.125% F TUBULAR	16299	C4-1/B-10-2151-F
A3R221	0698-4496	1	RESISTOR 2.99K Ω ±.125% F TUBULAR	16299	C4-1/B-10-2991-F
A3R222	2100-3211	1	RESISTOR-VAR 10K Ω ±.125% F TUBULAR	32997	3389M
A3R223	0698-4496	1	RESISTOR 3.16K Ω ±.125% F TUBULAR	24546	C4-1/B-10-3161-F
A3R224	0698-4496	1	RESISTOR 4.53K Ω ±.125% F TUBULAR	24546	C4-1/B-10-4532-F
A3R225	0698-4496	1	RESISTOR 6.87K Ω ±.125% F TUBULAR	24546	C4-1/B-10-6874-F
A3R226	0698-4496	1	RESISTOR 8.07K Ω ±.125% F TUBULAR	24546	C4-1/B-10-8074-F
A3R227	0698-4496	1	RESISTOR 10.0K Ω ±.125% F TUBULAR	24546	C4-1/B-10-1001-F
A3R228	0698-4496	1	RESISTOR 15.0K Ω ±.125% F TUBULAR	24546	C4-1/B-10-1501-F
A3R229	0698-4496	1	RESISTOR 20.0K Ω ±.125% F TUBULAR	24546	C4-1/B-10-2001-F
A3R230	0698-4496	1	RESISTOR 25.0K Ω ±.125% F TUBULAR	24546	C4-1/B-10-2501-F
A3R231	0698-4496	1	RESISTOR 30.0K Ω ±.125% F TUBULAR	24546	C4-1/B-10-3001-F
A3R232	0698-4496	1	RESISTOR 35.0K Ω ±.125% F TUBULAR	24546	C4-1/B-10-3501-F
A3R233	0698-4496	1	RESISTOR 40.0K Ω ±.125% F TUBULAR	24546	C4-1/B-10-4001-F
A3R234	0698-4496	1	RESISTOR 45.0K Ω ±.125% F TUBULAR	24546	C4-1/B-10-4501-F
A3R235	0698-4496	1	RESISTOR 50.0K Ω ±.125% F TUBULAR	24546	C4-1/B-10-5001-F
A3R236	2100-3352	2	RESISTOR-VAR 10K Ω ±.125% F TUBULAR	30983	M4C1/B-19-2872-F
A3R237	0698-7880	2	RESISTOR-VAR 10K Ω ±.125% F TUBULAR	30983	M4C1/B-19-2872-F
A3R238	0698-7360	1	RESISTOR 99K Ω ±.125% F TUBULAR	30983	M4C1/B-19-9902-F
A3R239	0698-4539	1	RESISTOR 398.5K Ω ±.125% F TUBULAR	30983	M4C1/B-19-3985-F
A3R240	0698-4539	1	RESISTOR 398.5K Ω ±.125% F TUBULAR	30983	M4C1/B-19-3985-F
A3R241	0698-4487	1	RESISTOR 402K Ω ±.125% F TUBULAR	19701	M4C1/B-19-4023-F
A3R242	0757-0273	1	RESISTOR 3.01K Ω ±.125% F TUBULAR	24546	C4-1/B-10-3011-F
A3R243	0757-0273	1	RESISTOR 3.01K Ω ±.125% F TUBULAR	24546	C4-1/B-10-3011-F
A3R244	0757-0273	1	RESISTOR 3.01K Ω ±.125% F TUBULAR	24546	C4-1/B-10-3011-F
A3R245	0757-0447	2	RESISTOR 16.2K Ω ±.125% F TUBULAR	24546	C4-1/B-10-1622-F
A3R246	2100-1656	1	RESISTOR-VAR 500 Ω ±.125% F TUBULAR	32997	3057M-1-501
A3R247	0757-0447	1	RESISTOR 7.5K Ω ±.125% F TUBULAR	24546	C4-1/B-10-7501-F
A3R248	0698-1055	1	RESISTOR 1M Ω ±.25% CC TUBULAR	01121	CB1055
A3R249	0698-1055	1	RESISTOR 1M Ω ±.25% CC TUBULAR	01121	CB1055
A3R250	0698-1055	1	RESISTOR 1M Ω ±.25% CC TUBULAR	01121	CB1055
A3R251	0698-4496	1	RESISTOR 1M Ω ±.25% CC TUBULAR	01121	CB1055
A3R252	0698-4496	1	RESISTOR 1M Ω ±.25% CC TUBULAR	01121	CB1055
A3R253	0698-4496	1	RESISTOR 1M Ω ±.25% CC TUBULAR	01121	CB1055
A3R254	0698-4496	1	RESISTOR 1M Ω ±.25% CC TUBULAR	01121	CB1055
A3R255	0698-4496	1	RESISTOR 1M Ω ±.25% CC TUBULAR	01121	CB1055
A3R256	0698-4496	1	RESISTOR 1M Ω ±.25% CC TUBULAR	01121	CB1055
A3R257	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R258	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R259	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R260	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R261	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R262	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R263	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R264	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R265	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R266	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R267	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R268	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R269	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R270	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R271	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R272	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R273	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R274	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R275	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R276	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R277	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R278	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R279	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R280	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R281	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R282	0757-0438	3	RESISTOR 592 Ω ±.125% F TUBULAR	24546	C4-1/B-10-5111-F
A3R283	2100-3274	2	RESISTOR-VAR 10K Ω ±.125% F TUBULAR	32997	3389M
A3R284	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F
A3R285	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F
A3R286	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F
A3R287	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F
A3R288	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F
A3R289	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F
A3R290	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F
A3R291	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F
A3R292	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F
A3R293	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F
A3R294	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F
A3R295	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F
A3R296	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F
A3R297	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F
A3R298	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F
A3R299	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F
A3R300	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F
A3R301	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F
A3R302	0698-4496	1	RESISTOR 1.87K Ω ±.125% F TUBULAR	16299	C4-1/B-10-1871-F

Table 6-3. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	PART NO. -hp-	TO	DESCRIPTION	MFR.	MFR. PART NO.
A3R303	0757-0473		RESISTOR 221K 1% .125W F TUBULAR	24546	C4-1/8-T0-2213-F
A3R304	0698-4482		RESISTOR 17.4K 1% .125W F TUBULAR	03888	PM555-1/8-T0-1742-F
A3R305	0698-4481		RESISTOR 17.4K 1% .125W F TUBULAR	24546	C4-1/8-T0-1652-F
A3R306	2100-0567		RESISTOR-VAR TRMR 2KOHM 10% C TOP	73138	72PR2K
A3R308	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R310	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R311	0698-4510		RESISTOR 84.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-8452-F
A3R312	0757-0473		RESISTOR 221K 1% .125W F TUBULAR	24546	C4-1/8-T0-2213-F
A3R314	0698-4483		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R315	2100-0567		RESISTOR-VAR TRMR 2KOHM 10% C TOP	73138	72PR2K
A3R316	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R318	0698-4510		RESISTOR 84.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-8452-F
A3R319	0698-4483		RESISTOR 18.7K 1% .125W F TUBULAR	24546	C4-1/8-T0-1872-F
A3R320	0698-4482		RESISTOR 17.4K 1% .125W F TUBULAR	03888	PM555-1/8-T0-1742-F
A3R321	2100-0567		RESISTOR-VAR TRMR 20KOHM 10% C TOP	73138	72PR2K
A3R322	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R325	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R326	0698-3243		RESISTOR 178K 1% .125W F TUBULAR	16299	C4-1/8-T0-1783-F
A3R327	0698-4510		RESISTOR 84.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-8452-F
A3R328	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R329	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R331	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R333	0698-4507		RESISTOR 76.8K 1% .125W F TUBULAR	24546	C4-1/8-T0-7682-F
A3R334	0698-3245		RESISTOR 20.5K 1% .125W F TUBULAR	16299	C4-1/8-T0-2052-F
A3R335	0698-3157		RESISTOR 19.6K 1% .125W F TUBULAR	16299	C4-1/8-T0-1962-F
A3R336	2100-0567		RESISTOR-VAR TRMR 2KOHM 10% C TOP	73138	72PR2K
A3R338	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R340	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R341	0698-4529		RESISTOR 226K 1% .125W F TUBULAR	24546	C4-1/8-T0-2263-F
A3R342	0698-4507		RESISTOR 76.8K 1% .125W F TUBULAR	24546	C4-1/8-T0-7682-F
A3R343	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R344	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R346	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R348	0698-4524		RESISTOR 174K 1% .125W F TUBULAR	24546	C4-1/8-T0-1743-F
A3R349	0757-0199		RESISTOR 21.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-2152-F
A3R350	0757-0567		RESISTOR-VAR TRMR 2KOHM 10% C TOP	73138	72PR2K
A3R351	0757-0349		RESISTOR 22.6K 1% .125W F TUBULAR	24546	C4-1/8-T0-2262-F
A3R353	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R355	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R356	0698-4524		RESISTOR 174K 1% .125W F TUBULAR	24546	C4-1/8-T0-1743-F
A3R357	0698-4524		RESISTOR 174K 1% .125W F TUBULAR	24546	C4-1/8-T0-1743-F
A3R358	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R359	0757-0465		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R360	0757-0465		RESISTOR 100K 1% .125W F TUBULAR	24546	C4-1/8-T0-1003-F
A3R361	0698-323	2	RESISTOR 100 OHM .1% .125W F TUBULAR	19701	MF4C1/B-19-100R-B
A3R362	0698-6448	2	RESISTOR 216.2 OHM .1% .125W F TUBULAR	03888	PM555-1-9
A3R363	0698-6447	2	RESISTOR 603.8 OHM .1% .125W F TUBULAR	03888	PM555-1-9
A3R365	0698-7330	1	RESISTOR 96.0K .1% .125W F TUBULAR	30983	MF4C1/B-12-96041-B
A3R366	0698-7376	1	RESISTOR 31.62 OHM .1% .125W F TUBULAR	30983	MF4C1/B-19-3162-B
A3R368	0698-6448	1	RESISTOR 68.38 OHM .1% .125W F TUBULAR	03888	PM555-1-9
A3R369	0698-6447	1	RESISTOR 216.2 OHM .1% .125W F TUBULAR	03888	PM555-1-9
A3R370	0698-3511	1	RESISTOR 665 OHM .1% .125W F TUBULAR	16299	C4-1/8-T0-665R-F
A3R371	0698-5145		RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R372	0698-5145		RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R373	0698-3275	2	RESISTOR 2.5K 1% .125W F TUBULAR	19701	MF4C1/B-19-2501-F
A3R374	0698-5145		RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R375	0757-0472		RESISTOR 200K 1% .125W F TUBULAR	24546	C4-1/8-T0-2003-F
A3R376	0698-3275		RESISTOR 2.5K 1% .125W F TUBULAR	19701	MF4C1/B-19-2501-F
A3R377	2100-3212	2	RESISTOR-VAR TRMR 200 OHM 10% C SIDE ADJ	32997	32997
A3R379	0698-1045		RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A3R380	0757-1094	1	RESISTOR 1.497K 1% .125W F TUBULAR	24546	C4-1/8-T0-1471-F
A3R381	0698-5145		RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R382	0698-1045		RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A3R383	0698-3945	1	RESISTOR 290K 5% .25W CC TUBULAR	01121	CB3945
A3R384	0698-1095	1	RESISTOR 1M 5% .25W CC TUBULAR	01121	CB1095
A3R385	0698-6302	1	RESISTOR 1K .1% .125W F TUBULAR	19701	MF4C1/B-19-1001-B
A3R386	0698-6446		RESISTOR 2.162K .1% .125W F TUBULAR	03888	PM555-1-9
A3R387	0757-0438		RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A3R388	0757-0446		RESISTOR 15K 1% .125W F TUBULAR	24546	C4-1/8-T0-1502-F
A3R389	0698-4123		RESISTOR 499 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-499R-F
A3R390	0698-4735		RESISTOR 47K 5% .25W CC TUBULAR	01121	CR4735

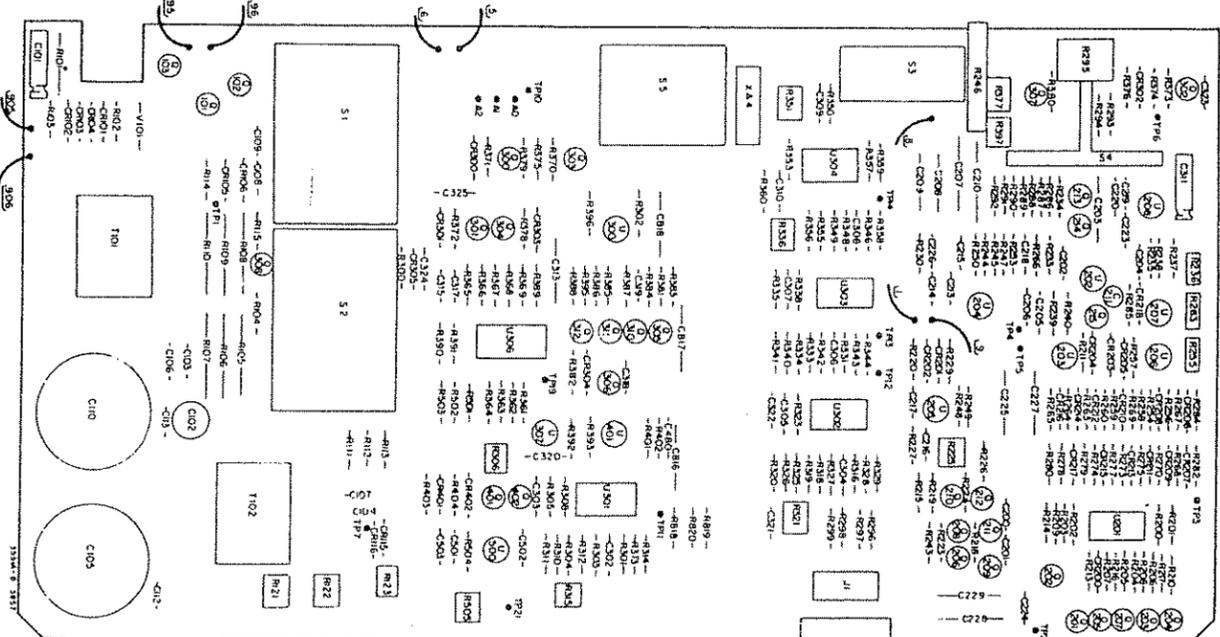
Table 6-3. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	PART NO. -hp-	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A4C28, C427	0160-3024	1	CAPACITOR-FXD 1700PF 1% 100WVDC	28480	0160-3024
A4C28	0160-2199	1	CAPACITOR-FXD 30PF 5% 300WVDC	28480	0160-2199
A4C29	0160-2414	1	CAPACITOR-FXD .022UF 5% 200WVDC	56289	292F2352
A4C31	0160-2199	1	CAPACITOR-FXD 30PF 5% 300WVDC	28480	0160-2199
A4C32, C433	0180-0228	1	CAPACITOR-FXD 22UF 10% 15VDC	56289	150D226X901582
A4C34	0140-0184	1	CAPACITOR-FXD 8200PF 1% 100WVDC	72136	DM20F822F0100WV1CR
A4C35	0180-0197	1	CAPACITOR-FXD 2.2UF 10% 20VDC	56289	150D225X9020A2
A4C36	0160-0128	1	CAPACITOR-FXD 2.2UF 20% 25WVDC	28480	0160-0128
A4C37	0150-0093	1	CAPACITOR-FXD .01UF +80-20% 100WVDC	28480	0150-0093
A4CR401	1902-3085	1	DIO-BKDN 4.75V	05713	SZ10939-89
A4CR402-407	1901-0025	1	DIO-SI 100V 200MA	28480	1901-0025
A4L401	9100-3211	1	INDUCTOR 255MH	28480	9100-3211
A4Q401, 402	1854-0071	1	XSTR-SI NPN	28480	1854-0071
A4Q403	1853-0086	1	XSTR-SI PNP	28480	1853-0086
A4Q404	1854-0071	1	XSTR-SI NPN	28480	1854-0071
A4Q405	1853-0086	1	XSTR-SI PNP	28480	1853-0086
A4Q406	1854-0071	1	XSTR-SI NPN	28480	1854-0071
A4Q407	1853-0086	1	XSTR-SI PNP	28480	1853-0086
A4Q408	1854-0071	1	XSTR-SI NPN	28480	1854-0071
A4Q409	1853-0086	1	XSTR-SI PNP	28480	1853-0086
A4Q410	1854-0071	1	XSTR-SI NPN	28480	1854-0071
A4Q411-413	1854-0071	1	XSTR-SI NPN	28480	1854-0071
A4Q414	1853-0086	1	XSTR-SI PNP	28480	1853-0086
A4Q415-417	1854-0071	1	XSTR-SI NPN	28480	1854-0071
A4Q418	1853-0086	1	XSTR-SI PNP	28480	1853-0086
A4Q419, 421	1854-0071	1	XSTR-SI NPN	28480	1854-0071
A4Q422	1854-0071	1	XSTR-SI NPN	28480	1854-0071
A4Q423	1853-0086	1	XSTR-SI PNP	28480	1853-0086
A4Q424-426	1854-0071	1	XSTR-SI NPN	28480	1854-0071
A4Q427	1853-0086	1	XSTR-SI PNP	28480	1853-0086
A4Q428, Q29	1854-0071	1	XSTR-SI NPN	28480	1854-0071
A4Q431	1854-0071	1	XSTR-SI NPN	28480	1854-0071
A4Q432	1853-0086	1	XSTR-SI PNP	28480	1853-0086
A4Q433, Q434	1854-0071	1	XSTR-SI NPN	28480	1854-0071
A4R401	0698-4498	1	R-FXD 53.6K 1% .125W F TUBULAR	24546	C4-1/8-T0-5362-F
A4R402	2100-3354	4	R-VAR 50K 10% F TUBULAR	73138	72XR104
A4R403	0698-4497	1	R-FXD 48.7K 1% .125W F TUBULAR	24546	C4-1/8-T0-4872-F
A4R404	0757-0460	1	R-FXD 61.9K 1% .125W F TUBULAR	24546	C4-1/8-T0-6192-F
A4R405	0698-4514	1	R-FXD 105K 1% .125W F TUBULAR	24546	C4-1/8-T0-1053-F
A4R406	0757-0442	4	R-FXD 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A4R407	0757-0452	2	R-FXD 27.4K 1% .125W F TUBULAR	24546	C4-1/8-T0-2742-F
A4R408	0757-0123	2	R-FXD 34.8K 1% .125W F TUBULAR	24546	C5-1/8-T0-3482-F
A4R409	1810-0027	7	R-NETWORK	28480	1810-0027
A4R410	2100-3354	2	R-VAR 50K 10% F TUBULAR	73138	72XR104
A4R411	0757-0449	2	R-FXD 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A4R412, 413	0698-4207	2	R-VAR 44.2K 1% .125W F TUBULAR	16299	C4-1/8-T0-4422-F
A4R414	0757-0161	1	R-FXD 604 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-604R-F
A4R415	0757-0349	1	R-FXD 22.6K 1% .125W F TUBULAR	24546	C4-1/8-T0-2262-F
A4R416	0757-0449	1	R-FXD 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A4R417, 418	0757-0442	1	R-FXD 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A4R419	0684-4751	1	R-FM 10% 1/4W	0121	CB4751
A4R421	0698-4483	1	R-FXD 18.7K 1% .125W F TUBULAR	24546	C4-1/8-T0-1872-F
A4R422	0684-6821	1	R-FXD 6800 OHM 10% 1/4W CC TUBULAR	01121	CB6821
A4R423	0698-3228	1	R-FXD 49.9K 1% .125W F TUBULAR	07716	CEA1/8-T04991-F
A4R424	0757-0470	1	R-FXD 162K 1% .125W F TUBULAR	24546	C4-1/8-T0-1623-F
A4R425	0757-0645	2	R-FXD 100K 1% .125W F TUBULAR	24546	C4-1/8-T0-1003-F
A4R426	0757-0442	2	R-FXD 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A4R427	0698-8191	1	R-FXD 12.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-1212-F
A4R428	0757-0427	1	R-FXD 1500 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-1501-F
A4R429	0757-0283	1	R-FXD 2K 1% .125W F TUBULAR	24546	C4-1/8-T0-1502-F
A4R430	2100-3354	1	R-VAR 50K 10%	73138	72XR104
A4R431, 433	0698-7673	2	R-FXD 49.9K 1% .125W F TUBULAR	30983	MFA4C1/8-T2-4991-B
A4R432	0698-8191	1	R-FXD 12.5K 1% .125W F TUBULAR	30983	MFA4C1/8-T2-1212-F
A4R433	0698-3519	1	R-FXD 12.4K 1% .125W F TUBULAR	16299	C4-1/8-T0-1242-F
A4R434	1810-0027	1	R-NETWORK	28480	1810-0027
A4R435	0698-7674	5	R-FXD 20K 1% .125W F TUBULAR	30983	MFA4C1/8-T2-13191-B
A4R436	0698-6943	1	R-FXD 13.19K 1% .125W F TUBULAR	19701	MFA4C1/8-T2-2002-B
A4R437	0698-7675	1	R-FXD 24.06K 1% .125W F TUBULAR	30983	MFA4C1/8-T2-24061-B
A4R438	0698-7670	1	R-FXD 23.69K 1% .125W F TUBULAR	30983	MFA4C1/8-T2-23691-B
A4R439	0698-3519	1	R-FXD 12.4K 1% .125W F TUBULAR	16299	C4-1/8-T0-1242-F
A4R440	2100-3354	1	R-VAR 50K 10%	73138	72XR104
A4R441	1810-0027	1	R-NETWORK	28480	1810-0027
A4R442	0698-6943	5	R-FXD 20K 1% .125W F TUBULAR	19701	MFA4C1/8-T2-2002-B
A4R443	0698-7670	1	R-FXD 23.69K 1% .125W F TUBULAR	30983	MFA4C1/8-T2-23691-B
A4R444	0698-6943	1	R-FXD 12.4K 1% .125W F TUBULAR	24546	C4-1/8-T0-1302-F
A4R445	0698-6943	1	R-FXD 20K 1% .125W F TUBULAR	19701	MFA4C1/8-T2-2002-B

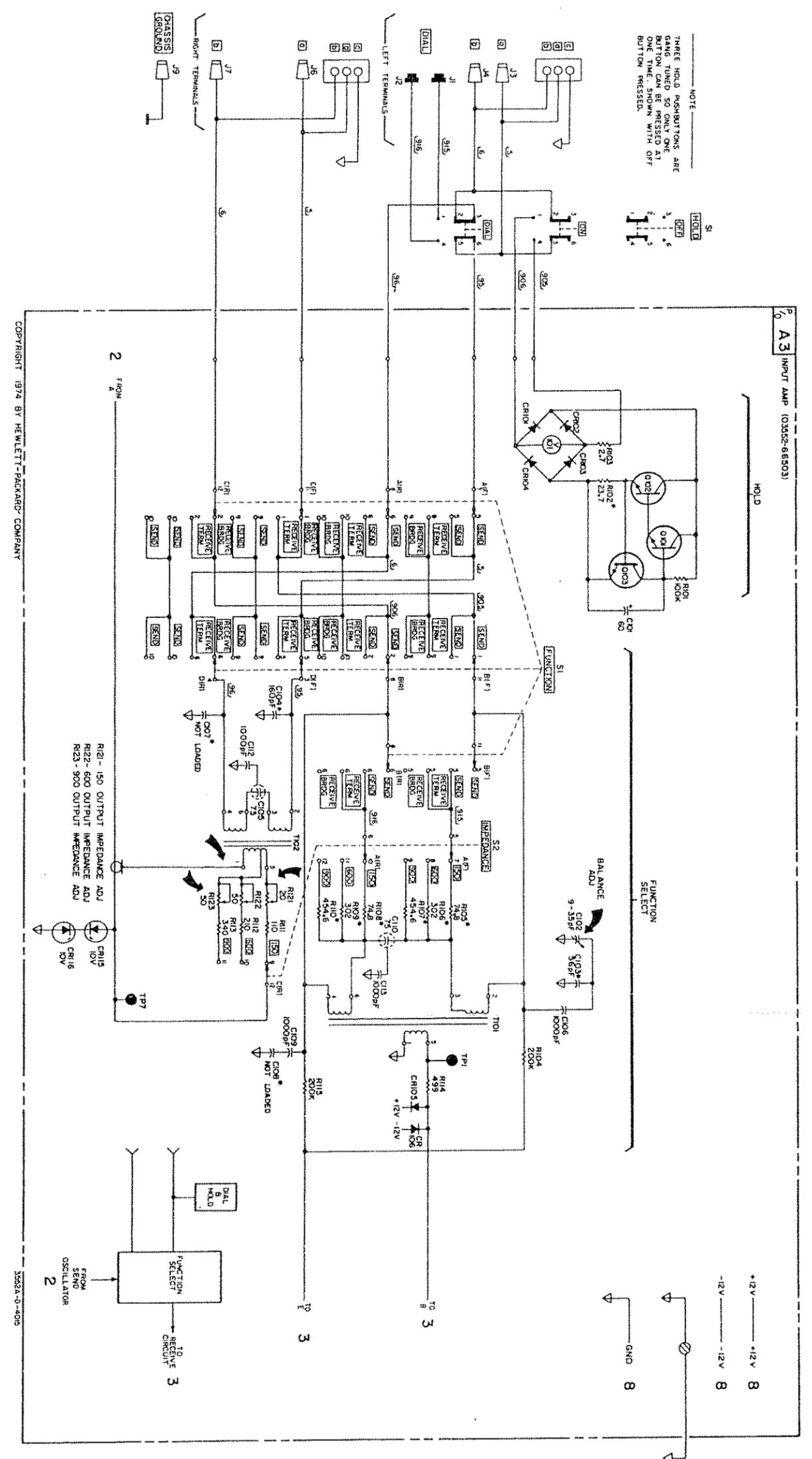
Table 6-3. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	PART NO. -hp-	TO	DESCRIPTION	MFR.	MFR. PART NO.
A4R445	0757-0465	2	R-FXD 100K 1% .125W F TUBULAR	24546	CA-1/8-T0-1003-F
A4R446	0698-7669	2	R-FXD 32.35K 1% .125W F TUBULAR	30983	MFAC1/8-T2-32351-B
A4R447	0757-0123	2	R-FXD 34.6K 1% .125W F TUBULAR	24546	CS-1/8-T0-3482-F
A4R448	0698-7668	2	R-FXD 39.91K 1% .125W F TUBULAR	30983	MFAC1/8-T2-39911-B
A4R449	1810-0027		R-NETWORK	28480	1810-0027
A4R451	0698-7668	1	R-FXD 39.91K 1% .125W F TUBULAR	30983	MFAC1/8-T2-39911-B
A4R452	0698-7682	1	R-FXD 52.98K 1% .125W F TUBULAR	30983	MFAC1/8-T2-52981-B
A4R453	0698-6943	1	R-FXD 20K 1% .125W F TUBULAR	30983	MFAC1/8-T2-2002-B
A4R454, 455	0698-7680	2	R-FXD 59.41K 1% .125W F TUBULAR	30983	MFAC1/8-T2-59411-B
A4R456	1810-0027		R-NETWORK	28480	1810-0027
A4R457	0698-7679	1	R-FXD 19.41K 1% .125W F TUBULAR	30983	MFAC1/8-T2-19411-B
A4R458	0698-6943	1	R-FXD 20K 1% .125W F TUBULAR	19701	MFAC1/8-T2-2002-B
A4R459	0698-7669	1	R-FXD 32.35K 1% .125W F TUBULAR	30983	MFAC1/8-T2-32351-B
A4R462	0757-0290	1	R-FXD 6190 OHM 1% .125W F TUBULAR	30983	MFAC1/8-T0-6191-F
A4R463	0757-0454	1	R-FXD 33.2K 1% .125W F TUBULAR	24546	CA-1/8-T0-3322-F
A4R464	1810-0027		R-NETWORK	28480	1810-0027
A4R465	0698-6943	1	R-FXD 20K 1% .125W F TUBULAR	19701	MFAC1/8-T2-2002-B
A4R466	0698-4307	1	R-FXD 14.3K 1% .125W F TUBULAR	19701	MFAC1/8-T2-1492-B
A4R467	0698-7681	1	R-FXD 15.33K 1% .125W F TUBULAR	30983	MFAC1/8-T2-15331-B
A4R468	0757-0434	1	R-FXD 3650 OHM 1% .125W F TUBULAR	24546	CA-1/8-T0-3651-F
A4R469	0698-4492	1	R-FXD 32.4K 1% .125W F TUBULAR	24546	CA-1/8-T0-3242-F
A4R471	0757-0459	1	R-FXD 56.2K 1% .125W F TUBULAR	24546	CA-1/8-T0-5622-F
A4R472	1810-0027		R-NETWORK	28480	1810-0027
A4R473	0698-4482	1	R-FXD 17.4K 1% .125W F TUBULAR	24546	CA-1/8-T0-1742-F
A4R474	0698-4489	1	R-FXD 28K 1% .125W F TUBULAR	24546	CA-1/8-T0-2802-F
A4R476	0683-4715	1	R-FXD 470 OHM 5% .25W CC TUBULAR	01121	CB4711
A4R477	0684-1011	1	R-FXD 100 OHM 10% .25W CC TUBULAR	01121	CB1011
A4R478	0684-1041	1	R-FXD 100K 10% .25W CC TUBULAR	01121	CB1041
A4S1	3100-2755	1	SWITCH-ROTARY	28480	3100-2755

Table 6-3. Replaceable Parts (Cont'd)

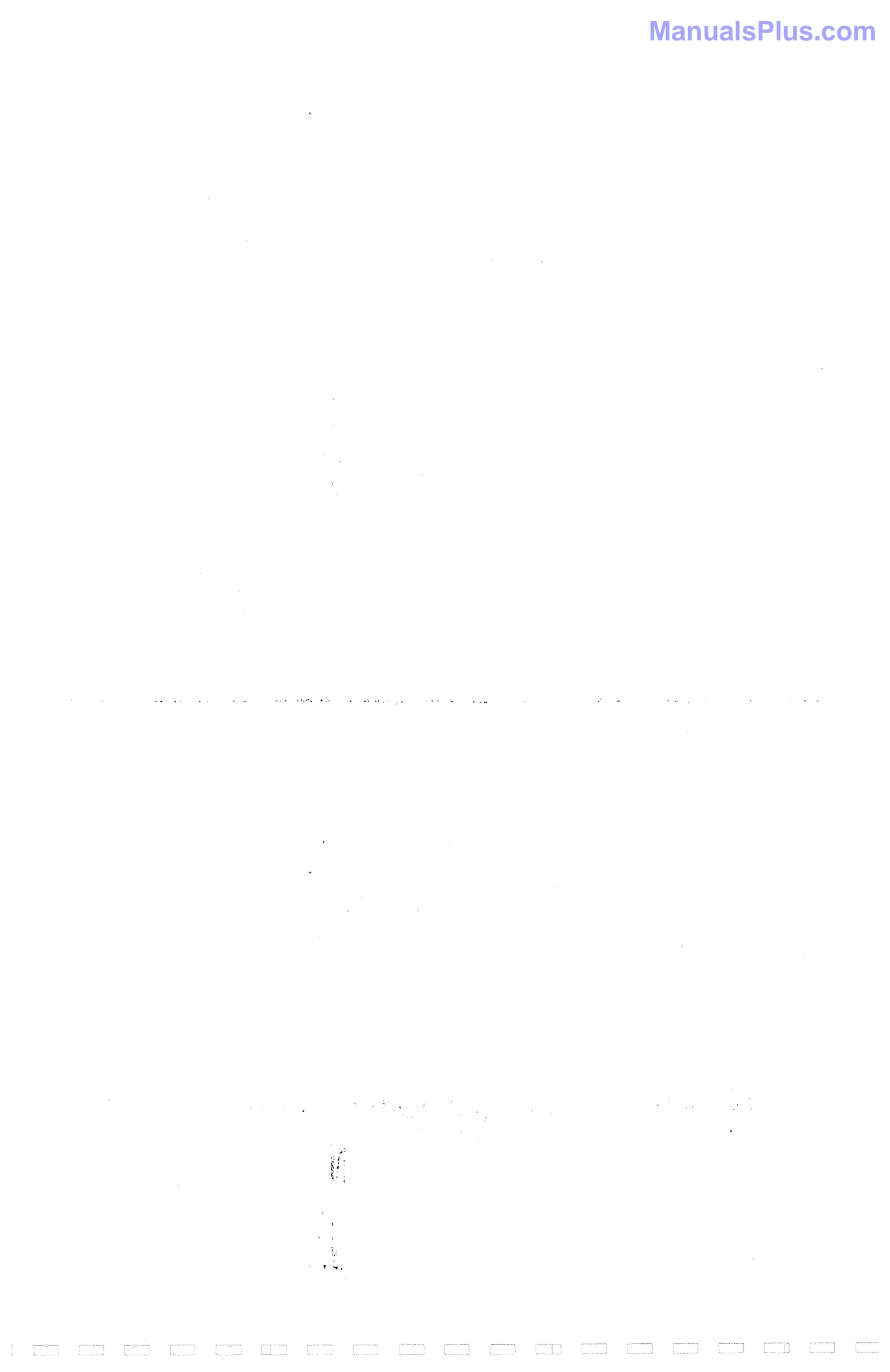


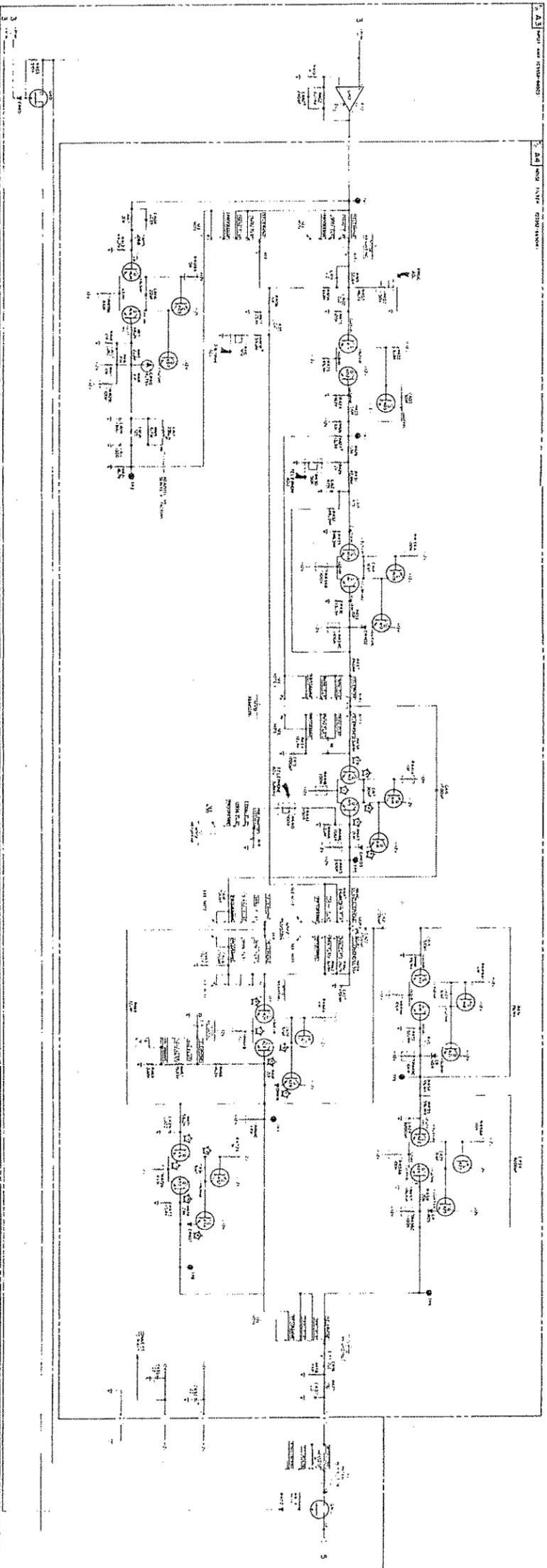
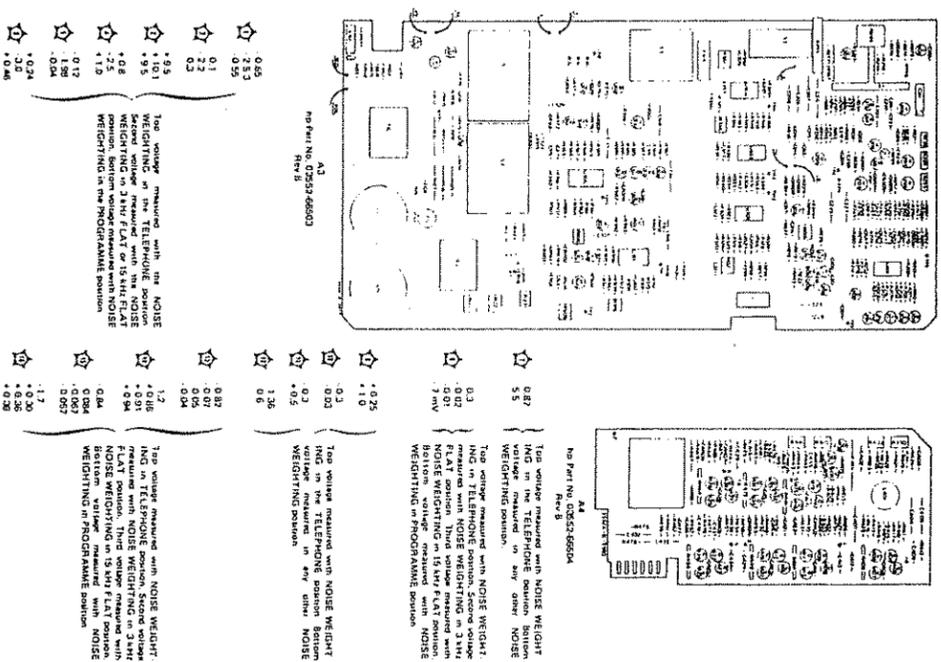
A3
hp Part No. 03552-66503
Rev B



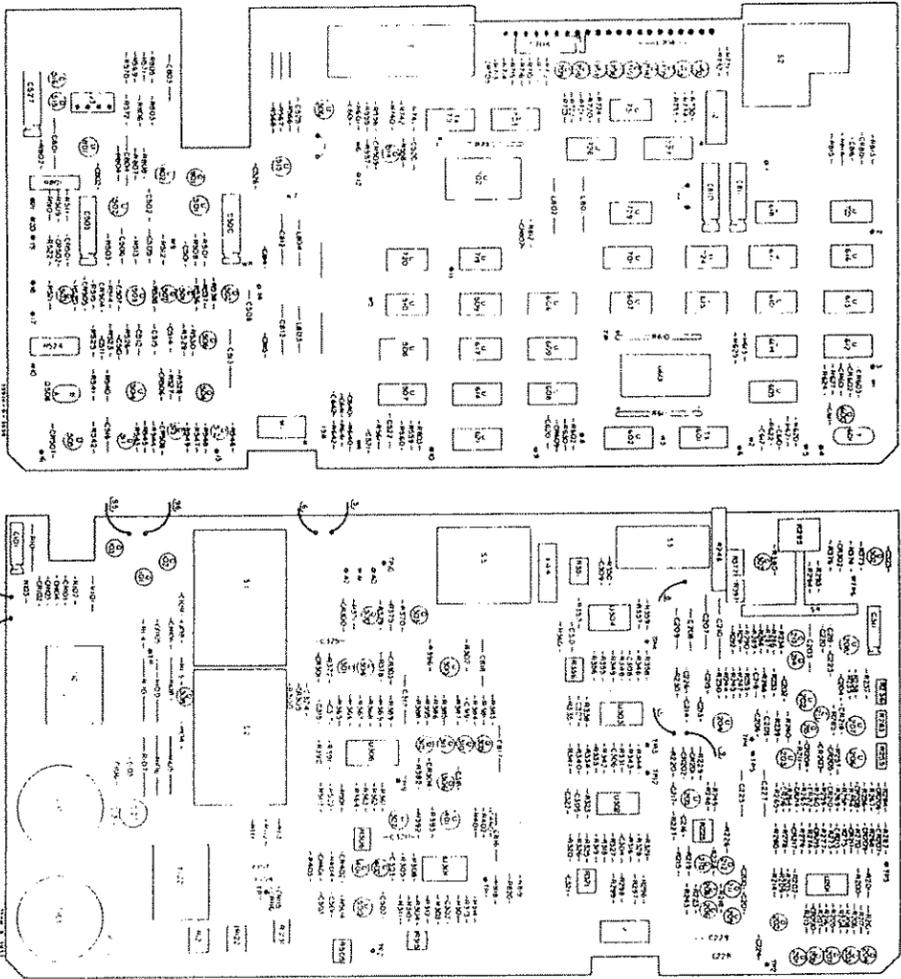
For Serial Numbers 1435A00140 and below
Figure 8-3. Dial and Hold, Function Select, A3.
8-13/8-14





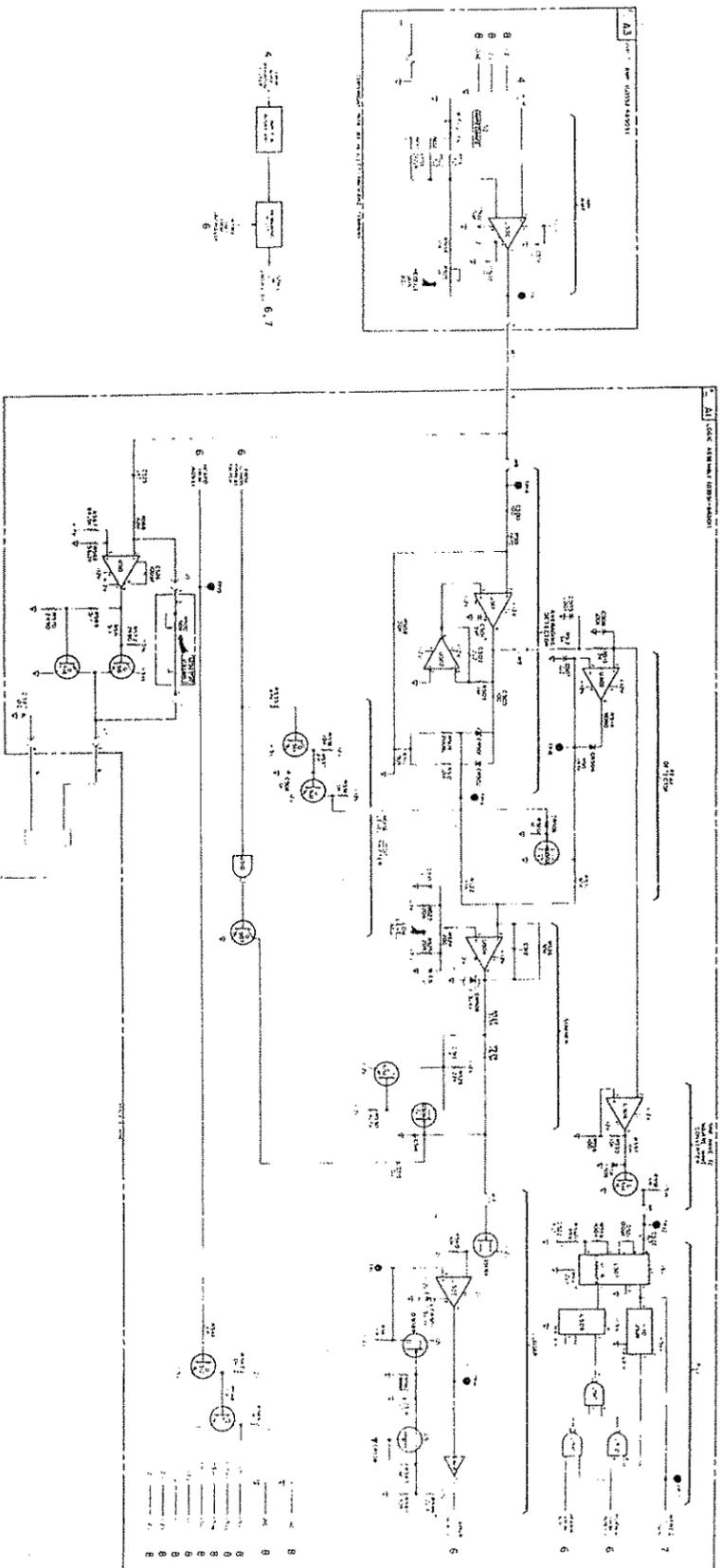


For Serial Numbers 1125A00200 and lower
and 1512U00220 and lower
Figure 8-6. Noise Weighting Filters, A3, A4.
8-19/8-20

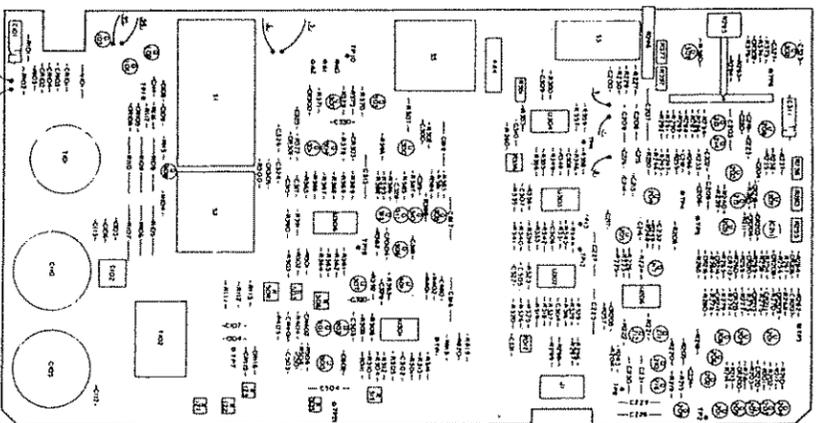
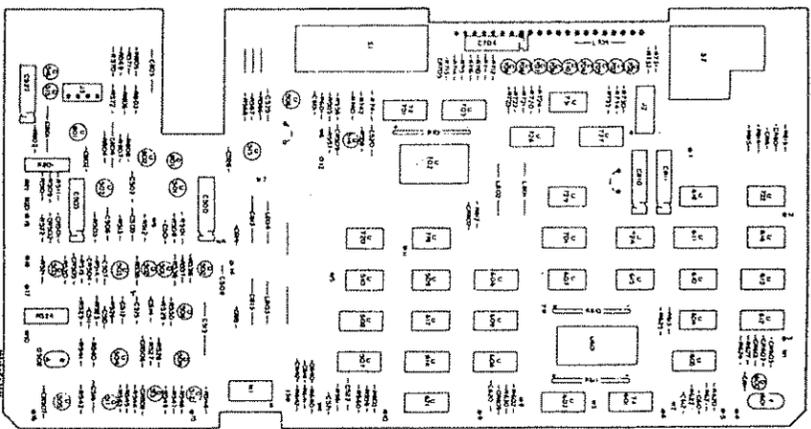


NOTE

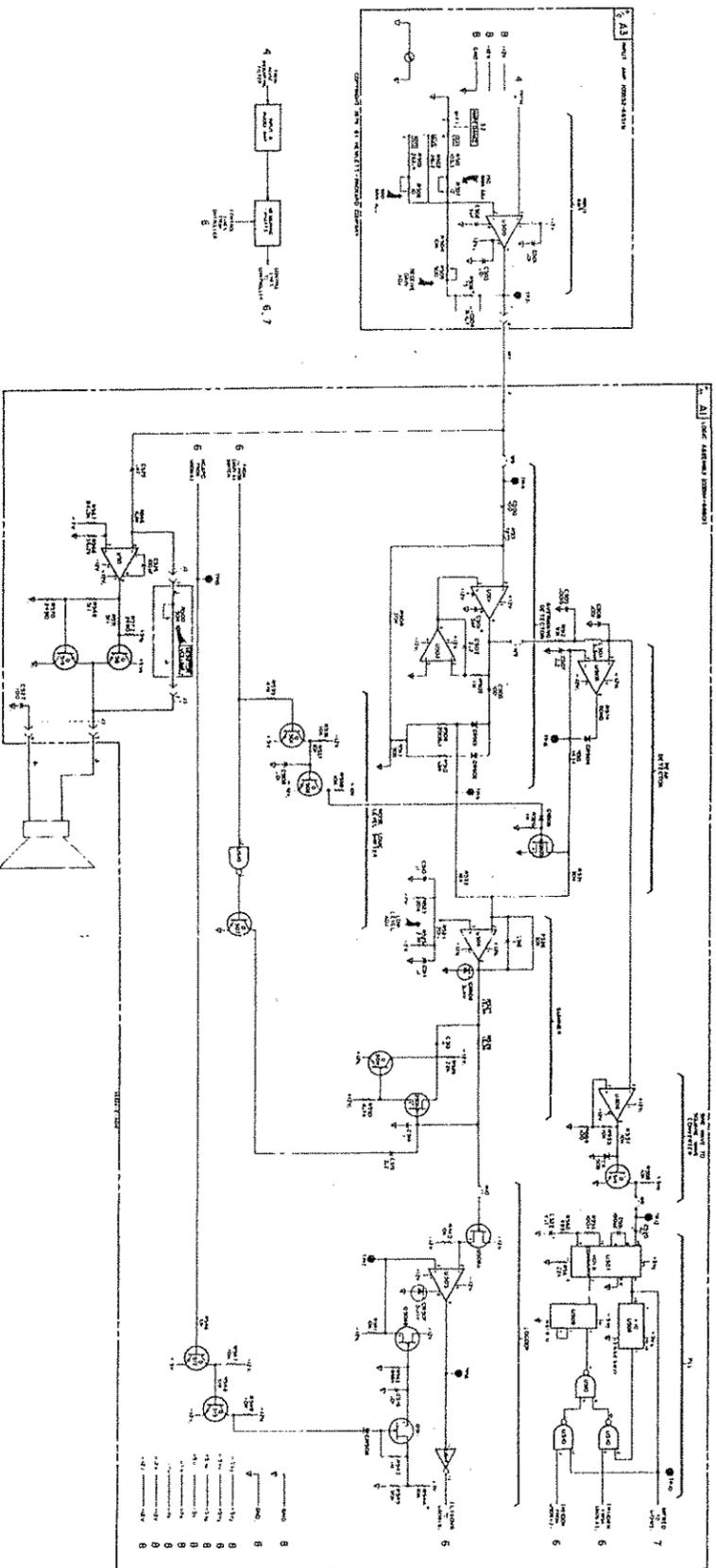
Because of the digital signals present in this circuitry, dc levels on the transistors are not meaningful. For troubleshooting, refer to the waveforms on the analog block diagram, Figure 7-11.



For Serial Numbers 1435A00140 and Below
 Figure 8-7. Input and Audio Amp, Measuring Circuits, A1, A3.
 8-21/8-22

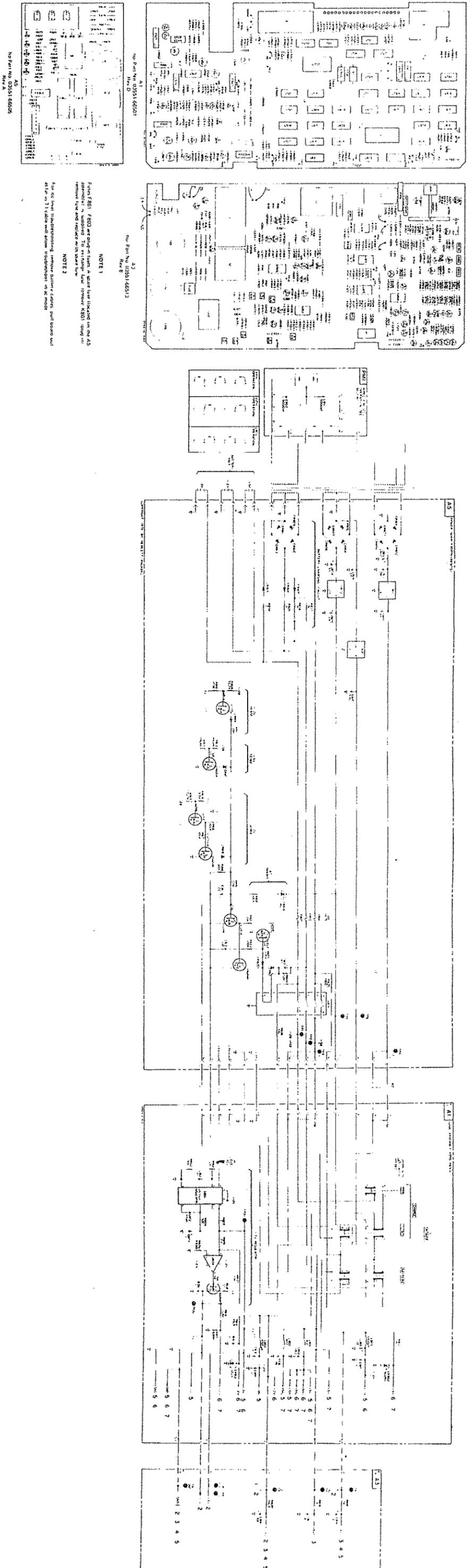


NOTE
Because of the digital signals present in this circuitry, dc levels on the transistors are not meaningful. For troubleshooting, refer to the waveforms on the analog block diagram, Figure 7-11.



For Serial Numbers 1125A00200 and lower
and 1152U00220 and lower
Figure 8-8. Input and Audio Amp. Measuring Circuits, A1, A3.
8-23/8-24







APPENDIX B

B-1. Radio Frequency Interference.

Some Test Sets may experience radio frequency interference, evidenced by music emanating from the instrument's speaker. This interference normally does not degrade any of the measurements. However, if RFI is a problem, a modification can be installed at the factory. Contact your nearest Sales and Service Office, listed in Appendix A. The following information applies to the RFI Filter modification.

No changes are necessary in the calibration procedures, however, it should be noted that with the case assembly removed from the instrument, low level inputs may give erroneous and/or noisy readings on the display.

IMPORTANT

The RFI modification creates the following

Add the following A6 Parts List to Table 6-3.

- A3R376 changed to 2.162 k Ω , 1%, 1.25W, 0698-6446
- A3R380 changed to 1.37 k Ω , 1%, 1.25W, 0698-4423
- A1C813 changed to 68 μ F, 15 V, 0180-1835
- A3C103* (starred value) is typically not loaded
- A3C108* (starred value) is typically a 470 pF

Make the following changes in Table 6-3.

operating peculiarity. If the SEND LEVEL RANGE is set for an output level greater than -10 dbm, OR if the SEND FREQUENCY is set greater than 6 kHz, the internal instrument cross talk may not allow the receiver to operate properly with an input level of less than -55 dbm.

REFERENCE DESIGNATOR	-hp- PART NO.	TO	DESCRIPTION	MFR.	MFR. PART NO.
A6	03551-66506	1	PC ASSY, RFI FLTR	28480	03551-66506
A6C101	0160-0196	1	Capacitor: fxd mica 24 pF \pm 5% 300 VDCW	04062	RDM15C240J3S
A6C102	0160-0763	1	Capacitor: fxd mica 5 pF \pm 10% 500 VDCW	28480	0160-0763
A6C103	0140-0193	1	Capacitor: fxd mica 82 pF \pm 5% 300 VDCW	28480	0140-0193
A6C104	0140-0145	1	Capacitor: fxd mica 22 pF \pm 5% 300 VDCW	28480	0140-0145
A6C105			Normally Not Loaded		
A6L101	9140-0161	1	Coil: fxd molded RF choke, 3.6 MH 5%	99800	2500-54
A6L102	9100-1664	1	Coil: fxd molded RF choke, 3 MH 5%	28480	9100-1664
A6R101	0698-3497	1	Resistor: fxd film 6.04 K 1% .125W tubular	28480	0698-3497

Table 6-3. Replaceable Parts (Cont'd)

Old style A3 boards, P/N 03552-66503 have not been available since April 1975. Also, new style A3 boards are not directly mechanically equivalent to or direct replacements for the old style A3 boards.

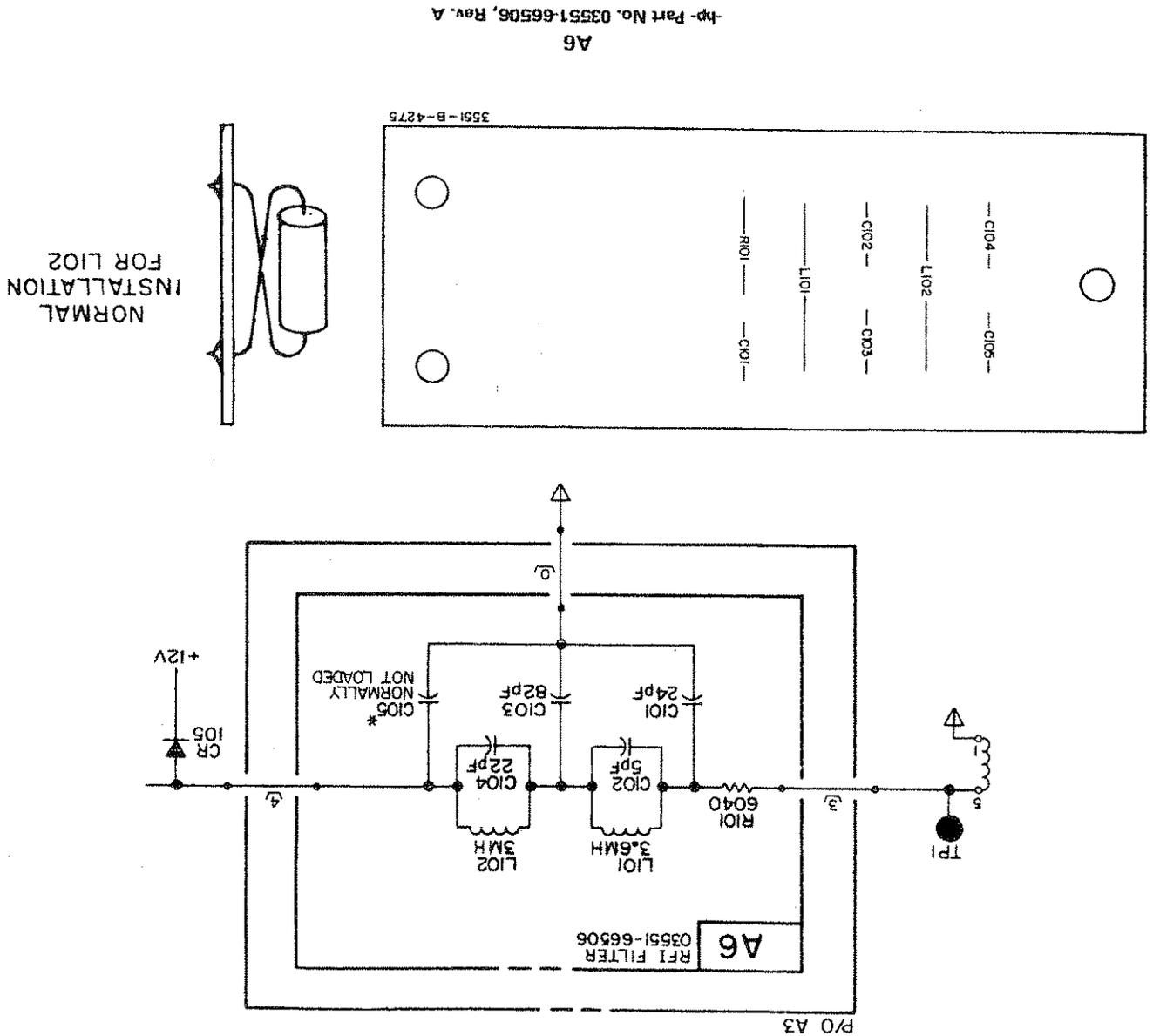
NOTE

B-2. Replacement of A3 Assembly in Instruments Serial No. 1435A00140 and lower. Beginning with Serial No. 1125A00141, the A3 Assembly was redesigned and the part number changed to 03552-66513 (old number, 03552-66503). If it is necessary to replace the entire assembly in an older instrument, use the following procedure.

If the replacement of A3 boards in units 3552A with or prior to Serial No. 1435A00140 is necessary, order new style A3 board (03552-66513) and old style level range dBm Rotary Switch A3S4 (3100-2754) and old style Vernier A3R295 (2100-3394). To make new A3 board mechanically compatible to old style instruments, remove A3S4 and A3R295 on the new style A3 board and replace them with the above old style parts (3100-2754 and 2100-3394). This will make new A3 board mechanically equivalent to old style A3 board. See revised Operating and Service Manual for other details on new send oscillator and input circuitry.

Along with the new A3 board, all 3552A's beginning with Serial No. 1125A00141 will have new front and front sub-

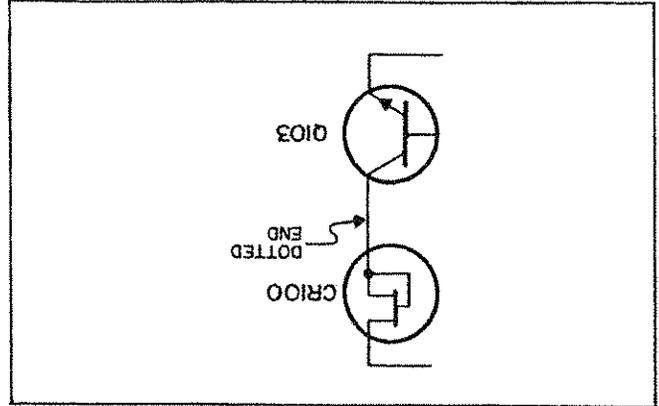
Add the following schematic diagram and component location drawing to Schematic No. 1 (A3).



A6
-hp- Part No. 03551-66506, Rev. A

- Set the Test Set front panel controls as follows:
 POWER..... AC (MAINS)
 FUNCTION (Black Input)
 Output Terminals..... REC TERM
 IMP..... 900
 SEND FREQUENCY RANGE..... 200-6 KHZ
 SEND LEVEL RANGE..... -10 to 0 dbm
 DISPLAY & MONITOR..... RECEIVE LEVEL
 RECEIVE NOISE/TONE..... TONE
 HOLD..... OFF
- Connect the SEND output to the RECEIVE input with a cable.
- Connect a DC Voltmeter (-hp- 3490A) in parallel with the RECEIVE input.
- Connect a DC power supply capable of supplying 30 mA at 60 volts to the TEST SET'S RECEIVE input thru a 100 ohm series resistor.
- Adjust the power supply voltage until the voltmeter indicates 53 V dc. Note the indication on the TEST SET display.

Figure 1. Schematic Representation.



- Remove A3C101 and discard.
- Remove A3V101 and install new protector tube in its place.
- Remove A3R101 and discard. Install the current "diode" goes towards the front of the instrument.
- Correct your manual schematic and parts list.

-hp- Part No.	Description	Quantity
1970-0073	Protection Tube	1
1901-0758	Current Regulator	1

Parts Needed For Modification

When the above instruments are operated with some customers electronic switching system, the response time of the 3552A hold circuit is insufficient to "hold the line", i.e., the phone line disconnects. If this problem exists, the following modification will help.

3552A S/N 1125A00170 and below
 3552A S/N 1604U00260 and below

Hold Circuit Drops E.S. Lines.

MODIFICATION 1.

It is possible for the 3552A to give erroneous readings when making level measurements using the HOLD circuit (measurements on a "wet line"). It is also possible for older instruments to drop the line (equivalent to hanging up the phone) when used on the new phone company electronic switching systems. The following modifications should help eliminate these problems.

B-3. Hold Circuit Modification.

If you have any questions, contact your nearest -hp- Sales and Service Office (Appendix A). In addition, the new assembly will require updated adjustment information. When the above instruments are operated on fringe lines the high (≈ 27 milliamperes) current sunk by the hold circuit may cause problems. Lowering the value of the current will decrease the probability of problems.

3552A S/N 1125A00261 and below
 3552A S/N 1625U00440 and below

MODIFICATION 2.

Hold Circuit Causes Erroneous Readings.

-hp- Part No.	Description	Quantity
0698-3433	Resistor, 28.7	1

Parts Needed For Modification

- Remove A3R102, usually a 20.5 Ω resistor, and discard.
- Install new resistor, 28.7 Ω , in place of A3R102.

NOTE

Do not inadvertently remove A3R103, a 2.7 ohm resistor. The location of A3R102 is different in 66503 and 66513 A3 boards. Use the applicable parts locator in your manual.

PERFORMANCE TEST.

The following test should be performed after either or both modifications are made. This test is also useful in trouble-shooting possibly defective HOLD circuits.

f. Turn TEST SET HOLD to ON, the display indication should be the same $\pm .1$ dbm (a switching transit will probably be observed, this is normal). NOTE. If the reading changes the HOLD circuit has failed, modification will NOT help.

g. Decrease the input voltage and assure that when HOLD is turned on and off the display reads the same ($\pm .1$ dbm) for any dc voltage greater than 6 volts. See note

i. Turn HOLD ON and note the dc voltage V_1 . The hold current = $12 - V_1$. This current should be about 27 mA on $\frac{100}{100}$ unmodified units and about 20 mA on modified units.

h. With HOLD OFF adjust the supply for 12 V dc as read on the voltmeter.

in Step f.

APPENDIX C

This appendix documents some performance improvements which can be made on instruments with Serial No. 1125A 00231 or lower and 1615U00300 or lower. Many of these modifications may be made under warranty. That is, the cost of modification will be borne by Hewlett-Packard.

The contents of this appendix are as follows:

Section C-1. GENERAL INFORMATION

- C-1 Table of board revisions and approximate serial number breaks
- C-2 Quick check list of known problems
- C-3 WARRANTY ALWAYS MODIFICATIONS

Section C-2. WARRANTY ALWAYS MODIFICATIONS

- C-3 OF SPECIFICATION
- C-4 WARRANTY NEVER MODIFICATIONS

Section C-1. GENERAL INFORMATION

Table C-2 is meant to be used as a quick overview of problems which may be made under warranty. That is, the cost of modification will be borne by Hewlett-Packard.

Serial No.	A4	A1	A3	A2	A5
	Board				
101	66501 REV A	66503 REV A	66504 REV B	66502 REV A	66505 REV A
111	66504 REV A	66504 REV B	66502 REV A	66505 REV A	66505 REV A
141	66504 REV A	66513 REV A	66502 REV A	66505 REV A	66505 REV A
201	66514 REV A	66513 REV A	66502 REV A	66505 REV A	66505 REV A

Serial Prefix with 'A'

Items which may exist on the 3552A. Column one indicates the part number of the board which may need modification while column two gives the board revision. Both the part number and the revision are printed on every board. Column three gives a very brief description of the problem which may exist. Information given later in this Appendix (the section column indicates where) indicates the necessary action to be taken if this problem exists. The status column indicates who pays for the cost of modification. WA means the modification will be done by any -hp- Sales and Service Office at no charge, no matter how old the instrument is.

The status of "WA*" means that the instrument should be checked following the procedure given in this service note and modified only if it fails the test. The modification, if needed, will be done at no cost (charged to warranty) no matter how old the instrument is.

WN means the cost of modification must be born by the customer. These modifications are not necessary for proper operation of the instrument.

Section C-2. WARRANTY ALWAYS

The following modifications should be PERFORMED ON ALL applicable instruments when they are in for repair. These modifications may be charged to warranty (WA) and will be performed at any -hp- office at no charge.

IMPORTANT

Perform the modifications only on the given

Table C-1. 3552A Approximate Serial Number Suffixes Corresponding to Circuit Board Changes.

Serial No.	A4	A1	A3	A2	A5
	Board				
101	66504 REV A	66501 REV B	66513 REV A	66502 REV A	66505 REV A
121	66504 REV A	66501 REV B	66513 REV A	66502 REV A	66505 REV A
150	66504 REV A	66501 REV B	66513 REV A	66502 REV A	66505 REV A
221	66514 REV A	66513 REV A	66502 REV A	66505 REV A	66505 REV A
281	66514 REV A	66513 REV A	66502 REV A	66505 REV A	66505 REV A

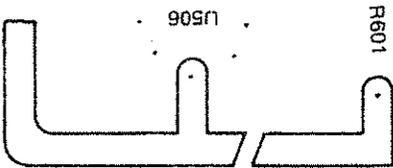
Serial Prefix with 'U'

- a. Check the resistance from the left side (as viewed from the top front) of A1C528 to ground. If there is continuity, the modification is already installed. If there is no continuity, continue.
- b. Remove left side of A1C528 from the board and install a terminal post Part No. 0360-1716 in the resulting

- a. Check the resistance from AIU506 pin 4 to the front end (viewed from the front of the instrument) of AIR701. If a short (less than 2 ohms) is measured, perform Step b. If about 14 ohms is measured, the modification is unnecessary.
- b. A trace shorting AI1804 should be cut. This trace is on the back side (non-component side) of the AI board between AIU506 pin 4 and AIR601.

C-2B
03552-66501 REV D

C-2A
03552-66501 REV B & C



revision and part number boards. If a revision is not listed, DO NOT make the modification on that board. i.e., if the title is 03552-66501 REV B & C, DO NOT make that modification on a 03552-66501 REV A board.

*Modification to be performed only if a problem exists.

Board	Revision	Fault	Status	Section
03552-66501	B & C	Short between front end of AIR601 and AIU506 pin 4	WA	C-2A
03552-66501	D	Open from left side of A1C528 to ground	WA	C-2B
03552-66501	D	A1U502 pin 4 at +5 V	WA	C-2C
03552-66501	D	No holddown on AIR601 crystal	WA	C-2D
03552-66503	A & B	A3C502 is 10 pF	WA	C-2E
03552-66513	A & B	A3R213 is 26.7 K and/or A3R216 is 40.2 K and/or A3C216 is blue or red in color	WA	C-2F
03552-66501	A & B & C	Crosstalk between Send and Receive too high	WA*	C-3A
03552-66501	A & B & C	Racking of display when measuring a HOLD TONE	WA*	C-3B
03552-66503	A & B	Inability to obtain +10 dbm output or maximum level overranges (blanks) display	WA*	C-3C
03552-66513	A & B	Received level at 100 Hz out of spec	WA*	C-3D
03552-66513	A & B	Send oscillator distortion out of spec	WA*	C-3E
03552-66513	---	FM Interference, coils on input jacks missing	WA*	C-3F
General 3552A	---	Display brightness uneven	WA*	C-3G
03552-66503	A & B	A3R236 at its endstop	WN	C-4A
03552-66503	A & B	Displayed send level not actual output at 60 KHz and 135 ohm IMP	WN	C-4B
03552-66513	A & B	Difficulty in adjusting send oscillator distortion	WN	C-4C
03552-66513	A	Marginal Longitudinal Balance	WN	C-4D
Case 3552A	---	RFI Interference - AM	WN	C-4E

Table C-2. Quick Checklist.

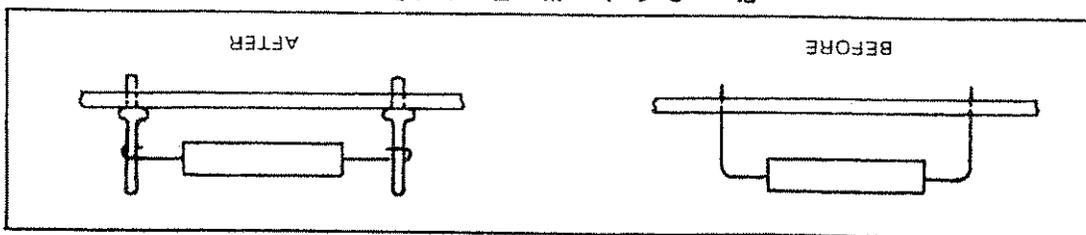
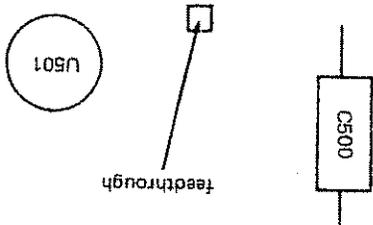


Figure C-1. Installing Terminal Posts.

approximately +5 volts (as opposed to +12 volts), install the following modification.

b. Using a 1/16 inch or 1.6 mm drill bit, drill out the feedthrough between A1C500 and A1U501 all the way through the board (see below).



hole in the board. Reconnect A1C528 to the post (see Figure C-1).

c. Run a fine wire from the terminal post to the "LSD" post (ground) on the non-component side of the board (see Figure C-2).

d. Attach the finewire to the board as shown with a thin coating of epoxy.

C-2C
03552-66501 REV D

a. Check the voltage on pin 4 of A1U502. If it is

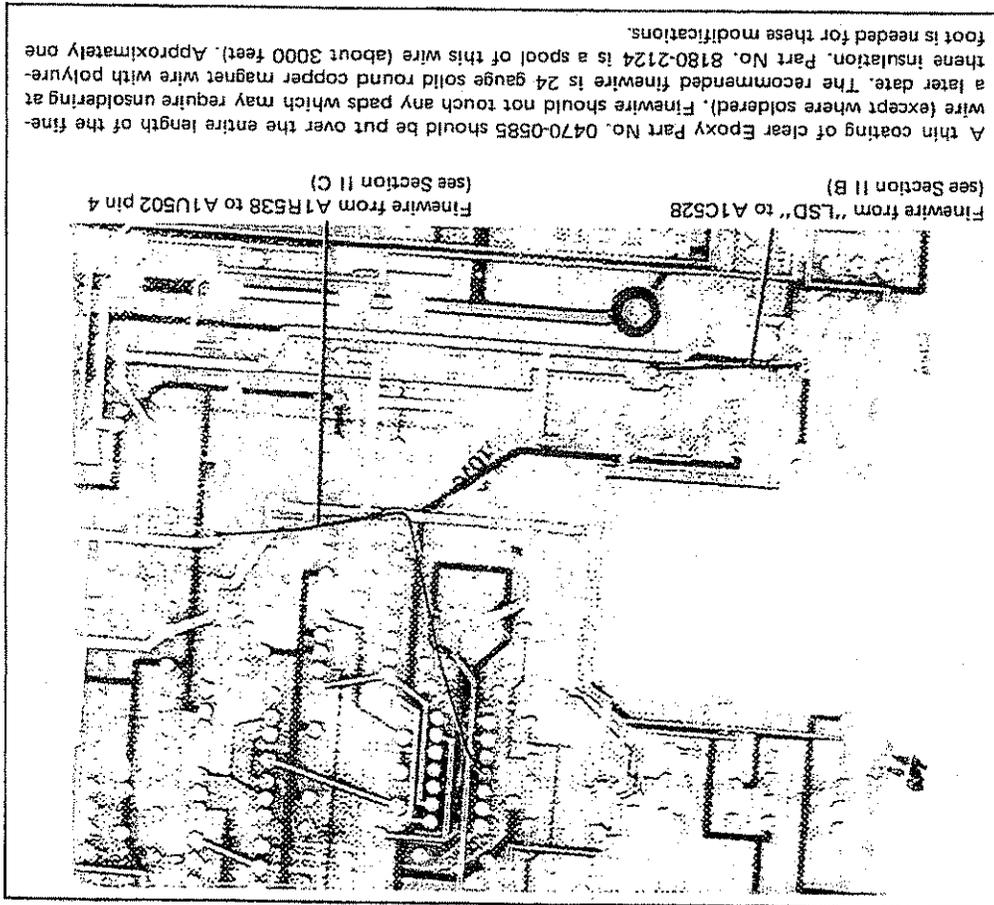


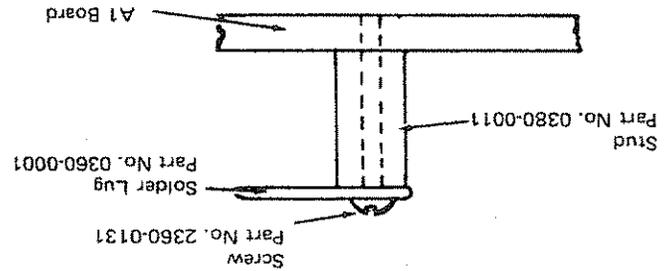
Figure C-2. Running Finwires.

a. Change A3C502 from a 10 pF to a 5 pF Part No. 0140-0209.

03552-66503 REV A & B
03552-66513 REV A & B

C-2E

d. Remove the AI board mounting screw adjacent to TP16. Install a spacer stud and screw as shown above (delete the solder lug).



c. Install a spacer stud and a solder lug over the hole as shown below. Position the solder lug over the top of the crystal (AIY601) can to hold it in the socket. Tighten the screw.

b. Remove the AI board mounting screw adjacent to the crystal.
there is not, proceed with Step b.
over the top of the crystal holding the crystal in place. If or plugged in. If it is plugged in, there should be a solder lug in
a. Locate the crystal AIY601 and see if it is soldered in

03552-66501 REV D
C-2D

h. Reinstall AIU502. Use a new IC Part No. 1826-0323 (to avoid intermittents due to solder on IC legs).

g. Attach the finewire to the board as shown with a thin coating of epoxy.
f. Run a finewire on the non-component side of the board from the new terminal post (on AIR538) to pin 4 of AIU502 IC socket (see Figure C-2).

e. Check for an open between AIU502 IC socket pin 4 and +5 volt supply (use +5 TP under A3 connector). If shorted, recheck "drilled out" feedthrough.

d. Remove U502 and install an IC socket Part No. 1200-0474.

c. Lift the end of R538 closest to the rear of the instrument and install a terminal post (Part No. 0360-1716) in the board. Reconnect R538 to the post (see Figure C-1).

If the 3552A has been retrofitted with the FRI modification per Service Note 3551A-2 (a small PC board mounted behind the "DIAL" terminals), use a SEND FREQUENCY of 6 kHz and/or a LEVEL of -10 dbm.

IMPORTANT

d. Set the 3552A FUNCTION switch to REC TERM IMP to 900, SEND FREQUENCY to 60 kHz and LEVEL to +11 dbm.

c. Set the synthesizer for a -55 dbm output at 40 Hz (3552A input of .398 mV).

b. Connect a 3320B Synthesizer to the 3552A through the 900 ohm impedance box (see Figure C-3).

a. This check should be made with the instrument in its case.

PERFORMANCE CHECK

03552-66501 REV A & B & C

C-3A

03552-66501 REV A board.
Perform the modification only on the given revision and part number boards (if they do not meet specifications). If a revision is not listed, DO NOT make the modification on that board, i.e., if the title is 03552-66501 REV B & C, DO NOT make that modification on a

IMPORTANT

The following performance checks should be made on all instruments when they are in for repair. Any instruments which DO NOT MEET the given SPECIFICATION SHOULD BE MODIFIED. This modification may be changed to warranty (WA).

Section C-3. WARRANTY ALWAYS IF OUT OF SPECIFICATIONS.

c. Check the color of A3C216. If it is RED or BLUE and has beads on the legs for spacing (beads may be absent on a small number of instruments), it should be replaced. Install an ORANGE capacitor Part No. 0160-3094 in place of A3C216. All three colors are .1 μ F capacitors but the temperature coefficients differ widely.

b. Change A3R216 from a 40.2 K to a 8.06 K Part No. 0698-4473.

a. Change A3R213 from a 26.7 K to a 5.36 K Part No. 0698-3258.

03552-66513 REV A & B

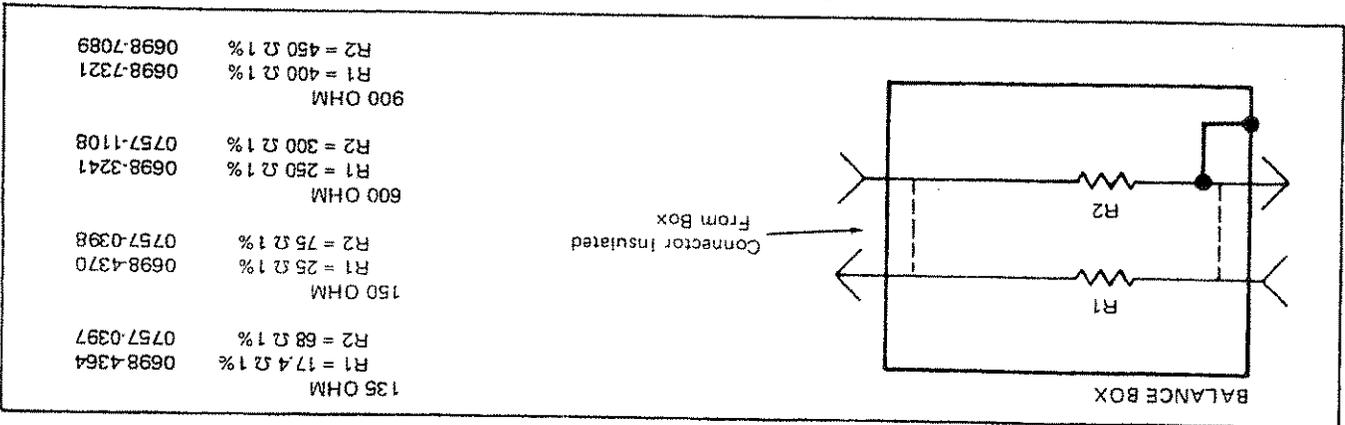
C-2F

- i. Dress all wires in the vicinity of the function switch away from the transformer.
- h. Measure the resistance between the case of A3T101 and ground. If it is over one ohm, remove T101 and solder a wire from pin 1 of the transformer to the case or outer can. Reinstall T101.
- g. Change AIR556 from 100 ohm to 402 ohm Part No. 0698-4453.
- f. Change AIR512 from 3 kilohm to 931 ohm Part No. 0698-4465.
- e. Change AIR513 from 3 kilohm to a 3.3 microhenry coil (L501) Part No. 9011-1665.
- d. Change A1C506 from .001 microfarad to .0039 microfarad Part No. 1060-0156.
- c. Change A1C505 from .001 microfarad to .0015 microfarad Part No. 0160-0298.
- b. Change A1C601 from .04 microfarad to 2.2 microfarad Part No. 0160-0128.
- a. Change A1C522 from 4.7 microfarad to 6.8 microfarad Part No. 0180-1701.

MODIFICATION

- h. Set the FUNCTION switch to REC BRDG and press the SEND FREQ monitor button. If the reading is incorrect, perform the following modification.
- g. Set the synthesizer to 60 kHz at a level of +20 dBm (3552A input of 4.46 V).
- f. Set SEND FREQ to 40 Hz and send LEVEL to minimum (< -60 dbm).
- e. Press RECEIVE FREQ and check the reading (≈ 40 Hz). If it is incorrect, perform the following modification. If the reading is correct, proceed to Step f.

Figure C-3. Impedance Box.

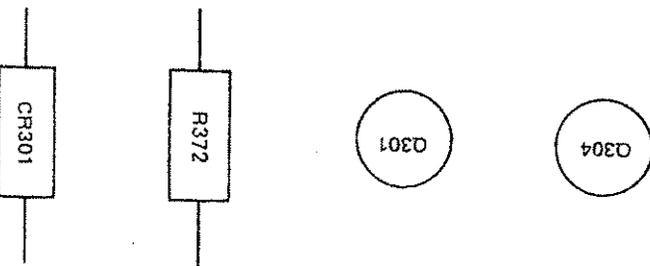


- j. If the instrument has a 03552-66503 board, continue with Step k; otherwise, the modification is complete.
- k. Check for a .1 microfarad capacitor across A3R379. If none is present:

- 1. Remove A3R379 and install terminal posts (Part No. 0360-1716) in the board at both ends (see Figure C-1).
- 2. Reconnect A3R379 between the posts and add a .1 microfarad capacitor Part No. 0150-0084 between the posts in parallel with A3R379.

1. Check the physical location of A3C324 (30 or 33 pF) as shown below. If it is connected between the front ends of A3CR301 and A3R372, remove it (save capacitor).

- m. Remove A3R372 and install terminal posts (Part No. 0360-1716) in the board at both ends (see Figure C-1).
- n. Install A3C324, either the one removed in Step m or if none was present, a new 30 pF capacitor (Part No. 0160-2199), between the posts in parallel with R372.



- o. Check for a 30 or 33 pF capacitor across A3R300. If none is present, remove R300 and install terminal posts (Part No. 0360-1716) in the board at both ends (see Figure C-1).
- p. Reinstall R300 and add a 30 pF capacitor (Part No. 0160-2199) between the posts in parallel with R300.

PROBLEM

Some instruments are troubled by low frequency noise causing a severe racking of the display when measuring a local office (phone company) HOLD TONE. If this is a problem, the following modification should be installed. Note that this racking CANNOT be seen when using a clean source to generate the proper frequency. Duplicating the customer's problem is somewhat involved and unnecessary in this case.

MODIFICATION

NOTE

It is recommended that this modification (if necessary) be performed last since it may require fully calibrating the instrument.

a. Check the values of A1C502 and AIR503. If they are 6.8 microfarad and 100 kilohm respectively, then the racking is already suppressed and the modification should NOT be installed.

b. Calibrate the instrument to assure it meets its published specifications (see above Note).

c. If A1C502 is a 2.2 microfarad capacitor, proceed.

d. Connect a 3320B Synthesizer to the 3552A through the 600 ohm impedance box (see Figure C-3).

e. Connect a 3490A AC Digital Voltmeter across the 3552A input in parallel with the synthesizer (via impedance box) input.

f. Set the 3552A to RECEIVE TONE, 600 Ω IMP, and depress the RECEIVE LEVEL button.

g. Adjust the synthesizer frequency to 1 KHz. Adjust the synthesizer level for a 3490A reading of .775 volts.

h. Note the 3552A reading; it should be 0.0 ± 1 dbm.

i. Set the synthesizer frequency to 40 Hz (maintaining the same input level).

j. Select AIR503 for a test set display of -4 dbm. Typically a 120 to 150 kilohm resistor is needed.

k. Recheck Steps g and h; there should be no change.

C-3C

03552-66503 REV A & B
03552-66513 REV A & B

PERFORMANCE CHECK

a. Depress the SEND LEVEL button and adjust the

- a. Change A3R506 to a started value.
- b. Typically a 75 ohm resistor, Part No. 0757-0398, will be needed.
- c. Redo the Performance Check (Steps a through e).

MODIFICATION

following modification.

- e. The received level should be within ± 1 dB of that noted in Step 3. If this level is not obtained, perform the following modification.
- d. Set the synthesizer frequency to 100 Hz.
- c. Press the RECEIVE LEVEL button and note the reading (≈ -2 dbm).
- b. Set the synthesizer for a $+8.79$ dB output at 1 KHz (3552A input of .6152 V).
- a. Connect a 3320B Synthesizer to the 3552A through the 600 ohm impedance box (see Figure C-3).

PERFORMANCE CHECK

C-3D
03552-66513 REV A & B

c. Redo the Performance Check (Steps a through g).

- a. Change A3R293 to a started value (newer schematic indicates this change).
- b. Select A3R293 for proper readings, typically a 1.33 kilohm to 1.5 kilohm resistor is needed. Higher values of R293 will lower the output reading.

MODIFICATION

perform the following modification.

- f. If either Step c or Step e does not work as stated, perform the following modification.
- e. The display should indicate a minimum of $+10$ dbm but should not indicate overrange (blancked display).
- d. Set the IMP switch to 600 ohms and the FREQUENCY control to 10 KHz.
- c. The display should indicate a minimum of $+10$ dbm (any value over $+10$ is acceptable).
- b. Set the IMP switch to 900 ohms and the FREQUENCY switch to HOLD TONE.

SEND LEVEL control for a maximum output ($> +10$ dbm).

C-3E
03552-66513 REV A & B

PERFORMANCE CHECK

- a. Check the send oscillator distortion as outlined in the Operating and Service Manuals Performance Tests section. Pay particular attention to 20 KHz (< -40 dB) and 4 KHz (< -50 dB).
- b. If the distortion is not within specifications, the following modification should be made.

MODIFICATION

Parts Needed for Modification

Quantity	Description	-hp-Part No.
4	Terminal Post	0360-1716
1	Capacitor, 100 pF	0160-2204
2	Capacitor, 1 μ F	0160-0127

- a. Change A3C215 to 100 pF.

- b. Lift the end of A3R284 closest to the rear of the instrument and install a terminal post in the board. Reconnect R284 to the post (see Figure C-1).
- c. Lift the end of A3R282 closest to the front of the instrument and install a post in the board. Reconnect R282.
- d. Connect a 1 μ F capacitor between the posts installed in Steps b and c.
- e. Lift the end of A3R254 closest to the front of the instrument and install a post in the board. Reconnect R254.
- f. Lift the end of A3R211 closest to the rear of the instrument and install a post in the board. Reconnect R211.

- g. Connect a 1 μ F capacitor between the posts installed in Steps e and f.
- h. Correct the manual schematic to show the new value of A3C215 and to add a 1 μ F capacitor from the junction of R283 and R282 to ground. Also, add a 1 μ F capacitor from the junction of R254 and R255 to ground.

**C-3F
MAINFRAME**

PROBLEM

Some instruments are troubled by FM radio stations causing interference with measurements. This is usually manifested by music from an FM radio station emitting from the instrument's speaker. If this is a problem, the following modification should be installed.

MODIFICATION

Parts Needed for Modification

Quantity	Description	-hp-Part No.
4	Solder Lug	0360-1190
4	Lockwasher	2190-0016
4	Nut	2950-0043
4	Coil, 1 μ H	9100-3551

It is recommended that the coils are added one at a time to avoid accidental swapping of wires.

- a. Unsolder the two wires attached to the rear of one of the front panel banana jacks.
- b. Unscrew the plastic mounting nut and remove the flat saddle washer (see Figure C-4). Discard saddle washer.
- c. Reinstall and tighten the plastic mounting nut. Then add the solder lug, lockwasher, and nut (Part No. 2950-0043) in that order to the rear of the banana jack (see Figure C-4).

(see Figure C-4).

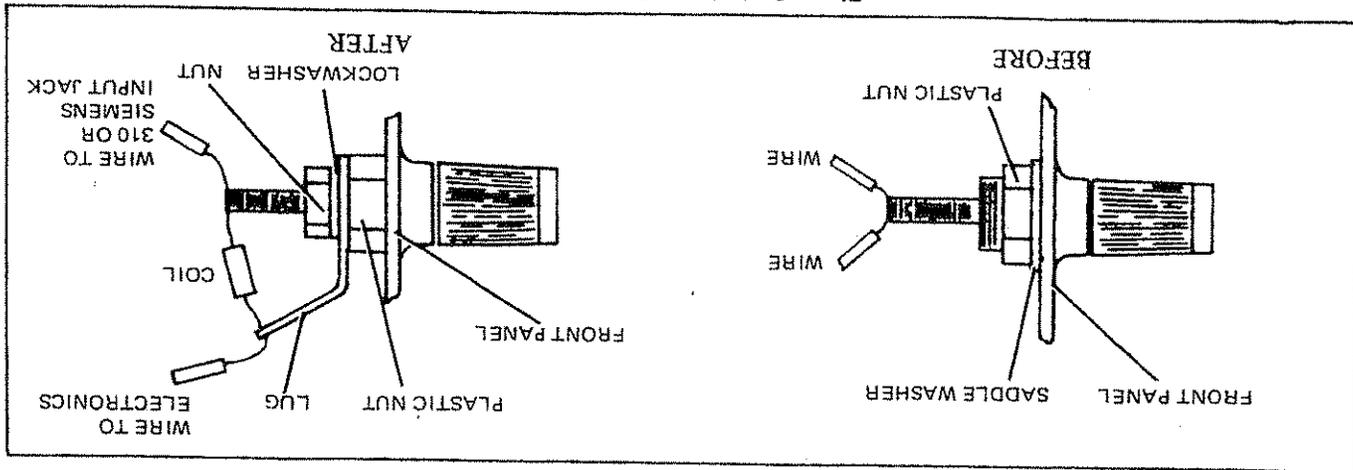


Figure C-4. Input Banana Jack.

- d. Connect a coil between the solder lug and the rear of the banana jack.
- e. Reconnect the wires as shown in Figure C-4.
- f. Redo Steps a to e on the three remaining banana jacks.

DISPLAY BRIGHTNESS UNEVEN

GENERAL
C-3G

3552A Serial Numbers 1435A00140 and below

Occasionally when a new display is ordered, its brightness will not correspond to the brightness of the unchanged displays. The original part numbers used, 1990-0447 and 1990-0434, could be any brightness code from A through F. This code is stamped on the side of the display.

The displays used in instruments with serial numbers higher than those given above are all brightness code D, and therefore little deviation in brightness should be encountered in them.

When a display needs changing in any 3552A, the new displays should be used.

Display an seg Part No. 1990-0491 (1 used)
Display num seg Part No. 1990-0490 (4 used)

It is recommended that the brightness code on the faulty display be checked. If the code is a C or D or E, then usually a D coded display can be used without difficulty. If the faulty display is any other brightness code, then all five displays should be changed using the newer part numbers. The cost of replacing any OPERATING displays (i.e., four or less per instrument) may be charged to warranty (WA).

Section C-4. WARRANTY NEVER MODIFICATIONS.
The following modifications provide improved performance in the manner indicated. These modifications must NOT BE charged to warranty (WN).

IMPORTANT

Perform the modification only on the given revision and part number boards. If a revision is unhisted, DO NOT make the modification on that board; i.e., if the title is 03552-66501 REV B & C, DO NOT make that modification on a 03552-66501 REV A board.

C-4A
03552-66503 REV A & B
03552-66513 REV A

RESULT
When calibrating distortion, A3R236 tended to be all the way to one end for best results.

MODIFICATION (WN)

Change A3R236 from a 1 kilohm pot to a 2 kilohm pot
Part No. 2100-3273.

C-4B
03552-66503 REV A & B
03552-66513 REV A & B

RESULT

This modification makes the displayed "SEND LEVEL" correspond more closely to the actual send output level at 60 kHz when the IMP switch is set to the 135 ohm position.

MODIFICATION (WN)

a. Remove A3R380 and install terminal posts (Part No. 0360-1716) in the resulting holes in the board (see Figure C-1).

b. Reconnect A3R380 between the terminal posts.

c. Add a 750 pF capacitor Part No. 0160-2035 between the terminal posts in parallel with A3R380.

C-4C
03552-66503 REV A & B
03552-66513 REV A

RESULT

The following modification makes it much easier to calibrate for minimum send oscillator output distortion.

MODIFICATION (WN)

a. Change A3R255 and A3R283 to 2 kilohm pots
Part No. 2100-3273.

b. Select A3R284 and/or A3R256 as necessary to allow minimum distortion when A3R255 and A3R283 are approximately centered.

C-4D
03552-66513 REV A & B

RESULT

The following modification results in a significant improvement in the Longitudinal Balance.

Some instruments are troubled by AM radio stations causing interference with measurements. This is usually manifested by music from an AM radio station emitting from the instrument's speaker. This can be caused by interference coming in the line power cord or through the front input terminals. If the interference is coming through the front terminals, Service Note 3551A/52A-2 describes a FACTORY ONLY, no charge retrofit, to alleviate the problem.

If the interference is coming through the line power cord and presents a problem, the following modification should help. This modification may not be charged to warranty (WN) since battery operation is recommended where extremely noisy power lines exist.

PROBLEM, RFI INTERFERENCE - AM

C-4E
CASE

Change A3R116 and A3R117 from 499 ohm to 505 ohm
1% Part No. 0698-6965.

MODIFICATION (WN)

NOTE

Some units are in the field with terminal posts and capacitors added in a slightly different manner. This is acceptable and remodification is not required. Be sure the label is present and correct.

- c. Reassemble instrument.
- d. Attach label to outside of case under AC input plug over existing label.
- e. Add parts used to the manual's parts list and correct the manual schematic to show a capacitor from R to ground and a capacitor from N to ground. Change the AC line input frequency in Table 1-2 to 48 to 66 Hz.

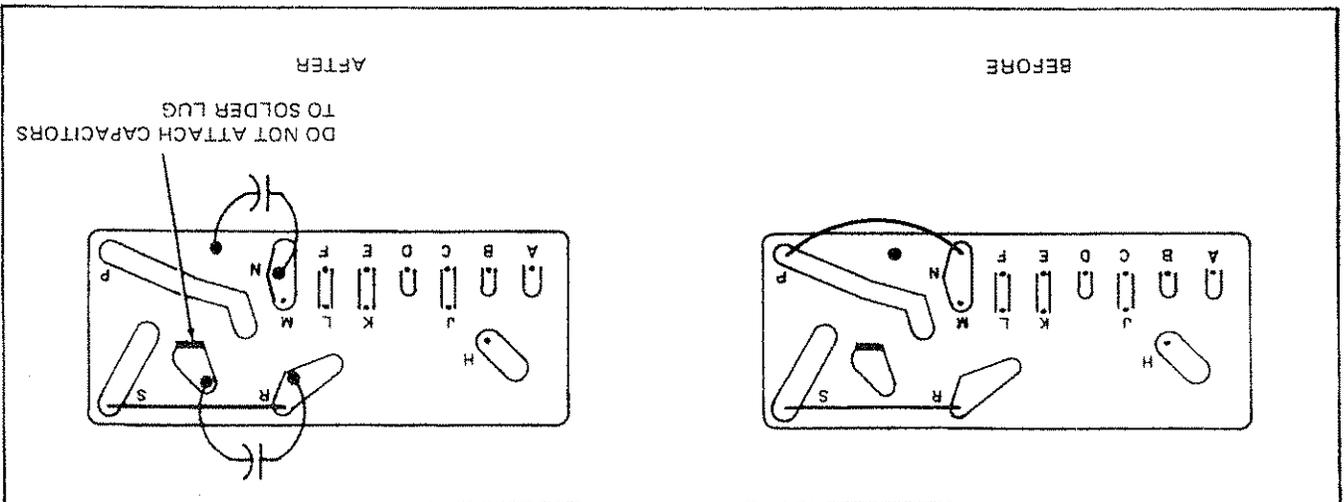
- a. Remove line module from case.
- b. Add capacitors as shown in Figure C-5 and C-6.

Quantity	Description	-hp- Part No.
2	Capacitor, .001 μ F	0160-0195
1	Label	7120-5361

Parts Needed for Modification

MODIFICATION (WN)

Figure C-5. Pictorial Representation.



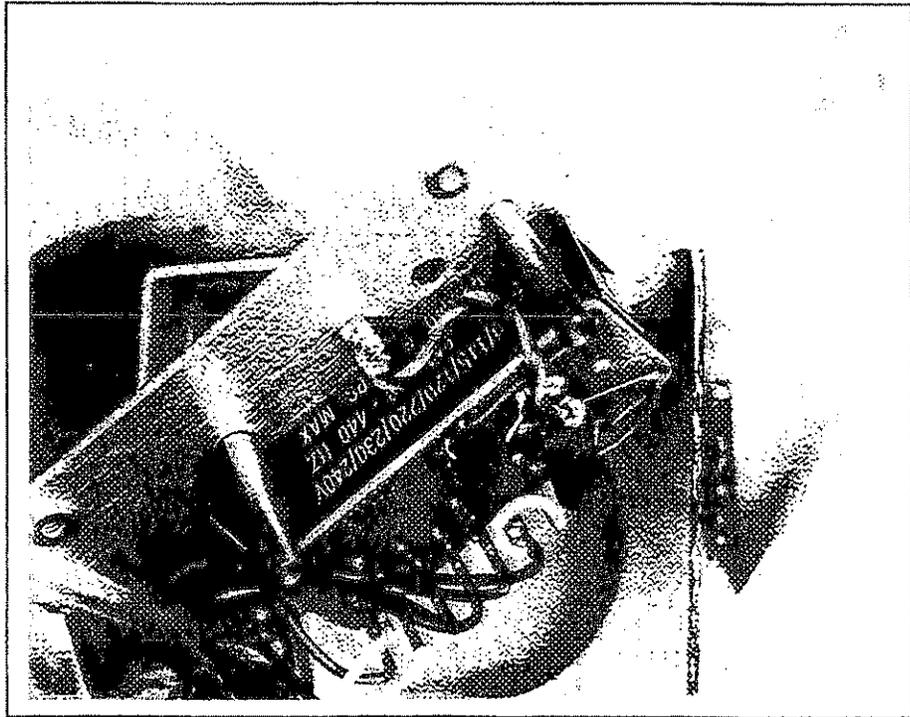


Figure C-6. Physical Parts Locator.



Reorder No. or
Manual Part No.

03552-90004



03552-90004

