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Errata

Title & Document Type: 3551A Transmission Test Set Operating and Service Manual

Manual Part Number: 03351-90001

Revision Date: January 1976

HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

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OPERATING AND SERVICE MANUAL

MODEL 3551A
TRANSMISSION TEST SET

Serial Number: 1425A00101 and higher

IMPORTANT NOTICE

This loose leaf manual does not normally require a change sheet. All major change information has been integrated into the manual by page revision. In cases where only minor changes are required, a change sheet may be supplied.

If the Serial Number of your instrument is lower than the one on this title page, the manual contains revisions that do not apply to your instrument. Backdating information given in the manual adapts it to earlier instruments.

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.

-hp- Part No. 03551-90002
(Complete Manual, including Binder)

Binder Part No. 03551-90011
(Includes Cover Inserts, No Pages)

3551A Manual Loose Leaf Pages only,
Part No. 03551-90001

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Table 1-2. General Information.

RECEIVER:

Level Measurements:
- Frequency range: 40 Hz to 60 kHz
- Dynamic range: + 15 dBm to - 70 dBm
- Resolution: 0.1 dB
- Sample rate: 10/second (NORMAL), 2/second (DAMPED)
- Detector type: average responding.

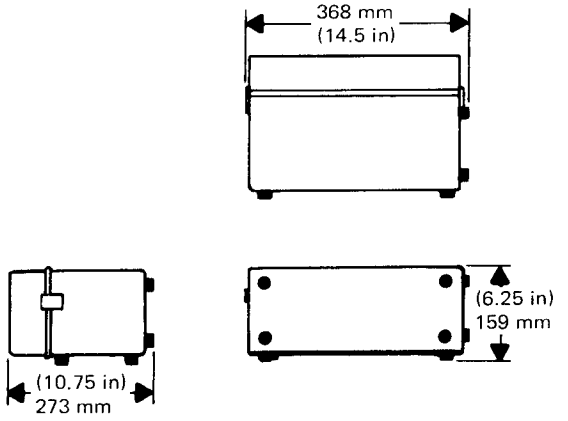
Noise Measurements:
- Dynamic range
  - Message circuit noise: 0 dBrn to + 85 dBrn.
  - Noise-with-tone: 10 dBrn to + 85 dBrn (600 Ω, 900 Ω).
  - Noise-to-ground: + 40 dBrn to + 125 dBrn.
- Resolution: 1 dB
- Sample rate: 2/second
- Detector type: Quasi RMS
- Weighting filters: C message, 3 kHz Flat, 15 kHz Flat, Program.

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 (NORMAL), 2/second (DAMPED)

TRANSMITTER:
- Frequency range: 40 Hz to 60 kHz
- Ranges: 40 Hz to 600 Hz
  200 Hz to 6 kHz.
  2 kHz to 60 kHz
  1004 Hz fixed.
- 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 (Hold Tone).
- Resolution: 0.1 dB.
- Sample rate: 10/second.

GENERAL
- Monitor: built-in speaker, monitors received or transmitted signal.
- Balanced impedances: 135 Ω, 600 Ω, 900 Ω.
- Maximum input/output voltage: 300 V dc metallic or 200 V peak longitudinal.
- 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. Complete recharge in 12 hours.
- AC line: 100 V, 120 V, 200 V, 240 V ± 10%; 48 Hz to 66 Hz; 15 VA.
- Temperature range:
  - Operating: 0°C to 55°C (32°F to 130°F).
  - Storage: - 20°C to 65°C (- 4°F to 149°F).
- Relative humidity: 0 to 95% (< 100°F, < 40°C).
- Weight:
  - Net: 6.6 kg (13 lb).
  - Shipping: 7.3 kg (16 lb).

Outline Drawing:



NOTE: Dimensions in millimeters and (inches).

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SECTION II
INSTALLATION

2-1. INTRODUCTION.

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.

2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be free of mars or scratches and operating correctly upon receipt. To confirm this, the instrument should be inspected for physical damage in transit. If damage has occurred, file a 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.

2-5. POWER REQUIREMENTS.

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.

NOTE

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

2-7. Battery.

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 OFF or ~ AC. Recharging time for the batteries is approximately 12 hours.

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.

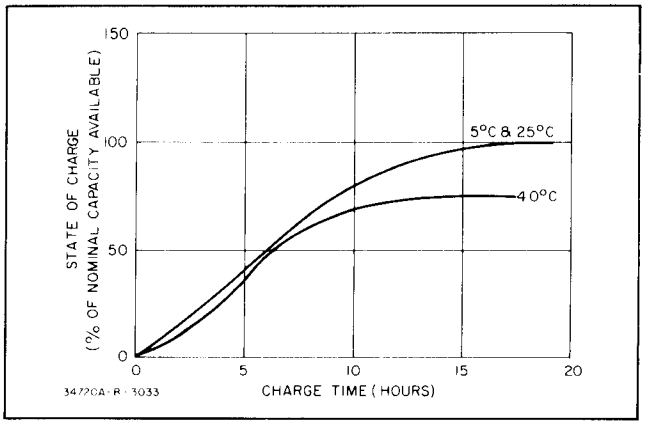


Figure 2-1. Battery Charge Acceptance vs. Temperature.

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.

CAUTION

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

2-11. The cycle-life of the batteries is based, by the manufacturer, on an end point of 80% of the rated 225 milliampere-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 2-5 for recharging procedures. Section V contains information concerning replacement of the batteries.

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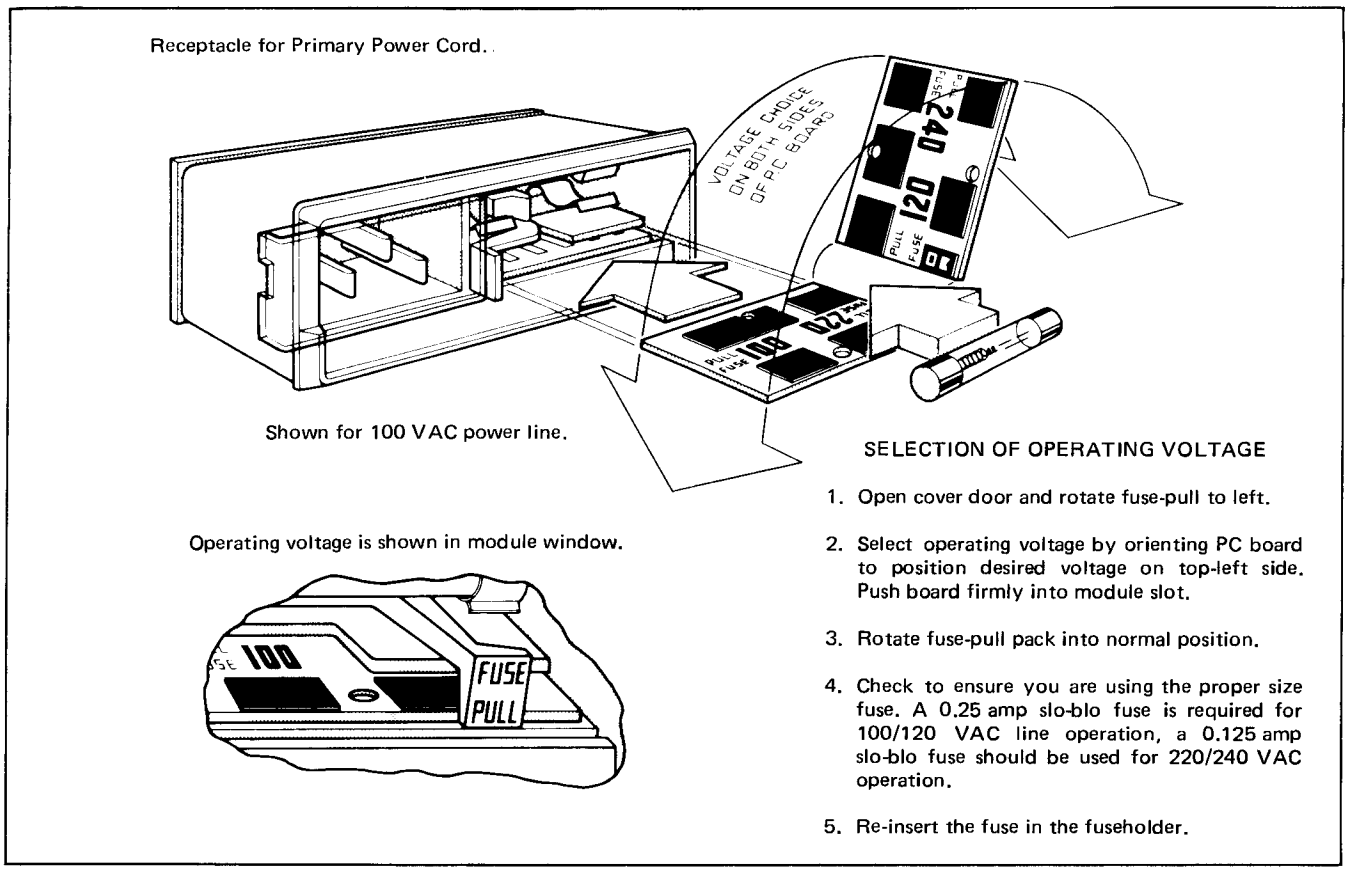


Figure 2-2. Voltage Selection.

2-13. AC Power.

2-14. The Test Set can be operated from any power source supplying 100 V ac, 120 V ac, 220 V ac or 240 V ac (- 10% + 5%), 48 Hz to 66 Hz. Power dissipation is 15 VA maximum. The Test Set is set for 120 V operation at the factory, If it is necessary to change the primary voltage setting, refer to Figure 2-2.

CAUTION

If the instrument is not set for the proper primary voltage and not properly fused, it may be seriously damaged.

2-15. Power Cords and Receptacles.

2-16. Figure 2-3 illustrates the standard configurations used for ac power cords. The -hp- part number directly above each drawing is the part number for an instrument power cord with a connector of that configuration. If the appropriate power cord is not received with your instrument, notify the nearest -hp- Sales and Service Office and a replacement cord will be provided.

2-17. Grounding Requirements.

2-18. To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. The Test Set is equipped with a three conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power plug is the ground connection.

WARNING

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

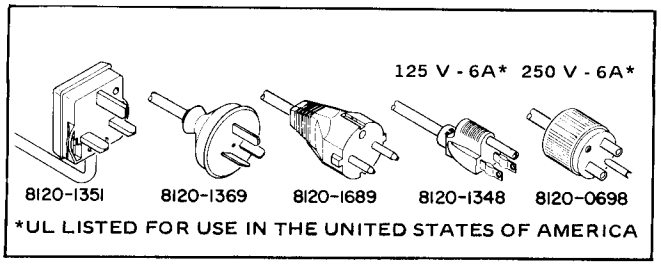


Figure 2-3. Power Cords.

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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 Test Set is designed to measure frequency and level of tone or noise on telecommunication circuits, while simultaneously providing calibrated test signals. It is ideally suited for measurements on voice program and data circuits. The input is capable of accepting both two-wire and four-wire balanced lines. Frequency or level measurements of received signals can be made in either a bridged or terminated mode. Terminated impedances can be selected at 135 ohm, 600 ohm or 900 ohm. The source impedance of the calibrated test signals is always equal to the selected terminating impedance.

3-5. Additional features of the Test Set include: digital LED display of level and frequency of received signals or the calibrated test signal; automatic resolution, time constants and sample rate for tone and noise level measurements and frequency measurements; dial and hold facilities; a choice of four weighting filters (C message, 3 kHz flat, 15 kHz flat or program); and ac power operation or rechargeable battery pack.

3-6. POWER AND WARM-UP.

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

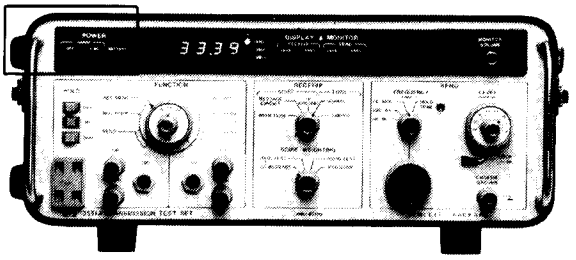
NOTE

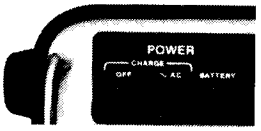
Do not operate the Test Set in the BATTERY mode while it is connected to an external ac source. The instrument will not operate under these conditions. Refer to Section V for battery replacement. The Test Set can be operated from a 100 V, 120 V, 220 V or a 240 V external ac power source. Ensure that 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, Paragraph 2-5.

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.

3-9. FRONT PANEL CONTROLS.

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 3-47.





3-11. Power.

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

WARNING

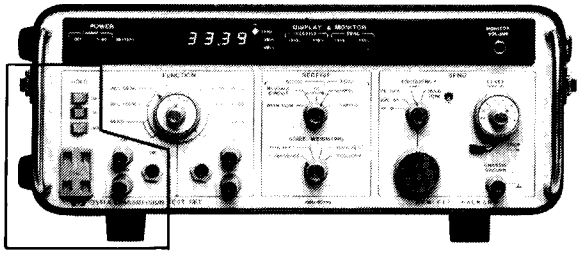
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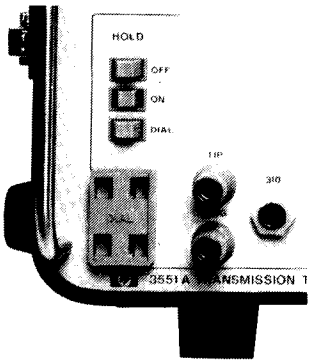
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To turn on the Test Set, press the AC pushbutton if external ac power is connected, or the BATTERY pushbutton if no external ac power is available.

NOTE

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 2-5, Section II.



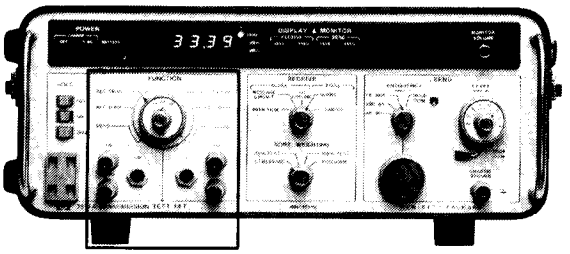


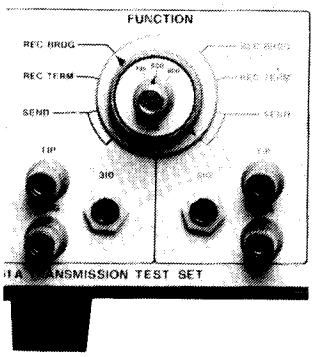
3-13. Dial and Hold.

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 TIP and RING (labeled in black) and the 310 input/output jack (labeled in 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.

NOTE

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





3-15. Input/Output Function Select.

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

3-17. The Test Set has two sets of input/output terminals. Each set consists of a Western Electric 310 jack connected in parallel with two binding posts. The binding posts, labeled TIP and RING, 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 (see Section II, Paragraph 2-24, for interfacing information).

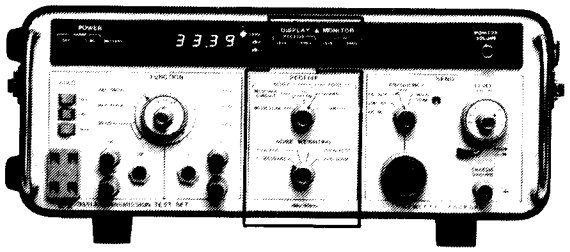
3-18. Either set of the input/output terminals can be used to receive or send. When one set is connected for receiving, the other set is simultaneously connected for sending. The selection of terminals is determined by the position of the input/output function select switch.

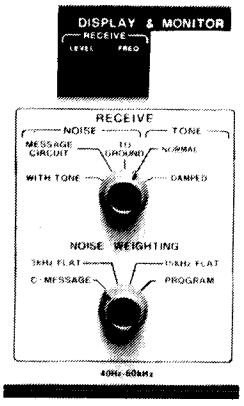
3-19. The input/output function select switch has four positions for each set of terminals—two send (SEND) positions, and two receive (REC BRDG, REC TERM) positions. The send positions connect the corresponding terminal set to the Test Set Send Oscillator. The operator is then provided with a calibrated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

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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 135 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—C message, 3 kHz Flat, 15 kHz Flat and Program. All measurements can be made for level or frequency. 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 circuitry. The notch filter is designed to filter out a 1004 Hz signal applied at the transmitting station. Once the tone has been filtered out at the receive end, the noise can be applied to a weighting filter (usually C message), then measured. The dynamic measurement range in the noise with tone mode is 10 dBrn to 85 dBrn.

3-25. Message Circuit Noise Mode. In the MESSAGE CIRCUIT position of the RECEIVE NOISE/TONE switch, background noise can be measured with both input lines isolated from earth ground. The input lines can be either bridged or terminated. Terminating impedances are 135 ohms, 600 ohms, or 900 ohms. Any of the four weighting filters can be used. Dynamic range for the message circuit noise mode is 0 dBrn to 85 dBrn.

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 40 dBrn to 125 dBrn.

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 26 dBrn and the noise-to-ground level of the same circuit is 90 dBrn, the balance is 26 - 90 = 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 postion, 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: C message, 3 kHz Flat, 15 kHz Flat, and Program.

3-30. C Message. The C message 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.

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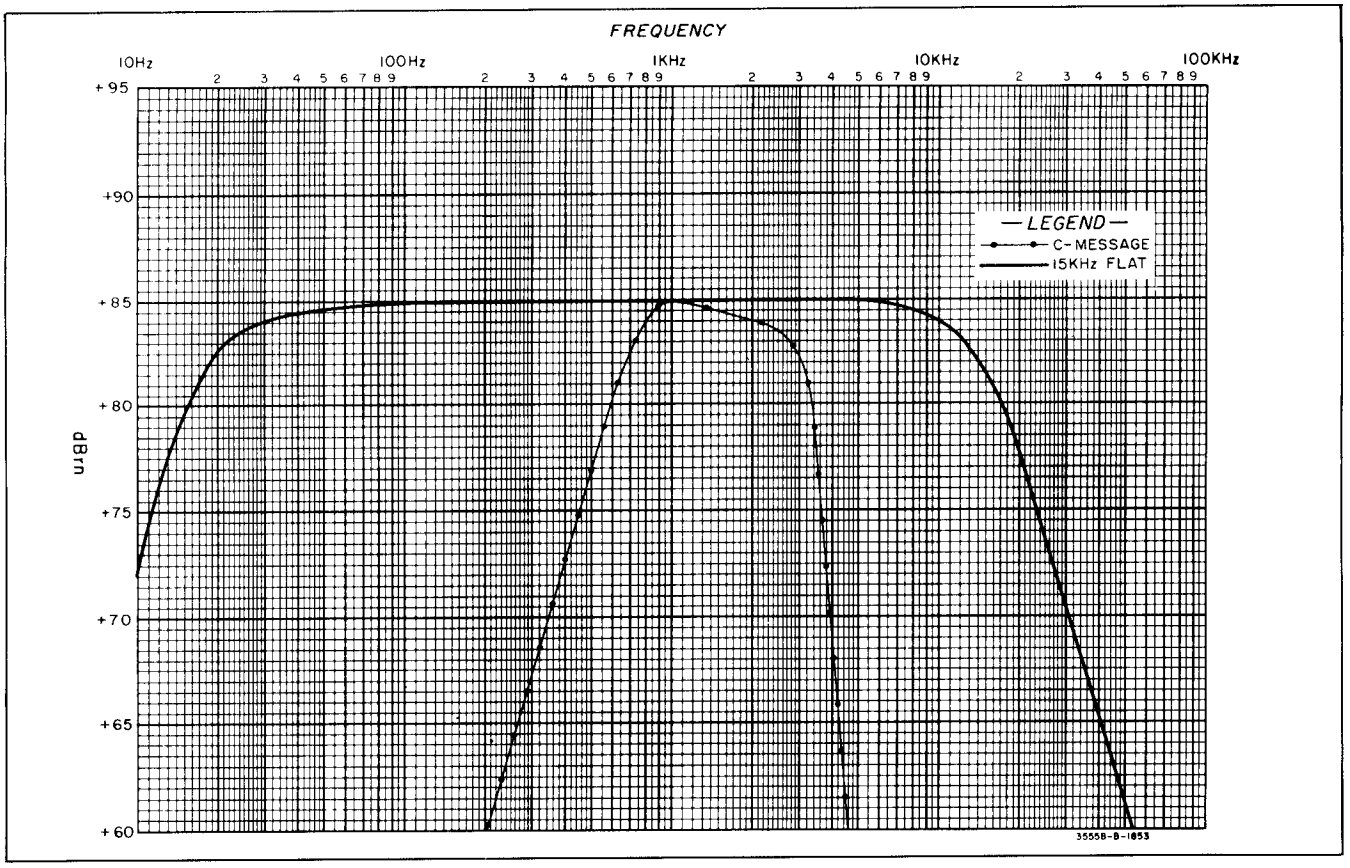


Figure 3-1. C-MSG and 15 kHz FLAT Weighting Curves.

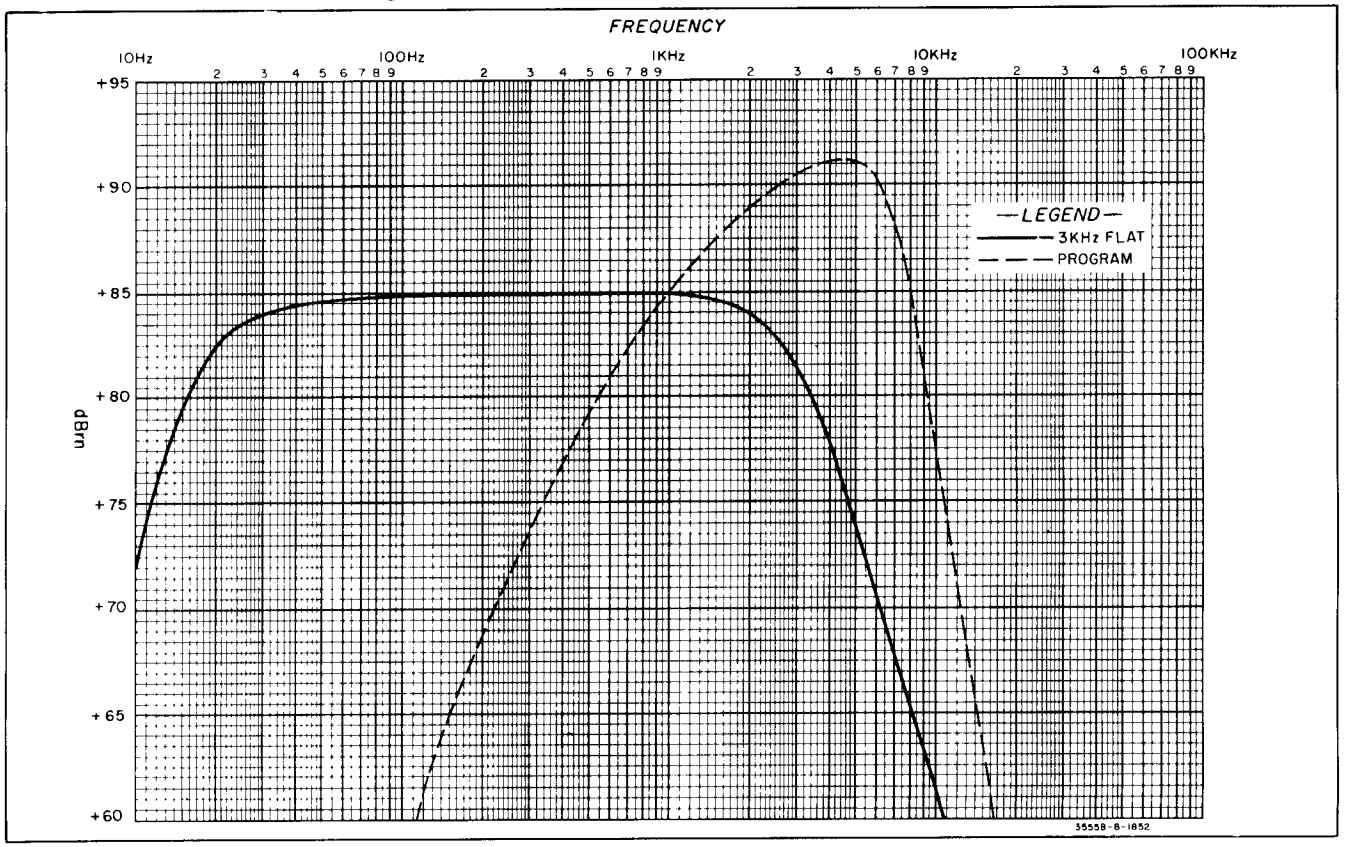


Figure 3-2. 3 kHz FLAT and Program Weighting Curves.

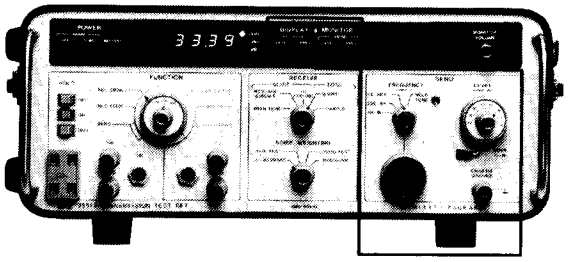
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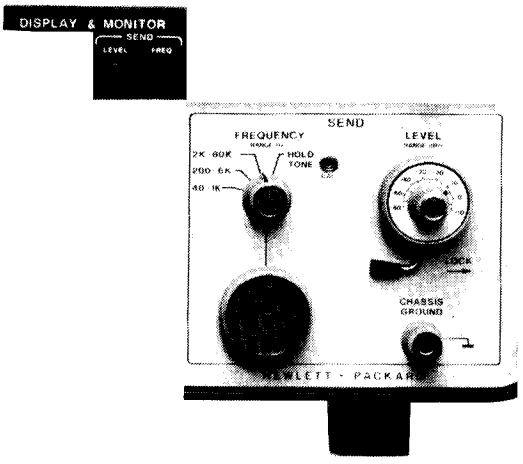
3-31. 3 kHz Flat. The 3 kHz Flat weighting filter is used on voice frequency circuits when investigating low-frequency noise, such as power induction. The frequency response of this filter is shown in Figure 3-2.

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 3-1.

3-33. Program. The Program 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 3-2.

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 autoranging. For a complete description of the display and monitoring operation, refer to Paragraph 3-40.





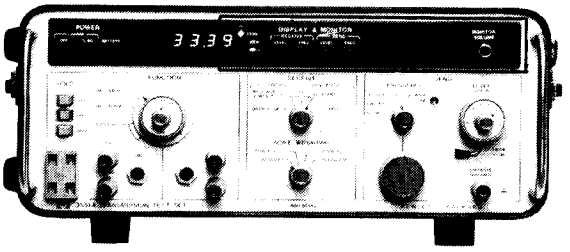
3-35. Send.

3-36. The send function of the Test Set provides the operator with a calibrated test signal at the output jack. The test signal can be variable in frequency from 40 Hz to 60 kHz, or a steady tone of 1004 Hz. The amplitude of the test signal is variable from -60 dBm to +10 dBm. Both frequency and amplitude can be monitored.

3-37. Frequency. The send frequency is controlled by the SEND FREQUENCY RANGE Hz switch and the frequency vernier control. There are three overlapping range positions, and one steady tone position. The range positions are 40 Hz to 600 Hz, 200 Hz to 6 kHz, and 2 kHz to 60 kHz. The hold tone position provides a 1004 Hz tone. A front panel screwdriver adjustment allows operator calibration of the tone. The frequency vernier is a dual (coarse and fine) frequency control.

3-38. Level. The send level is controlled by the SEND LEVEL RANGE dBm 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 autoranging. 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/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 measurements are displayed in three digits expressed in dBm. Receive noise level measurements are displayed in two digits expressed in dBrn.

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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.

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

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 large. The flashing minus 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.

Table 3-1. Input Levels.

Operating Mode	Minimum Level	Maximum Level
Receive noise with tone	10 dBrn	85 dBrn
Receive message circuit noise	0 dBrn	85 dBrn
Receive noise to ground	40 dBrn	125 dBrn
Receive tone, send level and all frequency measurements	-70 dBm	+15 dBm

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.

Table 3-2. Dial and Hold Operation.

Step	Procedures
1.	Turn the Test Set POWER on.
2.	Press the HOLD OFF pushbutton.
3.	Connect a linemans handset (butt-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 310 jack or TIP RING terminals labeled in black.
7.	Press the HOLD DIAL pushbutton and dial with the handset (butt-in).
8.	Press the HOLD ON pushbutton to maintain connection during test.

3-47. OPERATION.

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.

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

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

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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).

4-35. In the MESSAGE CIRCUIT and the 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.

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

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

4-36. Automatic Ranging Circuit.

4-37. Tone Measurements. The automatic measuring circuit compresses the 85 dBm 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.

NOTE

The 46 dB amplification is nominal for 135 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 and may vary ± 4 dB.

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

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

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.

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).

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

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

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.

Example 1:

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.
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

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

- 7 dBm is within the dynamic range of the measuring circuit (+ 5 dBm to - 10 dBm).

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Example 2:

1. Input signal level ..... - 32 dBm
2. Initial range position 5
3. Attenuation (Table 4-3) ..... 20 dB
   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
   Gain (Table 4-3) ..... 10 dB
9. Output of select block ..... - 52 dBm
10. Output of 4 dB amplifier ..... - 48 dBm
11. Input to logger ..... - 2 dBm

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

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).

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).

4-43. Noise Measurements. Noise measurements are ranged identically to the tone measurements. However, the 0 to 85 dBrn dynamic range is referenced to - 90 dBm so the dBm dynamic range is - 90 dBm to - 5 dBm. This 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 noise weighting filters and 5 dB gain in the detector in the measuring circuits. The total amplification between the ranging circuit and the logger is 66 dB for noise measurements.

Example 4:

1. Input signal level ..... - 8 dBrn
   In dBm, referenced to - 90 dBm . - 82 dBm
2. Range position 7
3. Attenuation (Table 4-3) ..... 0 dBm
   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

4-44. Noise Weighting Filters.

4-45. There are four noise weighting filters provided with the Test Set (C-Message, 3 kHz Flat, 15 kHz Flat and Program). 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 RECEIVE TONE position or when one of the DISPLAY and MONITOR SEND pushbuttons is pressed.

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.

4-47. Input Amplifier and Audio Amplifier.

4-48. The input amplifier is an operational amplifier which provides approximately 40 dB of amplification in the 135 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.

4-49. 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 complimentary driver stage for driving an 8 ohm speaker. A front panel MONITOR VOLUME control regulates the amplifier gain.

4-50. Measuring Circuits.

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 7-1, 7-2, and 7-3) for explanation of the mnemonics used in the following description.

4-52. Frequency Measurements. For frequency measurements, the input signal is bufferred in the averaging detector and applied to a sine-wave-to-square-wave converter. The square wave output of the converter is applied to a comparator in the 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 (MFREQ) 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

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÷ 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 H10KH and the H100K control signals from the controller. The controller bases the decision on the output frequency of the VCO (see Paragraph 4-64).

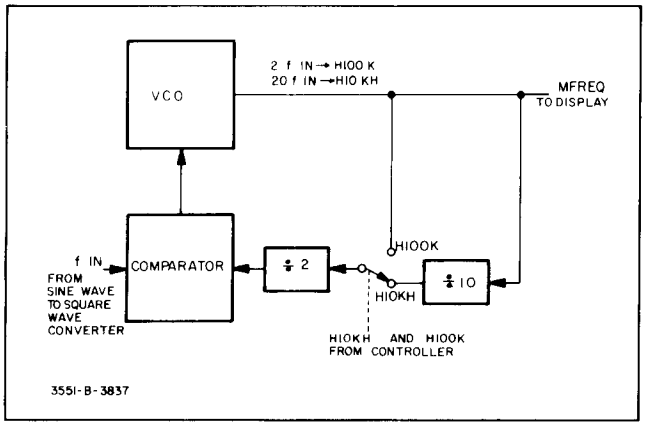


Figure 4-3. Phase-Lock Loop.

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.

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.

4-56. 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 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.

4-57. 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.

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 HCAPD 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 (LXOVR) to the controller (T_5, T_8).

4-59. The controller measures the period between setting HCAPD low and receiving the LXOVR pulse. If LXOVR 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 LXOVR 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 LXOVR occurs after 20 ms from HCAPD going low, the controller interprets this as an underload condition and ranges the automatic ranging circuit down.

4-60. As soon as LXOVR occurs, the controller will set HCAPD high and the measurement cycle will repeat. As noted on Figure 4-4, there is a 15 ms time interval in which the controller will accept LXOVR 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.

4-61. Display.

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 noise level). 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 dBrn with two digits and a resolution of 1 dBrn.

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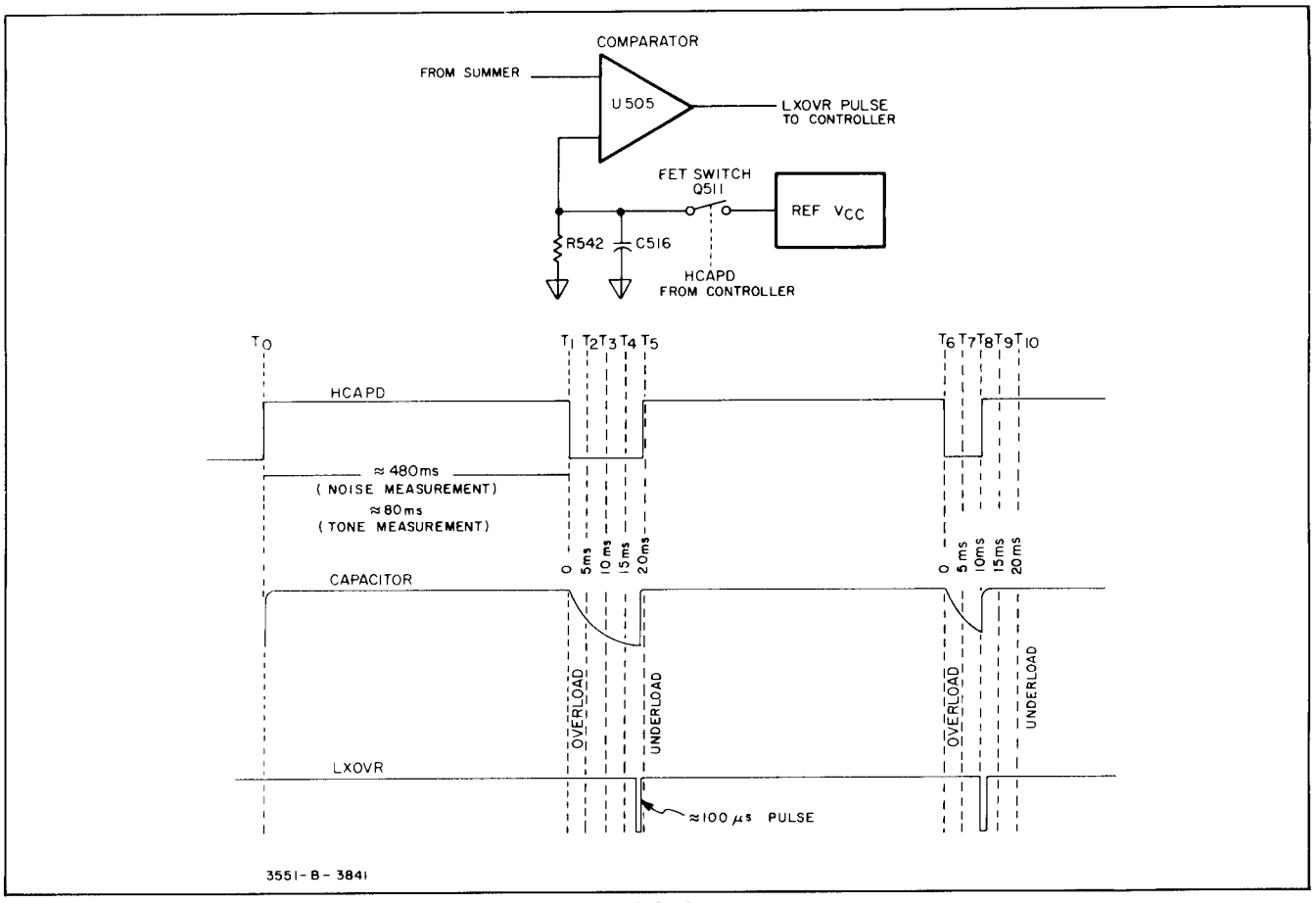


Figure 4-4. Logger.

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.

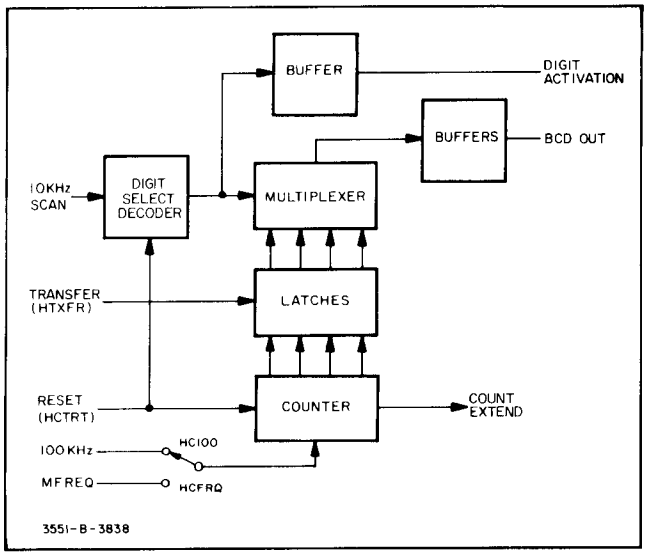


Figure 4-5. Data Accumulator.

4-64. Frequency Measurements. If the measurement to be made is a frequency measurement, the controller will set HCFRQ 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.

4-65. 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 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.

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

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SECTION V
MAINTENANCE

5-1. INTRODUCTION.

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

NOTE

Impedances matching networks are required to match the 50 ohm output of the 3320B Synthesizer used to supply the signals for these performance tests and the Test Set input impedances. Figure 5-1 shows the network configurations for each impedance.

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.

NOTE

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

PERFORMANCE TESTS

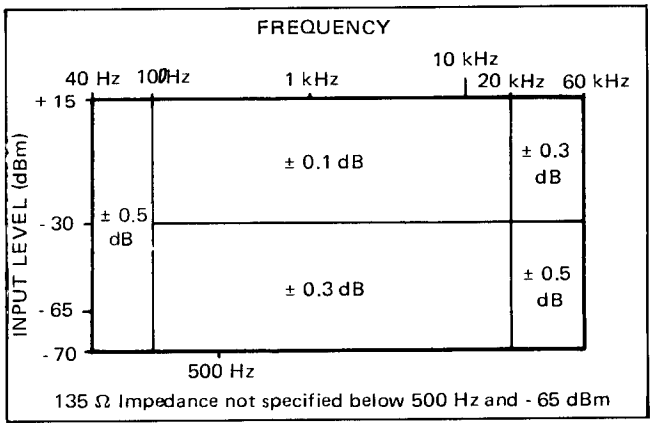
5-7. PERFORMANCE TESTS.

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 5-34. During the Performance Tests, periodically vary the line voltage ± 10% with a power line transformer to determine operation at various ac line voltages.

5-9. Receiver Level Accuracy.

5-10. This performance test determines if the Test Set meets the Receiver Level Measurement accuracy specifications listed in Table 1-1. These specifications are listed again in Table 5-2. The procedure for this performance test uses an oscillator to supply the signals over the frequency range and amplitude range specified. Where the accuracy specification is ± 0.1 dB, the oscillator signal is monitored with an ac voltmeter to ensure proper Test Set input level. The Test Set display indications are monitored to determine the Test Set accuracy.

Table 5-2. Receiver Level Measurement Accuracy.

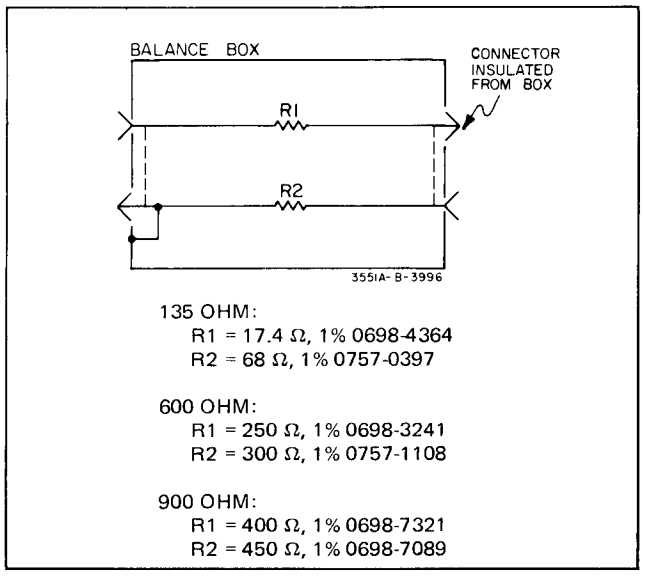


a. Connect the equipment as shown in Figure 5-2.

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

HOLD .....OFF
FUNCTION
(Black Input/Output Terminals) . REC TERM

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135 OHM:
R1 = 17.4 Ω, 1% 0698-4364
R2 = 68 Ω, 1% 0757-0397

600 OHM:
R1 = 250 Ω, 1% 0698-3241
R2 = 300 Ω, 1% 0757-1108

900 OHM:
R1 = 400 Ω, 1% 0698-7321
R2 = 450 Ω, 1% 0698-7089

Figure 5-1. Impedance Box.

RECEIVE
NOISE/TONE . . . . . TONE NORMAL
DISPLAY & MONITOR . . . RECEIVE LEVEL
IMP 135
POWER . . . . . ~ AC

c. Adjust the 3320B for an output frequency of 500 Hz and an output signal level, monitored on the ac voltmeter, of 1.84 V ac.

d. The Test Set display should indicate + 14.0 dBm ± 0.1 dB.

e. Repeat Steps c and d for the frequency settings listed in Table 5-3 under 135 impedance. The Test Set display indications and tolerances are listed in Table 5-4 in the column Input Level Settings, 1.84 V ac.

Table 5-3. Receiver Level Accuracy Test Frequencies.

	Impedance		
	135	600	900
Frequency	500 Hz 1 kHz 10 kHz 20 kHz 40 kHz 60 kHz	100 Hz 1 kHz 10 kHz 20 kHz 40 kHz 60 kHz	100 Hz 1 kHz 10 kHz 20 kHz 40 kHz 60 kHz

f. Repeat Steps c, d and e for the input level settings (under 135) and Test Set display indications listed in Table 5-4. For settings below a - 23 dBm, disconnect the ac voltmeter and set the 3320B output level to the dBm settings listed under oscillator settings in Table 5-4.

g. Repeat Steps c, d, e and f for the 600 and 900 positions of the Test Set front panel IMP control. Use the 600 ohm and 900 ohm impedance box in series with the 3320B output.

5-11. Transmitter Level Accuracy.

5-12. This performance test determines if the Test Set meets the Transmitter Level Accuracy specifications listed in Table 1-1. 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 display

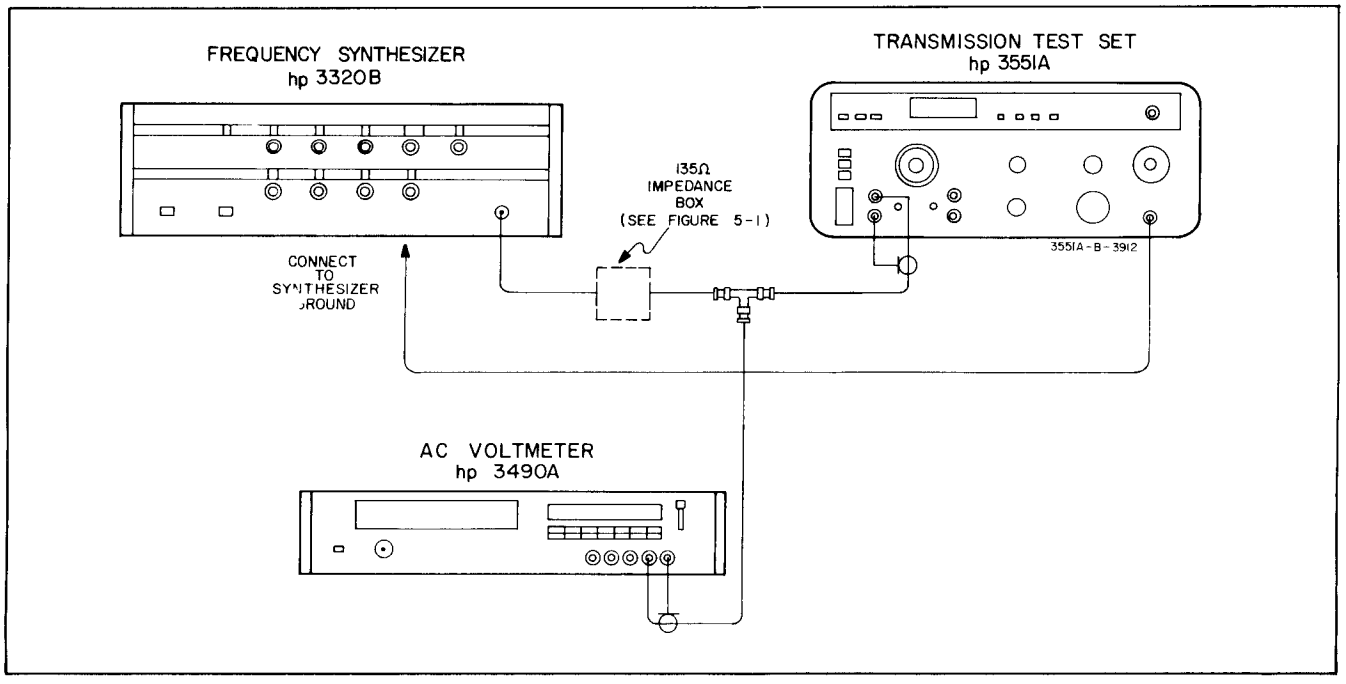


Figure 5-2. Receive Level Accuracy Test Setup.

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Table 5-4. Receiver Level Accuracy Test Specifications.

Input Level Settings (AC Voltmeter, V ac)			Test Set Display	
135	600	900	For Frequencies of 100 Hz to 20 kHz	For Frequencies of 40 kHz and 60 kHz
1.84	3.88	4.75	+ 14.0 ± 0.1	+ 14.0 ± 0.3
1.46	3.08	3.78	+ 12.0 ± 0.1	+ 12.0 ± 0.3
1.16	2.45	3.00	+ 10.0 ± 0.1	+ 10.0 ± 0.3
0.922	1.95	2.38	+ 8.0 ± 0.1	+ 8.0 ± 0.3
0.733	1.55	1.89	+ 6.0 ± 0.1	+ 6.0 ± 0.3
0.582	1.23	1.50	+ 4.0 ± 0.1	+ 4.0 ± 0.3
0.462	0.975	1.19	+ 2.0 ± 0.1	+ 2.0 ± 0.3
0.367	0.775	0.949	0.0 ± 0.1	0.0 ± 0.3
0.260	0.548	0.672	- 3.0 ± 0.1	- 3.0 ± 0.3
0.0823	0.173	0.212	- 13.0 ± 0.1	- 13.0 ± 0.3
0.0260	0.0548	0.0672	- 23.0 ± 0.1	- 23.0 ± 0.3
(synthesizer settings dBm)				
- 28.7	- 22.2	- 20.4	- 33.0 ± 0.3	- 33.0 ± 0.5
- 38.7	- 32.2	- 30.4	- 43.0 ± 0.3	- 43.0 ± 0.5
- 48.7	- 42.2	- 40.4	- 53.0 ± 0.3	- 53.0 ± 0.5
- 58.7	- 52.2	- 50.4	- 63.0 ± 0.3	- 63.0 ± 0.5

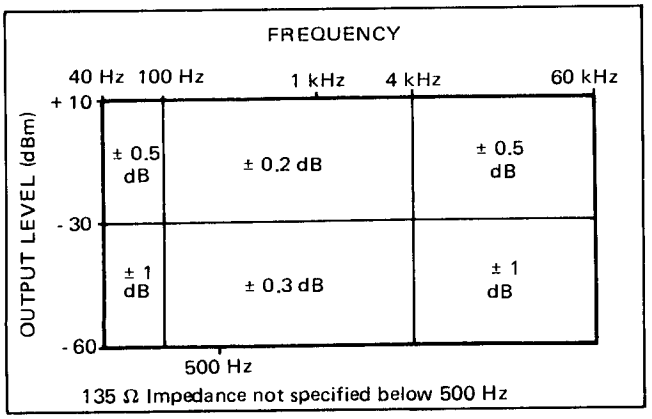
indicates the desired output level. For this reason, the level accuracy of the Test Set output is determined by the accuracy of the receive circuits. These circuits were tested in the previous performance test. It is only necessary, in this procedure, to test the frequency response of the Test Set output transformer and the overall range of the send oscillator level controls. The procedure uses a 3490A 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.

a. Connect an ac voltmeter to the blue input/output terminals. Connect a 135 ohm resistor across these terminals.

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

HOLD ..... OFF
FUNCTION
(Blue Input/Output Terminals) ..... SEND
IMP 135
SEND FREQUENCY RANGE Hz. . . . . 40 - 1K
SEND LEVEL RANGE dBm . . . . . 0 to + 10
DISPLAY & MONITOR ..... SEND FREQ
POWER ..... ~ AC

Table 5-5. Transmitter Level Measurement Accuracies.



c. Adjust the Test Set FREQUENCY vernier control for a Test Set display indication of 0.500 kHz.

d. Set the Test Set front panel DISPLAY& MONITOR control to SEND LEVEL.

e. Adjust the Test Set front panel SEND LEVEL vernier for a Test Set display of + 10.0 dBm.

f. The 3490A indication should be 1.16 V rms ± 0.03 V rms.

g. Repeat Steps c, d, e and f for the frequency settings listed in Table 5-3 under 135 impedance. For frequencies above 4 kHz, the 3490A tolerance should be ± 0.07 V rms.

h. Adjust the Test Set front panel SEND LEVEL vernier fully CW. The Test Set display indication should be greater than + 10.0 dBm.

i. Set the Test Set front panel SEND LEVEL RANGE dBm control to the - 10 to 0 position. The Test Set display indication should be greater than 0.0 dBm.

j. Repeat Step i for each of the remaining positions of the Test Set front panel SEND LEVEL RANGE dBm control. At each setting the Test Set display indication should be greater than the top indication of the range control position.

k. Set the Test Set front panel SEND LEVEL vernier fully CCW and the SEND LEVEL RANGE dBm 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 RANGE dBm control to the - 50 to - 40 position. The Test Set display indication should be less than - 50.0 dBm.

m. Repeat Step l for each of the remaining positions of the Test Set front panel SEND LEVEL RANGE dBm

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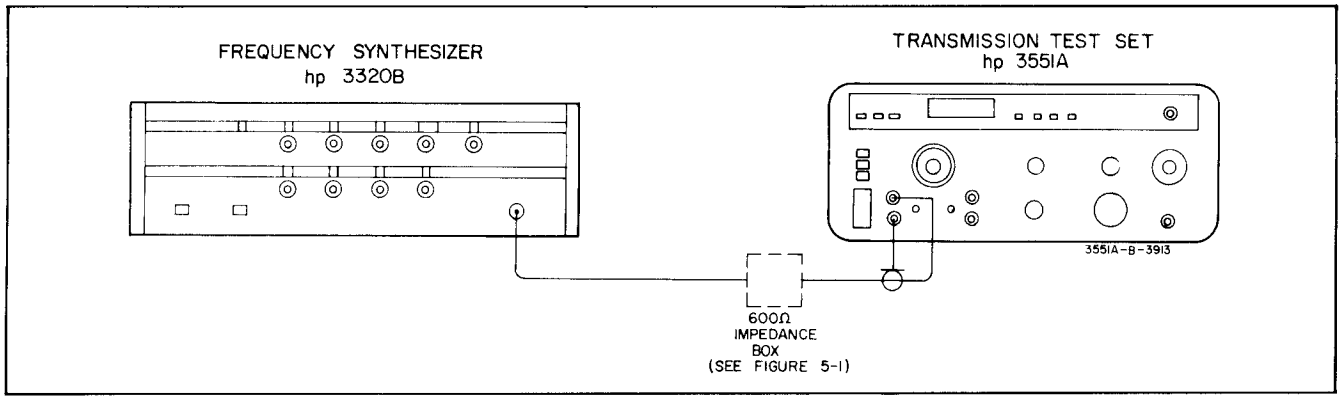


Figure 5-3. Frequency Accuracy Test Setup.

control. At each setting the Test Set display indication should be less than the bottom indication of the range control position.

5-13. Receiver Frequency Accuracy.

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. The procedure uses a 3320B Oscillator to supply the signals over the frequency range of the Test Set.

a. Connect the equipment as shown in Figure 5-3.

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

HOLD . . . . . OFF
FUNCTION
(Black Input/Output Terminals) . REC TERM
IMP 600
RECEIVE
NOISE/TONE. . . . . TONE NORMAL
DISPLAY & MONITOR . . . . RECEIVE FREQ
POWER . . . . . ~ AC

c. Set the 3320B frequency to 40 Hz.

d. The Test Set display should indicate 0.040 kHz ± 0.001 kHz.

e. Repeat Steps c and d for the frequency settings and tolerances listed in Table 5-6.

Table 5-6. Receiver Frequency Accuracy Test Frequencies and Specifications.

Synthesizer Frequency	Test Set Display
100 Hz	0.100 ± 0.001
1 kHz	1.000 ± 0.001
10 kHz	10.00 ± 00.01
20 kHz	20.00 ± 00.01
60 kHz	60.00 ± 00.01

5-15. Transmitter Frequency Accuracy.

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.

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

SEND FREQUENCY RANGE Hz. . . . 40 - 1 K
SEND LEVEL RANGE dBm . . . . . 0 to + 10
DISPLAY & MONITOR . . . . . .SEND FREQ
POWER. . . . . ~ AC

b. Adjust the Test Set SEND FREQUENCY vernier fully CCW. The Test Set display indication should be less than 0.040 kHz.

c. Adjust the Test Set SEND FREQUENCY vernier fully CW. The Test Set display indication should be greater than 0.600 kHz.

d. 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.

e. Adjust the Test Set SEND FREQUENCY vernier fully CCW. The Test Set display indication should be less than 0.200 kHz.

f. 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.

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g. Adjust the Test Set SEND FREQUENCY vernier fully CW. The Test Set display indication should be greater than 60.00 kHz.

5-17. Noise Weighting Filters Response.

5-18. This performance test determines if the Test Set meets the Weighting Filters Response specifications listed in Table 1-1. The specifications conform to the Bell System Technical Reference PUB 41009. This performance test uses the 3320B Synthesizer to provide the signal and the Test Set display is used to monitor the filter accuracies.

NOTE

This performance test uses two groups of tables. Group 1, consisting of Tables 5-8, 5-10, and 5-12, will be used with Test Sets which contain A or B revisions of the A1 board. Part No. 03551-66501. Group 2, consisting of Tables 5-7, 5-9, and 5-11, will be used with C revisions or higher boards.

a. Connect the 3320B through the 600 ohm impedance box to the Test Set black input/output terminals.

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

HOLD ..... OFF
FUNCTION
(Black Input/Output Terminals) . REC TERM
IMP 600
RECEIVE
NOISE/TONE..... TONE NORMAL
NOISE WEIGHTING ..... C MESSAGE
DISPLAY & MONITOR ... RECEIVE LEVEL
POWER ..... ~ AC

c. Connect a ground lead from the input side of the impedance box to the Test Set chassis ground.

d. Adjust the 3320B to a frequency of 1 kHz at an amplitude of - 7.0 dBm. Verify a Test Set display of 83 dBrn.

NOTE

If the Test Set display is not 83 dBrn, adjust the synthesizer output level until the display is correct. This reference input must be maintained during the entire test (Table 5-7). If your instrument requires the use of Table 5-8, the synthesizer output deviation from - 7 dB must be maintained throughout the test.

e. Adjust the 3320B to a frequency and amplitude level settings shown in Table 5-7. After each synthesizer adjustment compare the Test Set Display to the readings shown in the Indication and Tolerances column.

NOTE

Test Sets containing the A or B revision of the A1 board will not be able to display the third digit. These Test Sets should perform the C Message performance tests using Table 5-8.

f. Set the Test Set front panel NOISE WEIGHTING control to the 3 kHz Flat position.

Table 5-7. Noise Weighting Filter, C Message. (For Expanded Display)

Synthesizer Level (dBm)	Synthesizer Frequency (Hz)	Test Set Display Indication and Tolerances (dBrn) C Message
- 7.0	60	27.3 ± 2 dB
- 7.0	100	40.5 ± 2 dB
- 7.0	200	57 ± 2 dB
- 7.0	300	66.5 ± 2 dB
- 7.0	400	71.6 ± 1 dB
- 7.0	500	75.5 ± 1 dB
- 7.0	600	78.3 ± 1 dB
- 7.0	700	80.3 ± 1 dB
- 7.0	800	81.5 ± 1 dB
- 7.0	900	82.4 ± 1 dB
- 7.0	1,000	83 dB REF
- 7.0	1,200	82.8 ± 1 dB
- 7.0	1,300	82.5 ± 1 dB
- 7.0	1,500	82 ± 1 dB
- 7.0	1,800	81.7 ± 1 dB
- 7.0	2,000	81.7 ± 1 dB
- 7.0	2,500	81.6 ± 1 dB
- 7.0	2,800	81.1 ± 1 dB
- 7.0	3,000	80.5 ± 1 dB
- 7.0	3,300	77.8 ± 2 dB
- 7.0	3,500	75.4 ± 2 dB
- 7.0	4,000	68.5 ± 3 dB
- 7.0	4,500	61.5 ± 3 dB
- 7.0	5,000	54.5 ± 3 dB
- 7.0	10,000	< 41 dB
- 7.0	40,000	< 23 dB

Table 5-8. Noise Weighting Filter, C-Message.

Synthesizer Level (dBm)	Synthesizer Frequency (Hz)	Test Set Display Indication and Tolerances (dBrn) C-Message
- 7.3	60	27 ± 2 dB
- 7.5	100	40 ± 2 dB
- 7.0	200	57 ± 2 dB
- 7.5	300	66 ± 2 dB
- 7.6	400	71 ± 1 dB
- 7.5	500	75 ± 1 dB
- 7.3	600	78 ± 1 dB
- 7.3	700	80 ± 1 dB
- 7.5	800	81 ± 1 dB
- 7.4	900	82 ± 1 dB
- 7.0	1000	83 REF
- 7.8	1200	82 ± 1 dB
- 7.5	1300	82 ± 1 dB
- 7.0	1500	82 ± 1 dB
- 7.7	1800	81 ± 1 dB
- 7.7	2000	81 ± 1 dB
- 7.6	2500	81 ± 1 dB
- 7.1	2800	81 ± 1 dB
- 7.5	3000	80 ± 1 dB
- 7.8	3300	77 ± 2 dB
- 7.4	3500	75 ± 2 dB
- 7.5	4000	68 ± 3 dB
- 7.5	4500	61 ± 3 dB
- 7.5	5000	54 ± 3 dB
- 7.0	10,000	< 41
- 7.0	40,000	< 23

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g. Adjust the 3320B to a frequency of 1 kHz at an amplitude of - 8.0 dBm. Verify a Test Set display of 82 dBrn.

NOTE

If the Test Set display is not 82 dBrn, adjust the synthesizer output level until the display is correct. This reference input must be maintained during the entire test (Table 5-9). If your instrument requires the use of Table 5-10, the synthesizer output deviation from - 8 dB must be maintained throughout the test.

h. Adjust the 3320B to the frequency and amplitude level settings shown in Table 5-9. After each oscillator adjustment compare the Test Set display to the readings shown in the table.

NOTE

Test Sets containing the A or B revision A1 board should perform the 3 kHz Flat performance tests using Table 5-10.

Table 5-9. Noise Weighting Filter, 3 kHz Flat, 15 kHz Flat. (For Expanded Display)

Synthesizer Level (dBm)	Synthesizer Frequency (Hz)	Test Set Display and Tolerances (dBrn)	
		3 kHz Flat	15 kHz Flat
- 8.0	60	82 ± 2 dB	82 ± 2 dB
- 8.0	250	82 ± 1 dB	82 ± 1 dB
- 8.0	1,000	82 REF	82 REF
- 8.0	2,000	81.5 ± 2 dB	
- 8.0	2,500	80.5 ± 2 dB	
- 8.0	3,000	79 ± 3 dB	
- 8.0	10,000		81.2 ± 2 dB
- 8.0	15,000		79 ± 3 dB
- 8.0	20,000		75.8 ± 3 dB
- 8.0	30,000	< 42 dB	69.7 ± 3 dB
- 8.0	60,000	< 30 dB	< 57 dB

Table 5-10. Noise Weighting Filters, 3 kHz Flat, 15 kHz Flat.

Synthesizer Level (dBm)	Synthesizer Frequency (Hz)	Test Set Display Indication and Tolerances (dBrn)	
		3 kHz Flat	15 kHz Flat
- 8.0	60	82 ± 2 dB	82 ± 2 dB
- 8.0	250	82 ± 1 dB	82 ± 1 dB
- 8.0	1000	82 REF	82 REF
- 8.5	2000	81 ± 2 dB	
- 8.5	2500	80 ± 2 dB	
- 8.0	3000	79 ± 3 dB	
- 8.2	10,000		81 ± 2 dB
- 8.0	15,000		79 ± 3 dB
- 8.8	20,000		75 ± 3 dB
- 8.7	30,000	< 42	69 ± 3 dB
- 8.0	60,000	< 30	< 57

i. Set the Test Set front panel NOISE WEIGHTING control to the 15 kHz Flat position.

j. Adjust the 3320B for a frequency of 1 kHz at an amplitude of - 8.0 dBm. Verify a Test Set display of 82 dBrn.

k. Repeat Step h for the 15 kHz Flat position.

l. Set the Test Set front panel NOISE WEIGHTING control to the PROGRAM position.

m. Adjust the 3320B for a frequency of 1 kHz at an amplitude of - 16.0 dBm. Verify a Test Set display of + 74 dBrn.

NOTE

If the Test Set display is not 74 dBrn, adjust the synthesizer output level until the display is correct. This reference input must be maintained during the entire test (Table 5-11). If your instrument requires the use of Table 5-12, the synthesizer output deviation from - 16 dB must be maintained throughout the test.

n. Adjust the 3320B to the frequency and amplitude level settings shown in Table 5-11. After each oscillator adjustment compare the Test Set display to the readings shown in the table.

NOTE

Test Sets containing the A or B revision A1 board should perform the Program Performance Tests using Table 5-12.

Table 5-11. Noise Weighting Filter Program. (For Expanded Display)

Oscillator Level (dBm)	Oscillator Frequency (Hz)	Test Set Display Indication and Tolerances (dBrn) Program
- 16.0	100	47.7 ± 2 dB
- 16.0	200	56.7 ± 2 dB
- 16.0	300	61.8 ± 2 dB
- 16.0	400	65 ± 2 dB
- 16.0	500	67.4 ± 1 dB
- 16.0	600	69.3 ± 1 dB
- 16.0	700	70.8 ± 1 dB
- 16.0	800	72 ± 1 dB
- 16.0	900	73.2 ± 1 dB
- 16.0	1,000	74 REF
- 16.0	1,500	77.2 ± 1 dB
- 16.0	2,000	78.8 ± 2 dB
- 16.0	2,500	79.6 ± 2 dB
- 16.0	3,000	80 ± 2 dB
- 16.0	4,000	80.5 ± 2 dB
- 16.0	5,000	80.5 ± 3 dB
- 16.0	6,000	80.4 ± 3 dB
- 16.0	7,000	79.8 ± 3 dB
- 16.0	8,000	78 ± 4 dB
- 16.0	9,000	72.5 ± 4 dB
- 16.0	10,000	65.5 ± 4 dB
- 16.0	20,000	< 56 dB
- 16.0	60,000	< 41 dB

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5-19. Receiver Noise Accuracy.

5-20. This performance test determines if the Test Set meets the Receiver Noise Measurement Accuracy Specifications listed in Table 1-1. The specifications are:

Message circuit noise:
± 1 dB (+ 20 dBrn to + 85 dBrn).
± 2 dB (0 dBrn to + 20 dBrn).
Noise-with tone:
± 1 dB (+ 20 dBrn to + 85 dBrn).
± 2 dB (+ 10 dBrn to + 20 dBrn).
Noise-to-ground:
± 1 dB (+ 60 dBrn to + 125 dBrn).
± 2 dB (+ 40 dBrn to + 60 dBrn).

This performance test uses a 3320B Oscillator to supply a reference signal at levels through the dynamic range of the Test Set.

a. Connect the 3320B through the 600 ohm impedance box to the Test Set black input/output terminals.

Table 5-12. Noise Weighting Filter, Program.

Synthesizer Level (dBm)	Synthesizer Frequency (Hz)	Test Set Display Indication and Tolerances (dBrn) Program
- 15.7	100	48 ± 2 dB
- 15.7	200	57 ± 2 dB
- 15.8	300	62 ± 2 dB
- 16.0	400	65 ± 2 dB
- 16.4	500	67 ± 1 dB
- 16.3	600	69 ± 1 dB
- 15.8	700	71 ± 1 dB
- 16.0	800	72 ± 1 dB
- 16.2	900	73 ± 1 dB
- 16.0	1000	74 REF
- 16.2	1500	77 ± 1 dB
- 15.8	2000	79 ± 2 dB
- 15.6	2500	80 ± 2 dB
- 16.0	3000	80 ± 2 dB
- 15.5	4000	81 ± 2 dB
- 15.5	5000	81 ± 3 dB
- 16.4	6000	80 ± 3 dB
- 15.8	7000	80 ± 3 dB
- 16.0	8000	78 ± 4 dB
- 15.5	9000	73 ± 4 dB
- 15.5	10,000	66 ± 4 dB
- 15.0	20,000	< 56
- 16.0	60,000	< 41

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
NOISE WEIGHTING . . . . . .3 kHz FLAT
DISPLAY & MONITOR . . . RECEIVE LEVEL
POWER . . . . . ~ AC

c. Adjust the 3320B for 1 kHz and + 3.90 dBm. The Test Set display should indicate + 83 dBrn ± 1 dB.

d. Set the 3320B to - 6.10 dBm. The Test Set display should indicate 73 dBrn ± 1 dB.

e. Repeat Step d for the 3320B output level settings and Test Set display indications and tolerances listed in Table 5-13.

f. Set the 3320B output level to + 3.90 dBm. Ground the Test Set GROUND terminal to earth ground.

g. Set the Test Set front panel RECEIVE NOISE/TONE control to the TO GROUND position. The Test Set display should indicate + 83 dBrn ± 1 dB.

h. Adjust the 3320B frequency to 400 Hz.

i. Set the Test Set front panel RECEIVE NOISE/TONE control to the WITH TONE position. The Test Set display indication should be + 83 dBrn ± 1 dB.

j. Adjust the 3320B for 1700 Hz. The Test Set display indication should be + 83 dBrn ± 1 dB.

k. Repeat Steps d and e.

l. Adjust the 3320B to 995 Hz and + 3.90 dBm. The Test Set display indication should be less than 33 dBrn.

m. Repeat Step l for a 3320B frequency setting of 1025 Hz.

n. Adjust the 3320B to 862 Hz and + 3.90 dBm. The Test Set display indication should be at least 80 dBrn.

o. Repeat Step n for a 3320B frequency of 1182 Hz.

Table 5-13. Receiver Noise Accuracy Test Levels and Specifications.

Synthesizer Output Level (dBm)	Test Set Display Indication and Tolerances
- 16.10	+ 63 dBrn ± 1 dB
- 26.10	+ 53 dBrn ± 1 dB
- 36.10	+ 43 dBrn ± 1 dB
- 46.10	+ 33 dBrn ± 1 dB
- 56.10	+ 23 dBrn ± 1 dB
- 66.10	+ 13 dBrn ± 2 dB

5-21. Transmitter Harmonic Distortion.

5-22. 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 20 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 and > - 40 dB below reference from 40 Hz to 100 Hz and 4 kHz

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to 20 kHz. The discrete harmonic distortion specification is >- 55 dB below reference from 100 Hz to 4 kHz. The harmonic distortion specification for the 1004 Hz hold tone is >- 60 dB below reference for total harmonic distortion.

5-23. This performance test uses the 331A distortion analyzer to test the total harmonic distortion and a wave analyzer to test the discrete harmonic distortion.

a. Connect the 331A to the Test Set blue input/output terminals. Connect a 135 ohm resistor across the distortion analyzer input terminals.

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

HOLD ..... OFF
FUNCTION
(Blue Input/Output Terminals) ..... SEND
IMP 135
SEND FREQUENCY RANGE Hz. . . . .40 - 1K
SEND LEVEL RANGE dBm ..... 0 to + 10
DISPLAY & MONITOR ..... SEND FREQ
POWER ..... ~ AC

c. Adjust the Test Set SEND FREQUENCY vernier for a Test Set display indication of 40 Hz.

d. Adjust the Test Set SEND LEVEL vernier for a convenient reference on the distortion analyzer meter.

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 d.

f. Repeat Step e for the frequencies and specifications listed in Table 5-14.

g. Disconnect the 331A and connect the 3591A Selective Voltmeter to the Test Set blue input/output terminals. Set the 3591A input impedance to 135 ohms.

Table 5-14. Transmitter THD Test Frequencies and Specifications.

Test Set Frequency	Specification (dB Below Reference)
60 Hz	> 40
100 Hz	> 50
500 Hz	> 50
1 kHz	> 50
2 kHz	> 50
4 kHz	> 50
10 kHz	> 40
15 kHz	> 40
20 kHz	> 40
1004 Hz Hold Tone	> 60

h. Using the procedures outlined in the 3591A Operating and Service Manual, measure the second, third and fourth harmonics of each of the frequencies listed in Table 5-15. The 3591A indications for all harmonics should be more than 55 dB below the reference.

Table 5-15. Transmitter Discrete Harmonic Distortion Test Frequencies.

Test Set Frequency
100 Hz
500 Hz
1 kHz
2 kHz
4 kHz

5-24. Bridging Loss.

5-25. 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 a 3320B oscillator output is applied to a 3490A 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 5-4 with the Test Set disconnected.

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

HOLD ..... OFF
FUNCTION
(Black Input Terminals) ..... REC BRDG
POWER ..... ~ AC

c. Adjust the 3320B output for 100 Hz and a 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.

e. Adjust the 3320B for 20 kHz. The voltmeter indication should not vary more than 20 mV ac.

f. Adjust the 3320B for 60 kHz. The voltmeter indication should not vary more than 20 mV ac.

5-26. Return Loss.

5-27. 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 60 kHz for 135 ohm impedance and greater than 30 dB below the reference from 40 Hz to 20 kHz for the 600 ohm and 900 ohm impedance. To perform this test, it is necessary to construct a balanced bridge utilizing 0.1% resistors for each of the Test Set impedances. The bridge is shown in Figure 5-5. This performance test substitutes the impedance of the Test Set for a short in one leg of the

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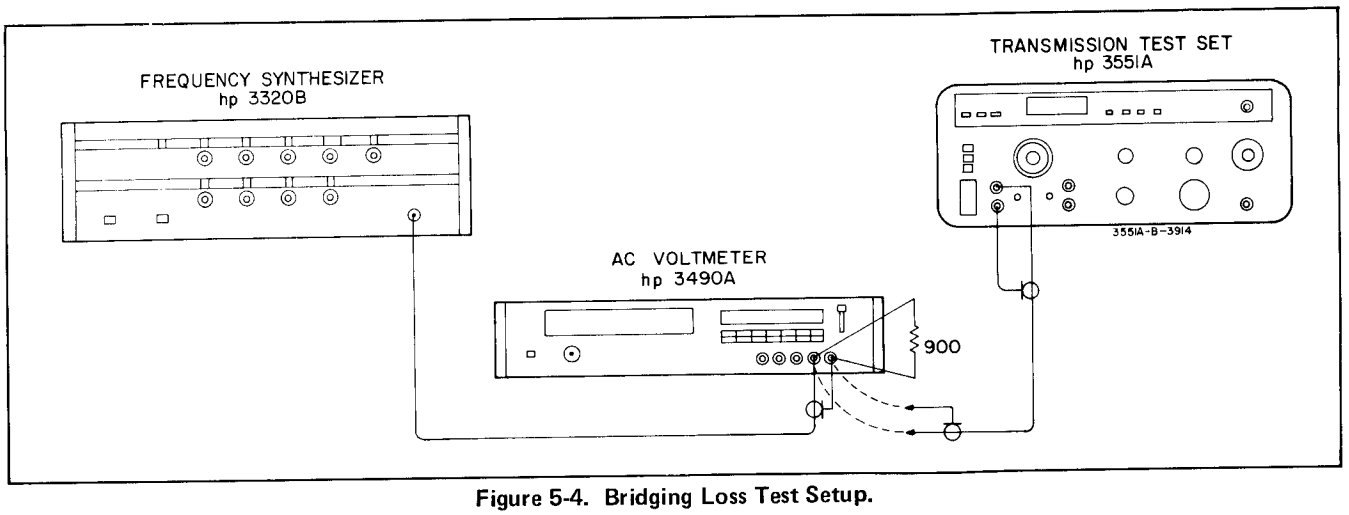


Figure 5-4. Bridging Loss Test Setup.

bridge. The short simulates maximum return loss. The difference voltage between the reference set while the short is in the bridge and when the Test Set impedance is placed in the bridge determines the return loss for the Test Set.

a. Connect the equipment as shown in Figure 5-5 using 135 ohm resistors in the bridge.

NOTE

The leads for the Test Set should be short clip leads and should be kept away from each other and from other leads. Keep all instruments away from other instruments in the test setup that may be referenced to earth ground.

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

HOLD ..... OFF
FUNCTION
(Black Input/Output Terminals) . REC TERM
IMP 135
POWER ..... ~ AC

c. Close S1 in the test setup. Adjust the 3320B for 1 kHz and 1.000 V ac indication on the 3490A.

d. Open S1 in the test setup. The indication on the 3490A should be less than 0.03 V ac.

e. Disconnect R4 in the test setup and connect the Test Set black input terminals in its place.

f. Close S1 and recheck the reference indication on the ac voltmeter. Open S1. The 3490A indication should be less than 0.031 V ac.

g. Tune the 3320B from 500 Hz to 60 kHz. The 3490A indication should remain less than 0.031 V ac. If at any frequency the voltage indication is out of specification, recheck the reference voltage at that frequency.

h. Repeat Steps c through g with the Test Set front panel IMP control in the 600 and 900 position. Use 600 ohm and 900 ohm resistors for the bridge circuitry

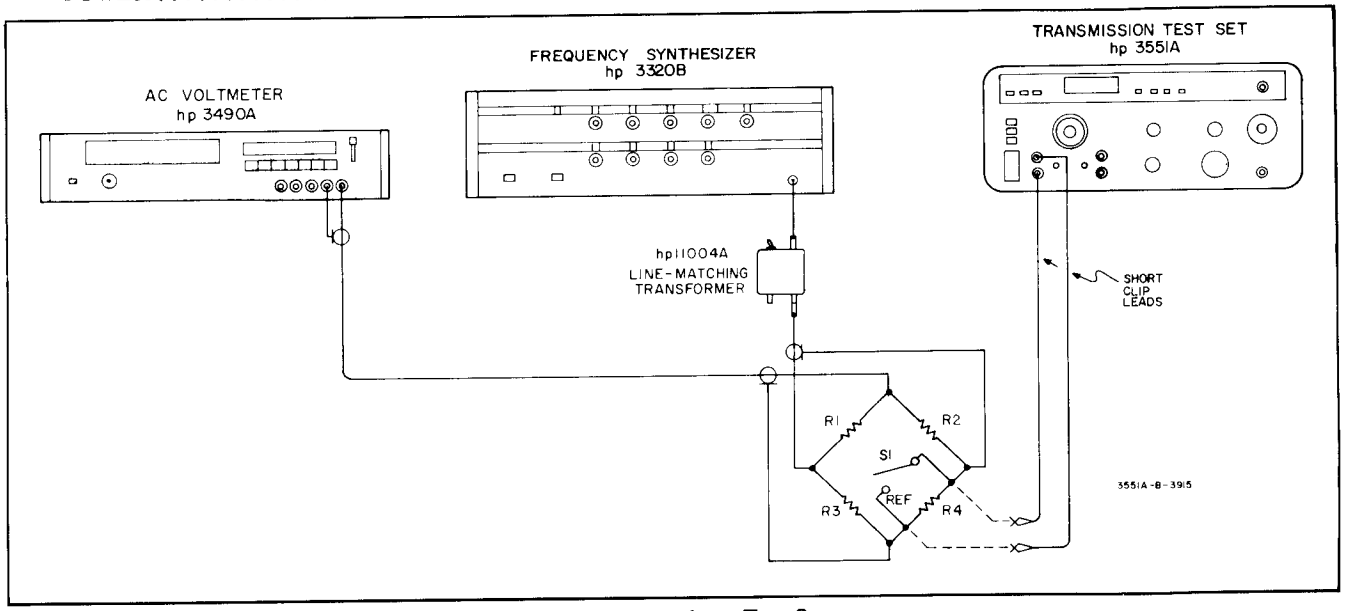


Figure 5-5. Return Loss Test Setup.

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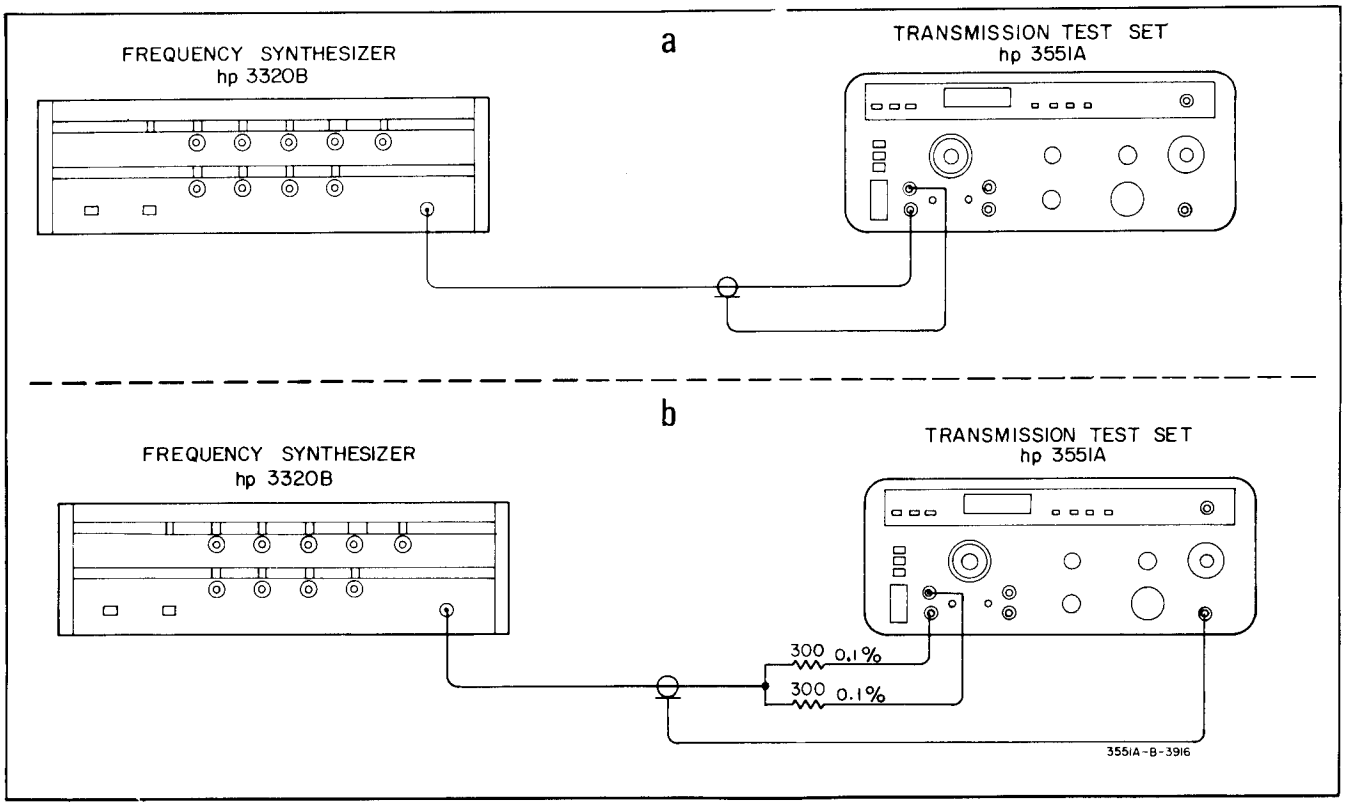


Figure 5-6(a,b). Receiver Balance Test Setup.

respectively. In Step g, tune the 3320B from 40 Hz to 20 kHz. All 3490A indications should be less than 0.031 V ac.

5-28. Longitudinal Balance.

5-29. 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.

5-30. The procedure for the receiver balance uses a 3320B oscillator 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.

5-31. The transmitter balance is tested in the same way except the Test Set serves as the oscillator and a 3490A external ac voltmeter serves as the monitor.

Receiver:

a. Connect the equipment as shown in Figure 5-6(a).

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

HOLD . . . . . OFF
FUNCTION
(Black Input/Output Terminals) . REC BRDG
IMP 600
RECEIVE
NOISE/TONE. . . . . TONE NORMAL
DISPLAY & MONITOR . . . RECEIVE LEVEL
POWER . . . . . ~ AC

c. Adjust the 3320B output for 6 kHz and a Test Set display indication of 0.0 dBm.

d. Connect the test equipment as shown in Figure 5-6(b).

e. The Test Set display indication should be greater than 60 dB below the 0.0 dBm reference of Step c.

Transmitter:

a. Connect the 3490A to the Test Set blue input/output terminals. Connect a 135 ohm resistor across the Test Set terminals.

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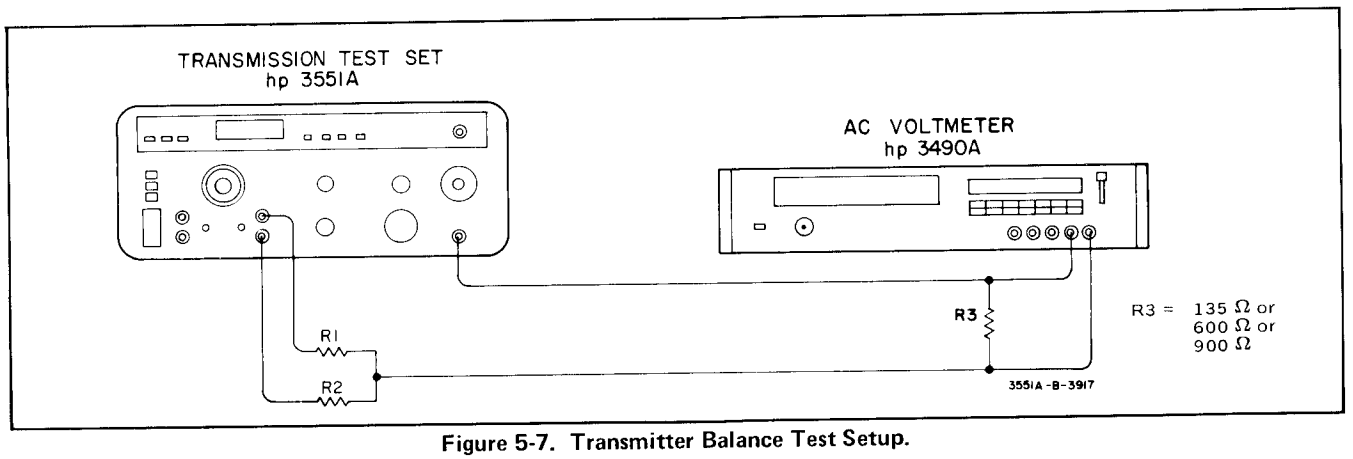


Figure 5-7. Transmitter Balance Test Setup.

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

HOLD . . . . . OFF
FUNCTION
(Blue Input/Output Terminals) . . . . . SEND
IMP 135
SEND FREQUENCY RANGE Hz . . 2 K - 60 K
SEND LEVEL RANGE dBm . . . . . 0 to + 10
DISPLAY & MONITOR . . . . . SEND FREQ
POWER . . . . . ~ AC

c. Adjust the Test Set SEND FREQUENCY vernier for 6 kHz on the Test Set display.

d. Adjust the Test Set SEND LEVEL for a 1.00 V ac indication on the 3490A.

e. Connect the equipment as shown in Figure 5-7. Use two 67.5 ohm resistors for R1 and R2.

f. The ac voltmeter indication should be less than 3.0 mV ac.

g. Repeat Steps a through f for the 600 and 900 positions of the Test Set IMP control. For the 600 position, use a 600 ohm resistor in Step a and two 300 ohm resistors in Figure 5-7 for R1 and R2. For the 900 position use a 900 ohm resistor in Step a and two 450 ohm resistors in Figure 5-7 for R1 and R2.

5-32. Hold Current.

5-33. This performance test determines if the Test Set meets the hold circuit specification listed in Table 1-1. The specification is greater than 24 milliamps. This performance test uses a 6215A dc power supply to supply the current for the holding circuit.

a. Connect the equipment as shown in Figure 5-8 with the Test Set disconnected.

b. Set the 6215A supply to + 12 V as indicated by the dc voltmeter.

c. Connect the Test Set. Press the Test Set front panel HOLD ON pushbutton and set the FUNCTION (black input/output terminal) to REC BRDG.

d. The 3490A indication should be less than 7.2 V dc.

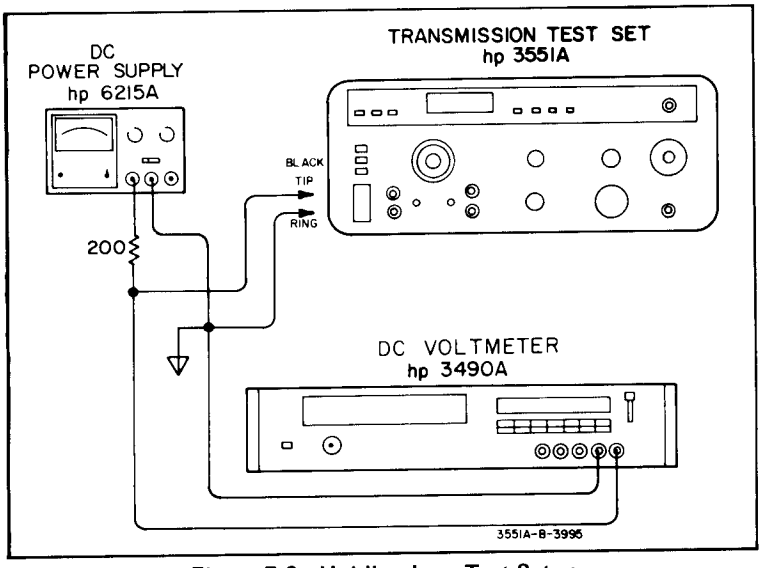


Figure 5-8. Holding Loss Test Setup.

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ADJUSTMENT PROCEDURES

5-34. ADJUSTMENT PROCEDURES.

5-35. 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.

5-36. To remove the Test Set from the case refer to Paragraph 5-57. Figures 5-10, 5-11 and 5-12 show the adjustment locations for A1, A3 and A4 respectively. The adjustment procedures use the Test Set display for monitoring and adjustment tolerances.

5-37. The Test Set display should have the last 4 LSD digits operating to correctly adjust the Test Set to the tolerance given. Change the jumper wire locations on the A1 board (Figure 5-10) as required. Note the original location of the A1 jumpers, so that they may be returned to their original location after adjustment.

NOTE

When the display is expanded the location of the decimal point is a function of the input frequency and not the dBm readings. On Test 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 C revision boards, they will be given in parentheses.

5-38. Receive Level Adjustment.

5-39. 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.

a. Connect the 3320B, through the 600 ohm impedance box, to the Test Set black input/output terminals. Refer to Figure 5-9 for Test Set Connection.

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

HOLD . . . . . OFF
FUNCTION
(Black Input/Output Terminals . .REC TERM
IMP 600
RECEIVE
NOISE/TONE . . . . . TONE NORMAL
DISPLAY & MONITOR . . . RECEIVE LEVEL
POWER . . . . . ~ AC

c. Adjust the 3320B frequency for 1 kHz at an amplitude of + 8.79 dBm.

d. Connect the dc voltmeter to A1W10. Ground A1TP19 with a short clip lead. Adjust A1R524 for 0 V dc indication on the dc voltmeter.

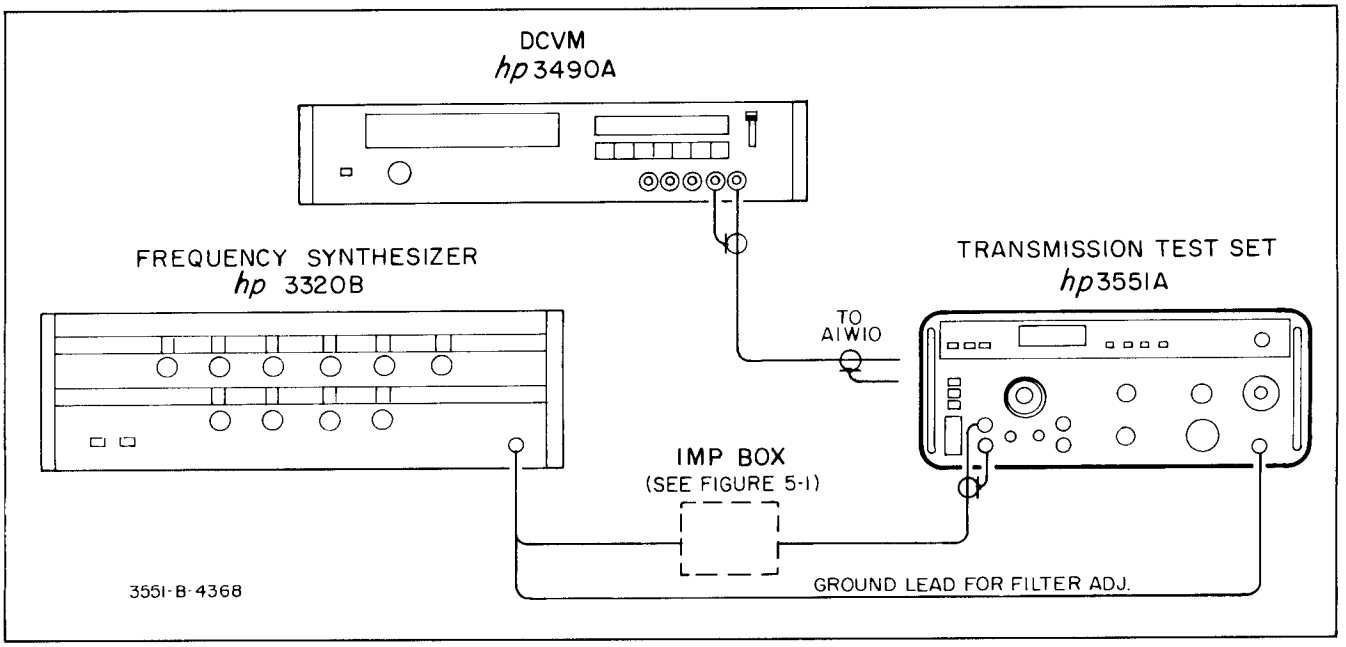


Figure 5-9. Receive Level and Noise Weighting Filters Adjustment.

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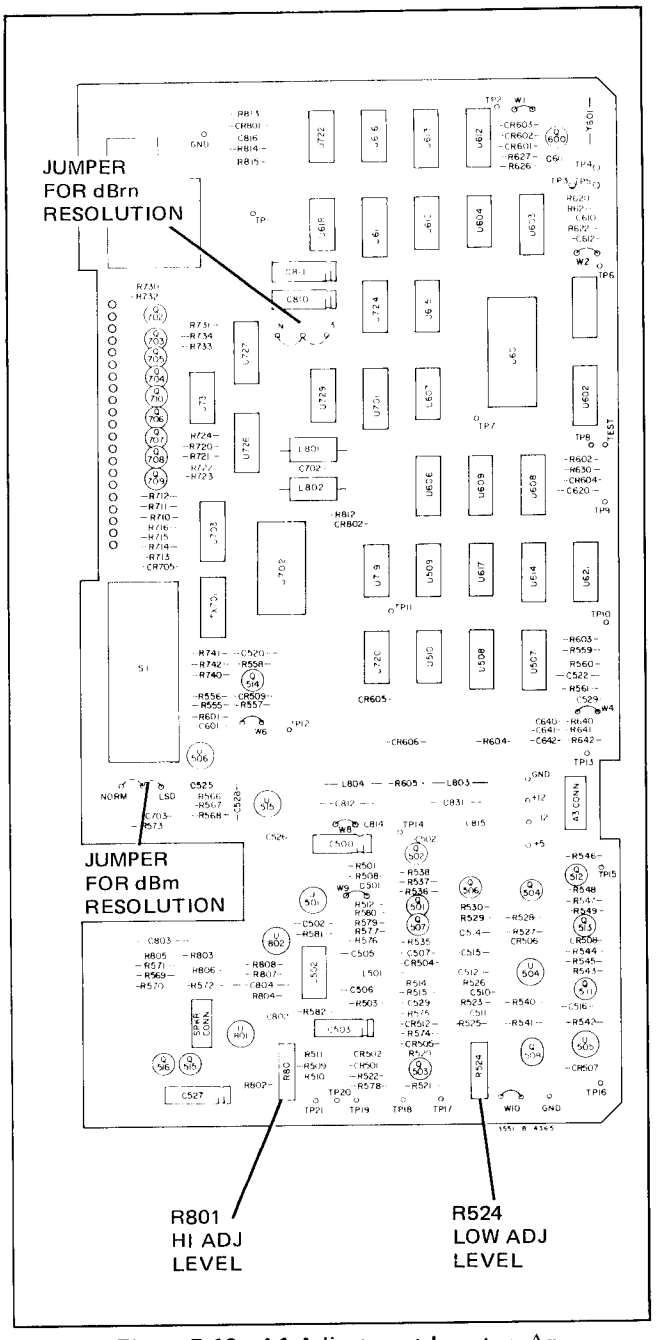


Figure 5-10. A1 Adjustment Locator. Δ5

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

f. Short A1TP8 to ground.

g. Set the 3320B to + 14.79 dBm.

h. Adjust A1R801 on the Test Set for a display flashing between + .401 and + .399 dBm.

NOTE

If + .399 to + .401 dBm cannot be reached, adjust A3R505 for a reading of + .410 dBm.

i. Set the 3320B to + 2.79 dBm.

j. Adjust A1R524 on the Test Set for a display of - .800 ± .002 dBm.

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

l. Set the 3320B to + 10.55 dBm.

m. Switch the 3551A IMP selector and the IMP box to 900 ohm.

n. Adjust A3R508 for a display flashing between - .199 and - .201 dBm.

NOTE

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

o. Set the 3320B to + 2.31 dBm.

p. Switch the 3551A front panel IMP selector and the IMP box to 135 ohm.

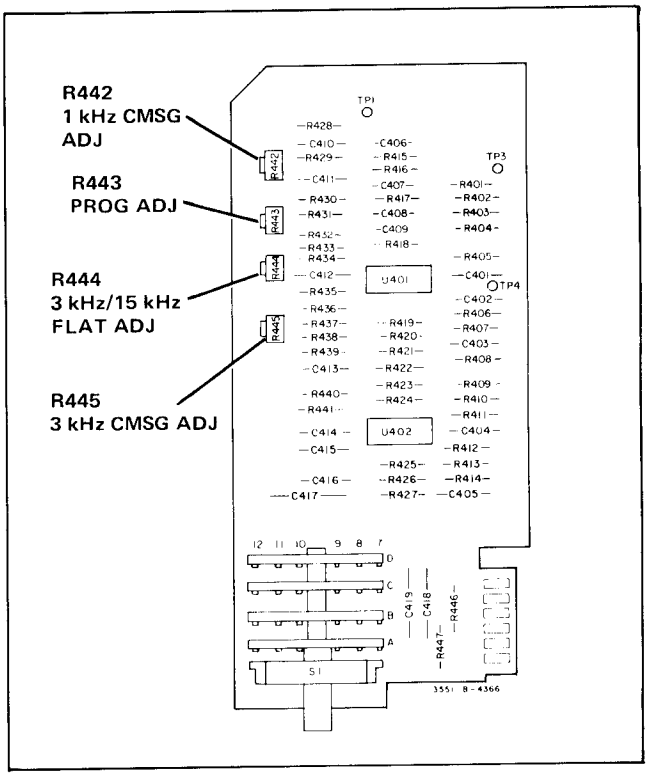


Figure 5-11. A4 Adjustment Locator. Δ5

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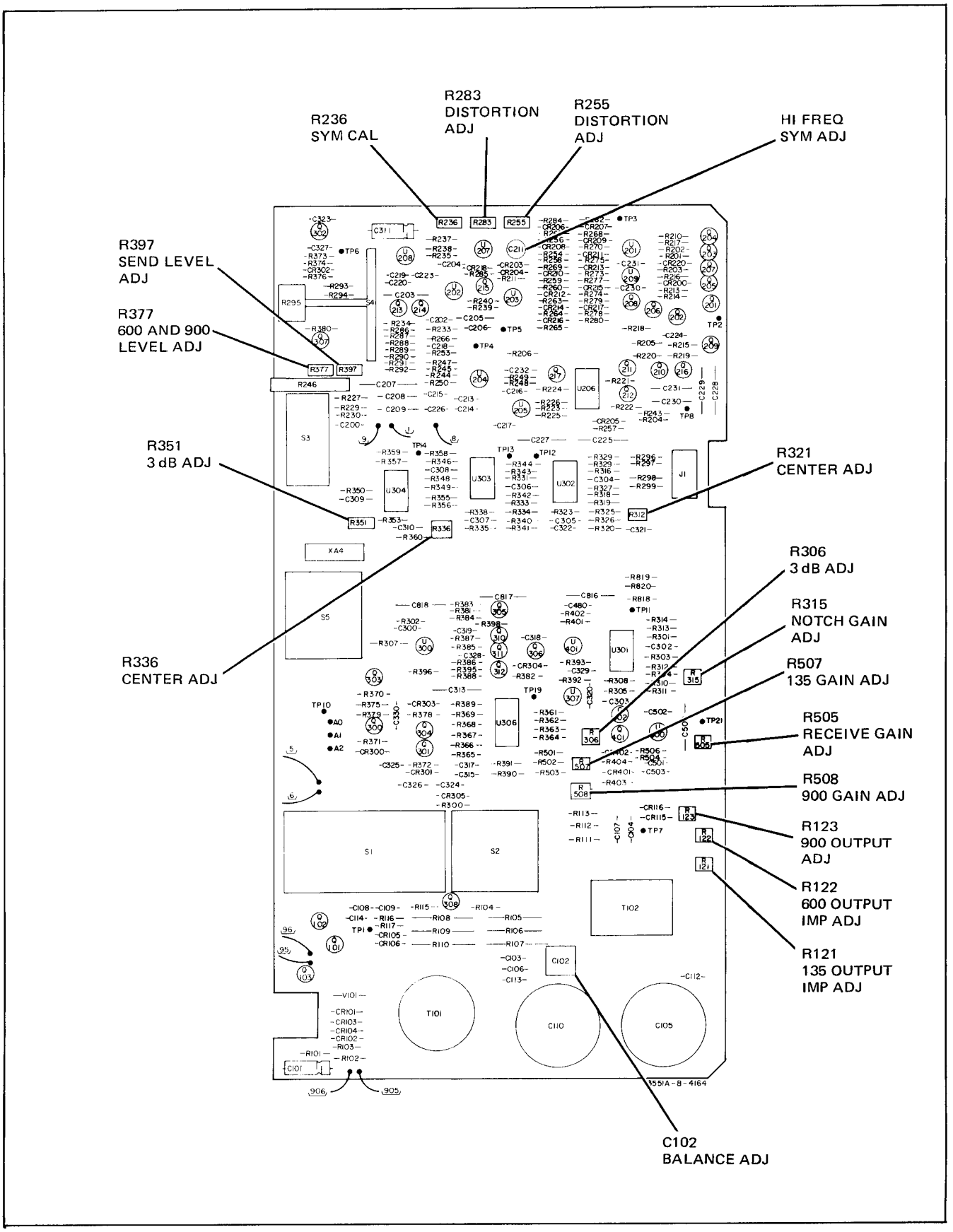


Figure 5-12. A3 Adjustment Locator. Δ_1

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q. Adjust A3R507 for a display flashing between - .199 and - .201 dBm.

NOTE

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

r. Set the 3320B to 60 kHz.

s. Remove A1TP8 short and observe the Test Set display for a reading of - .201 ± .02 dBm.

NOTE

If the display is not in tolerance, record the value and proceed to the next step.

t. Set the 3320B to - 17.69 dBm and observe the Test Set for a display of - 2.201 ± .02 dBm.

NOTE

If steps or t is not within tolerances, A3C315 and/or A3C317 may be padded using the values shown in Table 5-16. Increasing the value of A3C315 and/or decreasing the value of A3C17 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 higher (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.

u. Repeat Steps s and t until the Test Set readings are within tolerance.

v. Set the 3320B to - 37.69 dBm and observe the Test Set for a display of - 4.201 ± .02 dBm.

NOTE

If the display is not within tolerance, A3C318 may be padded using the values shown in Table 5-16. Increasing the value of C318 will cause the Test Set to display a larger relative number.

Table 5-16. Capacitor Padding Value.

A3C315		A3C317		A3C318	
Value	Part No.	Value	Part No.	Value	Part No.
300 pF	0140-0200	10 pF	0160-0205	43 pF	0160-2200
430 pF	0160-0939	12 pF	0140-0201	47 pF	0160-2307
460 pF	0140-0232	15 pF	0140-0202	56 pF	0140-0191
470 pF	0140-0145	18 pF	0160-2198	68 pF	0140-0192
510 pF	0160-0362				
560 pF	0140-0178				
620 pF	0160-0363				

5-40. Noise Weighting Filters Adjustment.

NOTE

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

5-41. 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.

a. Connect the 3320B to the Test Set as shown in Figure 5-9.

b. Set the Test Set front panel as follows:

HOLD . . . . . OFF
FUNCTION
(Black Input/Output Terminal . .REC TERM
IMP 600
RECEIVE NOISE/
TONE . . . . . MESSAGE CIRCUIT NOISE
DISPLAY & MONITOR . RECEIVE LEVEL
NOISE WEIGHTING . . . . . C MESSAGE
POWER . . . . . ~ AC

c. Adjust the 3320B for a 1 kHz frequency at an amplitude of - 5.21 dBm.

d. Short A1TP8 to ground.

e. Power OFF then power ON the 3551A to lock the Test Set on range 0.

f. Adjust A4R442 for a test set display of + 7.390 to + 7.410 (flashing between + 73/+ 74).

g. Set the Test Set Noise Weighting Control to the 3 kHz flat position.

h. Adjust A4R444 for a Test Set display of + 7.390 to + 7.410 (flashing between + 73/+ 74).

i. Set the Test Set Noise Weighting Control to the 15 kHz Flat position.

j. Adjust A4R444 for a Test Set display of + 7.390 to + 7.410 (flashing between + 73/+ 74).

NOTE

The 3 kHz and 15 kHz adjustments may need to be performed several times in order to achieve a balance between the two positions.

k. Set the Test Set NOISE WEIGHTING CONTROL to the Program position.

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l. Adjust A4R443 for a display of + 7.390 to + 7.410 (flashing between + 73/+ 74).

m. Set the Test Set NOISE WEIGHTING CONTROL to the C Message position.

n. Adjust the 3320B for an output frequency of 3 kHz with an amplitude of - 3.21 dBm.

o. Adjust A4R445 for a display of + 7.390 to + 7.410 (flashing between + 73/+ 74).

p. Repeat adjustment Steps c, f, n and o for the C Message position until calibrated.

q. Remove A1TP8 short.

5-42. Notch Filter Calibration.

NOTE

The RECEIVE LEVEL and NOISE WEIGHTING FILTER adjustment must be completed before proceeding.

5-43. This adjustment procedure sets the corner frequencies and the center of the Notch filters. A 3320B is used to supply precise frequencies and amplitudes to the test set input.

a. Connect the 3320B Frequency Synthesizer to the 3551A Test Set as shown in Figure 5-9.

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

HOLD . . . . . OFF
NOISE WEIGHTING . . . . . 15 kHz Flat
FUNCTION
(Black Input/Output Terminals) . . .REC TERM
RECEIVE NOISE/
TONE . . . . . .NOISE WITH TONE
DISPLAY & MONITOR . . . RECEIVE LEVEL
POWER . . . . . .~ AC

c. Adjust the 3320B frequency for 400 Hz at an amplitude of - 5.21 dBm.

d. Short A1TP8 to ground, then power OFF, power ON the 3551A Test Set.

e. Center pots (1 turn pots) A3R306, A3R321, A3R336, and A3R351. Refer to A3 adjustment locations shown on Figure 5-12.

f. Adjust A3R315 for a Test Set display + 7.395 to + 7.405 (flashing between + 73/+ 74).

g. Adjust the 3320B frequency to 1015 Hz.

h. Connect an ac voltmeter to A3TP13.

i. Set A3R306, A3R321 fully CW; A3R351 fully CCW.

j. Adjust A3R336 for a minimum ac voltmeter indication, typically less than 1 mV rms.

k. Disconnect the ac voltmeters from A3TP13 and reconnect to A3TP12. Adjust A3R321 for a minimum ac voltmeter indication, typically less than 1 mV rms.

l. Disconnect the ac voltmeter.

m. Adjust the 3320B frequency to 1182 Hz.

n. Adjust A3R306 for a display of + 7.395 to + 7.405 (flashing between + 73/+ 74).

o. Adjust the 3320B frequency to 862 Hz.

p. Verify display of + 7.275 ± .125 (+ 71 to + 74).

q. Remove the short at A1TP8.

5-44. Receiver Balance Adjustment.

5-45. The adjustment procedure sets the Test Set input balance. The 3320B is used to supply the Test Set with a signal applied equally between the Test Set terminals and referenced to the Test Set ground. The Test Set is then adjusted for a minimum Test Set display indication.

a. Connect the test setup as shown in Figure 5-6(b).

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

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

c. Adjust the 3320B output frequency to 6 kHz at an amplitude of + 26.99 dBm.

d. Adjust A3C102 for a minimum Test Set display.

NOTE

The display should be indicating less than - 4.2 (- 42 dBm). If the minimum display cannot be adjusted to less than this specification, then change A3C103 and/or A3C108* as follows (refer to Table 5-17 for padding values):*

1. *If A3C102 is at 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.*

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NOTE

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

5-54. Transmitter Level Display Adjustment.

NOTE

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

5-55. This adjustment procedure sets the level of the Test Set send oscillator to the Test Set display. The 3490A 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.

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

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

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. . . . . .~ AC

c. Connect the Test Set chassis to the ring terminal.

d. 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 ± 0.002 V ac.

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

f. Adjust A3R377 for a Test Set display indication of .000 dBm ± .003 dBm.

g. Set the Test Set front panel IMP control to 135. Change the 600 ohm load on the ac voltmeter to a 135 ohm load.

h. Adjust the Test Set front panel SEND LEVEL vernier for an ac voltmeter indication of 0.367 V ac ± 0.002 V ac.

i. Adjust A3R397 for a Test Set display indication of .000 dBm ± .003 dBm.

j. Set the Test Set front panel IMP control to 900 ohm. Change the 135 ohm load on the ac voltmeter to a 900 ohm load.

k. Adjust the Test Set front panel SEND LEVEL vernier for an ac voltmeter indication of 0.9487 V ac ± 0.001 V ac. The Test Set display indication should be .000 dBm ± .005 dBm. If not, adjust A3R377 until the reading is just within the specifications. Recheck the 600 ohm display level for .000 ± .005 dBm.

l. Set the Test Set output frequency for 60 kHz ± 1 kHz.

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

n. Adjust the Test Set SEND LEVEL vernier control for an output level of .775 V ac ± 0.002 V. The Test Set display should be .000 dBm ± .2 dBm. If not, pad A3C323 or A3C327 until the display is within specifications. Refer to Table 5-17 for capacitor padding values.

NOTE

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

o. Recheck the 135 ohm 60 kHz display for .000 dBm ± .2 dBm.

5-56. Return the green jumper leads used to expand the Test Set display to their original locations.

5-57. DISASSEMBLY INFORMATION.

5-58. 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.

5-59. Test Set Case Removal.

a. To remove the case for access to the internal parts, remove the five phillips head screws shown in Figure 5-14.

b. Slide the front panel out from the case, disconnect the internal power cable and monitor plug from the case.

5-60. Printed Circuit Card Removal.

5-61. 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.

a. To remove the A1 and A2 boards, unplug the A1 to A3 ribbon connector and A1 speaker connection. Remove the ten phillips head screws as shown in Figure 5-15. Then remove the board assembly so as not to damage the Power and Display & Monitor switches.

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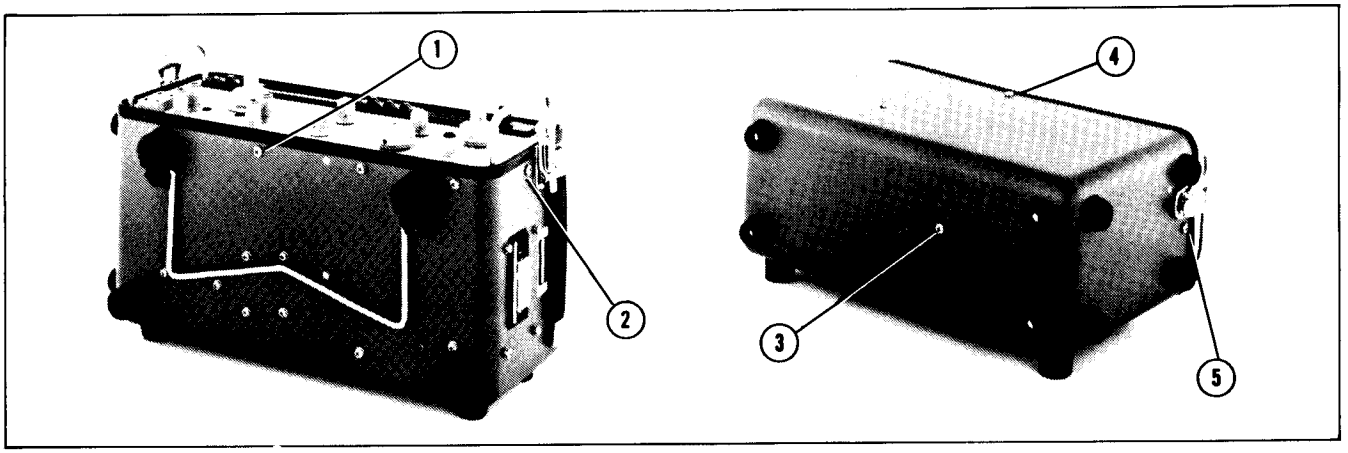


Figure 5-14. Case Disassembly.

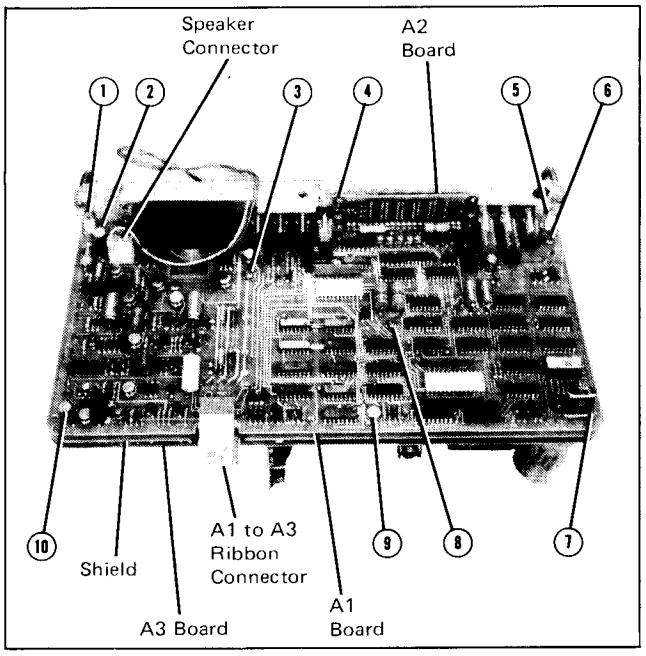


Figure 5-15. A1 and A2 Board Assembly Removal.

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 5-16. 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.

5-62. The internal Power Cable should be installed in the case and on the A1 board as shown in Figure 5-17.

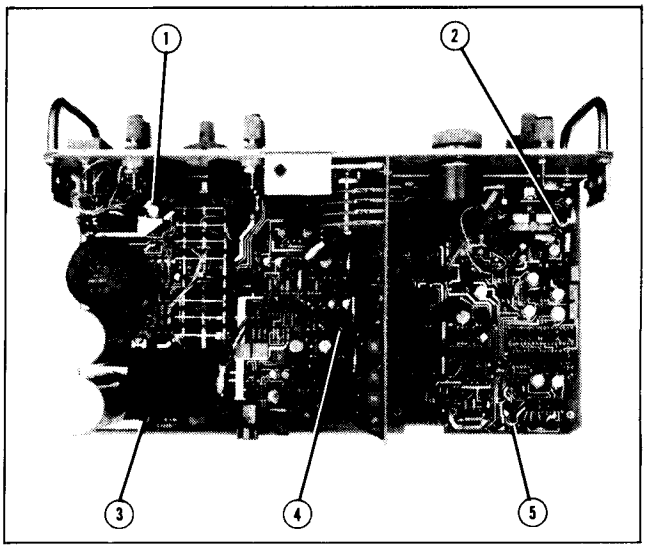


Figure 5-16. Shield Removal.

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	03551-66501	1	PC ASSY, LOGIC	28480	03551-66501
A1C500	0180-1800	2	CAPACITOR-FXD; 100UF+100-10% 6VDC AL	28480	0180-1800
A1C501	0160-0763	1	CAPACITOR-FXD 5PF +-10% 500WVDC MICA 0+	28480	0160-0763
A1C502 Δ5	0180-1701	2	CAPACITOR-FXD 6.8UF +-20% 6VDC CER	56289	150D685X0006A2
A1C503	0180-1800		CAPACITOR-FXD; 100UF+100-10% 6VDC AL	28480	0180-1800
A1C505	0160-0298	2	CAPACITOR-FXD .0015UF +-10% 200WVDC POLYE	56289	292P15292
A1C506	0160-0156		CAPACITOR-FXD .0039UF +-10% 200WVDC POLYE	56289	292P39292
A1C507 Δ5	0160-0127		CAPACITOR-FXD 1UF +-20% 25WVDC CER	28480	0160-0127
A1C508	0150-0093	20	CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C510	0160-3622	8	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	3	CAPACITOR-FXD 1UF +-20% 25WVDC CER	28480	0160-0127
A1C513	0160-3501	1	CAPACITOR-FXD 4UF +-10% 50WVDC MET POLYC	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	9	CAPACITOR-FXD .01UF +-1% 100WVDC MICA	28480	0160-3548
A1C520	0180-0309	2	CAPACITOR-FXD; 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A1C521	0160-2204	5	CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A1C522	0180-1701		CAPACITOR-FXD; 6.8UF +-20% 10VDC TA	56289	150D685X0006A2
A1C525	0180-0376	1	CAPACITOR-FXD; .47UF+-10% 35VDC TA	56289	150D474X9035A2
A1C526	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A1C527	0180-0303	1	CAPACITOR-FXD 100PF +75-10% 3VDC AL	56289	30D107G003CB2
A1C528 Δ5	0150-0014		CAPACITOR-FXD .005UF 500VDC	28480	0150-0014
A1C529 Δ5	0160-0127		CAPACITOR-FXD 1UF +25VDC	28480	0160-0127
A1C601	0160-0128		CAPACITOR-FXD 2.2UF 25V	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	1	CAPACITOR-FXD; .33UF+-20% 35VDC TA	56289	150D334X0035A2
A1C640	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C641, C642	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C702, 703 Δ5	0160-2204		CAPACITOR-FXD 100PF 300VDC	28480	0160-2204
A1C704	0180-1702	3	CAPACITOR-FXD; 180UF+-20% 6VDC TA-SOLID	56289	150D187X0006R2
A1C801	0180-0374	3	CAPACITOR-FXD; 10UF+-10% 20VDC TA-SOLID	56289	150D106X9020B2
A1C802	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A1C803	0180-0374		CAPACITOR-FXD; 10UF+-10% 20VDC TA-SOLID	56289	150D106X9020B2
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	2	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
A1CR501	1901-0518	3	DIODE-SCHOTTKY	28480	1901-0518
A1CR502	1901-0518		DIODE-SCHOTTKY	28480	1901-0518
A1CR504 Δ5	1901-0040		DIODE-SCHOTTKY	28480	1901-0040
A1CR505	1901-0040	40	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR506	1902-3062	1	DIODE-ZNR 3.92V 5% DO-7 PD=.4W TC=	04713	SZ 10939-65
A1CR507	1902-3041	1	DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=	04713	SZ 10939-98
A1CR508 CR509	1901-0040	11	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR512 Δ5	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR601	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR602	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR603, CR604	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR605, 606 Δ6	0160-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR705	1901-0518		DIODE-SCHOTTKY	28480	1901-0518
A1CR801	1902-3182	1	DIODE-ZNR 12.1V 5% DO-7 PD=.4W	04713	SZ 10939-206
A1CR802	1902-3149	1	DIODE-ZNR 9.09V 5% DO-7 PD=.4W	04713	SZ 10939-170
A1J2	1200-0423	3	SOCKET:IC BLK 16 CONTACT	23880	CSA2900-168
A1J3	1251-3305	1	CONNECTOR, 4-CONT, MALE, POST TYPE	27264	09-65-1041(2244-4A)
A1L501 Δ1	9100-1665		COIL: 3.3 MH	24226	221334
A1L704	9140-0083	3	COIL; FXD; MOLDED RF CHOKE; 400UH 10%	0004A	S-400J-1
A1L801	9140-0083		COIL; FXD; MOLDED RF CHOKE; 400UH 10%	0004A	S-400J-1
A1L802	9140-0083		COIL; FXD; MOLDED RF CHOKE; 400UH 10%	0004A	S-400J-1
A1L803	9140-0137	2	COIL; FXD; MOLDED RF CHOKE; 1MH 5%	24226	19/104
A1L804	9140-0137		COIL; FXD; MOLDED RF CHOKE; 1MH 5%	24226	19/104
A1Q501	1853-0020	5	TRANSISTOR PNP SI CHIP PD=300MW	28480	1853-0020
A1Q502	1854-0071	36	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q503	1855-0378	1	TRANSISTOR; J-FET N-CHAN, D-MODE SI	28480	1855-0378
A1Q504	1853-0066	5	TRANSISTOR PNP SI CHIP TO-92 PD=200MW	28480	1853-0066
A1Q506	1855-0081	3	TRANSISTOR; J-FET N-CHAN, D-MODE SI	01295	2N5245

See introduction to this section for ordering information

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1Q507	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q508	1855-0308	1	TRANSISTOR; JFET;DUAL; N-CHAN D-MODE SI	28480	1855-0308
A1Q511	1855-0412	2	TRANSISTOR; J-FET N-CHAN, D-MODE SI	28480	1855-0412
A1Q512	1853-0020		TRANSISTOR PNP SI CHIP PD=300MW	28480	1853-0020
A1Q513	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q514	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q515	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q516	1853-0020		TRANSISTOR PNP SI CHIP PD=300MW	28480	1853-0020
A1Q600	1855-0081		TRANSISTOR; J-FET N-CHAN, D-MODE SI	01295	2N5245
A1Q702	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q703	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q704	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q705	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q706	1853-0093	5	TRANSISTOR PNP SI CHIP TO-52 PD=360MW	28480	1853-0093
A1Q707	1853-0093		TRANSISTOR PNP SI CHIP TO-52 PD=360MW	28480	1853-0093
A1Q708	1853-0093		TRANSISTOR PNP SI CHIP TO-52 PD=360MW	28480	1853-0093
A1Q709	1853-0093		TRANSISTOR PNP SI CHIP TO-52 PD=360MW	28480	1853-0093
A1Q710	1853-0093		TRANSISTOR PNP SI CHIP TO-52 PD=360MW	28480	1853-0093
A1Q801	1855 0216		TRANSISTOR: J-FET P-CHAN D-MODE SI	28480	1855-0216
A1R501	0698 3274		RESISTOR 10K .125W 1%	24546	NE55
A1R503	0757 0465		RESISTOR 100K 1%	24546	C4 1/8-T0-1003-F
A1R508	0698-6630	3	RESISTOR 20K .1% .125W F TUBULAR	19701	MF4C1/8-T9 2002-B
A1R509	0698-7163	1	RESISTOR 2.0081K .1% .125W F TUBULAR	19701	MF4C1/8-T9-2008R1 B
A1R510	0757-0283	1	RESISTOR 2K 1%	24546	C4-1/8-T0-2001 F
A1R511	0698-6965	1	RESISTOR 505 OHM .1% .125W F TUBULAR	19701	MF4C1/8 T9-505R-B
A1R512 Δ1	0698-4465	2	RESISTOR 931 OHM 5% .25W CC TUBULAR	24546	C4-1/8-TO 931R-F
A1R513 Δ1					
A1R514	0698-3152	2	RESISTOR 3480 OHM 1%	16299	C4-1/8-TO-3481-F
A1R515	0757-0472	2	RESISTOR 200K 1%	24546	C4 1/8-T0-2003-F
A1R520	0683 1055	2	RESISTOR 1M 5% .25W CC TUBULAR	01121	CB1055
A1R521	0757 0453	1	RESISTOR 30.1K 1%	24546	C4 1/8-TO-3012-F
A1R522	0698-7880	1	RESISTOR 28.7K 1%	19701	MF4C1/8-T0-2872-F
A1R523	0698 6630		RESISTOR 20K .1% .125W F TUBULAR	19701	MF4C1/8-T9-2002-B
A1R524	2100-3095	1	RESISTOR-VAR TRMR 200 OHM 10% C SIDE ADJ	32997	3006P-1 201
A1R525	0698-6630		RESISTOR 20K .1% .125W F TUBULAR	19701	MF4C1/8-T9-2002-B
A1R526	0698 7082	1	RESISTOR 100K 1%	24546	NE55
A1R527	0757 0289	2	RESISTOR 13.3K 1% .125W F TUBULAR	30983	MF4C1/8-TO-1332 F
A1R528	0757-0289		RESISTOR 13.3K 1% .125W F TUBULAR	30983	MF4C1/8-T0-1332 F
A1R529	0683-2235		RESISTOR 22K 5% .25W CC TUBULAR	01121	CB2235
A1R530	0683 4725	1	RESISTOR 4.7K 5% .25W CC TUBULAR	01121	CB4725
A1R535	0683 4735	2	RESISTOR 47K 5% .25W CC TUBULAR	01121	CB4735
A1R536 541	0683-1035	23	RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R542	0698 5358	1	RESISTOR 866K .125	28480	0698-5358
A1R543	0683-1055		RESISTOR 1M 5% .25W CC TUBULAR	01121	CB1055
A1R544* Δ2 Δ5	0698 3274	1	RESISTOR 10K .1% .125W F TUBULAR	24546	NE55
A1R545	0698-6977	2	RESISTOR 30K .1% .125W F TUBULAR	19701	MF4C1/8-T9-4172 B
A1R546 555	0683 1035		RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R556 Δ1	0698-4453		RESISTOR 402 OHM 1% .125W F TUBULAR	24546	C4-1/8 TO-590R-F
A1R557, 558	0683-1035		RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R559	0757-0465	5	RESISTOR 100K 1% .125W F TUBULAR	24546	C4-1/8-T0-1003-F
A1R560	0698-4123	3	RESISTOR 499 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-499R F
A1R561*	0683-2235	2	RESISTOR 22K 5% .25W CC TUBULAR *FACTORY SELECTED PART	01121	CB2235
A1R566 Δ5	0698-4435		RESISTOR 2490 OHM 1%	16299	C4-1/8-TO-2491-F
A1R567	0698-4510	1	RESISTOR 84.5K 1% .125W F TUBULAR	24546	C4 1/8-T0-8452-F
A1R568	0757 0459	1	RESISTOR 56.2K 1% .125W F TUBULAR	24546	C4-1/8-T0-5622 F
A1R569	0757 0416	2	RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4 1/8 T0-511R-F
A1R570	0698 4435	4	RESISTOR 2.49K 1% .125W F TUBULAR	16299	C4-1/8-T0-2491-F
A1R571	0757-0416		RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-511R-f
A1R572	0698-4435		RESISTOR 2.49K 1% .125W F TUBULAR	16299	C4-1/8-T0 2491 F
A1R573	0698-4435		RESISTOR 2490 OHM 1%	16299	C4-1/8-T0 2491 F
A1R574	0757 0472	2	RESISTOR 200K 1%	24546	C4-1/8-T0-2003-F
A1R575	0698 3152		RESISTOR 3480 OHM 1%	16299	C4-1/8 T0-3481-F
A1R576	0698 3228	3	RESISTOR 49.9K 1%	03888	PME55S
A1R577	0757 0465		RESISTOR 100K 1%	24546	C4-1/8-T0-1003 F
A1R578	0698-4486	1	RESISTOR 24.9K 1%	24546	C4-1/8-TO-2492-F
A1R579	0683-1015		RESISTOR 100 5% .25W	01121	CB1015
A1R580	0757 0465		RESISTOR 100K 1%	24546	C4-1/8-T0-1003-F
A1R581	0698-3228	3	RESISTOR 49.9K 1%	03888	PME55S
A1R582	0698-3228		RESISTOR 49.9K 1%	03888	PME55S
A1R601	0757 0280	5	RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A1R602	0683-1035		RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R603	0683-1035		RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R604 Δ5	0683-4735		RESISTOR 47K 5% .25W CC TUBULAR	01121	CB4735
A1R605 Δ5	0683 5145	1	RESISTOR 510K 5% .25W	01121	CB5145
A1R610	1810-0055	3	CIRCUIT: PSIV: NON-RPRABLE IN	28480	1810 0055
A1R611	1810 0055		CIRCUIT: PSIV: NON-RPRABLE IN	28480	1810-0055

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1R613	0683-1035		RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R620	0683-1865	1	RESISTOR 18M 5% .25W CC TUBULAR	01121	CB1865
A1R621	0683-1265	1	RESISTOR 12M 5% .25W CC TUBULAR	01121	CB1265
A1R622	0683-2435	1	RESISTOR 24K 5% .25W CC TUBULAR	01121	CB2435
A1R624	0683-1035		RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R625	0683-1035		RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R627	0683-1035		RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R630	0683-2265	1	RESISTOR 22M 5% .25W CC TUBULAR	01121	CB2265
A1R640	0683-1045	12	RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A1R641	0683-1045		RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A1R642	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A1R701	1810-0055		CIRCUIT; PSIV; NON-RPRABLE IN	28480	1810-0055
A1R710	0757-0381	7	RESISTOR 15 OHM 1% .125W F TUBULAR	30983	MF4C1/8-T0-15R0-F
A1R711	0757-0381		RESISTOR 15 OHM 1% .125W F TUBULAR	30983	MF4C1/8-T0-15R0-F
A1R712	0757-0381		RESISTOR 15 OHM 1% .125W F TUBULAR	30983	MF4C1/8-T0-15R0-F
A1R713	0757-0381		RESISTOR 15 OHM 1% .125W F TUBULAR	30983	MF4C1/8-T0-15R0-F
A1R714	0757-0381		RESISTOR 15 OHM 1% .125W F TUBULAR	30983	MF4C1/8-T0-15R0-F
A1R715	0757-0381		RESISTOR 15 OHM 1% .125W F TUBULAR	30983	MF4C1/8-T0-15R0-F
A1R716	0757-0381		RESISTOR 15 OHM 1% .125W F TUBULAR	30983	MF4C1/8-T0-15R0-F
A1R720	0683-2015	5	RESISTOR 200 OHM 5% .25W CC TUBULAR	01121	CB2015
A1R721	0683-2015		RESISTOR 200 OHM 5% .25W CC TUBULAR	01121	CB2015
A1R722	0683-2015		RESISTOR 200 OHM 5% .25W CC TUBULAR	01121	CB2015
A1R723	0683-2015		RESISTOR 200 OHM 5% .25W CC TUBULAR	01121	CB2015
A1R724	0683-2015		RESISTOR 200 OHM 5% .25W CC TUBULAR	01121	CB2015
A1R730	0698-5842	1	RESISTOR 16 OHM 5% .25W CC TUBULAR	01121	CB1605
A1R731	0683-5105	4	RESISTOR 51 OHM 5% .25W CC TUBULAR	01121	CB5105
A1R732	0683-5105		RESISTOR 51 OHM 5% .25W CC TUBULAR	01121	CB5105
A1R733	0683-5105		RESISTOR 51 OHM 5% .25W CC TUBULAR	01121	CB5105
A1R734	0683-5105		RESISTOR 51 OHM 5% .25W CC TUBULAR	01121	CB5105
A1R740	0683-1035		RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R741	0683-1035		RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R742	0683-1035		RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R801	2100-3109	1	RESISTOR-VAR TRMR 2KOHM 10% C SIDE ADJ	32997	3006P-1-202
A1R802	0698-6977		RESISTOR 30K .1% .125W F TUBULAR	19701	MF4C1/8-T9-4172-B
A1R803	0683-1005	1	RESISTOR 10 OHM 5% .25W CC TUBULAR	01121	CB1005
A1R804	0757-0273		RESISTOR 3.01K 1% .125W F TUBULAR	24546	C4-1/8-T0-3011-F
A1R805	0698-6360	2	RESISTOR 10K .1% .125W F TUBULAR	19701	MF4C1/8-T9-1002-B
A1R806	0698-3279	2	RESISTOR 4.99K 1% .125W F TUBULAR	16299	C4-1/8-T0-4991-F
A1R807	0698-6360		RESISTOR 10K .1% .125W F TUBULAR	19701	MF4C1/8-T9-1002-B
A1R808	0683-1015	2	RESISTOR 100 OHM 5% .25W CC TUBULAR	01121	CB1015
A1R812	0683-1025	1	RESISTOR 1K 5% .25W CC TUBULAR	01121	CB1025
A1R813	0757-0277	2	RESISTOR 49.9 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-4992-F
A1R814	0698-3519	2	RESISTOR 12.4K 1% .125W F TUBULAR	16299	C4-1/8-T0-1242-F
A1R815	0698-3279		RESISTOR 4.99K 1% .125W F TUBULAR	16299	C4-1/8-T0-4991-F
A1S1	3101-1848	1	SWITCH, PUSHBUTTON :DISPLAY & MONITOR	28480	3101-1848
A1S2	3101-1847	1	SWITCH, PUSHBUTTON :POWER	28480	3101-1847
A1U501	1826-0109	4	IC LIN AMPLIFIER	34371	HA2-2625-B0593
A1U502 Δ5	1826-0323	1	IC OP AMP HA4741	28480	1826-0323
A1U503	1820-0223		IC LIN LM301AH AMPLIFIER	27014	LM301AH
A1U504	1825-0043		IC LIN LM307H AMPLIFIER	27014	LM307H
A1U505	1820-0223		IC LIN LM301AH AMPLIFIER	27014	LM301AH
A1U506	1820-0223		IC LIN LM301AH AMPLIFIER	27014	LM301AH
A1U507	1820-1188	1	IC DGTL CD4046AE PHASE LOCK LOOP	02735	CD4046AE
A1U508	1820-1189	1	IC DGTL MC14510CP COUNTER	04713	MC14510CP
A1U509	1820-0939	7	IC DGTL CD4013AE FLIP-FLOP	86684	CD4013AE
A1U510	1820-0949	8	IC;DGTL;GATE	86684	CD4011AE
A1U515	1820-0223		IC LIN LM301AH AMPLIFIER	27014	LM301AH
A1U601	1818-2239	1	IC MEMORY	28480	1818-2239
A1TX601	1200-0423	2	SOCKET-IC 16-CONT	28480	1200-0423
A1U602	1820-1190	2	IC DGTL MM84C173N FLIP-FLOP	27014	MM74C173N
A1U603	1820-1190		IC DGTL MM74C173N FLIP-FLOP	27014	MM47C173N
A1U604	1820-0939		IC DGTL CD4013AE FLIP-FLOP	86684	CD4013AE
A1U606	1820-0927	1	IC DGTL CD4028AE DECODER	02735	CD4028AE
A1U607	1820-0949		IC;DGTL;GATE	86684	CD4011AE
A1U608	1820-1241	2	IC DGTL MC14512CP	04713	MC14512CP
A1U609	1820-1241		IC DGTL MC14512CP	04713	MC14512CP
A1U610	1820-0939		IC DGTL CD4013AE FLIP-FLOP	86684	CD4013AE
A1U611	1820-1145	3	IC;DGTL;BUFFER/DRIVER/LINE DRIVER	02735	CD4049AE
A1U612	1820-1123	1	IC DGTL MK 5009P	50088	MC5009P
A1U613	1820-1122	1	IC DGTL MC14518CL COUNTER	04713	MC14518CL
A1U614	1820-1145		IC;DGTL;BUFFER/DRIVER/LINE DRIVER	02735	CD4049AE
A1U615	1820-0939		IC DGTL CD4013AE FLIP-FLOP	86684	CD4013AE
A1U616	1820-0949		IC;DGTL;GATE	86684	CD4011AE
A1U617	1820-0939		IC DGTL CD4013AE FLIP-FLOP	86684	CD4013AE
A1U618	1820-0939		IC DGTL CD4013AE FLIP-FLOP	86684	CD4013AE
A1U621	1820-1114	1	IC DGTL MC14516CL COUNTER	04713	MC14516CL

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1U701	1820-1239	1	IC DGTL MK 5007P COUNTER	50088	MK5007P
A1TX701	1200-0423		SOCKET-IC 16-CONT	28480	1200-0423
A1U702	1818-2240	1	ROM, MOS	28480	1818-2240
A1U703	1820-1233	1	IC DGTL SN74L 47 N DECODER	01295	SN74L47N
A1U719	1820-0949		IC;DGTL;GATE	86684	CD4011AE
A1U720	1820-0939		IC DGTL CD4013AE FLIP-FLOP	86684	CD4013AE
A1U722	1820-0949		IC;DGTL;GATE	86684	CD4011AE
A1U724	1820-0949		IC;DGTL;GATE	86684	CD4011AE
A1U726	1820-1146	1	IC DGTL CD4050AE BUFFER	02735	CD4050AE
A1U727	1820-1145		IC;DGTL;BUFFER/DRIVER/LINE DRIVER	02735	CD4049AE
A1U729	1820-0949		IC;DGTL;GATE	86684	CD4011AE
A1U731	1820-0949		IC;DGTL;GATE	86684	CD4011AE
A1U801	1820-0196	1	IC LIN REGULATOR	07263	723HC
A1U802	1826-0043		IC LIN LM307H AMPLIFIER	27014	LM307H
A1W1	03551-61601	1	CABLE ASSY, FLAT	28480	03551-61601
A1Y601	0410-0561	1	CRYSTAL	28480	0410-0561
A1A2	03551-66502	1	PC ASSY, DISPLAY	28480	03551-66502
A1A2CR701	1990-0416	3	LED-VISIBLE	28480	1990-0416
A1A2CR702	1990-0416		LED-VISIBLE	28480	1990-0416
A1A2CR703	1990-0416		LED-VISIBLE	28480	1990-0416
A1A2CR704	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1A2CR706	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1A2CR707	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1A2R701	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A1A2U701 Δ1	1990-0491	1	DISPLAY AN SEG 1 CHAR .28 IN HIGH	28480	1990-0491
A1A2U702 Δ1	1990-0490	4	DISPLAY NUM SEG 1 CHAR .3 IN HIGH (D Brightness)	28480	1990-0490
A1A2U703 Δ1	1990-0490		DISPLAY NUM SEG 1 CHAR .3 IN HIGH (D Brightness)	28480	1990-0490
A1A2U704 Δ1	1990-0490		DISPLAY NUM SEG 1 CHAR .3 IN HIGH (D Brightness)	28480	1990-0490
A1A2U705 Δ1	1990-0490		DISPLAY NUM SEG 1 CHAR .3 IN HIGH (D Brightness)	28480	1990-0490
A2			SEE A1A2		
A3 Δ1	03551-66513	1	PC ASSY, INPUT AMPLIFIER	28480	03551-66513
A3C101 Δ6					
A3C102 Δ1	0121-0147	1	CAPACITOR; VAR; TRMR; CER; 2/19.3PF	74970	189-507-5
A3C103* Δ1		1	NORMALLY NOT LOADED *FACTORY SELECTED PART		
A3C104*	0160-2206	1	CAPACITOR-FXD 16JPF +-5% 300WVDC MICA *FACTORY SELECTED PART	28480	0160-2206
A3C105	0180-0543	2	CAPACITOR-FXD; 75UF+100-20% 300VDC AL	90201	SPO 32-8428
A3C106	0150-0050	4	CAPACITOR-FXD 1000PF +80-20% 1000WVDC	28480	0150-0050
A3C107*		6	NORMALLY NOT LOADED		
A3C108* Δ1	0140-0190		CAPACITOR-FXD 39PF +-5% 300WVDC MICA	72136	DM15E390J0300WV1CR
A3C109	0150-0050		CAPACITOR-FXD 1000PF +80-20% 1000WVDC	28480	0150-0050
A3C110	0180-0543		CAPACITOR-FXD; 75UF+100-20% 300VDC AL	90201	SPO 32-8428
A3C112	0150-0050		CAPACITOR-FXD 1000PF +80-20% 1000WVDC	28480	0150-0050
A3C113 Δ1					
A3C200	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A3C201 Δ1					
A3C202	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A3C203	0160-0156	1	CAPACITOR-FXD 3900PF +-10% 200WVDC POLYE	56289	292P39292
A3C204	0160-0938	3	CAPACITOR-FXD 1000PF +-5% 100WVDC MICA	53021	D15C1E102J
A3C205 Δ1	0180-1743		CAPACITOR-FXD .1UF +-20% 25WVDC CER	56289	150D104X9035A2
A3C206	0160-0938		CAPACITOR-FXD 1000PF +-5% 100WVDC MICA	53021	D15C1E102J
A3C207 Δ1	0160-3188	1	CAPACITOR-FXD .27UF +-5% 50WVDC MET	28480	0160-3188
A3C208	0160-4232	1	CAPACITOR-FXD .047UF +5-0% 50WVDC MET	28480	0160-4232
A3C209	0160-4231	1	CAPACITOR-FXD 4700PF +-5% 50WVDC MET	28480	0160-4231
A3C210 Δ1					
A3C211 Δ1	0121-0060	1	CAPACITOR-VAR 2-8PF	73899	DV11PS8A

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3C213	0150-0093		CAPACITOR-FXD: .01UF +80-20% 100WVDC CER	28480	0150-0093
A3C214	0150-0093		CAPACITOR-FXD: .01UF +80-20% 100WVDC CER	28480	0150-0093
A3C215*	0140-0176		CAPACITOR FXD: 100PF +-2% 300WVDC MICA	72136	DM15F101G0300WV1CR
A3C216	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C217	0160-0938		CAPACITOR-FXD 1000PF +-5% 100WVDC MICA	53021	D15C1E102J
A3C218* Δ1Δ5	0150-0045	1	CAPACITOR-FXD 8.2PF 500VDC	95121	TYPE QC
A3C219	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A3C220	0160-2150	1	CAPACITOR-FXD 33PF +-5% 300WVDC MICA	28480	0160-2150
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	0180-0229	2	CAPACITOR-FXD; 33UF+-10% 10VDC TA-SOLID	56289	150D336X9010B2
A3C226	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A3C227	0180-0229		CAPACITOR-FXD; 33UF+-10% 10VDC TA-SOLID	56289	150D336X9010B2
A3C228	0180-0228	7	CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A3C229	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A3C230 Δ1 Δ3	0150-0093		CAPACITOR-FXD .01UF 100WVDC	28480	0150-0093
A3C231 Δ1 Δ3	0150-0093		CAPACITOR-FXD .01UF 100WVDCz		
A3C232 Δ1	0160-0127		CAPACITOR-FXD 1UF +-20% 25WVDC	28480	0160-0127
A3C233, 234	0160-0127		CAPACITOR-FXD: 1UF +-20% 25WVDC CER	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	0160-0127		CAPACITOR-FXD 1UF +-20% 25WVDC CER	28480	0160-0127
A3C311 Δ1	0180-0161		CAPACITOR-FXD: 3.3UF +75-10% 35V AL	56289	150D335X0035B2
A3C13	0180-0106		CAPACITOR-FXD 60UF +-20% 6VDC TA-SOLID	56289	150D606X0006B2
A3C315* Δ1 Δ3	0140-0149		CAPACITOR-FXD 470PF +-5% 300WVDC MICA	72136	DM15F471J0300WV1CR
A3C317	0160-0205	4	CAPACITOR-FXD 10PF +-5% 500WVDC MICA 0+	28480	0160-0205
A3C318* Δ1 Δ3	0160-2200		CAPACITOR-FXD 43PF +-5% 300WVDC MICA	28480	0160-2200
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	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A3C322	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A3C323* Δ1			NORMALLY NOT LOADED		
A3C325	0160-2199		CAPACITOR-FXD 30PF +-5% 300WVDC MICA	28480	0160-2199
A3C326 Δ1	0160-0269		CAPACITOR-FXD .1UF +-20% 500WVDC	28480	0160-0269
A3C327 Δ1 Δ5	0140-0149		CAPACITOR-FXD 470PF +-5% 300WVDC MICA	72136	DM15F471J0300WV1CR
A3C328 Δ1	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A3C330 Δ1	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C480*Δ1	0160-2205		CAPACITOR-FXD 120PF +-5% 300V	28480	0160-2205
A3C501	0150-0093		*FACTORY SELECTED PART CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A3C502 Δ1	0140-0209		CAPACITOR-FXD 5PF 10% 500WVDC MICA 0+	72136	DM15C050K0500WV1CR
A3C503	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A3C504 Δ1	0180-0100		CAPACITOR-FXD 4.7UF 10% 35VDC TA	56289	150D475X903582
A3C816	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A3C817	0180-1704	1	CAPACITOR-FXD; 47UF+-10% 6VDC TA-SOLID	56289	150D476X9006B2
A3C818 Δ1	0160-2200		CAPACITOR-FXD; 43PF	28480	0160-2200
A3CR100	1901-0758		DIODE	28480	1901-0758
A3CR101	1901-0028	4	DIODE-PWR RECT 400V 750MA	04713	SR1358-9
A3CR102	1901-0028		DIODE-PWR RECT 400V 750MA	04713	SR1358-9
A3CR103	1901-0028		DIODE-PWR RECT 400V 750MA	04713	SR1358-9
A3CR104	1901-0028		DIODE-PWR RECT 400V 750MA	04713	SR1358-9
A3CR105	1901-0050	4	DIODE-SWITCHING 2NS 80V 200MA	28480	1901-0050
A3CR106	1901-0050		DIODE-SWITCHING 2NS 80V 200MA	28480	1901-0050
A3CR115	1902-0554	2	DIODE; ZENER; 10V VZ; 1W MAX PD	04713	SZ 11213-140
A3CR116	1902-0554		DIODE; ZENER; 10V VZ; 1W MAX PD	04713	SZ 11213-140
A3CR200	1902-0048	1	DIODE-ZNR 6.81V 5% DO-7 PD=.4W	28480	1902-0048
A3CR201 Δ1					
A3CR202 Δ1					
A3CR203	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR204	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR205	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR206	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR207	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR208	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR209	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR210	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR211	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR212	1901-0040	*	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR213	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR214	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR215	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR216	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR217	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR218	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR220 Δ1	1901-0518		DIODE-SCHOTTKY	28480	1901-0518
A3CR300	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR301	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR302	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3CR303	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR304	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR305	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR401	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR402	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3J1	1200-0423		SOCKET:IC BLK 16 CONTACT	23880	CSA2900-16B
A3Q101	1854-0234		TRANSISTOR NPN 2N3440 SI PD=1W	02735	2N3440
A3Q102	1854-0234		TRANSISTOR NPN 2N3440 SI PD=1W	02735	2N3440
A3Q103 Δ1	1854-0071		TRANSISTOR SI NPN	28480	1854-0071
A3Q201	1853-0086	12	TRANSISTOR PNP SI CHIP PD=310MW	28480	1853-0086
A3Q202	1853-0086		TRANSISTOR PNP SI CHIP PD=310MW	28480	1853-0086
A3Q203	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3Q204	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3Q205	1853-0086		TRANSISTOR PNP SI CHIP PD=310MW	28480	1853-0086
A3Q206	1853-0086		TRANSISTOR PNP SI CHIP PD=310MW	28480	1853-0086
A3Q207	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3Q208	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3Q209	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3Q210	1853-0086		TRANSISTOR PNP SI CHIP PD=310MW	28480	1853-0086
A3Q211 Δ1	1853-0086		TRANSISTOR PNP SI CHIP PD=310MW	28480	1853-0086
A3Q212 Δ1	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3Q213	1855-0410		TRANSISTOR J-FET N-CHAN, D-MODE SI	28480	1855-0410
A3Q214	1855-0410		TRANSISTOR: J-FET N-CHAN, D-MODE SI	28480	1855-0410
A3Q215	1855-0081		TRANSISTOR: J-FET N-CHAN, D-MODE SI	01295	2N5245
A3Q216 Δ1	1853-0086		TRANSISTOR PNP SI	28480	1853-0086
A3Q217 Δ1	1855-0410		TRANSISTOR J FET N-CHAN D-MODE	28480	1855-0410
A3Q300	1855-0414		TRANSISTOR J-FET N-CHAN, D-MODE SI	17856	2N4393
A3Q301	1854-0414		TRANSISTOR J-FET N-CHAN, D-MODE SI	28480	1854-0414
A3Q302	1855-0410		TRANSISTOR; J-FET N-CHAN, D-MODE SI	28480	1855-0410
A3Q303	1854-0233	1	TRANSISTOR NPN 2N3866 SI PD=1W	02735	2N3866
A3Q304	1855-0414		TRANSISTOR; J-FET N-CHAN, D-MODE SI	17856	2N4393
A3Q305	1855-0414		TRANSISTOR; J-FET N-CHAN, D-MODE SI	17856	2N4393
A3Q306	1853-0020		TRANSISTOR PNP SI CHIP PD=300MW	28480	1853-0020
A3Q307	1855-0410		TRANSISTOR; J-FET N-CHAN, D-MODE SI	28480	1855-0410
A3Q308	1855-0414		TRANSISTOR; J-FET N-CHAN, D-MODE SI	17856	2N4393
A3Q310	1855-0377	1	TRANSISTOR; J-FET N-CHAN, D-MODE SI	28480	1855-0377
A3Q311	1853-0020		TRANSISTOR PNP SI CHIP PD=300MW	28480	1853-0020
A3Q312	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3Q401	1855-0410		TRANSISTOR; J-FET N-CHAN, D-MODE SI	28480	1855-0410
A3Q402	1855-0410		TRANSISTOR; J-FET N-CHAN, D-MODE SI	28480	1855-0410
A3R101 Δ6					
A3R102* Δ1	0698-4367		RESISTOR 20.5 1% .125W F	03888	PME55-1/8-TO-20R5-F
A3R103	0683-0275	1	RESISTOR 2.7 OHM 5% .25W CC TUBULAR	01121	CB27G5
A3R104	0757-0472	3	RESISTOR 200K 1% .125W F TUBULAR	24546	C4-1/8-T0-2003-F
A3R105*	0698-8558	2	RESISTOR 67.3 OHM 1% .5W F TUBULAR *FACTORY SELECTED PART	28480	0698-8558
A3R106*	0698-8559	2	RESISTOR 302 OHM 1% .5W F TUBULAR *FACTORY SELECTED PART	28480	0698-8559
A3R107*	0698-8561	2	RESISTOR 454.6 OHM 1% .5W F TUBULAR *FACTORY SELECTED PART	28480	0698-8561
A3R108*	0698-8558		RESISTOR 67.3 OHM 1% .5W F TUBULAR *FACTORY SELECTED PART	28480	0698-8558
A3R109*	0698-8559		RESISTOR 302 OHM 1% .5W F TUBULAR *FACTORY SELECTED PART	28480	0698-8559
A3R110*	0698-8561		RESISTOR 454.6 OHM 1% .5W F TUBULAR *FACTORY SELECTED PART	28480	0698-8561
A3R111	0757-0400	1	RESISTOR 90.9 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-90R9-F
A3R112	0698-4419	1	RESISTOR 210 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-210R-F
A3R113	0698-4451	1	RESISTOR 340 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-340R-F
A3R114 Δ1					
A3R115	0757-0472		RESISTOR 200K 1% .125W F TUBULAR	24546	C4-1/8-TO-2003-F
A3R116, R117 Δ1	0698-6965		RESISTOR 505 OHM 1% .125W	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 Δ1					
A3R201 Δ1	0757-0442		RESISTOR 10K 1% .125W	24546	C4-1/8-TO-1002-F
A3R202 Δ1	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-TO-1001-F
A3R203	0757-0442		RESISTOR 10K 1% .125W	24546	C4-1/8-TO-1002-F
A3R204 Δ1	0698-3228		RESISTOR 49.9K 1% .125W F TUBULAR	03888	PME55S
A3R205 Δ1	0698-3228		RESISTOR 49.9K 1% .125W F TUBULAR	03888	PME55S
A3R206 Δ1	0757-0442		RESISTOR 10K 1% .125W	24546	C4-1/8-TO-1002-F
A3R207 Δ1					
A3R208 Δ1					
A3R209 Δ1					
A3R210 Δ1	0757-0283		RESISTOR 2K 1% .125W F TUBULAR	24546	C4-1/8-TO-2001-F
A3R211	0757-0427		RESISTOR 1.5K 1% .125W F TUBULAR	24546	C4-1/8-TO-1501-F
A3R213 Δ1	0698-3258		RESISTOR 5360 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-5361-F

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3R391	0683-4735		RESISTOR 47K 5% .25W CC TUBULAR	01121	CB4735
A3R392	0698-6801	1	RESISTOR 3.48K 1% .125W F TUBULAR	19701	MF4C1/8-T9-3481-F
A3R393	0698-8182	1	RESISTOR 2.21K 1% .125W F TUBULAR	30983	MF4C1/8-T9-2211-F
A3R395	0757-0387		RESISTOR 27.4 OHM 1% .125W F TUBULAR	30983	MF4C1/8-T0-27R4-F
A3R396	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A3R397	2100-3212		RESISTOR-VAR TRMR 200 OHM 10% C SIDE ADJ	32997	3389P-1-201
A3R398 Δ1	0757-0449		RESISTOR 20K 1% .125W	24546	C4-1/8-TO-2002-F
A3R401	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-TO-1001-F
A3R401 Δ1 Δ5	0698-3497	1	RESISTOR 6040 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-604R-F
A3R403, 404	0683-5145		RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R501	0698-6323		RESISTOR 100 OHM .1% .125W F TUBULAR	19701	MF4C1/8-T9-100R-B
A3R502 Δ1	0698-6448	1	RESISTOR-FXD 216.2 .001 .125W	24546	NE55
A3R503	0698-5369	1	RESISTOR-FXD 262.4 .001	28480	0698-5369
A3R504	0698-3274	1	RESISTOR 10K 1% .125W F TUBULAR	19701	MF4C1/8-T9-1002-F
A3R505 Δ1	2100-3351		RESISTOR-VAR TRMR 5000HM 10% C SIDE ADJ	73138	72XR500
A3R506*	0757-0398		RESISTOR 75 1% .125W F	24546	C4-1/8-TO-75R0-F
A3R507, 508 Δ1	2100-3345		RESISTOR-VAR 100HM 10% C TOP ADJ	73138	72PR10
A3R818	0683-2405		RESISTOR 24 OHM 5% .25W CC TUBULAR	01121	CB2405
A3R819	0684-1021	3	RESISTOR 1K 10% .25W CC TUBULAR	01121	CB1021
A3R820	0757-0277		RESISTOR 49.9 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-4992-F
A3S1, A3S2	03551-61901	2	SWITCH, ASSEMBLY ROTARY:FUNCTION AND IMP	28480	03551-61901
A3S3	3100-2753	1	SWITCH, ROTARY: FREQ RANGE HZ	28480	3100-2753
A3S4 Δ1	3100-3351	1	SWITCH, ROTARY: LEVEL RANGE DBM	28480	3100-3351
A3S5 Δ7	3100-3377	1	SWITCH, ROTARY: RECEIVE NOISE/TONE	28480	3100-3377
A3T101 Δ1 Δ3	9100-3489	1	TRANSFORMER, RECEIVE	28480	9100-3489
A3T102	9100-3449	1	TRANSFORMER, SEND	28480	9100-3449
A3U201 Δ1	1826-0218	1	IC LIN AMPLIFIER	02735	CA3100T
A3U202	1820-0478	4	IC LIN LM308H AMPLIFIER	27014	LM308H
A3U203	1820-0478		IC LIN LM308H AMPLIFIER	27014	LM308H
A3U204	1826-0109		IC LIN AMPLIFIER	34371	HA2-2625-B0593
A3U205	1820-0478		IC LIN LM308H AMPLIFIER	27014	LM308H
A3U206 Δ1	1826-0222		IC LIN RC4136CP AMPLIFIER	0059R	RC4136DP
A3U207	1826-0043		IC LIN LM307H AMPLIFIER	27014	LM307H
A3U208	1826-0109		IC LIN AMPLIFIER	34371	HA2-2625-B0593
A3U209 Δ1	1826-0218		IC LIN AMPLIFIER	02735	CA3100T
A3U300	1826-0013		IC LIN AMPLIFIER	28480	1826-0013
A3U301	1826-0222		IC LIN RC4136CP AMPLIFIER	0059R	RC4136DP
A3U302	1826-0222		IC LIN RC4136CP AMPLIFIER	0059R	RC4136DP
A3U303	1826-0222		IC LIN RC4136CP AMPLIFIER	0059R	RC4136DP
A3U304	1826-0222		IC LIN RC4136CP AMPLIFIER	0059R	RC4136DP
A3U306	1820-1315	1	IC;DGTL;MULTIPLEXER	02735	CD4051AE
A3U307	1820-0478		IC LIN LM308H AMPLIFIER	27014	LM308H
A3U401	1826-0013		IC LIN AMPLIFIER	28480	1826-0013
A3U500	1826-0109		IC LIN AMPLIFIER	34371	HA2-2625-B0593
A3V101 Δ6	1970-0073	1	TUBE, ELCTRN, 81-C90, SURGE V PT CTR	28480	1970-0073
A3XA4	1251-1941	1	CONNECTOR; PC EDGE; 6-CONT; DIP SOLDER	71785	252-06-30-310
			A3 MISCELLANEOUS		
	03551-01203	1	BRACKET, ANALOG SWITCH	28480	03551-01203
	03551-26503	1	PC BOARD, INPUT AMPLIFIER	28480	03551-26503
	03551-61602	1	CABLE ASSY	28480	03551-61602
	03551-61604	1	CABLE ASSY	28480	03551-61604
	03551-61603	1	CABLE ASSY	28480	03551-61603
	1200-0043	3	INSULATOR; XSTR; TO- 3; .02 THK	28480	1200-0043
	1205-0250	1	THERMAL-LINK; SGL; TO-5 PKG	28480	1205-0250

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4 Δ5	03551-66504	1	PC ASSY, FILTER	28480	03551-66504
A4C401 404	0160-3024	4	CAPACITOR-FXD 1700PF +/-1% 100WVDC MICA	28480	0160-3024
A4C405	0180-0197	2	CAPACITOR-FXD 2.2UF +/-10% 20VDC TA	56289	150D225X9020A2
A4C406	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A4C407	0140-0177	1	CAPACITOR-FXD 400PF +/-1% 300WVDC MICA	72136	DM15F401F0300WV1CR
A4C408, C409	0160-2130	2	CAPACITOR-FXD 865PF +/-1% 100WVDC MICA	28480	0160-2130
A4C410, C411	0140-0163	6	CAPACITOR-FXD 4751PF +/-1%	72136	DM20F4751F0300WV1CR
A4C412	0180-0197		CAPACITOR-FXD; 2.2UF +/-10% 20VDC TA	56289	150D225X9020A2
A4C413-416	0140-0163		CAPACITOR-FXD 4751PF +/-1% 300WVDC MICA	72136	DM20F4751F0300WV1CR
A4C417	0170-0066	1	CAPACITOR-FXD .027UF 200VDC	56289	292P27392
A4C418, 419	0180-0228		CAPACITOR-FXD 22UF +/-10% 15VDC TA-SOLID	56289	150D226X9015B2
A4C456	0150-0093		CAPACITORFXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A4Q409	1853-0086		TRANSISTOR PNP SI CHIP	28480	
A4R401	0698-7372		RESISTOR 108.94K .1% .125W F TUBULAR	30983	MF4C1/8-T2-108441-B
A4R402	0698-6943	5	RESISTOR 20K .1% .125W F TUBULAR	19701	MF4C1/8-T2-2002-B
A4R403	0698-7376	1	RESISTOR 11.397K .1% .125W F TUBULAR	30983	MF4C1/8-T2-11397R-B
A4R404	0698-7375	2	RESISTOR 28.64K .1% .125W F TUBULAR	30983	MF4C1/8-T2-28641
A4R405	0698-4205	1	RESISTOR 21K 1% .125W F TUBULAR	16299	C4-1/8-T0-2102-F
A4R406	0698-4207	1	RESISTOR 44.2K 1% .125W F TUBULAR	16299	C4-1/8-T0 4422-F
A4R407	0698-7371	2	RESISTOR 20.605K .1% .125W F TUBULAR	30983	MF4C1/8-T2-20605R-B
A4R408	0698-4488	1	RESISTOR 26.7K 1% .125W F TUBULAR	24546	C4-1/8-T0-2672-F
A4R409	0698-7371		RESISTOR 20.605K .1% .125W F TUBULAR	30983	MF4C1/8-T2-20605R-B
A4R410	0698-3158		RESISTOR 23.7K 1% .125W F TUBULAR	16299	C4-1/8-T0-2372-F
A4R411	0698-4445		RESISTOR 5760 OHM .01%	16299	C4-1/8-T0-5761-F
A4R412	0698-6943		RESISTOR 20K .125W F TUBULAR	19701	MF4C1/8-T2-2002-B
A4R413	0698-7370	1	RESISTOR 17.579K .1% .125W F TUBULAR	30983	MF4C1/8-T2-17579R-B
A4R414	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-T0-1002-F
A4R415	0757-0450	2	RESISTOR 22.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-2212-F
A4R416	0698-4482		RESISTOR 17.4K 1% .125W F TUBULAR	03888	PME55-1/8-T0-1742-F
A4R417	0698-7373	1	RESISTOR 98.941K .1% .125W F TUBULAR	30983	MF4C1/8-T2-98941R-B
A4R418	0698-7372	2	RESISTOR 108.94K .1% .125W F TUBULAR	30983	MF4C1/8-T2-108441-B
A4R419	0698-7375		RESISTOR 28.64K .1% .125W F TUBULAR	30983	MF4C1/8-T2-28641-B
A4R420	0698-3158	2	RESISTOR 23.7K 1% .125W F TUBULAR	16299	C4-1/8-T0-2372-F
A4R421	0698-6943		RESISTOR 20K .1% .125W F TUBULAR	19701	MF4C1/8-T2-2002-B
A4R422*	0757-0442		RESISTOR 10K .01% .125W	24546	C4-1/8-T0-1002-F
A4R423*	0698-8191		RESISTOR 12.5K .1% .125W F TUBULAR	19701	MF4C1/8-T9-1251-B
A4R424	0698-6943		RESISTOR 20K .1% .125W F TUBULAR	19701	MF4C1/8-T2-2002-B
A4R425	0698-7368		RESISTOR 36.901K .1% .125W F TUBULAR	30983	MF4C1/8-T2-36901R-B
A4R426	0698-7368	2	RESISTOR 36.901K .1% .125W F TUBULAR	30983	MF4C1/8-T2-36901R-B
A4R427	0757-0401		RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-101-F
A4R428	0698-3557	1	RESISTOR 806 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-806R-F
A4R429	0757-0443	1	RESISTOR 11K 1% .125W F TUBULAR	24546	C4-1/8-T0-1102-F
A4R430	0757-0469	1	RESISTOR 150K 1% .125W F TUBULAR	24546	C4-1/8-T0-1503-F
A4R431	0698-3162	1	RESISTOR 46.4K .01%	16299	C4-1/8-T0-4642-F
A4R432	0698-3519		RESISTOR 12.4K 1% .125W F TUBULAR	16299	C4-1/8-T0-1242-F
A4R433*	0757-0442		RESISTOR 10K .01% .125W	24546	C4-1/8-T0-1002-F
A4R434	0757-0448		RESISTOR 15.2K .01%	24546	C4-1/8-T0-1822-F
A4R435	0757-0465		RESISTOR 100K 1% .125W F TUBULAR	24546	C4-1/8-T0-1003-F
A4R436	0698-3245	1	RESISTOR 20.5K 1% .125W F TUBULAR	16299	C4-1/8-T0-2052-F
A4R437	0757-0455	1	RESISTOR 36.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-3652-F
A4R438	0698-7366		RESISTOR 109.64K .1% .125W F TUBULAR	30983	MF4C1/8-T2-109641-B
A4R439	0698-7366		RESISTOR 109.64K .1% .125W F TUBULAR	30983	MF4C1/8-T2-109641-B
A4R440	0698-6943		RESISTOR 20K .1% .125W F TUBULAR	19701	MF4C1/8-T2-2002-B
A4R441	0698-7367	1	RESISTOR 78.028K .1% .125W F TUBULAR	30983	MF4C1/8-T2-78028R-B
A4R442-444	2100-3274	3	RESISTOR VAR TRMR 5K 10% C SIDE ADJ	73138	72XR10K
A4R445	2100-3207		RESISTOR 5K .1% .50W	32997	86X 1-502
A4R446, 447	0757-0407		RESISTOR 200 1% .125W F	24546	C4-1/8-TO-201-F
A4R491	0684-1021		RESISTOR 1K 10% .25W CC TUBULAR	01121	CB1021
A4S1	3100-2750	1	SWITCH ROTARY NOISE WEIGHTING	28480	3100-2750
A4U401, 402	1826-0312	2	IC LINEAR	28480	1826-0312

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5	03551-66505	1	PC ASSY, POWER SUPPLY	28480	03551-66505
A5C801	0180-2563	2	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	5	CAPACITOR-FXD; 390 +100-10% 20VDC AL	90201	MTV377N020E1JP
A5C804	0180-2511		CAPACITOR-FXD; 390 +100-10% 20VDC AL	90201	MTV377N020E1JP
A5C805	0180-2511		CAPACITOR-FXD; 390 +100-10% 20VDC AL	90201	MTV377N020E1JP
A5C806	0180-2511		CAPACITOR-FXD; 390 +100-10% 20VDC AL	90201	MTV377N020E1JP
A5C810	0180-2511		CAPACITOR-FXD; 390 +100-10% 20VDC AL	90201	MTV377N020E1JP
A5C811	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A5C812	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C813	0180-0097	1	CAPACITOR-FXD; 47UF+-10% 35VDC TA-SOLID	56289	150D476X9035S2
A5CR801	1901-0158	15	DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5CR802	1901-0158		DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5CR803	1901-0158		DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5CR804	1901-0158		DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5CR805	1901-0158		DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5CR806	1901-0158		DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5CR807	1901-0158		DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5CR808	1901-0158		DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5CR809	1901-0158		DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5CR810	1901-0158		DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5CR811	1901-0158		DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5CR812	1901-0158		DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5CR813	1901-0158		DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5CR814	1901-0158		DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5CR815	1901-0158		DIODE-PWR RECT 200V 750MA	04713	SR1358-3
A5CR816	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A5CR817	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A5CR818	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A5CR819	1902-0766	1	DIODE-ZNR 18.2V 5% DO-7 PD=.4W	04713	SZ 10939-257
A5CR820	1901-0050		DIODE-SWITCHING 2NS 80V 200MA	28480	1901-0050
A5CR821	1901-0050		DIODE-SWITCHING 2NS 80V 200MA	28480	1901-0050
A5F801	2110-0046	3	FUSE .5A 125V	71400	TYPE GMW-1/2
A5F802	2110-0046		FUSE .5A 125V	71400	TYPE GMW-1/2
A5F803	2110-0046		FUSE .5A 125V	71400	TYPE GMW-1/2
A5J1	1200-0423		SOCKET:IC BLK 16 CONTACT	23880	CSA2900-16B
A5J2 Δ4	1251-3751	1	CONNECTOR; 8-CONT; MALE; POST TYPE	27264	09-65-1081
A5J3	1251-3745	3	CONNECTOR PLUG: +5V INCLUDES THE FOLLOWING:	28480	1251-3745
	1251-3746	2	CONTACT CONNECTOR	28480	1251-3746
A5J4	1251-3745		CONNECTOR PLUG: +12V INCLUDES THE FOLLOWING:	28480	1251-3745
	1251-3747	4	CONTACT CONNECTOR	28480	1251-3747
A5J5	1251-3745		CONNECTOR PLUG: -12V INCLUDES THE FOLLOWING:	28480	1251-3745
	1251-3747		CONTACT CONNECTOR	28480	1251-3747
A5K801	0490-0569	1	RELAY	28480	0490-0569
A5Q804	1853-0066		TRANSISTOR PNP SI CHIP TO-92 PD=200MW	28480	1853-0066
A5Q805	1853-0066		TRANSISTOR PNP SI CHIP TO-92 PD=200MW	28480	1853-0066
A5Q806	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A5Q807	1853-0066		TRANSISTOR PNP SI CHIP TO-92 PD=200MW	28480	1853-0066
A5Q808	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A5Q809	1853-0066		TRANSISTOR PNP SI CHIP TO-92 PD=200MW	28480	1853-0066
A5Q810	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A5R804	0813-0040	1	RESISTOR 20 OHM 5% 5W PW TUBULAR	91637	CW5-2-5W-T2-20R-J
A5R805	0812-0070	1	RESISTOR 10 OHM 5% 5W PW TUBULAR	91637	CW5-2-5W-T2-10R-J
A5R806	0811-3114	1	RESISTOR 75 OHM 3% 5W PW TUBULAR	00213	1500S
A5R807	0811-1854	1	RESISTOR 50 OHM 5% 5W PW TUBULAR	56289	243E50K5
A5R809	0698-4494	2	RESISTOR 35.7K 1% .125W F TUBULAR	24546	C4-1/8-T0-3572-F

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5R810	0698-3451	2	RESISTOR 133K 1% .125W F TUBULAR	16299	C4-1/8-T0-1333-F
A5R811	0698-4489	1	RESISTOR 28K 1% .125W F TUBULAR	24546	C4-1/8-T0-2802-F
A5R812	0698-3162	1	RESISTOR 46.4K 1% .125W F TUBULAR	16299	C4-1/8-T0-4642-F
A5R813	0698-4502	1	RESISTOR 64.9K 1% .125W F TUBULAR	24546	C4-1/8-T0-6492-F
A5R814	0698-3451		RESISTOR 133K 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
A5R820	0683-1045		RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A5R821	0683-1035		RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A5R822	0683-1045		RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A5R823	0683-1045		RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A5R824	0757-0427		RESISTOR 1.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-1501-F
A5R825	0757-0427		RESISTOR 1.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-1501-F
A5R826	0683-1015		RESISTOR 100 OHM 5% .25W CC TUBULAR	01121	CB1015
A5U801	1820-0430	1	IC LIN LM309K REGULATOR	27014	LM309K
A5U802	1826-0117	1	IC LIN REGULATOR	07263	7812KC
A5U803	1826-0123	1	IC LIN LM320K-12 REGULATOR	27014	LM320K-12
			A5 MISCELLANEOUS		
	03551-01205	1	BRACKET, BATTERY CONNECTOR	28480	03551-01205
	0380-0160	1	STANDOFF	28480	0380-0160
	0490-0541	1	RETAINER, SOCKET	28480	0490-0541
	0490-0570	1	SOCKET, RELAY	28480	0490-0570
			CHASSIS PARTS		
BT1	1420-0220	1	BATTERY PACK: 5V	28480	1420-0220
BT2	1420-0221	2	BATTERY PACK: 12V	28480	1420-0221
BT3	1420-0221		BATTERY PACK: 12V	28480	1420-0221
F1	2110-0201	1	FUSE .25A 250V SLO-BLO	75915	313.250S
J3	1510-0091	4	BINDING-POST; SINGLE;3/8-32;JGK/RED;SGL	28480	1510-0091
J4	1510-0091		BINDING-POST; SINGLE;3/8-32;JGK/RED;SGL	28480	1510-0091
J5	1251-0687	2	CONNECTOR; TEL; 3-CKT JACK .25 SHK DIA	82389	MN-112B
J6	1510-0091		BINDING-POST; SINGLE;3/8-32;JGK/RED;SGL	28480	1510-0091
J7	1510-0091		BINDING-POST; SINGLE;3/8-32;JGK/RED;SGL	28480	1510-0091
J8	1251-0687		CONNECTOR; TEL; 3-CKT JACK .25 SHK DIA	82389	MN-112B
J9	1510-0087	1	BINDING-POST, SINGLE,6-32,JGK/BLK	28480	1510-0087
J10	1251-3954	2	JACK	28480	1251-3954
L1 – L4 Δ1	9100-3551	4	COIL:FXD 1UH	24226	9493
PM1	0960-0444	1	LINE MODULE	28480	0960-0444
R200	2100-0669	1	RESISTOR-VAR 50K 10% CC	12697	SERIES 63M
R500	2100-0352	1	RESISTOR-VAR 50K-5K OHM 5% 2W	28480	2100-0352
S1	3101-1849	1	SWITCH: PUSHBUTTON, HOLD	28480	3101-1849
T1	9100-3451	1	TRANSFORMER: POWER	28480	9100-3451
W2	03570-61625	1	CABLE ASSY	28480	03570-61625
			MISCELLANEOUS PARTS		
	Δ1,7 03551-00221	1	PANEL, FRONT	28480	03551-00221
	Δ1 03551-00212	1	PANEL, FRONT, SUB	28480	03551-00212
	03551-01201	1	BRACKET, PRIMARY POWER MOUNTING	28480	03551-01201
	03551-01202	1	CLAMP, CABLE	28480	03551-01202
	03551-04101	1	INSULATOR, LINE V	28480	03551-04101
	03551-04301	1	PLATE, PC BOARD MOUNTING	28480	03551-04301
	Δ1 03551-65001	1	LOCK	28480	03551-65001
	03551-23701	1	ROD, AUTO OFF	28480	03551-23701
	Δ1 03551-24710		HOUSING, LOCK	28480	03551-24710
	Δ1 03551-24901		HANDLE, LOCK	28480	03551-24901
	Δ1 03551-27901		SCREW, LOCK	28480	03551-27901
	03551-64101	1	COVER ASSY	28480	03551-64101
	ΔA 03551-64521	1	CASE ASSY	28480	03551-64521
	0370-1003	1	KNOB, MONITOR VOLUME	28480	0370-1003
	0370-1005	2	KNOB, IMP & SEND LEVEL RANGE	28480	0370-1005
	0370-1099	3	KNOB, SEND FREQUENCY RANGE	28480	0370-1099
	0370-1099		KNOB, RECEIVE NOISE TONE	28480	0370-1099
	0370-1099		KNOB, NOISE WEIGHTING	28480	0370-1099
	0370-1303	1	KNOB, SEND FREQUENCY VERNIER	28480	0370-1303
	0370-1318	1	KNOB, FUNCTION	28480	0370-1318
	Δ1 0370-1810		KNOB, LEVER	28480	0370-1810
	0370-2486	3	PUSHBUTTON, COVER HOLD	28480	0370-2486
	0370-2497	7	PUSHBUTTON, COVER;POWER, DISPLAY & MONIT	28480	0370-2497
	0370-2627	1	KNOB ASSY, SEND LEVEL VERNIER	28480	0370-2627
	1251-3167	1	CONNECTOR; 4-CONT; FEM; POST TYPE	27264	09-50-3041
	1251-3301	1	CONNECTOR; 8-CONT; FEM; POST TYPE	28480	1251-3301
	1460-1341	1	SPRING WFRM STL	28480	1460-1341
	4040-0985	1	LENS DISPLAY	28480	4040-0985
	5040-7695	1	MOUNT, SPEAKER	28480	5040-7695
	5060-7452	1	DIAL CONT ASSY	28480	5060-7452

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ΔA For Serial Numbers 1425A-00130 and below, case assembly part no. is 03551-64501 (see Figure 7-17 ΔA).

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
	5250-49A	1	HANDLES	28480	5250-49A
	8120-1518	1	CABLE, POWER	28480	8120-1518
	9160-0229	1	SPEAKER	28480	9160-0229
			HANDLE, CARRYING (CONSISTS OF THE FOLLOWING PARTS):		
	1440-0071		HANDLE-PLASTIC W/STL INSR 4.25" L .25 THK	12136	1876-372
	1440-0050		HANDLE-CMPNT .75-L	12136	1875-376-370
	1440-0049		HANDLE-CMPNT .75-L	12136	1875-376-370
	2200-0143		SCREW-MACH 4-40 .375-IN-LG PAN-HD	28480	2200-0143
	2260-0001		NUT-HEX-DBL CHAM 4-40 THD	28480	2260-0001
	2190-0004		WASHER LK INTL T NO. 4 .115 IN ID .27 IN	U1453	1904

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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 problem, the procedure will also direct the user to the A1 or A3 board. The second part provides analog troubleshooting 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:

CAUTION

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

a. Set the Test Set controls as follows:

FUNCTION . . . . . .REC TERM
IMP 600
RECEIVE NOISE/
TONE . . . . . .TONE NORMAL
HOLD. . . . . OFF
POWER. . . . . .~ AC

b. Connect a 3320B through a 600 ohm balanced load to the Test Set input terminals.

c. Adjust the 3320B to 1 kHz at a level of + 10.79 dBm.

NOTE

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.

d. Press the DISPLAY & MONITOR Receive Level button and verify a display of 0 dBm.

e. Press the DISPLAY & MONITOR Frequency Level button and verify a display of 1 kHz.

NOTE

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.

f. Measure A1TP14 with the 180C Oscilloscope. The oscilloscope should indicate a 30 mV rms 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

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the reading is incorrect, then refer to the analog troubleshooting section. The malfunction is most likely to have occurred on the A1 board. A correct reading would indicate that the Digital Troubleshooting procedures should be used.

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 a 3320B Oscillator to the Test Set black input/output terminals through a 600 ohm impedance box.

b. Adjust the 3320B to 1 kHz at a + 10.79 dBm output level.

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 A1 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.

Table 7-1. Receive Tone Test Points.

Test Point	Reading AC	Reading DC
1. Test Set Input Terminals	774.6 mV	
2. A1W10C		+ 1.68 V
3. A3TP19	1.6 mV	
4. Attenuator Input	511.5 mV	
5. A3TP1	511.8 mV	
6. A3TP10	511.6 mV	
7. A3TP21	130 mV	
8. Pin 3, A3U500	2.6 mV	
9. A1TP14	130 mV	
10. A1TP18		- 2.54 V
11. A1TP19	980 mV	- .475 mV

a. Adjust the 3320B frequency to 1 kHz and amplitude level to + 5.79 dBm.

b. Set the Test Set front panel controls to:

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

c. Connect the 3320B to the Test Set black input terminals through the 600 ohm Balance Box (Figure 5-9).

d. Switch the NOISE WEIGHTING control through each of the four switch positions. Observe the Test Set display for + 84.9 to + 85.1 or flashing between + 84/ + 85 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.

Table 7-2. Noise Weighting Filters Test Points.

Test Point	Reading AC	Reading DC
1. A1W10		+ 2.84 V
2. A4TP1	3.6 mV	
3. Pin 6, U401	3.6 mV	
4. Pin 4, XA4	3.6 mV	
5. A4TP5 (C Message Filter)	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	- 486 mV
20. A1TP18		- 3.34 mV

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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.

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

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

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

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.

7-22. 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.

7-23. Measure Circuit Troubleshooting.

a. Set the Test Set controls as follows:

FUNCTION . . . . . .REC TERM
IMP 600
RECEIVE NOISE/
TONE . . . . . TONE NORMAL
HOLD. . . . . OFF
POWER. . . . . ~ AC

b. Connect a 3320B through a 600 ohm balanced load to the Test Set input terminals.

c. Adjust the 3320B to 1 kHz at a level 0 to + 10.79 dBm.

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

NOTE

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

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

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

b. U205 and associated circuitry control X Axis symmetry.

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.

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

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

f. The current through the switching transistors A3Q211 and A3Q212 should be approximately equal.

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

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

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

7-25. Digital Troubleshooting.

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.

7-27. 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.

NOTE

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.

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.

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

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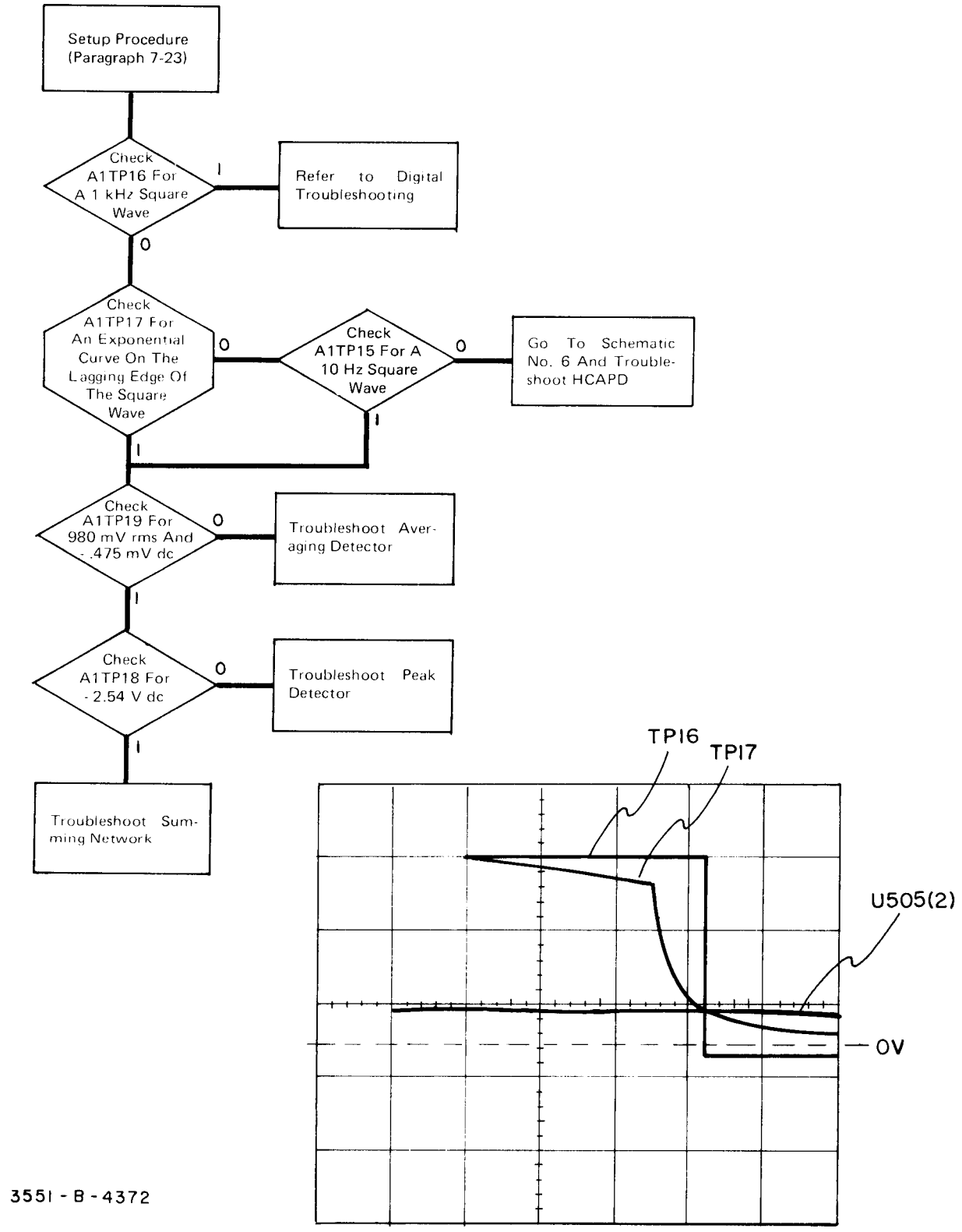


Figure 7-2. Measure Circuit Troubleshooting Flow Chart.

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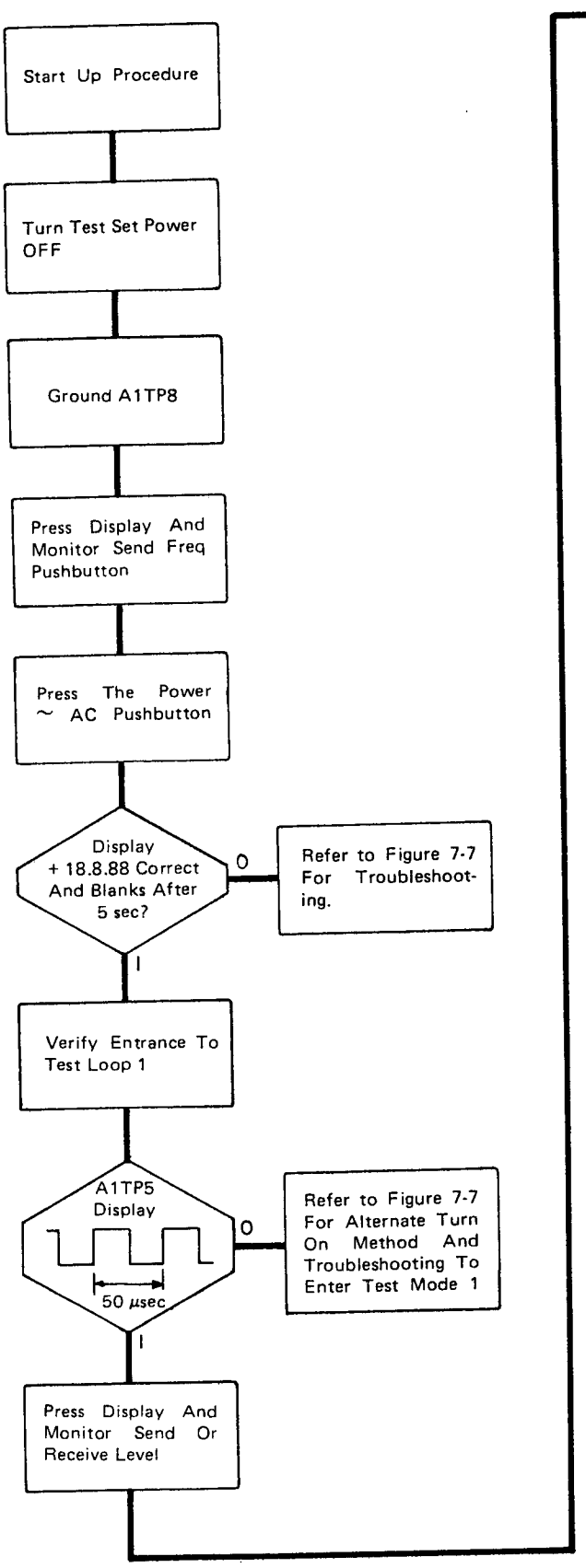
If the jumper wire for display brightening (Schematic 6, A1) is in the + 5 V position, the display will indicate + 10 as soon as the + 18.8.88 indication disappears. If the jumper wire is connected to U613 pin 12, the display will blank as soon as the + 18.8.88 indication disappears.

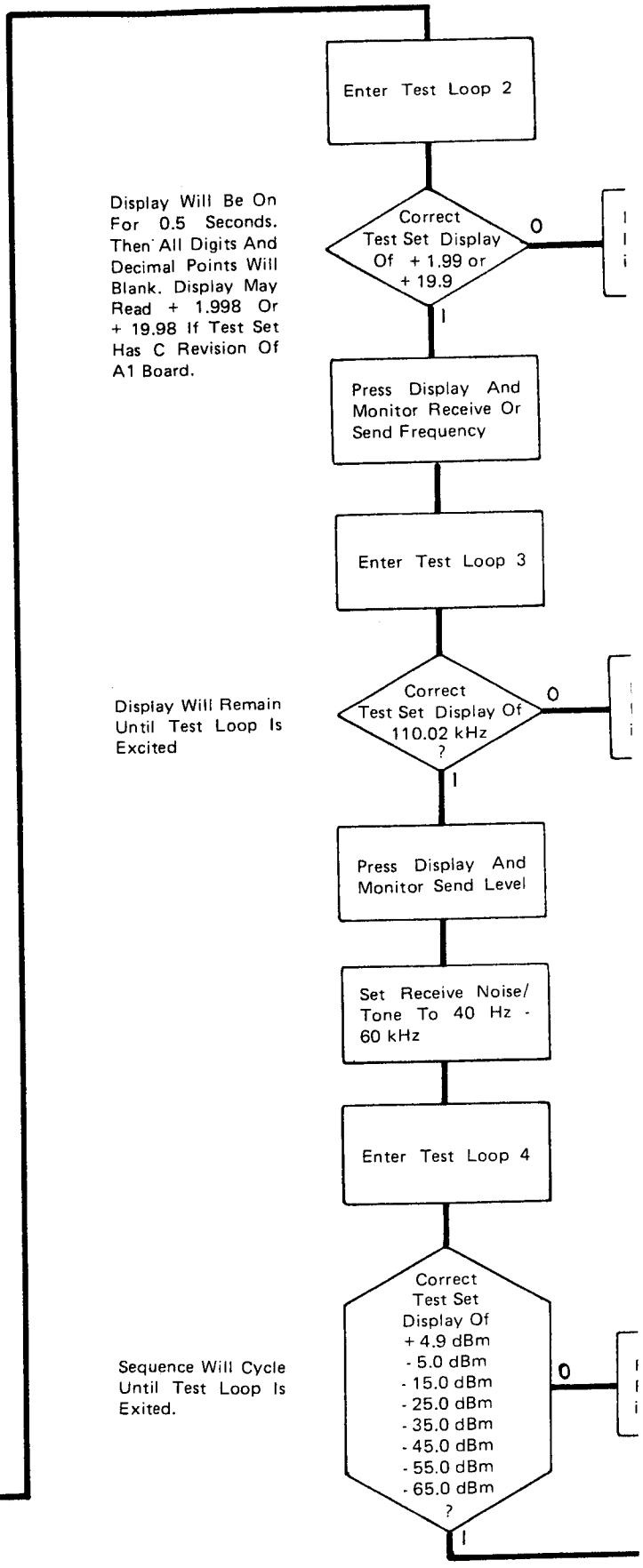
This verifies proper operation of the LED drive circuits. The display can be locked onto this indication by grounding A1TP9 if the five second interval is not adequate for verification. After verification, remove the ground from A1TP9.

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er wire for display brighten-
tic 6, A1) is in the + 5 V po-
lisplay will indicate + 10 as
+ 18.8.88 indication disap-
jumper wire is connected to
2, the display will blank as
+ 18.8.88 indication disap-

s proper operation of the
circuits. The display can be
this indication by grounding
ıe five second interval is not
r verification. After verifica-
e the ground from A1TP9.





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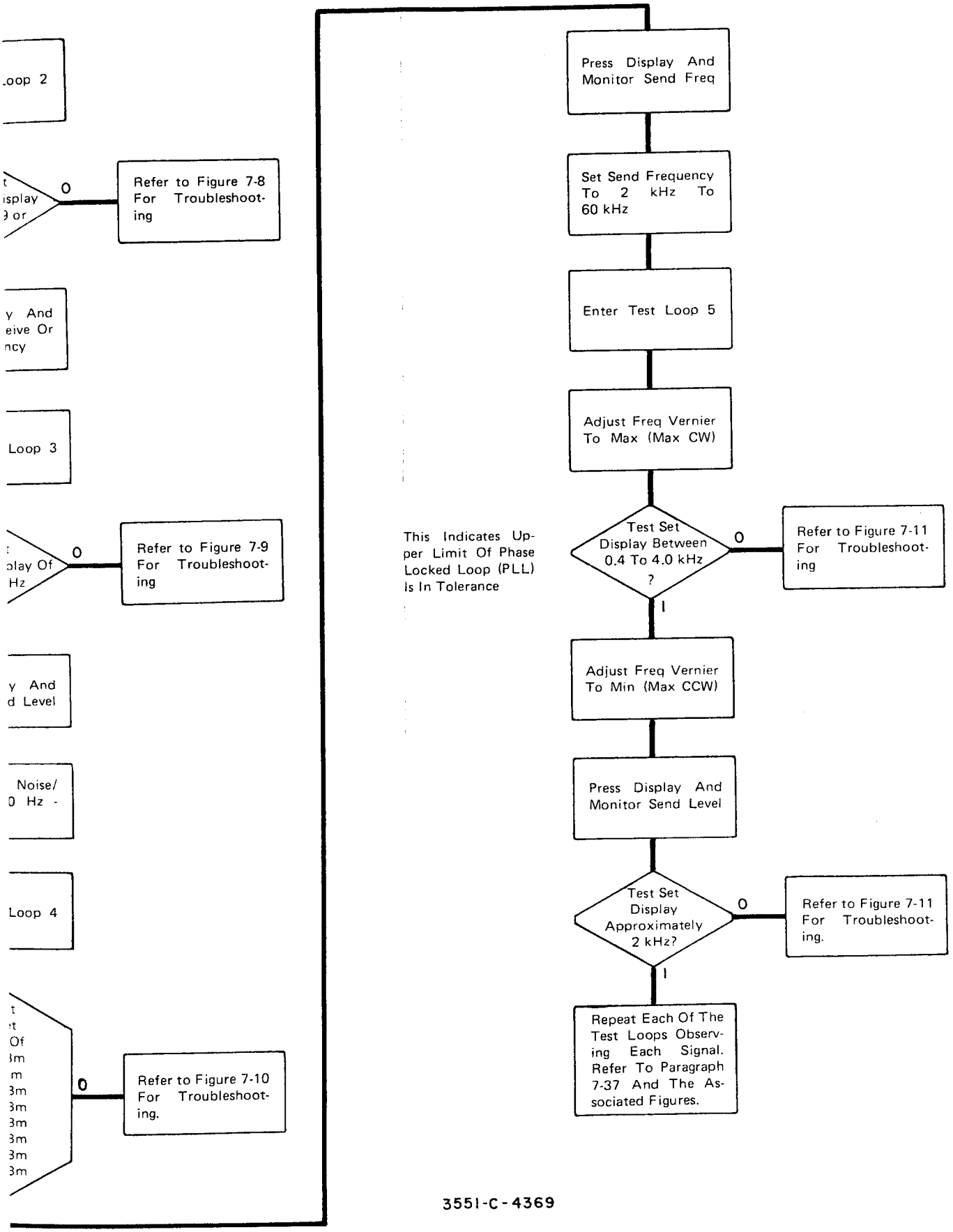
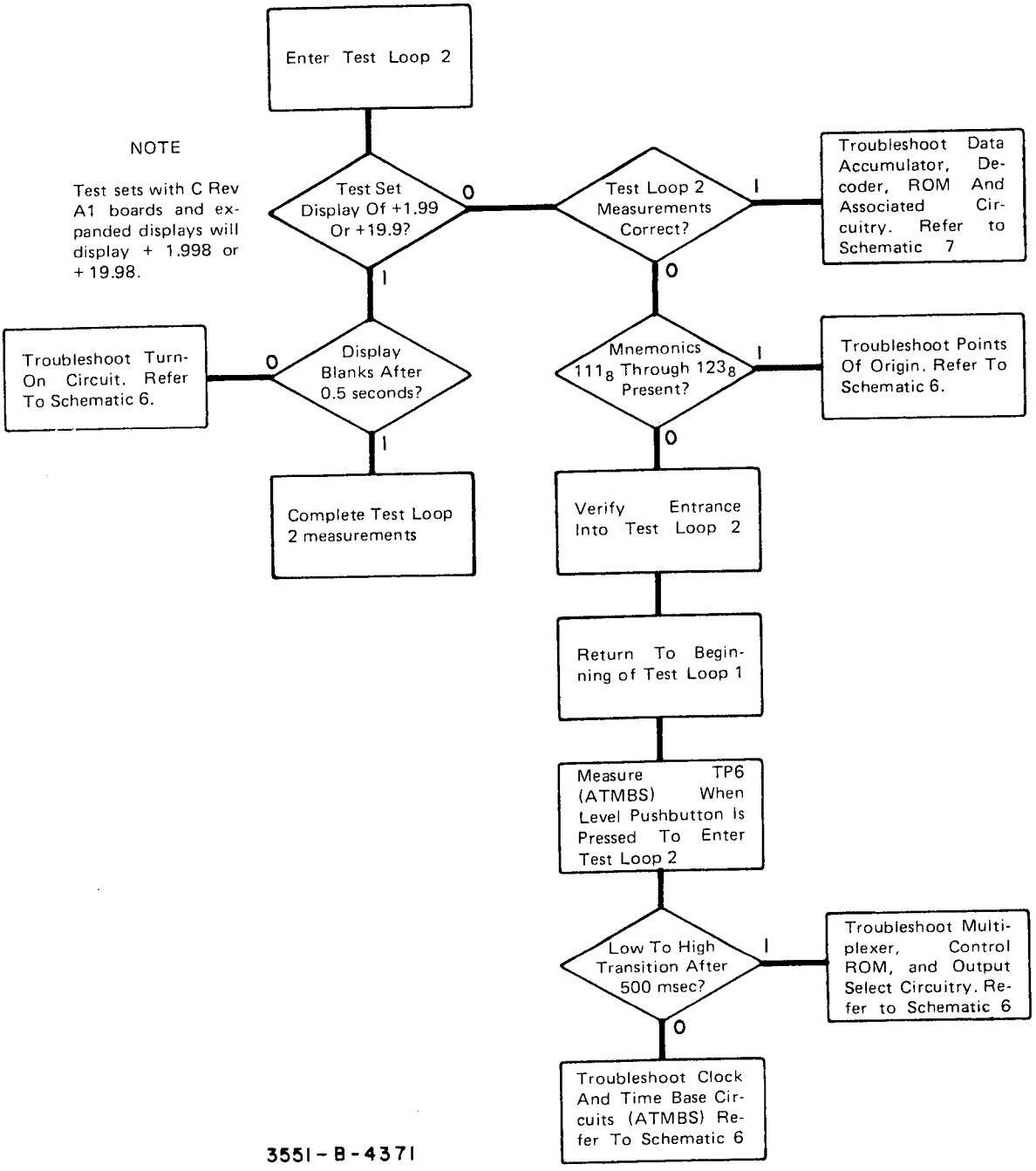


Figure 7-5. Simplified Test Loop Flow Chart.

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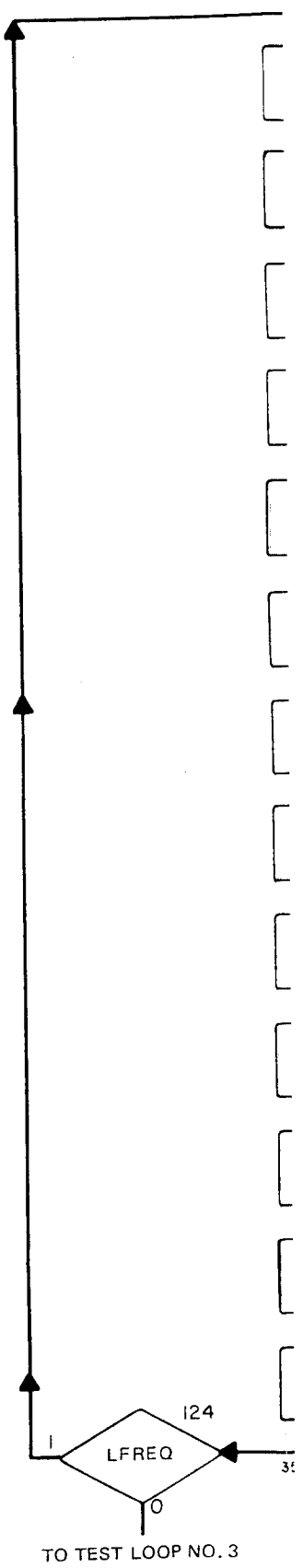
INTRODUCTION.

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 LFREQ 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 μsec long. To verify if the Test Set is in Test Loop No. 2, connect an oscilloscope to A1TP5 and verify that the repetition rate of HTBRT pulses is approximately 140 μsec.

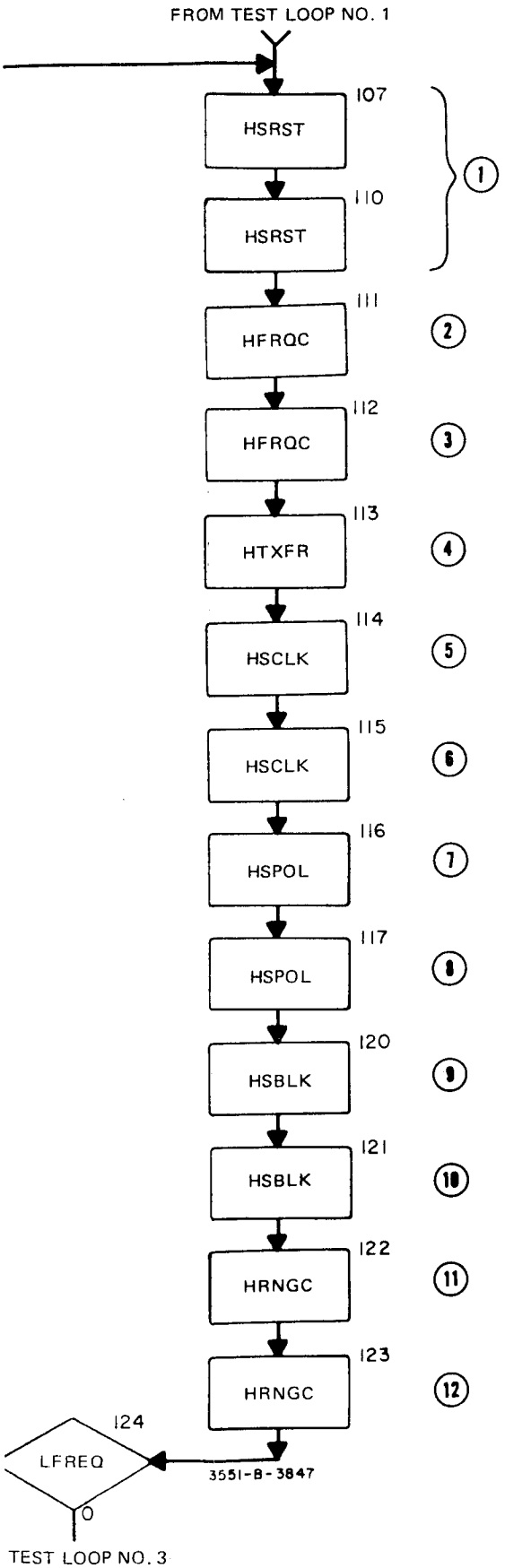
Connect the external trigger input of an oscilloscope to A1TP5 (HTBRT) and verify the shape and timing of the signals listed in Notes 1 through 12. If a malfunction is discovered, it must be corrected before going to the next step.

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.



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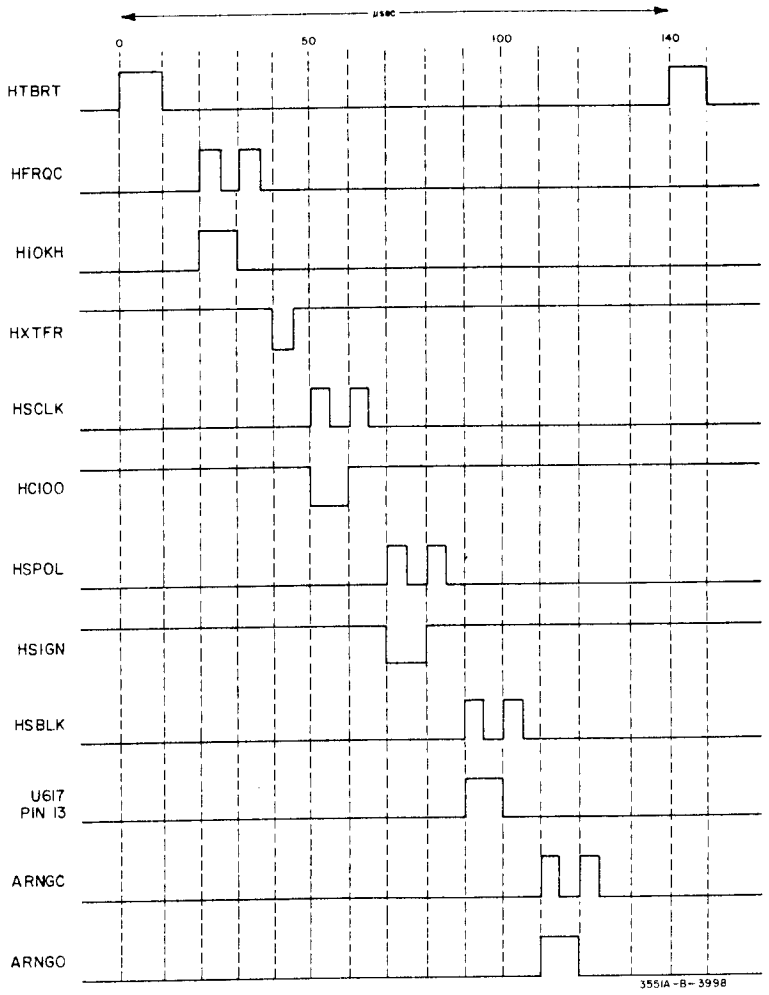


Figure 7-8. Test Loop Number 2.
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(1) Set counter in Data Accumulator to count input frequency.

(2) Wait period of 50 ms for frequency count.

(3) 3553 Option.

(4) Transfer count for frequency measurement.

(5) Detection for frequency down-ranging

(6) Detection for frequency up-ranging

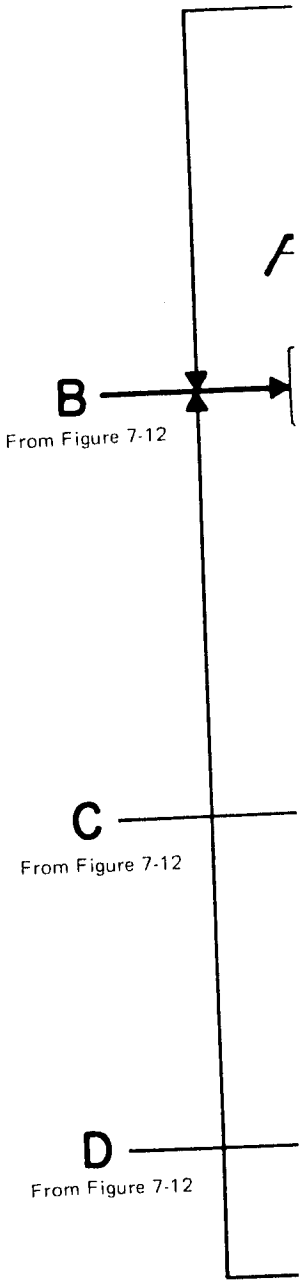
(7) Polarity blanking

(8) Display blanking

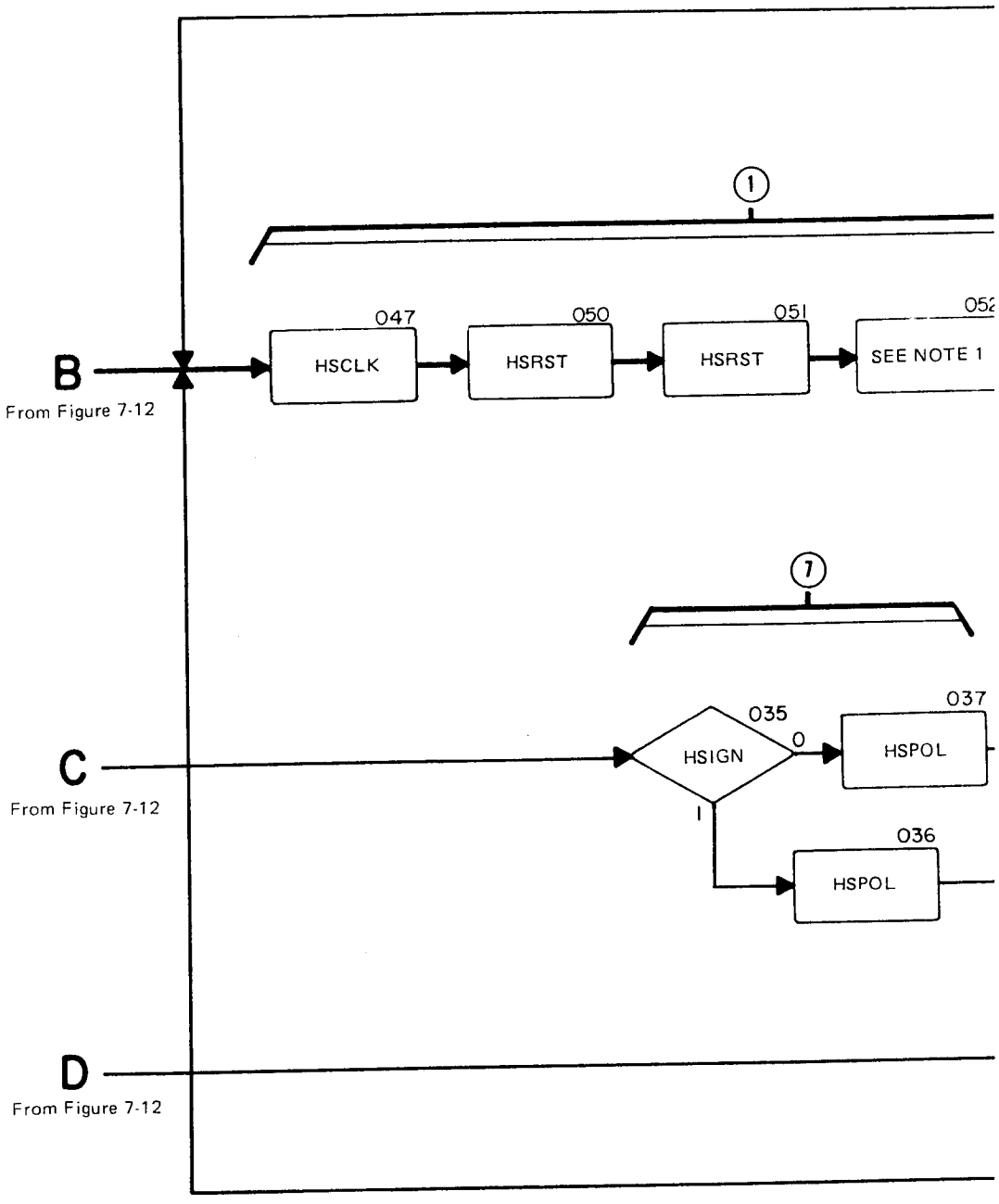
(9) Autoranging settling time (80 to 100 ms).

(10) Manual frequency ranging for internal test routine.

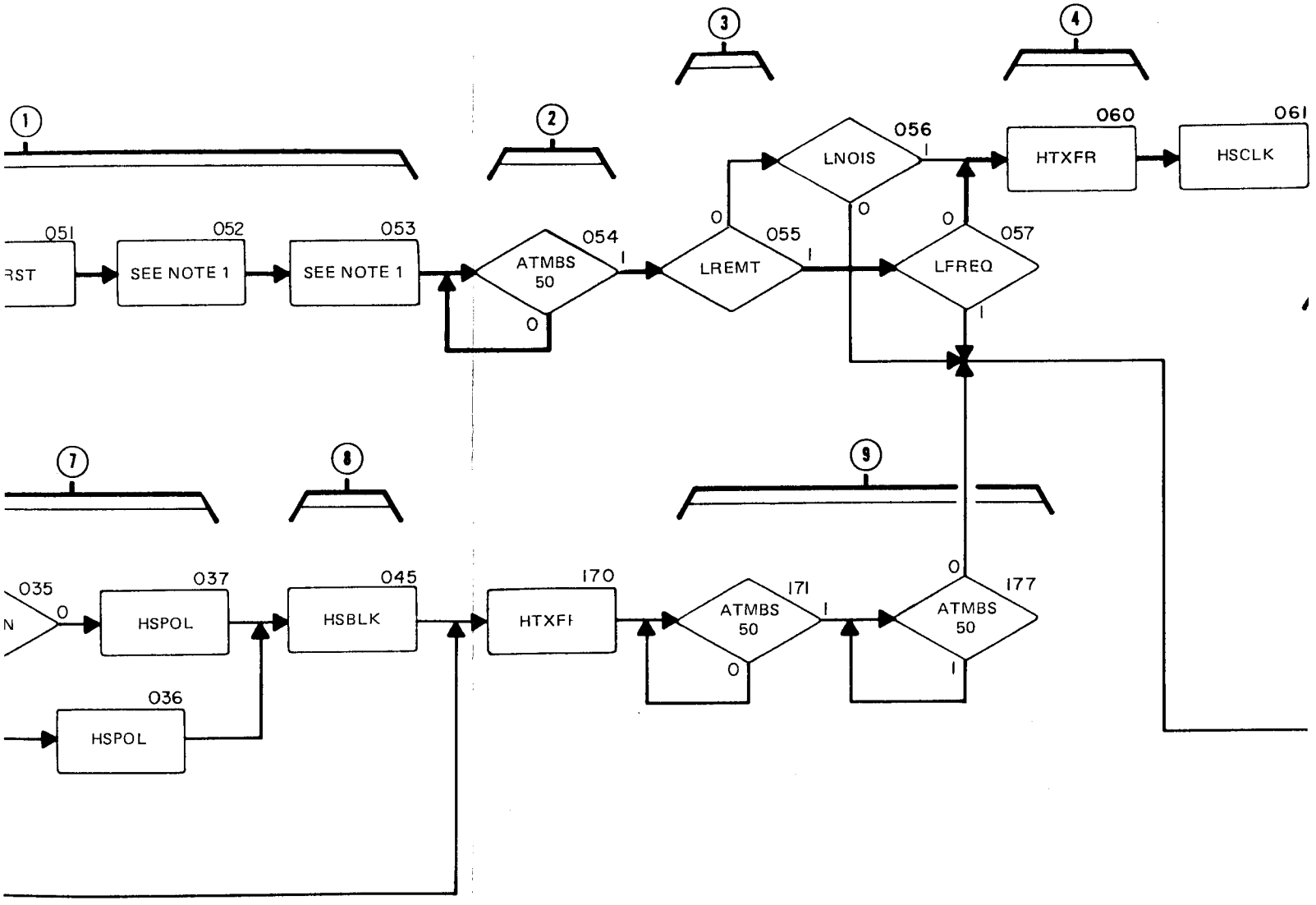
(11) Wait period for noise measurements (420 to 500 ms).



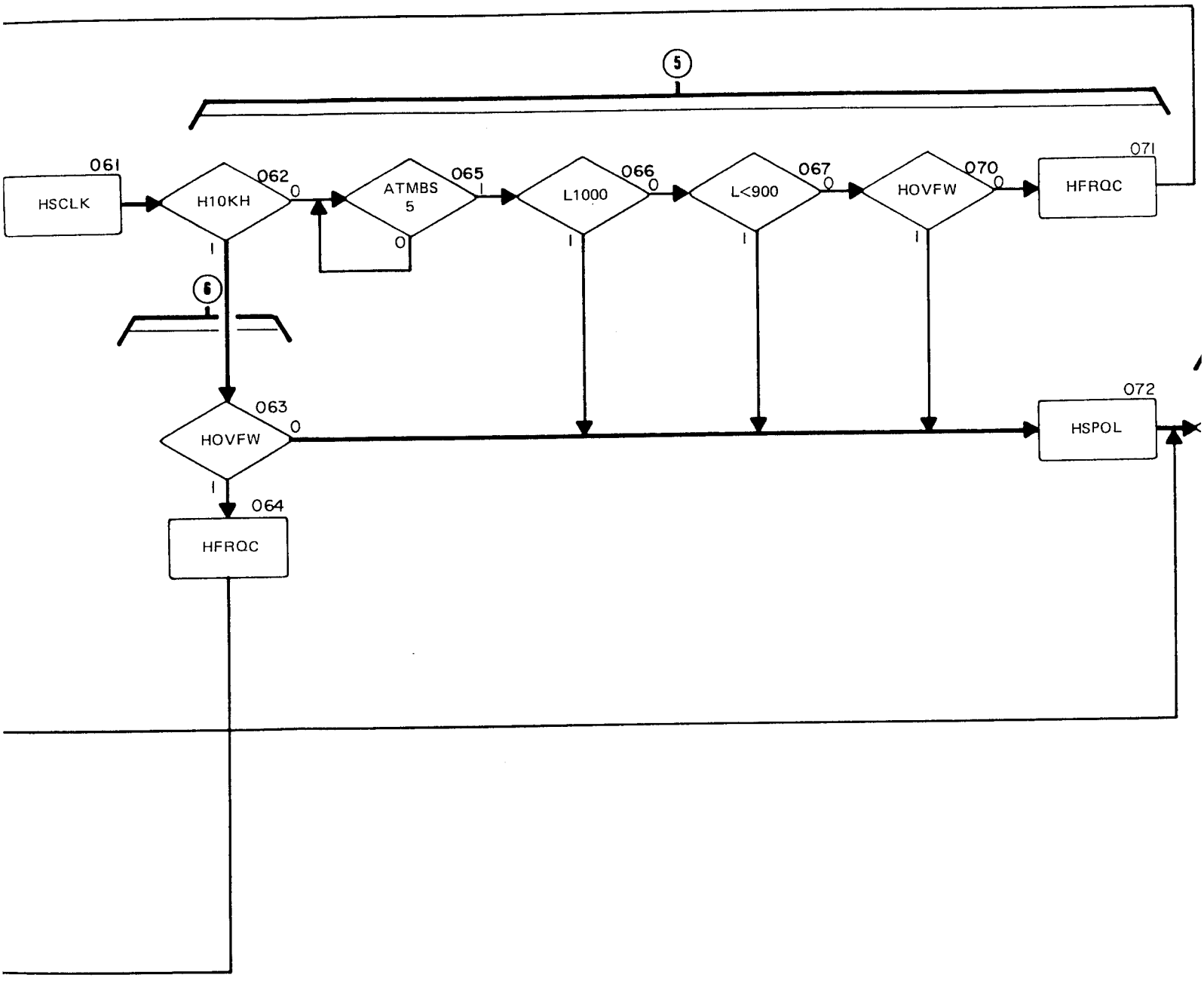
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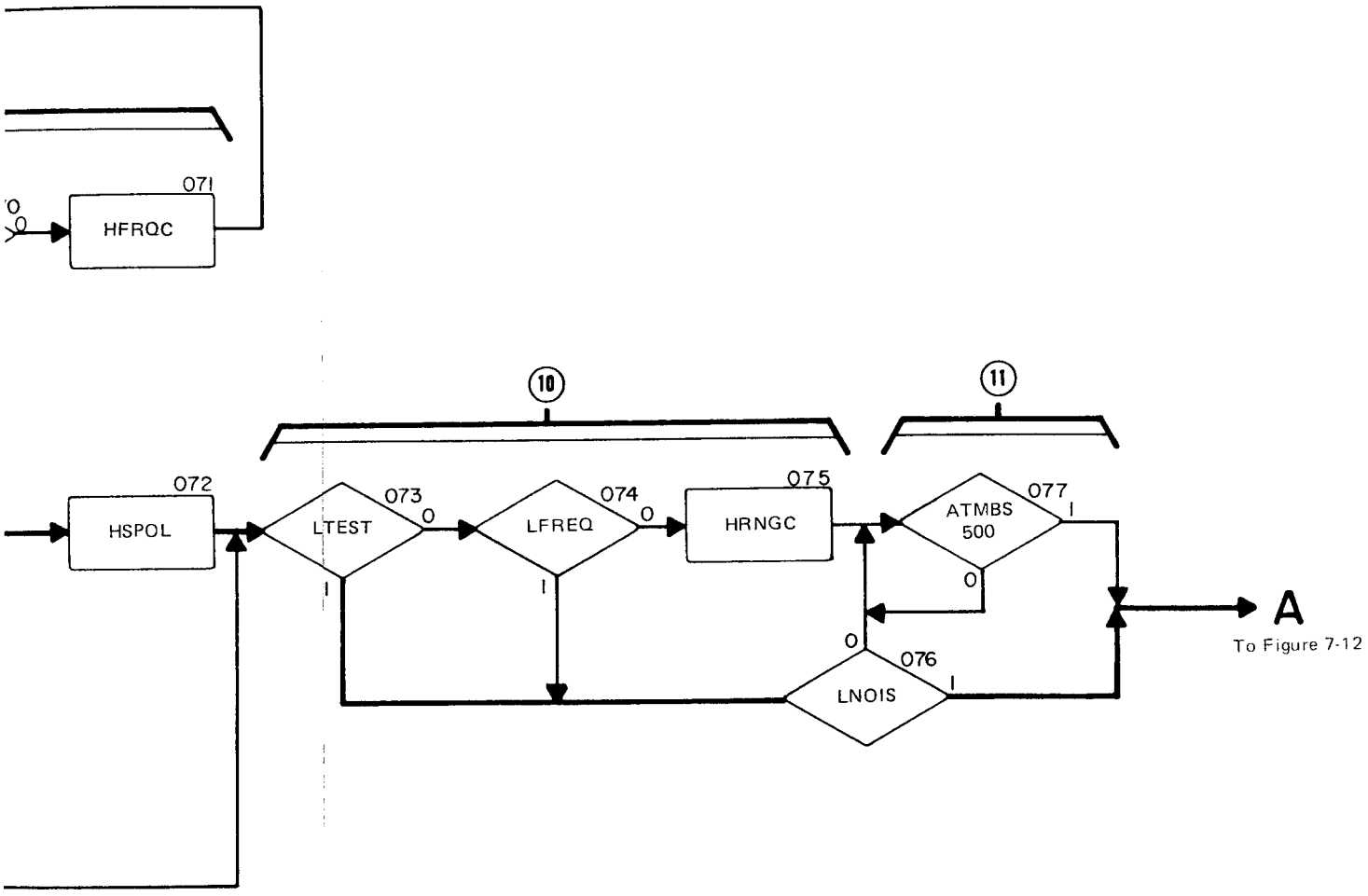


Figure 7-13. p/o Operational Flow Chart.
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INTRODUCTION.

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.

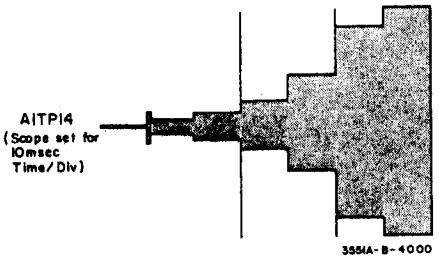
NOTE 3. Connect an oscilloscope to A1U606 pin 15 and verify the signal (HRNGC). Verify ARNG0, ARNG1 and ARNG2 at A1U621 pins 6, 11 and 14 respectively.

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

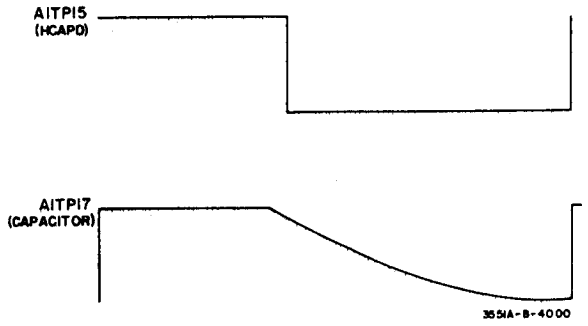
This sequence should repeat as long as LFREQ is high (DISPLAY & MONITOR SEND LEVEL is pressed).

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.

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4 verifies the operation of the range up-down), the automatic amplitude ranging circuits and the nplitude decoding process. The analog ranging litude measurement circuits will also be tested. er has entered the loop, it will run between states 151 as long as LFREQ is high (DISPLAY & LEVEL pushbutton pressed).

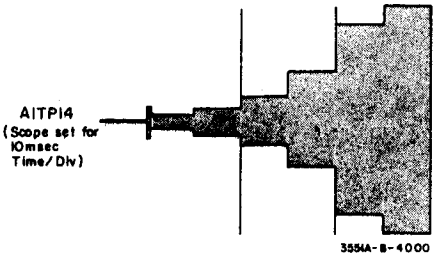
low (A1TP8 grounded) there is a 500 ms delay in _TEST is high (A1TP8 ground removed) there is ıy. To verify if the Test Set is in Test Loop No. 4,)scope to A1TP5 with A1TP8 grounded and verify pulse repetition rate is approximately 500 ms. ınd from A1TP8 and verify that the HTBRT approximately 15 ms. To verify the operation of externally trigger the oscilloscope at A1TP5 and in Notes 1 through 4 as shown in the timing

1. HSRST verified in Test Loop No. 1.
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.
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.
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

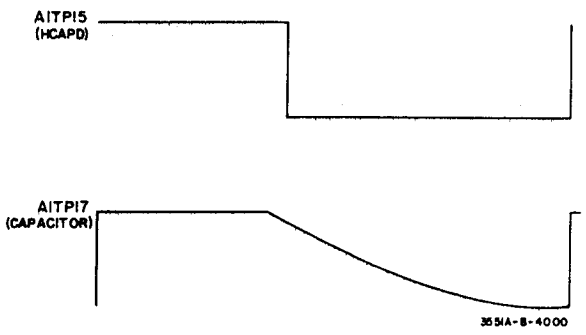
   This sequence should repeat as long as LFREQ is high (DISPLAY & MONITOR SEND LEVEL is pressed).

   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:

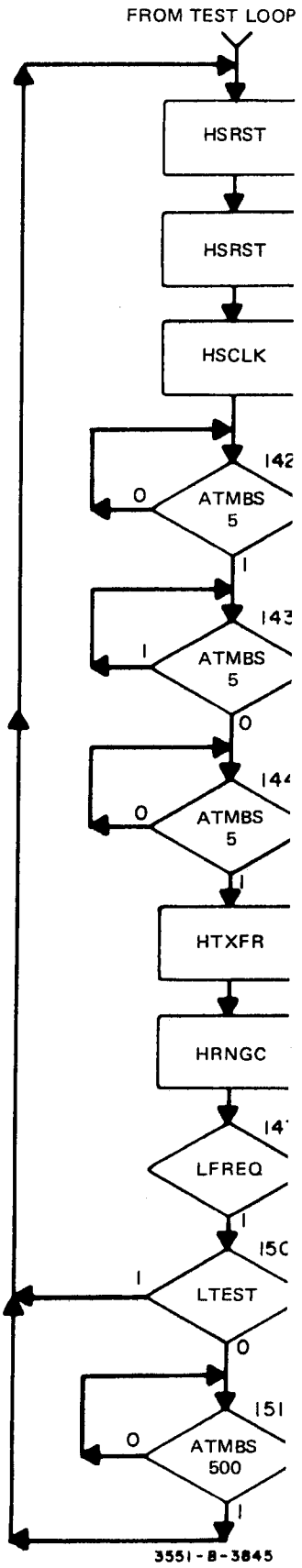


This verifies proper operation of the Range Select Block A3U306.

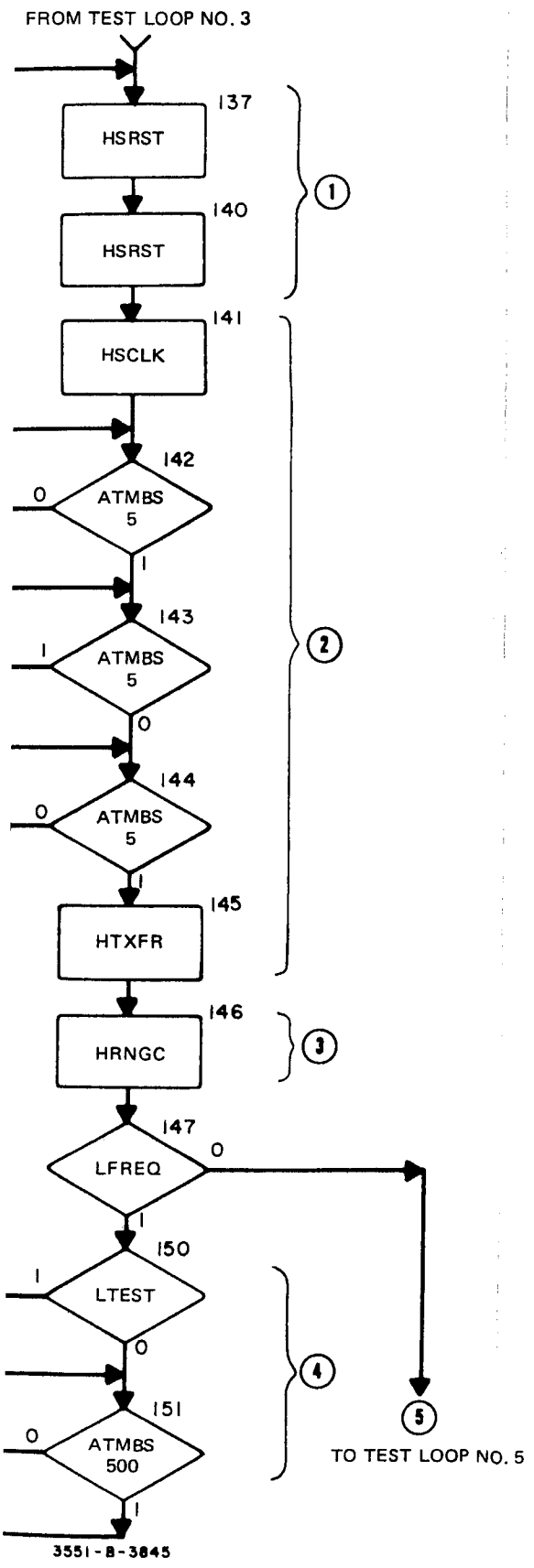
c. Connect one channel of a dual channel oscilloscope to A1TP14 (HCAPD). The oscilloscope indication should be a square wave. Connect the other channel of the oscilloscope to A1TP17. The oscilloscope indication should be the charge and discharge pattern of A1C516. Verify the charge of A1C516 occurs while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



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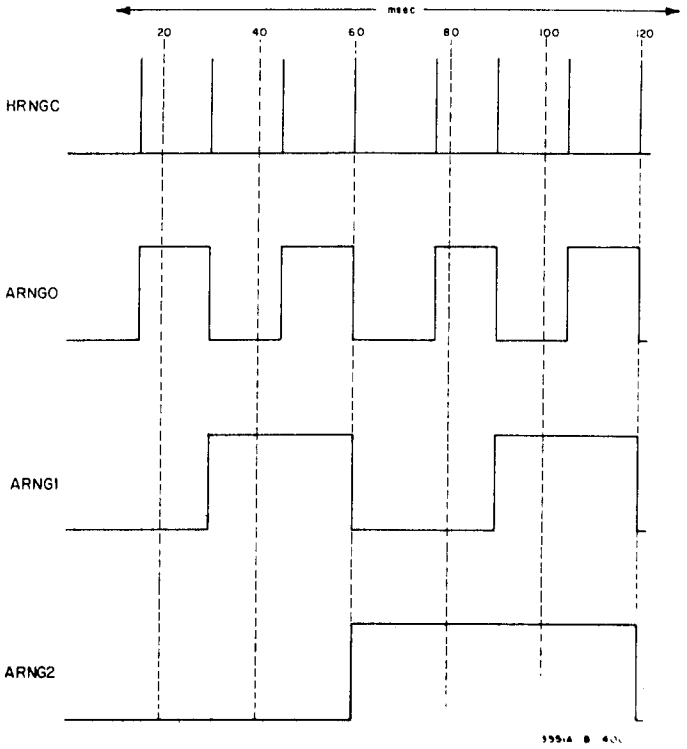


Figure 7-10. Test Loop Number 4.
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(1) Logger capacitor charge sequence.

(2) Reset counter in Data Accumulator.

(3) Wait loop for counter in Data Accumulator
for level measurements, wait period = 0 ms.
for noise measurements, wait period = 0 ms.
for noise-to-ground measurements, wait period = 50 ms.
for 3552 noise measurements, wait period = 20 ms.

(4) Check for LXOVR.
Address 014 = overload indication
Address 016 = + 5 dBm to 0 dBm level
Address 020 = 0 dBm to - 5 dBm level
Address 022 = - 5 dBm to - 10 dBm level

(5) Normal path for level measurements.

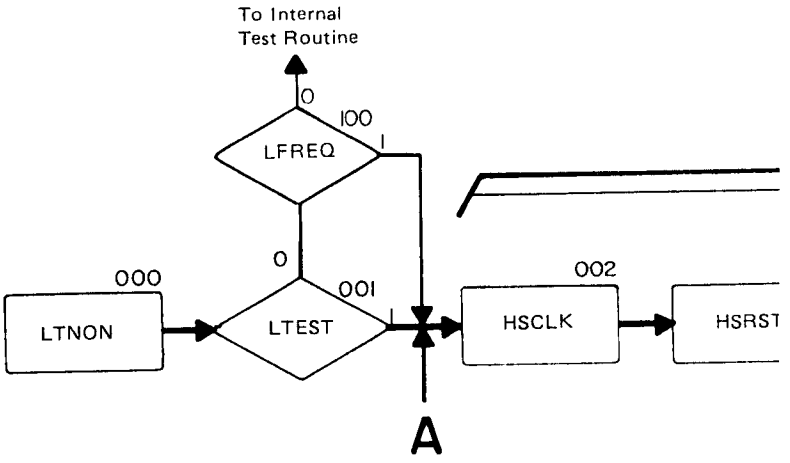
(6) Down-range path for level measurements.

(7) Up-range path for level measurements.

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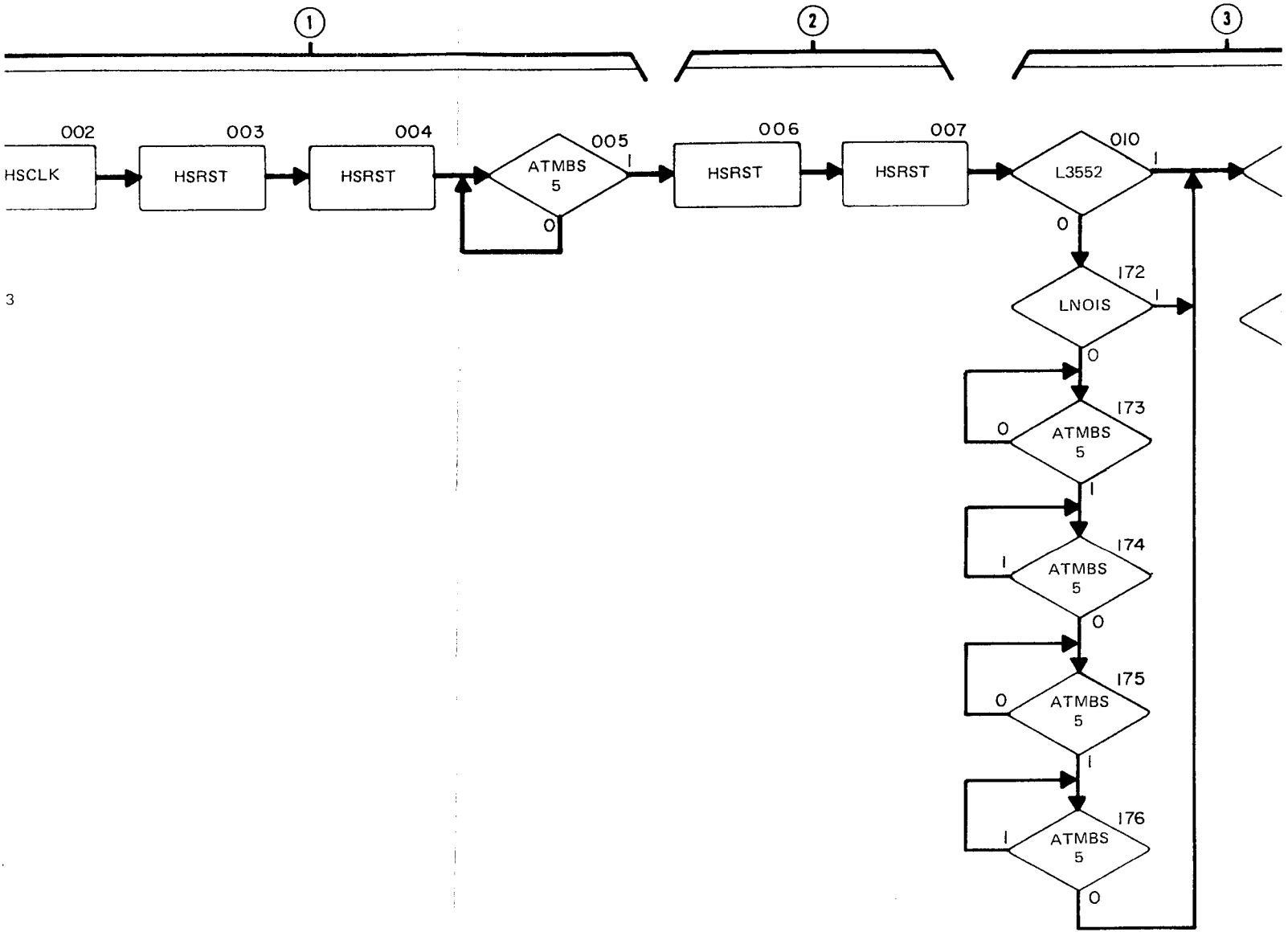
ıs.
ns.
period =

ł = 20 ms.



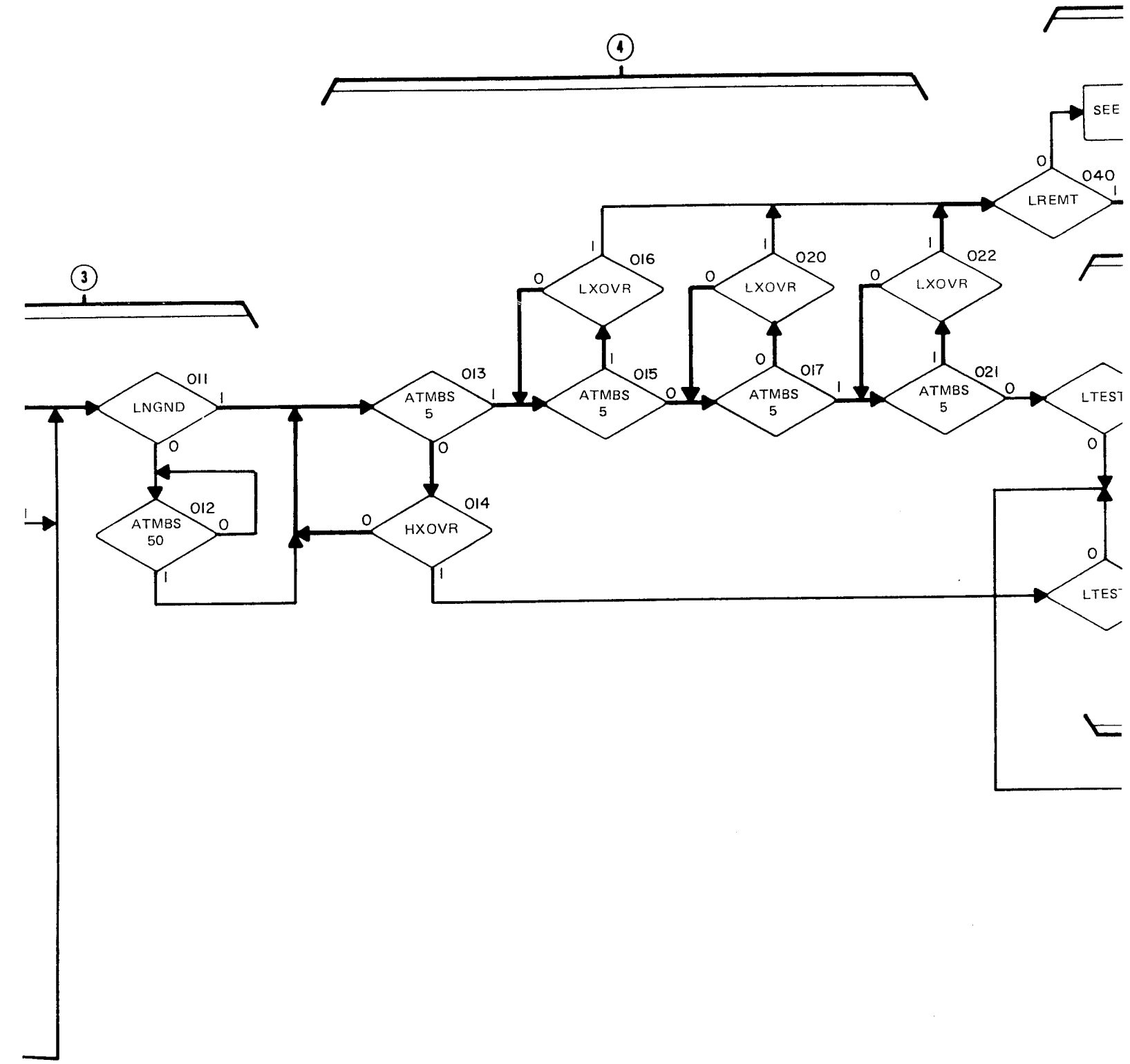
From Figure 7-13

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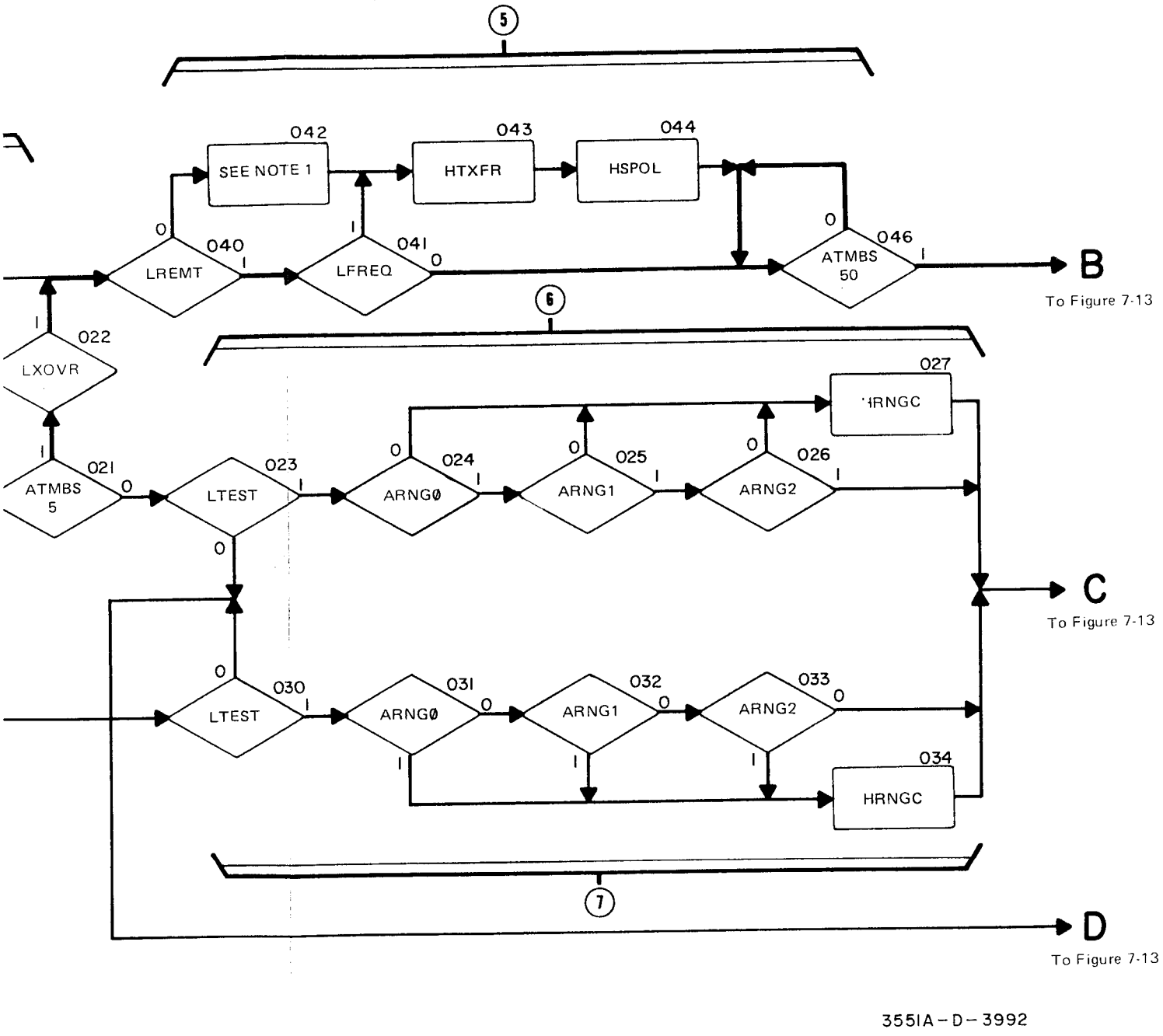


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Figure 7-12. p/o Operational Flow Chart.

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